Empirical Article

Clinical Psychological Science
2018, Vol. 6(1) 63–75

DOI: 10.1177/2167702617730877
www.psychologicalscience.org/CPS

Anticipatory Emotion in Schizophrenia

Erin K. Moran[1] and Ann M. Kring[2]
[1]Department of Psychiatry, Washington University School of Medicine, and [2]Department of Psychology, University of California, Berkeley

Abstract
While people with schizophrenia report experiencing as much emotion in the presence of emotionally evocative stimuli as do people without schizophrenia, evidence suggests that they have deficits in the anticipation of positive emotion. However, little is known about the anticipation of negative emotion in schizophrenia, thus leaving open whether anticipation deficits are more general. We sought to assess anticipation of positive and negative stimuli across multiple methods of measurement. We measured reported experience and emotion-modulated startle response in people with (n = 27) and without (n = 27) schizophrenia as they anticipated and subsequently viewed evocative pictures. People with schizophrenia showed an overall dampened response during the anticipation of positive and negative stimuli, suggesting a more general deficit in anticipatory emotional responses. Moreover, anticipatory responses were related to symptoms and functioning in people with schizophrenia. Together, these findings point to important new directions for understanding emotion deficits in schizophrenia

Keywords
schizophrenia, emotion, startle, blink response, anticipation

Received 8/30/16; Revision accepted 7/20/17

People with schizophrenia (SZ) report experiencing just as much positive emotion as do people without SZ in the presence of positive stimuli (see Cohen & Minor, 2010 and Kring & Moran, 2008 for reviews). While "in the moment" experience of positive emotion may be largely intact, affective science has highlighted the importance of studying the time course of emotion in SZ, including the anticipation and maintenance of emotion (Kring & Elis, 2013; Strauss, 2013). The present study sought to measure anticipatory and in-the-moment responses to both positive and negative stimuli in people with and without SZ using a multimethod approach. In addition, we sought to examine whether anticipatory emotional responses were related to clinical symptoms and functioning.

In-the-Moment Experience of Emotion in SZ

In addition to research showing intact in-the-moment emotional experience, many studies find that people with SZ exhibit comparable neural and physiological responses in the presence of evocative stimuli compared to people without SZ (e.g., Hempel, Tulen, van Beveren, Mulderm, & Hengeveld, 2007; Hempel et al., 2005; Kring & Neale, 1996; Ursu et al., 2011; Volz, Hamm, Kirsch, & Rey, 2003; Williams et al., 2004). Why, then, is it that SZ has long been associated with anhedonia, which is defined as the diminished experience of pleasure? One explanation comes from trait-level reports of pleasure, which are demonstrably lower for people with SZ compared to people without SZ (Horan, Kring, & Blanchard, 2005). Trait-level measures require people to report on feelings that are not necessarily occurring in the moment but rather have occurred in the past or might occur in the future (Kring & Elis, 2013; Strauss, 2013). A related explanation for anhedonia in SZ holds that the anhedonic deficit is found in anticipation, not in the current experience of positive emotion (Kring & Caponigro, 2010).

Corresponding Author:
Erin K. Moran, Washington University School of Medicine, St. Louis–Psychiatry, Campus Box 1125, 1 Brookings Hall, St. Louis, MO 63130
E-mail: ekmoran@wustl.edu

Anticipation in SZ

Informed by research in affective neuroscience and social psychology, we have developed a time-course model of anticipatory emotion (Kring & Caponigro, 2010; Kring & Elis, 2013; Painter & Kring, 2016) that comprises interrelated processes, including retrospection and memory, prospection (i.e., simulating mental representations of what the future may look like), current emotion experience, and predicted emotion experience (i.e., predicting how good or bad one will feel when the future event actually happens; Gilbert & Wilson, 2007; Kring & Caponigro, 2010; Lowenstein, Weber, Hsee, & Welch, 2001; Schacter & Addis, 2007). Current experience for future positive events can guide motivated behavior, while current experience for future negative events can signal the need to prepare for (and possibly avoid) aversive events (e.g., Carver & White, 1994; Miloyan & Suddendorf, 2015; Schultz, 2002).

Accumulated evidence suggests that people with SZ have difficulties in anticipatory positive emotion or pleasure; fewer studies have assessed anticipatory negative emotion. Gard, Kring, Gard, Horan, and Green (2007) assessed the prediction of future pleasure in daily life and found that although people with and without SZ reported comparable in-the-moment enjoyment experience, people with SZ predicted less enjoyment from future-goal-directed activities compared to CTL (healthy control group) participants. Trémeau and colleagues (2010) found no differences between SZ and CTL participants in their predicted enjoyment for positively valenced pictures and sounds. However, participants were asked to predict how they would feel before seeing an entire set of 48 stimuli. Moreover, participants were asked to make this single prediction using an item ranging from unpleasant to pleasant, rather than asking about each valence separately. Thus, the study was unable to parse apart anticipated emotional responses to stimuli of differing valences. Further, it is difficult to draw conclusions about anticipatory responses from just one rating for an entire set of stimuli.

Most studies assessing anticipatory pleasure in SZ have used a self-report measure of anticipation experience to mostly sensory events (temporal experience of pleasure scale, or TEPS; Gard, Gard, Kring, & John, 2006). Deficits in trait anticipatory pleasure (i.e., generally experiencing less pleasure while anticipating future events) have been found in diverse samples, including people with chronic SZ (Gard et al., 2007; Kring, Siegel, & Barrett, 2014; Wynn, Horan, Kring, Simons, & Green, 2010), people with SZ from other countries and cultures (Chan et al., 2010; Favrod, Ernst, Giuliana, & Bonsack, 2009), people early in the course of SZ (Mote, Minzenberg, Carter, & Kring, 2014), and people at clinical high risk for SZ (Schlosser et al., 2014). Buck and Lysaker (2013) found that lower TEPS anticipatory pleasure predicted worse interpersonal functioning 6 months later. Importantly, not all studies find deficits in anticipatory pleasure using the TEPS (e.g., Strauss, Wilbur, Warren, August, & Gold, 2011), and though certainly useful, the TEPS assesses just one domain of anticipatory pleasure (reported experience while anticipating future sensory events).

To our knowledge, only two studies have investigated the prediction of negative emotion in SZ, and no studies have assessed current emotion experience while anticipating negative events. Yet it remains important to understand if anticipatory deficits in SZ are specific to positive emotion or are more broadly observed across valence. For example, work in anxiety disorders suggests a possible dissociation between positive and negative anticipatory responses such that various anxiety disorders show heightened negative emotion during the anticipation of future negative events but not during anticipation of positive events (e.g., MacLeod & Byrne, 1996).

In one study (Brenner & Ben-Zeev, 2014), people with SZ overestimated how negative they would feel compared to how they felt at the time of various daily life events. In a second study (Engel et al., 2016), people with and without SZ were assigned to either an inclusion or exclusion condition in a computer game and were asked to predict their pleasure, again using only one item, prior to playing the game. People with SZ in the exclusion condition did not differ from controls in predicted pleasure; however, people with SZ in the inclusion condition predicted less pleasure than controls.

In the current study, we assessed the experience of emotion *while anticipating* future positive and negative stimuli using self-report and psychophysiological measures of anticipation. Although heightened anticipation of negative emotion has been observed in other clinical disorders, including anxiety (e.g., social phobia, Davidson, Marshall, Tomarken, & Henriques, 2000; panic disorder, Grillon, 2008; posttraumatic stress disorder, Grillon et al., 2009) and depression (e.g., Abler, Erk, Herwig, & Walter, 2007; MacLeod & Rutherford, 1998), it has not been well studied in SZ. It may be that, given that people with SZ report elevated trait negative affect (Blanchard, Horan, & Brown, 2001), they may experience greater negative emotion during anticipation, as do people with anxiety disorders, which, instead of propelling a person toward action, may foster avoidance. This avoidance may in turn be linked with functional and motivation impairments in SZ. However, given known deficits in anticipatory positive emotion,

it could also be that people with SZ demonstrate an overall dampening of anticipation such that they do not distinguish anticipation of emotional events from each other or from nonemotional events. This would suggest that anticipatory deficits are not specific to positive emotion but rather represent a more widespread difficulty in anticipating future experiences.

Studying Anticipation

One method well suited to studying anticipation is the startle eyeblink modulation (SEM) paradigm (e.g., Bradley, Lang, & Cuthbert, 1993). In this paradigm, the eyeblink component of the startle reflex in reaction to an abrupt stimulus (e.g., a burst of white noise) is measured during presentation of evocative stimuli. The eyeblink response varies by valence such that the magnitude of the blink is potentiated when a person is experiencing negative emotion and attenuated when a person is experiencing positive emotion. In other words, a linear pattern of blink response is typically observed with responses to positive stimuli being smaller than responses to neutral stimuli, which are smaller than responses to negative stimuli (e.g., Dichter, Tomarken, Shelton, & Sutton, 2004; Lang, 1994, 1995; Sabatinelli, Bradley, & Lang, 2001). SEM studies in SZ have all found that people with SZ exhibit the same linear pattern of blink modulation as do people without SZ while viewing evocative stimuli (Curtis, Lebow, Lake, Katsanis, & Iacono, 1999; Kring, Germans Gard, & Gard, 2011; Schlenker, Cohen, & Hopmann, 1995; Volz et al., 2003; Yee et al., 2010).

Although no study has yet assessed anticipation in SZ using SEM, a handful of studies have used SEM to assess anticipatory emotion in other populations (e.g., Grillon, Ameli, Woods, Merikangas, & Davis, 1991; Lipp et al., 2001; Moran, Mehta, & Kring, 2012; Nitschke et al., 2002; Sabatinelli et al., 2001; Skolnick & Davidson, 2002). For example, Sabatinelli and colleagues (2001) found that startle response during anticipation was modulated by emotion valence, such that the startle response was larger during the anticipation of positive and negative pictures than to neutral. In contrast, participants showed the expected linear response while viewing valenced stimuli. Nitschke and colleagues (2002) reported similar results when looking at the anticipatory period. Startle in response to anticipatory cues showed a curvilinear effect wherein positive and negative anticipatory cues elicited larger startle responses relative to neutral cues. These findings suggest that anticipatory startle responses are sensitive to arousal rather than valence. That is, positive and negative cues are likely more arousing than neutral cues, and the magnitude of startle responses is equally large to positive and negative cues. This pattern of responses suggests that anticipatory blink responses may be sensitive to emotional arousal rather than valence.

Present Investigation

We first sought to replicate prior findings of intact in-the-moment emotional responses, and we predicted that people with and without SZ would report comparable emotion experience (valence and arousal) in response to evocative pictures. We also predicted that people with and without SZ would show a linear pattern of blink responses (i.e., blink response smallest to positive pictures, followed by neutral, and negative pictures).

Second, we tested several hypotheses about anticipation in SZ, expecting that people with SZ would differ from people without SZ in both self-report and blink response. For reported emotional experience in SZ, we tested competing hypotheses. Given evidence that people with SZ experience elevated trait negative affect (Cohen & Minor, 2010), people with SZ may report greater anticipated experience for negative but not positive and neutral stimuli compared to controls. By contrast, given evidence for dampened anticipatory positive emotion (Kring & Elis, 2013), the SZ group's anticipated experience may not vary by picture type but instead be similar regardless of the evocative cue (i.e., positive = neutral = negative). That is, anticipated experience in SZ might be dampened overall compared to controls, rather than just in anticipation of positive emotion. Based on past research with healthy people, we predicted that the CTL group's anticipated experience would vary by cue valence.

For anticipatory blink response, we also tested competing hypotheses for the SZ group (elevated responding for negative stimuli vs. overall dampened responding). That is, we tested whether people with SZ would show greater blink responses to negative stimuli compared to CTLs versus whether people with SZ would show no valence-modulated blink responses during the anticipation of emotionally evocative stimuli (i.e., positive = neutral = negative). For controls, we predicted that CTLs would show a quadratic blink response during anticipation such that blink responses during the anticipation of positive and negative pictures would be larger than blink responses during anticipation of neutral pictures, a pattern consistent with prior literature (e.g., Sabatinelli et al., 2001).

Finally, we examined the relationship between emotional responses (reported emotion experience and blink response), clinical symptoms, and functioning.

Method

Participants

Participants included 32 people with SZ (n = 25) or schizoaffective disorder (n = 7; not in a current mood episode) and 33 healthy controls.[1] Four participants (2 SZ; 2 CTL) were excluded due to equipment failure, and 7 participants (3 SZ; 4 CTL) were excluded due to a lack of blink response in more than half of trials, consistent with recommendations for use of blink response data (Blumenthal et al., 2005). The final sample included 27 in the SZ group and 27 in the CTL group. People with SZ were recruited from outpatient treatment and local board and care facilities. Healthy control participants were recruited via community fliers or online advertisement. Exclusion criteria for both groups included a history of head trauma, substance dependence or abuse within the last 6 months, current episode of major depression or mania, or an IQ less than 70 as measured by the Wechsler Test of Adult Reading (WTAR; Wechsler, 2001). In addition, control participants were excluded if they had a family history of SZ or bipolar disorder, if they had one or more episodes of mania, or if they had more than two lifetime episodes of depression.

Measures

Clinical assessments. Diagnoses were confirmed using the Structured Clinical Interview for *DSM–IV* Axis I disorders (SCID; First, Gibbon, Spitzer, & Williams, 1996), and the absence of diagnoses for the control group was confirmed using the SCID non-patient version (SCID-I/NP; First, Spitzer, Gibbon, & Williams, 2002). Participants in the SZ group were interviewed for general psychiatric symptoms using the Brief Psychiatric Rating Scale (BPRS) rated on a 7-point scale from 1 (*not present*) to 7 (*extremely severe*) (Lukoff, Nuechterlein, & Ventura, 1986). Negative symptoms were assessed using the Clinical Assessment Interview for Negative Symptoms (CAINS; Kring, Gur, Blanchard, Horan, & Reise, 2013), scored with motivation and pleasure (MAP) and emotional expressiveness (EXP) scales. The Role Functioning Scale (RFS; Goodman, Sewell, Cooley, & Leavitt, 1993) assessed current functioning.

Stimuli

Sixty-five pictures (20 positive, 20 neutral, and 20 negative and 5 practice) were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005). Pictures were selected based on published rating norms (Lang et al., 2005) such that mean arousal ratings for positive and negative pictures were comparable (mean = 6.46 and 6.50, respectively). Neutral pictures (e.g., household items) were selected based on normative valence ratings, placing them midway between positive and negative pictures. As is typically done in studies utilizing IAPS pictures, men and women (e.g., Dichter et al., 2004) were shown the same set of pictures except for a selection of positive pictures that were selected to ensure comparable normative ratings of arousal and valence.[2] Analyses were conducted with and without sex-specific pictures, and results remained the same.

Procedure

After obtaining informed consent, participants completed the clinical assessments. Participants then completed (a) a startle task where blink responses were assessed along with anticipatory experience and (b) an experience task where in-the-moment experience of emotion was assessed. Both tasks took place in a dimly lit and quiet laboratory room.

Startle task. The startle task was designed to assess emotional experience and blink response during the *anticipation* of evocative pictures as well as blink responses during the *viewing* of evocative pictures. Participants were positioned in a comfortable chair approximately .5 meters from a 36-cm LCD laptop computer screen. Experimenters prepared the skin, placed electrodes for recording blink responses, and checked impedance (Berg & Balaban, 1999). Participants wore headphones and were told that they would hear periodic noises but that they could ignore the noises. Participants were told that a series of cues and pictures would be presented on the computer screen and that cues indicated the valence (plus sign, +, for positive; minus sign, –, for negative; and a circle, O, for neutral) of the pictures that were subsequently presented. Participants were then asked to rate how they felt while anticipating the upcoming picture ("how do you feel right now while anticipating the upcoming picture") using the Self-Assessment Manikin (SAM; Levenston, Patrick, Bradley, & Lang, 2000), a nonverbal pictorial assessment technique that assesses valence and arousal on 9-point scales from "unhappy" to "happy" and from "calm" to "aroused." Participants completed five practice trials with three of those trials containing a startle probe.

Participants then completed the startle task consisting of 60 trials. Each trial began with a blank screen followed by a 0.5-s cue (+, –, or O), followed by a 4-s blank screen anticipation period during which participants anticipated the upcoming picture. Participants then made the two anticipatory experience ratings on

the computer. Pictures were then displayed for 6 s followed by a jittered intertrial interval (ITI: 5–7 s).

Startle probes were pseudo-randomly ordered and presented during either the anticipatory period (7 during each of the positive, neural, and negative conditions; 2,500 ms after the anticipatory cue and prior to picture onset), during picture presentation (7 during each of the positive, neural, and negative conditions; 3,500 ms after picture onset), or during the ITI (n = 8; 3,000 ms after picture offset). Unprobed trials (n = 10) were included to minimize predictability. No more than one startle probe was presented during a trial, and no more than two pictures of the same valence were presented sequentially. Three picture orders were used to allow assessment of order effects; there were none.

Experience task. Following the startle task, participants were shown the same 60 IAPS pictures and asked to rate their emotional experience (valence and arousal) while viewing the pictures using the same 9-point scales on the SAM. Pictures were displayed for 6 s followed by a 2- to 3-s ITI. Pictures were ordered such that no more than 2 of a similar valence were shown in sequence. We used three picture orders to assess order effects, and again, there were none. Stimulus presentation and timing for the task was controlled by E-prime software (Psychology Software Tools Inc., Pittsburgh, PA).

Blink response recording and data reduction

Electrode placement and skin preparation followed guidelines for human startle research (Blumenthal et al., 2005). Electromyography (EMG) electrodes were filled with electrolyte gel and placed in the orbicularis oculi region, one directly below the pupil of the left eye and one lateral to this. A third electrode was placed in the middle of the forehead as a grounding electrode. Impedances were kept below 15 kOhm. Acoustic startle probes were digitally generated .WAV files of a 50-ms burst of white noise with instantaneous rise time. Startle probes were amplified to 105 dB by a Radio Shack SA-155 Integrated Stereo Mini-Amplifier and binaurally presented through Sennheiser HD 490 headphones. Picture presentation and probes were controlled by VPM software (Cook, Atkinson, & Lang, 1987).

The EMG signal was filtered using a 13–1,000-Hz passband and amplified using a Coulbourn V75-04 Isolated Bioamplifier with Bandpass Filter. EMG was sampled at 1,000 Hz for 350 ms, starting 50 ms prior to probe onset and ending 300 ms after probe onset. The signal was digitally refiltered offline with a 28–500-Hz passband (Van Boxtel, Boelhouwer, & Bos, 1998) and digitally rectified and integrated using a 30-ms time constant.

Raters visually confirmed and scored the EMG data segments using blink scoring software. Blinks were only scored if they fell 20 ms to 150 ms after probe onset. Intraclass correlations (ICCs) for agreement between raters was high (ICC = .94). Following the current recommendations for startle research (Blumenthal et al., 2005), blink data were standardized within each person to produce a metric of responsivity (T scores) comparable across participants. Specifically, each person's blink magnitudes were converted to T scores (mean = 50; SD = 10). Mean blink magnitudes for valence (positive, neutral, negative) and time (anticipatory, in the moment) were computed. The average number of valid startle trials did not differ between conditions or groups (ps < .34)

Data analytic plan

Repeated-measures multivariate analyses of variance (MANOVA) were used for the analyses. All results were examined for quadratic and linear effects. Greenhouse-Geisser corrections were used when appropriate. Partial correlations controlling for age and sex were conducted to examine relationships between emotion variables, symptoms, and functional outcomes.[3] When applicable, follow-up pairwise comparisons and computation of correlations were conducted using Bonferroni corrections. Effect sizes are reported as partial Eta squared (η_p^2).

Results

As shown in Table 1, the groups did not differ on any demographic variable. Although we did not pose hypotheses about sex differences, we included sex as a between-subjects variable in preliminary analyses. We found no interactions between group and sex; thus, we collapsed across sex[4] for the reported analyses.

In-the-moment responses

We conducted three separate 2 (Group: SZ, CTL) × 3 (Valence: Positive, Neutral, Negative) MANOVAs for reported valence, reported arousal, and blink response.

Valence. As predicted and shown in Table 2 and Figure 1c, neither the group main effect nor the Group × Valence interaction were significant (ps > .19). We found a significant valence main effect, $F(1, 52) = 126.79$, $p < .001$, $\eta_p^2 = .71$, and posthoc pairwise comparisons revealed that each pair of valence conditions was significantly different from one another (ps < .001). Thus, consistent with our predictions, all participants reported feeling most pleasant after seeing positive pictures followed by neutral and negative pictures.

Table 1. Demographic and Clinical Participant Characteristics

	SZ (n = 27)	CTL (n = 27)	Statistic
Age, mean (*SD*), in years	46.69 (10.73)	46.22 (11.23)	t = .16
Gender (male: female)	(14:13)	(12:15)	χ^2 = .30
Ethnicity, n			χ^2 = 2.57
White	17	15	
African American	4	5	
Asian	4	4	
American Indian	1	0	
Multiethnic	0	1	
Latino	1	2	
Education, mean (*SD*), years	14.58 (2.49)	15.61 (2.31)	t = 1.57
WTAR	105.85 (11.27)	105.30 (10.93)	t = .18
Antipsychotic medication (n)			
Typical	4		
Atypical	19		
Both	2		
None	2		
BPRS			
Total Score	43.19 (11.21)		
Positive Symptoms	10.96 (5.17)		
Negative Symptoms	7.81 (2.45)		
CAINS			
MAP	14.96 (5.81)		
EXP	5.50 (3.64)		
RFS (n = 21)	4.64 (1.01)		

Note: BPRS = Brief Psychiatric Rating Scale; CAINS EXP = Expression Subscale; CAINS MAP = Motivation and Pleasure Subscale of the Clinical Assessment Interview for Negative Symptoms; CTL = Healthy control group; RFS = Role Functioning Scale; SZ = Schizophrenia group; WTAR = Wechsler Test of Adult Reading.

Arousal. We found a significant group main effect, $F(1, 52) = 7.27$, $p < .01$, $\eta_p^2 = .12$, wherein people with SZ reported experiencing more arousal than CTLs in response to all pictures. We also found a significant valence main effect, $F(1, 52) = 29.66$, $p < .001$, $\eta_p^2 = .36$, and follow-up tests indicated that all participants reported experiencing greater arousal while viewing positive and negative pictures compared to neutral (ps < .01).

Blink responses. As hypothesized and consistent with prior studies, we did not find a significant group main effect or Group × Valence interaction (ps > .15) for blink responses during picture viewing. We found a significant valence main effect, $F(1, 52) = 51.42$, $p < .001$, $\eta_p^2 = .50$, and posthoc pairwise comparisons revealed that each pair of valence conditions was significantly different from one another (ps < .007), confirming that blink magnitude while viewing

Table 2. Reports of Experienced Emotion in Response to Evocative Pictures

	Valence		Arousal	
	SZ	CTL	SZ	CTL
In the moment				
Positive pictures	5.99 (1.38)	6.44 (1.31)	5.50 (1.98)	4.47 (2.57)
Neutral pictures	4.63 (1.10)	4.91 (1.08)	3.74 (1.67)	2.81 (1.89)
Negative pictures	2.97 (1.46)	2.82 (1.37)	4.73 (2.01)	3.24 (1.92)
Anticipation				
Positive cue	5.40 (1.32)	6.32 (1.26)	5.31 (1.78)	4.31 (2.40)
Neutral cue	5.09 (1.19)	5.08 (1.18)	4.84 (1.39)	3.38 (1.93)
Negative cue	5.21 (1.16)	3.90 (1.17)	4.44 (1.69)	3.33 (1.71)

Note: Values are means with standard deviations in parentheses. Scores range from 1 to 9; lower values indicate more unpleasantness, and higher values indicate more pleasantness.

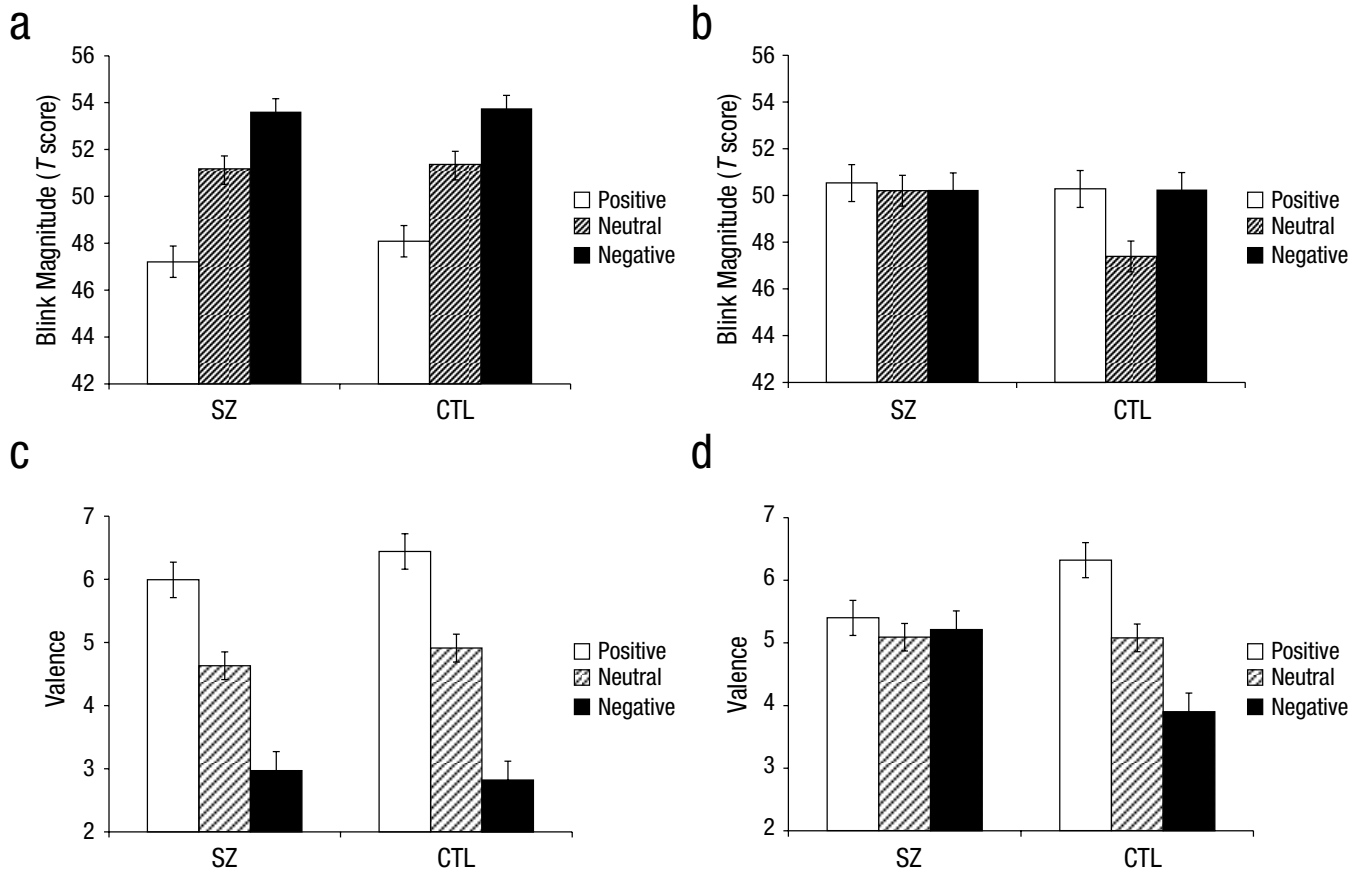

Fig. 1. (a) Mean blink magnitudes during picture presentation. (b) The mean startle responses during anticipation in individuals with SZ and controls. (c) Mean valence ratings during picture presentation in individuals with SZ and controls. Note that higher values indicate more pleasant experience. (d) Mean valence ratings during anticipation in individuals with SZ and controls. Note higher values indicate more pleasant experience.

positive pictures was smallest, followed by neutral, followed by viewing negative pictures (see Fig. 1a).

Anticipatory responses

We conducted three separate 2 (Group: SZ, CTL) × 3 (Valence: Positive, Neutral, Negative) MANOVAs for reported valence, reported arousal, and blink responses during anticipation.

Valence. We found a significant valence main effect, $F(1, 52) = 50.41$, $p < .001$, $\eta_p^2 = .49$, and follow-up comparisons indicated that all participants reported feeling most pleasant when anticipating positive pictures followed by neutral and negative pictures (ps < .001). However, this was qualified by a significant Group × Valence interaction, $F(1, 52) = 4.24$, $p < .05$, $\eta_p^2 = .08$. For controls, all pairwise comparisons were significant such that controls felt most pleasant anticipating positive pictures (see Fig. 1d), followed by neutral and negative pictures (ps < .001). Consistent with the dampening hypothesis, people with SZ reported feeling as pleasant while anticipating positive compared to neutral ($p < .07$) and negative pictures ($p < .23$).

Arousal. For anticipatory arousal, we found a significant valence main effect, $F(1, 52) = 8.59$, $p < .01$, $\eta_p^2 = .14$, indicating that all participants reported experiencing more arousal while anticipating positive and negative pictures relative to neutral (ps < .01). We also found a significant group main effect, $F(1, 52) = 8.34$, $p < .01$, $\eta_p^2 = .14$, indicating that people with SZ reported more arousal during anticipation compared to CTLs. No other effects were significant.

Blink responses. For blink responses during anticipation, we found a significant valence main effect, $F(1, 50) = 8.09$, $p < .01$, $\eta_p^2 = .14$, but this was qualified by a significant Group × Valence interaction, $F(1, 52) = 6.29$, $p < .05$, $\eta_p^2 = .11$. Post hoc within-group comparisons (see Fig. 1b) revealed, consistent with our dampening hypothesis, a lack of valence modulation in the SZ group (ps > .73). In contrast, the CTL groups' blink responses were larger during the

Table 3. Symptom and Functioning Correlates of Emotion Responses in SZ

		BPRS Pos	MAP	EXP	RFS
Anticipatory valence					
	Positive anticipation valence	–.41*	–.42*	–.29	.53*
	Negative anticipation valence	.29	.46*	.07	–.30
Anticipatory arousal					
	Positive anticipation arousal	–.13	–.29	–.27	.56*
	Negative anticipation arousal	.19	.07	–.24	.06
Anticipatory blink responses					
	Positive anticipation blink	–.09	–.38^	–.09	.51*
	Negative anticipation blink	.11	–.21	–.06	.18
In-the-moment valence					
	Positive picture valence	–.21	–.20	–.37	.19
	Negative picture valence	.08	.38^	.48*	–.35
In-the-moment arousal					
	Positive picture arousal	.10	–.14	–.28	.59*
	Negative picture arousal	.12	–.27	–.33	–.08
In-the-moment blink responses					
	Positive picture blink	–.08	.20	.01	–.28
	Negative picture blink	.16	.20	–.13	.18

Note: BPRS Pos = BPRS Positive Symptom Score; EXP = CAINS Expression Scale; MAP = CAINS Motivation and Pleasure Scale; RFS = Role Functioning Scale. Bonferroni corrections accounted for 48 comparisons.
*$p < .05$. ^$p = .06$, did not survive Bonferroni correction.

anticipation of positive and negative pictures than during anticipation of neutral ($ps < .005$), while blink responses in anticipation of positive and negative pictures were not significantly different from each other ($p = .98$).

Emotion response correlates in SZ

As shown in Table 3, following Bonferroni correction, we found that greater experienced pleasantness in anticipation of positive pictures was associated with *fewer* motivation and pleasure negative symptoms and that greater experienced unpleasantness in anticipation of negative pictures was associated with *more* motivation and pleasure negative symptoms. In addition, greater experienced pleasantness and arousal and larger blink responses during anticipation of positive pictures was associated with higher levels of functioning as measured by the RFS. We also found that greater experienced unpleasantness was associated with fewer expression negative symptoms. Stated differently, the "expected" response (i.e., greater unpleasantness to negative stimuli) was associated with fewer expression negative symptoms in those with SZ. These associations held when controlling for age and sex.

Discussion

The present study replicates and extends previous research on emotion in SZ by investigating anticipation of positive, negative, and neutral stimuli in people with and without SZ using multiple methods of measurement. Consistent with prior research, we found that in-the-moment emotional responses were intact. However, people with SZ exhibited deficits during anticipation, and these deficits extended beyond just positive stimuli. Indeed, our findings suggest that anticipatory deficits in SZ extend to negative stimuli, suggesting an overall dampening of anticipatory emotion. Moreover, emotional responses during anticipation were linked to negative symptoms and real-world functioning, highlighting the significance of anticipation in SZ.

Consistent with our hypotheses and previous research, people with SZ did not differ from controls in reported valence experience and blink response in the presence of emotionally evocative pictures (e.g., Curtis et al., 1999; Kring et al., 2011; Volz et al., 2003; Yee et al., 2010). The present study provides further evidence demonstrating that, regardless of whether measuring reported emotional experience or a physiological measure such as the emotion-modulated blink response, people with SZ have intact emotion responses in the presence of evocative stimuli.

We also found that the SZ group reported experiencing more arousal while viewing (and anticipating) pictures compared to the CTL group, consistent with some prior studies (e.g., Anticevic, Repovs, & Barch, 2011; Tremeau et al., 2009; Yee et al., 2010) but not all (e.g., Burbridge & Barch, 2007; Herbener, Song, Khine, & Sweeney, 2008; Kring et al., 2011). In their meta-analysis, Llerena, Strauss, and Cohen (2012) reported that the wording used to assess arousal (i.e., scale of calm to

excited vs. low to high) and stimuli type (e.g., IAPS pictures vs. words) were important moderators. By utilizing a variety of stimuli and methods of assessing arousal, future studies will be better able to clarify these discrepant results.

Our findings extend previous research by assessing emotional responses during the anticipation of positive, negative, and neutral pictures. Consistent with our dampening hypothesis, we found that people with SZ failed to show valence-modulated blink responses in anticipation of evocative pictures. This extends prior work on anticipatory deficits in SZ by showing that anticipatory deficits are not confined solely to positive events but rather are dampened overall. While not a measure of anticipation per se, Heerey and Gold (2007) found that people with SZ demonstrated less valence modulation than controls in "wanting" (indexed by button presses) following the offset of positive, neutral, and negative pictures, indicating that when the evocative stimuli were not on screen, people with SZ did not exhibit as much valence differentiation as controls in their behavior to indicate that they would like to view particular pictures again. It may be that deficits in anticipation and wanting relate to a deficit in ability to recall, represent, generate, or maintain emotional experiences in the absence of explicit stimuli and this results in diminished valence modulation. Indeed, Heerey and Gold (2007) found that better working memory performance was related to more differentiated wanting behavior, thus suggesting that ability to maintain that emotional experience within working memory and using it to guide future behaviors is likely an important aspect in wanting and anticipation.

In our study, the cues (plus or minus signs) used to indicate an upcoming emotional picture may not have been potent enough to evoke a representation of something positive or negative which would in turn elicit anticipatory emotional responses. Future studies could investigate this further by providing additional information during anticipation (e.g., a word, different type of picture) to investigate whether anticipatory responses vary depending upon the level of detail provided by the cues. Other studies have shown, however, that evocative pictures may not be potent enough to facilitate the maintenance of a response in service of goal-directed behavior (Heerey & Gold, 2007; Kring et al., 2011).

Diminished emotion modulation during anticipation may also reflect a type of context insensitivity. In other words, people with SZ did not vary their responses according to changes in context (i.e., the cues signaling forthcoming pictures) and instead showed similar blink responses regardless of whether they were anticipating positive, neutral, or negative pictures. Sensitivity to emotional context has been hypothesized as a critical aspect of emotional life that is associated with adaptive adjustments to changing environments (e.g., Keltner & Gross, 1999), psychological adjustment (Bonanno & Burton, 2013; Coifman & Bonanno, 2010), and mental health (Rottenberg, Gross, & Gotlib, 2005). Indeed, emotion context insensitivity has been observed in those with major depression (see Bylsma, Morris, & Rottenberg, 2008 for review) and those reporting symptoms of depression (e.g., Moran et al., 2012) and is linked to functioning and symptoms longitudinally (e.g., Coifman & Bonanno, 2010; Rottenberg, Kasch, Gross, & Gotlib, 2002).

We also found that diminished emotion modulation during anticipation in SZ is related to negative symptoms and impairments in functioning. Reduced experienced pleasantness while anticipating positive pictures was related to greater motivation and pleasure negative symptoms as assessed by the CAINS. Importantly, the CAINS MAP scale includes items assessing anticipatory pleasure, something that is rare among negative symptom rating scales. Practically speaking, if a person does not feel pleasant while anticipating future positive events, they may be less likely to pursue those events, thus engaging in fewer positive events (Miloyan & Suddendorf, 2015). Experienced emotion and blink responses during anticipation of positive pictures were also associated with real-world functioning, suggesting that anticipatory pleasure deficits may be related to goal-directed behaviors such as getting a job, taking care of the home, and making and maintaining social relationships. Although in need of replication, these findings suggest that the anticipation of positive emotion is an important marker of impairment in SZ and is linked to motivational impairments and real-life functioning.

Our findings suggest that anticipation of negative emotion is an important aspect of the time course of emotion. To our knowledge, only two other studies have assessed anticipation (prediction) of negative emotional events in SZ. While the anticipation of negative emotional events may serve to alert us to threat and motivate us to action, there is a point where too much anticipatory unpleasantness is impairing, as is the case with anxiety (e.g., Nitschke et al., 2009). Although we did not find a group-level difference in experienced unpleasantness while anticipating negative pictures, we found that more unpleasantness experienced while anticipating negative pictures was associated with greater motivation and pleasure negative symptoms. This was not predicted, however, and must be interpreted with caution. It may be that feeling negative while anticipating relates to avoidance toward pursuing goals. For example, feeling negative while anticipating applying for a job may be linked to avoidance of following through, thus contributing to motivational behavior impairments.

Several questions remain about the anticipation of negative emotion in SZ. For example, people with SZ report higher trait negative emotion relative to controls

(Cohen & Minor, 2010); however, we do not know if this extends to trait anticipatory negative emotion. In the present study, we did not find evidence of heightened anticipatory negative emotion, either in self-report or blink responses. However, people with SZ may nevertheless experience greater trait-level anticipatory negative emotion, which may in turn relate to reduced motivation and goal-directed behavior. For example, instead of leading to action, greater trait-level negative anticipatory emotion may lead to avoidance, which can decrease negative emotion in the short term, and in turn reinforce avoidance learning behaviors (e.g., Kim, Shimoko, & O'Doherty, 2006). Future research should investigate the link between trait-level positive and negative anticipation and how these are linked to motivational impairments and functioning to help clarify new targets for treatment.

Taken together, our anticipation findings add to the growing literature suggesting that anticipatory emotion should be included in assessments of emotion deficits in SZ. The findings also suggest that anticipation of positive and negative emotion has clinical significance with its linkage to symptoms. Future research ought to further examine the relationship between anticipatory emotion and daily life functioning. Furthermore, additional research to ascertain whether anticipatory emotion deficits may be mechanisms linked to negative symptoms will help elucidate additional treatment development work. For example, interventions might incorporate skills geared toward increasing positive anticipatory emotion such as identifying and savoring future positive events (Caponigro, Moran, Moskowitz, & Kring, 2013). Another interesting direction for future research will be to directly assess linkages between anticipatory emotion and motivated behavior, including approach-related negative emotions, such as anger.

As with any study, it is important to acknowledge limitations. First, the sample sizes were relatively modest. Second, we used standardized emotional pictures, thus limiting the ability to generalizability of the present findings to daily life. Although we opted to use pictures to evoke positive and negative emotion, other stimuli such as money or personally relevant stimuli may be more emotionally evocative. Future research might utilize a range of stimuli to investigate whether alternate stimuli evoke a different pattern of response in those with and without SZ. Third, people in the SZ group were taking medications, including typical and atypical antipsychotics and antidepressants. It is difficult to understand the impact of medication on emotional responses, though some evidence suggests effects may be minimal (Juckel et al., 2006; Kring & Earnst, 1999). Curtis and colleagues (1999) found that different medication types did not affect blink response in people with SZ, and others have found no significant relationship between antidepressant medications and blink response (Dichter et al., 2004; Dichter & Tomarken, 2008). Finally, the range of emotional experience ratings during anticipation was relatively constrained. It may be that more explicit information about the upcoming evocative stimuli would provide information that could alter anticipation ratings. For example, words indicating valence or even the theme (e.g., puppies, mutilation) of upcoming pictures may elicit a more evocative anticipatory response. By varying the signaling value of anticipatory cues, we can observe the boundaries of anticipatory deficits in SZ.

In summary, we found that people with SZ exhibited dampened anticipatory emotional responses, such that their blink response while anticipating positive and negative pictures was similar to their response while anticipating neutral pictures. Thus, our findings suggest an overall dampening in anticipatory responses in SZ, rather than a deficit in only anticipatory pleasure, which has been the focus of most the work investigating anticipation in SZ. The present study points to the importance of anticipation in SZ, highlighting the link between anticipatory emotional responses, negative symptoms, and functional outcome.

Author Contributions

Both authors developed the study concept and design. E. K. Moran collected and prepared the data. E. K. Moran analyzed and interpreted the findings under the supervision of A. M. Kring. E. K. Moran drafted the manuscript. Both authors approved the final version of the manuscript for submission.

Acknowledgment

Data for this study were collected at University of California, Berkeley.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research was supported in part by National Institute of Mental Health (NIMH) Grant R01-MH082782, and E. K. Moran was supported by NIMH Grant T32-MH089919-01A1 during the writing of the manuscript.

Notes

1. There were no significant differences on any study variable between those diagnosed with SZ and schizoaffective disorder.
2. IAPS Slide Numbers: 1050, 1525, 2190, 2215, 2383, 2440, 2446, 2480, 2570, 2811, 3000, 3051, 3530, 4006m, 4225m, 4310m, 4320m, 4538f, 4542f, 4599, 4656f, 4660, 4670f, 4677f, 4681, 4690m 5120, 5621, 5629, 6243, 6260, 6300, 6370, 6510, 6540, 6571, 7009, 7025, 7034, 7060, 7090, 7110, 7170, 7211, 7224, 7234, 7235, 7700, 8030, 8080, 8179, 8185f, 8186, 8190, 8200, 8400m, 8490, 8496, 8499, 9250, 9410, 9424, 9425, 9611, 9635, 9910. Note: f denotes pictures shown only to women; m denotes pictures shown only to men.

3. The pattern of findings remained the same regardless of whether age and sex were included in the correlational analyses.
4. We observed significant sex main effects for reported anticipatory valence and anticipatory blink responses: All women exhibited less differentiation in blink response and reported valence across pictures than men.

References

Abler, B., Erk, S., Herwig, U., & Walter, H. (2007). Anticipation of aversive stimuli activates extended amygdala in unipolar depression. *Journal of Psychiatry Research*, *41*, 511–522. doi:10.1016/j.jpsychires.2006.07.020.

Anticevic, A., Repovs, G., & Barch, D. M. (2011). Emotion effects on attention, amygdala activation and functional connectivity in schizophrenia. *Schizophrenia Bulletin*, *38*, 967–980. doi:10.1093/schbul/sbq168

Berg, W. K., & Balaban, M. T. (1999). Startle elicitation: Stimulus parameters, recording techniques, and quantification. In A. M. Dawson, A. M. Schell, & A. H. Boehmelt (Eds.), *Startle modification: Implications for neuroscience, cognitive science, and clinical science* (pp. 21–50). New York, NY: Cambridge University Press.

Blanchard, J. L., Horan, W. P., & Brown, S. A. (2001). Diagnostic differences in social anhedonia: A longitudinal study of schizophrenia and major depressive disorder. *Journal of Abnormal Psychology*, *110*(3), 363.

Blumenthal, T. D., Cuthbert, B., Filion, D., Hackley, S., Lipp, O., & Van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, *42*(1), 1–15. doi:10.1111/j.1469-8986.2005.00271.x

Bonanno, G. A., & Burton, C. L. (2013). Regulatory flexibility: An individual differences perspective on coping and emotion regulation. *Perspectives on Psychological Science*, *8*(6), 591–612. doi:10.1177/1745691613504116

Bradley, M. M., Lang, P. J., & Cuthbert, B. N. (1993). Emotion, novelty, and the startle reflex: Habituation in humans. *Behavioral Neuroscience*, *107*(6), 970–980. doi:10.1037//0735-7044.107.6.970

Brenner, C. J., & Ben-Zeev, D. (2014). Affective forecasting in schizophrenia: comparing predictions to real-time Ecological Momentary Assessment (EMA) ratings. *Psychiatric Rehabilitation Journal, 37*, 316–320.

Buck, B., & Lysaker, P. H. (2013). Consummatory and anticipatory anhedonia in schizophrenia: Stability, and associations with emotional distress and social function over six months. *Psychiatry Research*, *205*, 30–35. doi:10.1016/j.psychres.2012.09.008

Burbridge, J. A., & Barch, D. M. (2007). Anhedonia and the experience of emotion in individuals with schizophrenia. *Journal of Abnormal Psychology*, *116*(1), 30–42. doi:10.1037/0021-843X.116.1.30

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review*, *28*, 676–691. doi:10.1016/j.cpr.2007.10.001

Caponigro, J. M., Moran, E. K., Moskowitz, J., & Kring, A. M. (2013). Awareness and coping with emotion in schizophrenia: Acceptability, feasibility, and case illustrations. *Clinical Psychology and Psychotherapy*. doi:10.1002/cpp.1839

Carver, C. S., & Whilte, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment:the BIS/BAS scales. *Journal of Personality and Social Psychology*, *67*, 319–333. doi:10.1037/0022-3514.67.2.319

Chan, R., Wang, Y., Huang, J., Shi, Y., Wang, Y., Hong, X., . . . Kring, A. M. (2010). Anticipatory and consummatory components of the experience of pleasure in schizophrenia: Cross-cultural validation and extension. *Psychiatry Research*, *175*(1–2), 181–183. doi:10.1016/j.psychres.2009.01.020

Cohen, A. S., & Minor, K. S. (2010). Emotional experience in patients with schizophrenia revisited: Meta-analysis of laboratory studies. *Schizophrenia Bulletin*, *36*(1), 143–150. doi:10.1093/schbul/sbn061

Coifman, K. G., & Bonanno, G. A. (2010). When distress does not become depression: Emotion context sensitivity and adjustment to bereavement. *Journal of Abnormal Psychology*, *119*(3), 479–490. doi:10.1037/a0020113

Cook, E. W., Atkinson, L., & Lang, K. (1987). Stimulus control and data acquisition for IBM PCs and compatibles. *Psychophysiology*, *24*(6), 726–727. doi:10.111/j.1469-8986.1987.tb00361x

Curtis, C. E., Lebow, B., Lake, D., Katsanis, J., & Iacono, W. G. (1999). Acoustic startle reflex in schizophrenia patients and their first-degree relatives: Evidence of normal emotional modulation. *Psychophysiology*, *36*(4), 469–475. doi:10.1017/S0048577299980757

Davidson, R. J., Marshall, J. R., Tomarken, A., & Henriques, J. (2000). While a phobic waits: Regional brain electrical and autonomic activity in social phobics during anticipation of public speaking. *Biological Psychiatry*, *47*(2), 85–95. doi:10.1016/S0006-3223(99)00222-X

Dichter, G. S., & Tomarken, A. (2008). The chronometry of affective startle modulation in unipolar depression. *Journal of Abnormal Psychology*, *117*(1), 1–15. doi:10.1037/0021-843X.117.1.1

Dichter, G. S., Tomarken, A., Shelton, R., & Sutton, S. (2004). Early- and late-onset startle modulation in unipolar depression. *Psychophysiology*, *41*(3), 433–440. doi:10.1111/j.1469-8986.00162.x

Engel, M., Fritzsche, A., Lincoln, T. M. (2016). Anticipation and experience of emotions in patients with schizophrenia and negative symptoms. An experimental study in a social context. *Schizophrenia Research, 170*, 191–197.

Favrod, J., Ernst, F., Giuliana, F., & Bonsack, C. (2009). Validation of the temporal experience of pleasure scale (TEPS) in a French-speaking environment. *L'Encephale*, *35*(3), 241–248. doi:10.1016/j.encep.2008.02.013

First, M. B., Gibbon, M., Spitzer, R. L., & Williams, J. B. W. (1996). *Structured Clinical Interview for DSM-IV Axis I disorders. Patient edition*. New York, NY: Biometrics Research.

Gard, D. E., Gard, M. G., Kring, A. M., & John, O. P. (2006). Anticipatory and consummatory components of the experience of pleasure: A scale development study. *Journal of Research in Personality*, *40*(6), 1086–1102. doi:10.1016/j.jrp.2005.11.001

Gard, D. E., Kring, A. M., Gard, M. G., Horan, W. P., & Green, M. F. (2007). Anhedonia in schizophrenia: Distinctions between anticipatory and consummatory pleasure. *Schizophrenia Research*, *93*(1–3), 253–260. doi:10.1016/j.schres.2007.03.008

Gilbert, D. T., & Wilson, T. D. (2007). Prospection: Experiencing the future. *Science*, *317*(5843), 1351–1354. doi:10.1126/science.1144161

Goodman, S. H., Sewell, D., Cooley, E., & Leavitt, N. (1993). Assessing levels of adaptive functioning: The role functioning scale. *Community Mental Health Journal*, *29*(2), 119–131. doi:10.1007/BF00756338

Grillon, C. (2008). Models and mechanisms of anxiety: Evidence from startle studies. *Psychopharmacology*, *199*, 421–437. doi:10.1007/s00213-007-1019-1

Grillon, C., Ameli, R., Woods, S., Merikangas, K., & Davis, M. (1991). Fear-potentiated startle in humans: Effects of anticipatory anxiety on the acoustic blink reflex. *Psychophysiology*, *28*(5), 588–595.

Grillon, C., Pine, D., Lissek, S., Rabin, S., Bonne, O., & Vythilingam, M. (2009). Increased anxiety during anticipation of unpredictable aversive stimuli in posttraumatic stress disorder but not in generalized anxiety disorder. *Biological Psychiatry*, *66*(1), 47–53. doi:10.1016/j.biopsych.2008.12.028

Heerey, E. A., & Gold, J. M. (2007). Patients with schizophrenia demonstrate dissociation between affective experience and motivated behavior. *Journal of Abnormal Psychology*, *116*(2), 268–278. doi:10.1037/0021-843X.116.2.268

Hempel, R. J., Tulen, J. H., van Beveren, N., Mulder, P., & Hengeveld, M. (2007). Subjective and physiological responses to emotion-eliciting pictures in male schizophrenic patients. *International Journal of Psychophysiology*, *64*, 174–183. doi:10.1016/j.ijpsycho.2007.01.008

Hempel, R. J., Tulen, J. H., van Beveren, N. J., van Steenis, H., Mulder, P., & Hengeveld, M. W. (2005). Physiological responsivity to emotional pictures in schizophrenia. *Journal of Psychiatric Research*, *39*(5), 509–518. doi:10.1016/j.jpsychires.2004.11.004

Herbener, E. S., Song, W., Khine, T., & Sweeney, J. (2008). What aspects of emotional functioning are impared in schizophrenia. *Schizophrenia Research*, *98*, 239–246. doi:10.1016/j.schres.2007.06.025

Horan, W. P., Kring, A. M., & Blanchard, J. J. (2005). Anhedonia in schizophrenia: A review of assessment strategies. *Schizophrenia Bulletin, 32*, 259–273.

Juckel, G., Schlagenhauf, F., Koslowski, M., Wustenberg, T., Villringer, R., Knutson, B., . . . Heinz, A. (2006). Dysfunction of ventral striatal reward prediction in schizophrenia. *NeuroImage*, *29*(2), 409–416. doi:10.1016/j.neuroimage.2005.07.051

Keltner, D., & Gross, J. J. (1999). Functional accounts of emotions. *Cognition & Emotion*, *13*(5), 467–480. doi:10.1080/026999399379140

Kim, H., Shimoko, S., & O'Doherty, J. (2006). Is avoiding an aversive outcome rewarding? Neural substrates of avoidance learning in the human brain. *PLoS*, *4*, 1453–1461.

Kring, A. M., & Caponigro, J. M. (2010). Emotion in schizophrenia: Where feeling meets thinking. *Current Directions in Psychological Science*, *19*(4), 255–259. doi:10.1177/0963721410377599

Kring, A. M., & Earnst, K. S. (1999). Stability of emotional responding in schizophrenia. *Behavior Therapy*, *30*, 373–388. doi:10.1016/S0005-7894(99)80016-1

Kring, A. M., & Elis, O. (2013). Emotion deficits in people with schizophrenia. *Annual Review of Clinical Psychology*, *9*, 409–433. doi:10.1146/annurev-clinpsy-050212-185538

Kring, A. M., Germans Gard, M., & Gard, D. E. (2011). Emotion deficits in schizophrenia: Timing matters. *Journal of Abnormal Psychology*, *120*(1), 79–87. doi:10.1037/a0021402

Kring, A. M., Gur, R. E., Blanchard, J. J., Horan, W. P., & Reise, S. P. (2013). The clinical assessment interview for negative symptoms (CAINS): Final development and validation. *The American Journal of Psychiatry*, *170*(2), 165–172. doi:10.1176/appi.ajp.2012.12010109

Kring, A. M., & Moran, E. K. (2008). Emotional response deficits in schizophrenia: Insights from affective science. *Schizophrenia Bulletin*, *34*(5), 819–834. doi:10.1093/schbul/sbn071

Kring, A. M., & Neale, J. M. (1996). Do schizophrenic patients show a disjunctive relationship among expressive, experiential, and psychophysiological components of emotion? *Journal of Abnormal Psychology*, *105*, 249–257. doi:10.1037/0021-843X.105.2.249

Kring, A. M., Siegel, E. H., & Barrett, L. F. (2014). Unseen affective faces influence person perception judgments in schizophrenia. *Clinical Psychological Science*, *2*(4), 443–454. doi:10.1177/2167702614536161

Lang, P. J. (1994). The motivational organization of emotion: Affect-reflex connections. In S. H. M. v. Goozen, N. E. v. d. Poll, & J. A. Seargeant (Eds.), *Emotions: Essays on emotion theory* (pp. 61–93). Hillsdale, NJ: LEA.

Lang, P. J. (1995). The emotion probe. Studies of motivation and attention. *American Psychologist*, *50*(5), 372–385. doi:10.1037/0003-066X.50.5.372

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Gainesville, FL: University of Florida.

Levenston, G. K., Patrick, C. J., Bradley, M. M., & Lang, P. J. (2000). The psychopath as observer: Emotion and attention in picture processing. *Journal of Abnormal Psychology*, *109*(3), 373–385. doi:10.1037/0021-843X.109.3.373

Lipp, O. V., Cox, D., & Siddle, D. A. (2001). Blink startle modulation during anticipation of pleasant and unpleasant stimuli. *Journal of Psychophysiology, 15*, 155–162.

Llerena, K., Strauss, G. P., & Cohen, A. S. (2012). Looking at the other side of the coin: A meta-analysis of self-reported emotional arousal in people with schizophrenia. *Schizophrenia Research*, *142*, 65–70. doi:10.1016/j.schres.2012.09.005

Lowenstein, G. F., Weber, E., Hsee, C., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin*, *127*(2), 267–286. doi:10.1037/0033-2909.127.2.267

Lukoff, D., Nuechterlein, K. H., & Ventura, J. (1986). Manual for the Expanded Brief Psychiatric Rating Scale (BPRS). *Schizophrenia Bulletin*, *12*, 594–602.

MacLeod, A. K., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology*, *105*(2), 286.

MacLeod, C., & Rutherford, E. (1998). Automatic and strategic cognitive biases in anxiety and depression. In K. Kirsner, C. Speelman, & M. Mayberg (Eds.), *Implicit and explicit mental processes* (pp. 233–254). Mahwah, NJ: Eribaum.

Miloyan, B., & Suddendorf, F. (2015). Feelings of the future. *Trends in Cognitive Science*. Advance online publication. doi:10.1016/j.tics.2015.01.008

Moran, E. K., Mehta, N., & Kring, A. M. (2012). Emotional responding in depression: Distinctions in the time course of emotion. *Cognition & Emotion*, *26*, 1153–1157. doi:10.1080/02699931.2011.638909

Mote, J., Minzenberg, M. J., Carter, C. S., & Kring, A. M. (2014). Deficits in anticipatory but not consummatory pleasure in people with recent-onset schizophrenia spectrum disorders. *Schizophrenia Research, 159,* 76–79.

Nitschke, J. B., Larson, C. L., Smoller, M., Navin, S., Pederson, A., Ruffalo, D., . . . Davidson, R. J. (2002). Startle potentiation in aversive anticipation: Evidence for state but not trait effects. *Psychophysiology*, *39*(2), 254–258. doi:10.1111/1469-8986.3920254

Nitschke, J. B., Sarinopoulos, I., Oathes, D. J., Johnstone, T., Whalen, P. J., Davidson, R. J., & Kalin, N. H. (2009). Anticipatory activation in the amygdala and anterior cingulate in generalized anxiety disorder and prediction of treatment response. *American Journal of Psychiatry*, *166*, 302–310. doi:10.1176/appi.ajp.2008.07101682

Painter, J. M., & Kring, A. M. (2016). Toward an understanding of anticipatory pleasure deficits in schizophrenia: Memory, prospection, and emotion experience. *Journal of Abnormal Psychology*, *125*(3), 442. doi:10.1037/abn0000151

Rottenberg, J., Gross, J. J., & Gotlib, I. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology*, *114*(4), 627–639. doi:10.1037/0021-843X.114.4.627

Rottenberg, J., Kasch, K. L., Gross, J. J., & Gotlib, I. (2002). Sadness and amusement reactivity differentially predict concurrent and prospective functioning in major depressive disorder. *Emotion*, *2*, 135–146. doi:10.1037/1528-3542.2.2.135

Sabatinelli, D., Bradley, M. M., & Lang, P. J. (2001). Affective startle modulation in anticipation and perception. *Psychophysiology*, *38*(4), 719–722. doi:10.1111/1469-8986.3840719

Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: Remembering the past and imagining the future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1481), 773–786. doi:10.1098/rstb.2007.2087

Schlenker, R., Cohen, R., & Hopmann, G. (1995). Affective modulation of the startle reflex in schizophrenic patients. *European Archives of Psychiatry and Clinical Neuroscience*, *245*(6), 309–318. doi:10.1007/BF02191873

Schlosser, D., Fisher, M., Gard, D., Fulford, D., Loewy, R., & Vinogradov, S. (2014). Motivational deficits in individuals at-risk for psychosis and across the course of schizophrenia. *Schizophrenia Research*, *158*, 52–57. doi:10.1016/j.schres.2014.06.024

Schultz, W. (2002). Getting formal with dopamine and reward. *Neuron*, *36*, 241–263. doi:10.1016/S0896-6273(02)00967-4

Skolnick, A. J., & Davidson, R. J. (2002). Affective modulation of eyeblink startle with reward and threat. *Psychophysiology, 39*, 835–850.

Spitzer, R. L., Gibbon, M. E., Skodol, A. E., Williams, J. B., & First, M. B. (2002). *DSM-IV-TR casebook: A learning companion to the Diagnostic and Statistical Manual of Mental Disorders, text rev.* Washington, DC: American Psychiatric Association.

Strauss, G. P. (2013). The emotion paradox of anhedonia in schizophrenia: Or is it? *Schizophrenia Bulletin*, *39*(2), 247–250. doi:10.1093/schbul/sbs192

Strauss, G. P., Wilbur, R. C., Warren, K., August, S., & Gold, J. M. (2011). Anticipatory vs. consummatory pleasure: What is the nature of hedonic deficits in schizophrenia? *Psychiatry Research*, *187*(1–2), 36–41. doi:10.1016/j.psychres.2011.01.012

Trémeau, F., Antonius, D., Cacioppo, J. T., Ziwich, R., Butler, P., Malaspina, D., & Javitt, D. (2010). Anticipated, online and remembered positive experience in schizophrenia. *Schizophrenia Research*, *122*, 199–205. doi:10.1016/j.schres.2009.10.019

Trémeau, F., Antonius, D., Cacioppo, J., Ziwich, R., Jalbrzikowski, M., Saccente, E., . . . Javitt, D. (2009). In support of Bleuler: Objective evidence for increased affective ambivalence in schizophrenia based upon evocative testing. *Schizophrenia Research*, *107*, 223–231. doi:10.1016/j.schres.2008.09.020

Ursu, S., Kring, A. M., Gard, M. G., Minzenberg, M. J., Yoon, J., Ragland, J. D., . . . Carter, C. S. (2011). Prefrontal cortical deficits and impaired cognition-emotion interactions in schizophrenia. *American Journal of Psychiatry*, *168*, 276–285. doi:10.1176/appi.ajp.2010.09081215

Van Boxtel, A., Boelhouwer, A., & Bos, A. (1998). Optimal EMG signal bandwidth and interelectrode distance for the recording of acoustic, electrocutaneous, and photic blink reflexes. *Psychophysiology*, *35*(6), 690–697. doi:10.1111/1469-8986.3560690

Volz, M., Hamm, A., Kirsch, P., & Rey, E. (2003). Temporal course of emotional startle modulation in schizophrenia patients. *International Journal of Psychophysiology*, *49*(2), 123–137. doi:10.1016/S0167-8760(03)00100-4

Wechsler, D. (2001). *Wechsler Test of Adult Reading (WTAR)*. San Antonio, TX: The Psychological Corporation.

Williams, L. M., Das, P., Harris, A. W., Liddell, B., Brammer, M., Olivieri, G., . . . Gordon, E. (2004). Dysregulation of arousal and amygdala-prefrontal systems in paranoid schizophrenia. *American Journal of Psychiatry*, *161*, 480–489. doi:10.1176/appi.ajp.161.3.480

Wynn, J. K., Horan, W. P., Kring, A. M., Simons, R. F., & Green, M. F. (2010). Impaired anticipatory event-related potentials in schizophrenia. *International Journal of Psychophysiology, 77*, 141–149.

Yee, C. M., Mathis, K., Sun, J., Lang, P. J., Bachman, P., Williams, T., . . . Nuechterlein, K. H. (2010). Integrity of emotional and motivational states during the prodromal, first-episode, and chronic phases of schizophrenia. *Journal of Abnormal Psychology*, *119*(1), 71–82. doi:10.1037/a0018475