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Anticipatory Emotion in Schizophrenia

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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

People with schizophrenia (SZ) report experiencing just as much positive emotion as do people without schizophrenia 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 schizophrenia (SZ) using a multi-method 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 Schizophrenia

In addition to research showing intact in the moment reported 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., Kring & Neale, 1996; Hempel, Tulen, van Beveren, Mulderm, & Hengeveld, 2007; Hempel et al., 2005; Ursu et al., 2010; Volz, et al., 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, 2006). 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 schizophrenia holds that the anhedonic deficit is found in anticipation, not in the current experience of positive emotion (Kring & Caponigro, 2010).

Anticipation in Schizophrenia

Informed by research in human and 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; Shacter & 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; Schultz, 2002; Miloyan & Suddendorf, 2015).

Accumulated evidence suggests that people with SZ have difficulties in anticipatory positive emotion or pleasure; fewer studies have assessed anticipatory negative emotion. Gard and colleagues (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 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 schizophrenia have used a self-report measure of anticipation experience to mostly sensory events (TEPS; Gard Germans 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 schizophrenia (Mote, Minzenberg, Carter, & Kring, 2014), and in people at clinical high risk for schizophrenia (Schlosser et al., 2014). Buck and Lysaker (2013) found that lower TEPS anticipatory pleasure predicted worse interpersonal functioning six 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; post traumatic stress disorder, Grillon, et al., 2009) and depression (e.g., Abler, Erk, Herwig, & Walter, 2007; MacLeod & Rutherford, 1999), it has not been well studied in schizophrenia. 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 towards action, may foster avoidance. This avoidance may in turn be linked with functioning 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 non-emotional 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 schizophrenia have all found that people with schizophrenia exhibit the same linear pattern of blink modulation as do people without schizophrenia while viewing evocative stimuli (Curtis, Lebow, Lake, Katsanis, & Iacono, 1999; Kring, Germans Gard, & Gard, 2011; Schlenker, Cohen, & Hopmann, 1995; Volz, Hamm, Kirsch, & Rey, 2003; Yee et al., 2010).

Although no study has yet assessed anticipation in schizophrenia using SEM, a handful of studies have used SEM to assess anticipatory emotion in other populations (e.g., Grillon, et al., 1991; Lipp, et al., 2001; Moran, Mehta, & Kring, 2012; Nitschke, et al., 2002; Skolnick and Davidson, 2003; Sabatinelli et al., 2001). 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 schizophrenia, 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 NA (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 schizophrenia 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.

Methods

Participants

Participants included 32 people with schizophrenia ($n = 25$) or schizoaffective disorder ($n = 7$; not in a current mood episode) and 33 healthy controls¹. 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 six 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 schizophrenia or bipolar disorder, if they had 1 or more episodes of mania, or if they had more than 2 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, 2002b). Participants in the

¹There were no significant differences on any study variable between those diagnosed with schizophrenia and schizoaffective disorder.

SZ group were interviewed for general psychiatric symptoms using the Brief Psychiatric Rating Scale rated on a 7-point scale from 1 (*not present*) to 7 (*extremely severe*) (BPRS; 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 valence². 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: (1) a startle task where blink responses were assessed along with anticipatory experience, and (2) 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

²IAPS 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.

“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 0.5s cue (+, −, or o), followed by a 4s 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 seconds followed by a jittered intertrial interval (ITI: 5–7s).

Startle probes were pseudo-randomly ordered and presented during either the anticipatory period (7 during each of the positive, neutral, and negative conditions; 2500 ms after the anticipatory cue and prior to picture onset), during picture presentation (7 during each of the positive, neutral, and negative conditions; 3500 ms after picture onset), or during the ITI ($n = 8$; 3000 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 seconds followed by a 2–3s 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 13–1000 Hz passband and amplified using a Coulbourn V75-04 Isolated Bioamplifier with Bandpass Filter. EMG was sampled at 1000 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 et al., 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. Intra-class 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 ($M = 50$; $SD = 10$). Mean blink magnitudes for valence (positive, neutral, negative) and time (anticipatory, in the moment) was 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 outcomes³. 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 sex⁴ for the reported analyses.

In the Moment Responses

We conducted three separate 2 (Group: SZ, CTL) X 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 X 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.

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 X Valence interaction ($ps > .15$) for blink responses

³The pattern of findings remained the same regardless of whether age and sex were included in the correlational analyses.

⁴We 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.

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 positive pictures were smallest, followed by neutral, followed by viewing negative pictures (see Figure 1A).

Anticipatory Responses

We conducted three separate 2 (Group: SZ, CTL) X 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 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 X 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 Figure 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 X Valence interaction ($F(1,52) = 6.29, p < .05, \eta_p^2 = .11$). Posthoc within group comparisons (see Figure 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 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 schizophrenia 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 schizophrenia 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., Treméau et al., 2009; Yee et al., 2010; Anticevic, Repovs, & Barch, 2011), but not all (e.g., Burbridge & Barch, 2007; Herbener et al., 2008; Kring et al., 2011). In their meta-analysis, Llerena and colleagues (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 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 by 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, Mehta, & Kring, 2012), and is linked to functioning and symptoms longitudinally (e.g., Coifman & Bonanno, 2010; Rottenberg et al., 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 schizophrenia 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 towards 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, Shimojo, & 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. Our 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 towards 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 (Kring & Earnst, 1999; Juckel et al., 2006). 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 responses 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 schizophrenia. The present study points to the importance of anticipation in SZ, highlighting the link between anticipatory emotional responses, negative symptoms and functional outcome.

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Figure 1.

Panel A presents mean blink magnitudes during picture presentation. Panel B presents the mean startle responses during anticipation in individuals with schizophrenia and controls. Panel C presents mean valence ratings during picture presentation in individuals with schizophrenia and controls. Note higher values indicate more pleasant experience. Panel D presents the mean valence ratings during anticipation in individuals with schizophrenia and controls. Note higher values indicate more pleasant experience.

Table 1

Demographic and Clinical Participant Characteristics

	SZ (<i>n</i> = 27)	CTL (<i>n</i> = 27)	Statistic
Age (Yrs)	46.69 (10.73)	46.22 (11.23)	$t = .16$
Gender (male: female)	(14:13)	(12:15)	$\chi^2 = .30$
Ethnicity, <i>n</i>			$\chi^2 = 2.57$
Caucasian	17	15	
African American	4	5	
Asian	4	4	
American Indian	1	0	
Multiethnic	0	1	
Latino	1	2	
Education (Yrs)	14.58 (2.49)	15.61 (2.31)	$t = 1.57$
WTAR	105.85 (11.27)	105.30 (10.93)	$t = .18$
Antipsychotic medication (<i>n</i>)			
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 (<i>n</i> = 21)	4.64 (1.01)		

Note: SZ = Schizophrenia group; CTL = Healthy control group; WTAR = Wechsler Test of Adult Reading; BPRS = Brief Psychiatric Rating Scale; CAINS MAP = Motivation and Pleasure Subscale of the Clinical Assessment Interview for Negative Symptoms; CAINS EXP = Expression Subscale; RFS = Role Functioning Scale. Mean values are displayed with standard deviations in parentheses where applicable.

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: Tabled 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.

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

Anticipatory Valence	BPRS Pos	MAP	EXP	RFS
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; MAP = CAINS Motivation and Pleasure Scale; EXP = CAINS Expression Scale; RFS = Role Functioning Scale. Bonferroni corrections accounted for 48 comparisons.

* $p < .05$

[^] $p = .06$, did not survive Bonferroni correction