Published in final edited form as:

J Abnorm Psychol. 2013 May ; 122(2): 492–505. doi:10.1037/a0031212.

The Processing of Emotional Stimuli During Periods of Limited Attentional Resources in Schizophrenia

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Abstract

When participants are asked to attend to two target stimuli in a rapid serial visual presentation sequence the successful identification of the 1st target (T1) leads to transient impairment in reporting the 2nd target (T2)- this effect is known as the attentional blink (AB). In healthy individuals, this AB effect is either diminished or accentuated when emotional stimuli are presented in the T2 or T1 positions, respectively, suggesting that affective content influences bottom-up (i.e., exogenous) attention. In the current study, we conducted two separate experiments using the Emotional Attentional Blink paradigm where emotional words were presented in the T2 or T1 position to determine whether schizophrenia patients with high and low negative symptoms differ from controls in the extent to which emotional stimuli influence bottom-up attentional processes. Participants included 33 schizophrenia patients and 28 controls in Experiment 1 (T2 Task), and 30 schizophrenia patients and 24 controls in Experiment 2 (T1 Task). In both experiments, patients were divided into high (HI-NEG) and low (LOW-NEG) negative symptom sub-groups using the Scale for the Assessment of Negative Symptoms. Results of Experiment 1 indicated that controls and LOW-NEG patients displayed the typical pattern of AB sparing at early lags for emotional relative to neutral words; however, HI-NEG patients showed no difference in T2 accuracy between emotional and neutral stimuli. Results of Experiment 2 indicated that controls and LOW-NEG patients displayed reduced T2 accuracy following unpleasant T1 stimuli, while HI-NEG patients showed no decrement in T2 accuracy following emotional T1s. Across both experiments, findings suggest that emotional stimuli have a bottom-up competitive advantage in LOW-NEG patients and controls; however, this bottom-up advantage is absent in HI-NEG patients.

Keywords

Schizophrenia; Negative Symptoms; Emotion; Attention; Anhedonia; Avolition

Introduction

Anhedonia, traditionally defined as a reduced capacity to experience pleasure (Krapelin, 1919), is generally regarded as a core feature of schizophrenia. However, this clinical understanding of anhedonia may be inaccurate given that patients and controls report similar levels of positive emotion in response to evocative stimuli (for meta-analysis and review see Cohen & Minor, 2010; Kring & Moran, 2008), show similar increases in positive emotion when engaged in activities in their daily lives (Gard, Kring, Gard, Horan, & Kring, 2007;

Oorschot et al., in press), and display similar neural activation when reporting their in-the-moment feelings in response to positive stimuli (see Taylor et al., 2012 for a meta-analysis) (see Strauss & Gold, 2012 for a review). Although in-the-moment pleasure may be intact in schizophrenia, it is clear that not all aspects of emotion are normal as there is consistent evidence that patients have reductions in pleasure-seeking behavior (Kirkpatrick et al., 2011; Myin-Germeys, Delespaul, deVries, 2000; Oorschot et al., in press). Thus, an important question still remains: How is it that individuals with schizophrenia can have an intact ability to experience pleasure, yet still not seek out potentially pleasurable activities?

Aberrant cognition-emotion interactions may be one potential mechanism for why patients' intact emotional experiences do not get translated into motivated, goal-directed behaviors. In healthy individuals, it has been suggested that cognitive processes such as encoding, retrieval, and generating mental representations of value may play an important role in the anticipation of future pleasure and the motivation to engage in pleasurable activities (Gilbert & Wilson, 2007). Individuals with schizophrenia display a range of abnormalities in cognition-emotion interactions, and these have often been linked to greater severity of negative symptoms, particularly anhedonia and avolition. For example, despite normal hedonic reactions to stimuli, patients display deficits in long-term emotional memory (Herbener, 2008, 2009; Herbener, Rosen, Khine, Sweeney, 2007; Holt et al., 2009), impaired emotional working memory capacity and maintenance (Anticevic et al., 2011; Gard et al., 2011; Kring, Germans-Gard, Gard, 2011; Pauly et al., 2008; Ursu et al., 2011), and difficulty forming mental representations of value that are capable of guiding stimulus learning and action-selection (Gold et al., 2008, 2012; Heerey & Gold, 2007a; Heerey et al., 2007, 2011; Strauss et al., 2011ab; Waltz et al., 2007).

Emotion-attention interactions may also play an important role in motivated behavior. A primary function of the attentional system is to determine which environmental stimuli are subjected to selective attention and which are filtered out (Lavie, Hirst, Fockert, & Viding, 2004). In healthy individuals, affective stimuli may receive special prioritization within the attentional system, influencing bottom-up (i.e., attention is automatically captured by salient stimulus qualities), as well as top-down attentional processes (i.e., intentionally searching for selected stimuli based upon instructions or self-generated focus) (Fox, Russo, Bowles, & Dutton, 2001; Ohman, Hamm, & Hugdahl, 2000; Nummenmaa, Hyona, & Calvo, 2006; Keil, Moratti, Sabatinelli, Bradley, & Lang, 2005; Strauss & Allen, 2006, 2009). It is adaptive to have an attentional system that is flexible and capable of attending to emotional content in the presence of other stimuli competing for selection, as attentional selection facilitates appraisal and the initiation of approach/avoidance behaviors (Lang, Bradley, & Cuthbert, 1997).

Studies examining emotion-attention interactions in schizophrenia have produced inconsistent results. There is some evidence that emotional stimuli influence the attention of patients similarly to controls, both with regard to behavioral performance and neurophysiological response (Anticevic, Repovs, & Barch, in press; Horan, Wynn, Kring, Simons, & Green, 2010; Horan, Foti, Hajcak, Wynn, & Green, in press); however, other studies indicate that unpleasant stimuli influence the attention of individuals in the schizophrenia-spectrum to a greater extent than controls (Kinderman, Prince, Waller, & Peters, 2003; Mohanty et al., 2001, 2005, 2008; Park, Park, Chun, Kim, & Kim, 2008; Besnier et al., 2011; Fear, Sharp, & Healy, 1996) and that pleasant stimuli fail to influence attention to the same extent in patients as controls (Strauss et al 2008; Strauss, Llerena, Catalano, & Gold, in preparation). Heterogeneity of symptom presentation and whether tasks assess bottom-up or top-down emotion-attention interactions may explain these discrepancies to some extent, as positive symptoms have been associated with greater influence of unpleasant stimuli on bottom-up attention in several studies (Besnier et al.,

2011; Kinderman et al., 2003; Mohanty et al., 2001, 2005; Van Strien & Van Kampen, 2009; Fear et al., 1996), whereas negative symptoms have been associated with reduced bottom-up capture for pleasant stimuli (Strauss et al., 2008; Strauss et al., in preparation) and difficulty disengaging top-down attention from unpleasant stimuli in others (Strauss et al., 2008; Strauss, Llerena, Gold, 2011).

The majority of the aforementioned studies have investigated the interaction between emotional stimuli and spatial attention, indexing selective attention by manipulating the spatial location of stimuli competing for selection. However, most real-life situations do not afford the luxury of processing one or two stimuli in isolation. Rather, we are constantly inundated by a stream of information in a continuous temporal sequence that is competing for selective attention. A task developed in the affective neuroscience literature, the Emotional Attentional Blink (AB) (Anderson, 2005), has been widely used to study the preferential processing of emotional stimuli and temporal dynamics of attention. The emotional AB is a variant of the basic (i.e., nonaffective) version of this task. In the nonaffective/basic version, participants are presented with a Rapid Serial Visual Processing (RSVP) stream of stimuli (e.g., letters), and asked to identify two target words that are printed in different colored ink from a stream of distractors. An “Attentional Blink” (AB) effect is said to take place when the two target stimuli (referred to as T1 and T2) are presented within approximately 500 ms of each other (lags 1–3), causing participants to be unable to report the second of the two targets accurately, even though they were able to identify the first (Raymond, Shapiro, & Arnell, 1992; Shapiro, Arnell, & Raymond, 1997). The AB effect is thought to occur because the allocation of attention to T1 stimuli leaves less attentional resources available for T2 stimuli, thereby making T2 stimuli more susceptible to decay or substitution (Chun & Potter, 1995; Jolicoeur, 1999; Luck, Vogel, & Shapiro, 1996; Vogel, Luck, & Shapiro, 1998). Individuals with schizophrenia have been found to show deficits on the basic AB task (Cheung et al., 2002; Wynn et al., 2006; Mathis et al., 2011, in press).

Interestingly, the AB effect can be attenuated or accentuated when emotionally arousing stimuli are presented in the T2 and T1 positions, respectively. Numerous studies have demonstrated that the AB is greatly attenuated if T2 stimuli are emotionally salient, i.e., participants identify T2 emotional stimuli with higher accuracy than T2 neutral stimuli at early lags (Anderson, 2005; Anderson & Phelps, 2001; Keil & Ihssen, 2004; De Martino, Kalisch, Rees, & Dolan, 2009; Fox et al., 2005; Milders, Sahraie, Logan, & Donnellon, 2006; Keil, Ihssen, & Heim, 2006). Reduction in the AB effect by T2 emotional stimuli is most evident when T1 and T2 stimuli are close together (< 500ms), when attentional resources are occupied with the processing of the preceding neutral T1. Attenuation of the AB effect has been shown to result from both T2 pleasant and unpleasant stimuli in healthy individuals. More recently, studies have also examined the effects of emotional stimuli in the T1 position on accuracy for subsequent T2 neutral stimuli presented at early and later lags. These studies indicate that high arousal unpleasant and taboo stimuli (but not moderately unpleasant or pleasant stimuli) presented in the T1 position enhance the AB effect, impairing T2 identification for lags falling within 500ms of T1 (Matthewson, Arnell, & Mansfield, 2008; Stein, Zwickel, Ritter, Kitzmantel, & Schneider, 2009; Schwabe et al., 2011).

A leading two-stage bottleneck theory of the AB has been used to explain these effects, positing that accurate target identification requires two distinct stages: 1) attentional orienting and representation of stimulus features, and 2) encoding and consolidation of the target for later report (Chun & Potter, 1995; Jolicoeur, 1999). These stages apply to the processing of both T1 and T2 stimuli, and their interplay within a dual-target RSVP stream is thought to produce the “blink” effect. Specifically, these theories propose that stage 1

occurs relatively automatically, but stage 2 takes longer to complete and requires significant attentional resources. Given the amount of attentional resources needed to complete stage two, the processing of T2 must wait until the stage two processing of T1 is completed. If T2 arrives before the processing of T1 is completed, the short-lived representation of T2 at stage one may be overwritten by subsequent distractor stimuli in the RSVP stream, causing T2 to never reach stage two where it could be encoded and consolidated sufficiently for subsequent report. Following this logic, one interpretation of AB attenuation for emotional relative to neutral T2s is that emotional stimuli facilitate stage one attentional orienting, thereby allowing the representation of emotional T2s to survive their delayed stage two processing until after the processing of T1 is complete (see Anderson, 2005; Matthewson et al., 2008). However, it is also likely that emotional stimuli facilitate stage two activities and become subjected to enhanced working memory processes that facilitate accurate report at the end of the RSVP stream. For the T2 task version, AB attenuation for emotional stimuli may therefore result from enhanced stage one orienting, stage two processes that facilitate encoding, or both processes in combination. Similarly, in the T1 task version, AB enhancement for high-arousal unpleasant stimuli may result from increased attentional orienting to T1 stimuli at stage one or increased attention at stage two, which leaves too few resources available for an accurate report of T2 neutral words occurring close in time. This interpretation is supported by research proposing a resource sharing account of the AB (Shapiro, Schmitz, Martens, Hommel, & Schnitzler, 2006) and evidence that the amount of processing resources allocated to T1 stimuli predict AB duration (Hommel & Doeller, 2005; Olson, Chun, & Anderson, 2001). Given that individuals with schizophrenia display aberrant emotion-attention and emotion-memory interactions, the emotional AB offers a novel means of assessing cognition-emotion interactions under conditions where cognitive resources are limited.

In the current study, we conducted two experiments to determine whether emotional stimuli modulate the AB effect in controls and schizophrenia patients who were divided into high and low negative symptom sub-groups. In Experiment 1, we administered the widely implemented T2 variant of the Emotional AB task. Based upon our previous research (Strauss et al., 2008), we hypothesized that controls and low negative symptom patients would display the typical emotional modulation of the AB effect, as indicated by enhanced T2 accuracy for emotional relative to neutral words at early lags. In contrast, we predicted that high negative symptom patients would fail to show emotional modulation of the AB effect at early lags, which would suggest that emotional stimuli fail to sufficiently influence bottom-up attention when cognitive resources are taxed by competing task demands. In Experiment 2, we administered the T1 version of the emotional AB task, and hypothesized that unpleasant stimuli would enhance the AB effect at early lags to a greater extent than neutral stimuli in controls and low negative symptom patients. However, AB enhancement following unpleasant T1s was predicted to be reduced at early lags in high negative symptom patients. Across both Experiments, reduced emotional modulation of the AB was expected to correlate more strongly with the avolition/anhedonia/asociality component of negative symptoms than the emotional expressivity component (see Blanchard & Cohen, 2006; Strauss et al., in press) based upon prior research suggesting that cognition-emotion interactions are more closely associated with this domain (e.g., Strauss et al., 2008 e.g., Strauss et al., 2011b; Foussias & Remington, 2010; Gold et al., 2012). In both experiments, the effects of pleasant and unpleasant stimuli were examined separately to determine whether abnormal emotion-attention interactions seen in high negative symptom patients primarily occur in relation to pleasant stimuli, as we found in Strauss et al. (2008).

Experiment 1

Method

Participants—Participants included 33 patients meeting DSM-IV-TR criteria for schizophrenia ($n = 29$) or schizoaffective disorder ($n = 4$) and 28 healthy controls (CN). Patients were recruited from the outpatient clinics at the Maryland Psychiatric Research Center. All patients were on constant doses and types of medication for at least 4 weeks at the time of testing and were considered to be clinically stable by their treatment providers. Consensus diagnosis was established with a best-estimate approach based on medical records and confirmed using the Structured Clinical Interview for DSM-IV (SCID) (First, Spitzer, Gibbon, & Williams, 2001). All patients were prescribed antipsychotic medications.

CN participants were recruited from the community via random digit dialing, word of mouth among recruited participants, and through the use of newspaper advertisements. Controls had no current Axis I or II diagnoses as established by the SCID (First et al., 2001) and SID-P (Pfohl, Blum, Zimmerman, 1997), no family history of psychosis, and were not taking psychotropic medications. All participants denied a history of significant neurological injury or disease, and significant medical or substance use disorders within the last 6 months. All participants provided informed consent for a protocol approved by the University of Maryland Institutional Review Board.

Patients were divided into High (HI-NEG) and Low Negative (LOW-NEG) symptom groups based upon a median split on the Scale for Negative Assessment of Negative Symptoms (SANS; Andreasen, 1983; Buchanan et al., 2007) total score of archival data from all patients included in our outpatient clinics at the Maryland Psychiatric Research Center (MPRC) (Median score used = 34; $n = 1374$ ratings). The three groups did not significantly differ on age, gender, or ethnicity; however, they did differ on parental education, such that HI-NEG had lower parental education than CN or LOW-NEG. HI-NEG and LOW-NEG patients significantly differed on the Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1962) negative symptom factor score, but not on positive symptoms, disorganization, or the total scale score. HI-NEG and LOW-NEG patients were also prescribed a similar regimen of antipsychotic medications at the time of testing (see Table 1).

Measures—Participants completed the T2 version of the Emotional AB Task. In this task, each trial consisted of an RSVP stream of 15 words, including two target words (T1 and T2) and 13 distractor items. Target 1 (T1) and Target 2 (T2) words were presented in bright green ink, and distractor words in black. Stimuli were presented in uppercase letters against a gray background. Participants were asked to attend to the stream of words and report the two words printed in green ink.

An example trial sequence is presented in Figure 1. Each trial began with a central fixation point that appeared for 1 second. The RSVP stream then started 1000 ms after the fixation offset. Each item in the stream was presented for 175 ms and was immediately followed by the subsequent item. After presentation of each stream, participants indicated the two targets by verbally reporting each word to the experimenter who then typed them into the prompted text box. Participants were asked to guess when appropriate, and experimenters were instructed to record “don’t know responses” as well. Participants did not receive feedback regarding performance.

There were seven possible lags between T1 and T2, ranging from Lag 1 (no intervening items, stimulus onset asynchrony SOA 175 ms) to Lag 7 (six intervening items, SOA 1050 ms). T1 was presented with equal probability in positions 2–5 of the 15-item stream. T1

serial position was crossed with T2 emotion condition and T1–T2 lag. In the pleasant, unpleasant, and neutral T2 conditions, there were four trials for each combination of lag and condition. Thus, there were a total of 84 experimental trials. There were also five practice trials, which consisted of neutral T1 and T2 words.

The word stimuli were presented in 18-point Courier New font. The stimuli were viewed from an average distance of 60 cm. T1 stimuli were 28 neutral words and distractor items were 60 neutral words. The T2 stimuli consisted of 28 pleasant, 28 unpleasant, and 28 neutral words taken from the ANEW (Bradley & Lang, 1999) stimulus set (see Appendix). These words did not represent specific emotional categories (e.g., sadness, anxiety), but more generally pleasant or unpleasant emotions as indicated by the Strauss and Allen (2008) word norm set. Pleasant, unpleasant, and neutral T2 words were similar with regard to frequency and length. Pleasant and unpleasant words did not differ in arousal, but were both significantly more arousing than neutral words. The three conditions differed in valence as expected, with positive words rated as more pleasant than neutral, which were more pleasant than negative words. Mean (SD) valence ratings per condition were: Unpleasant 2.6 (1.7), Pleasant: 8.0 (1.4), Neutral: 5.2 (1.3). Mean (SD) arousal ratings per condition were: Unpleasant: 7.1 (2.2), Pleasant: 7.1 (2.1), Neutral: 3.6 (2.1).

Results

T1 accuracy was examined to determine whether there were group differences in initial target accuracy. One-way ANOVA indicated a significant difference among groups, $F(2, 60) = 11.52, p < .001$ (HI-NEG: $M = 75\%$, $SD = 28$; LOW-NEG: $M = 72\%$, $SD = 32\%$; CN: $M = 95\%$, $SD = 7\%$). Post hoc LSD contrasts indicated that both HI-NEG and LOW-NEG patients had lower T1 performance than controls ($p < .001$ for both), but did not differ from each other.

Figure 2 presents mean T2 accuracy (following correct T1 trials) for pleasant, unpleasant, and neutral stimuli at lags 1–7. A $3 \times 3 \times 7$ (Group [HI-NEG, LOW-NEG, CN] $\times$ Emotion [Pleasant, Unpleasant, Neutral] $\times$ Lag [lags 1 through 7]) repeated measures ANOVA was conducted to determine whether groups displayed a different pattern of accuracy for pleasant, unpleasant, and neutral stimuli across early and later lags. The three-way Group $\times$ Emotion $\times$ Lag interaction was significant, $F(2, 58) = 1.77, p = .013$ ($\eta^2 = .06$) as was the main effect of emotion, $F(2, 58) = 3.48, p = .034$ ($\eta^2 = .06$), the main effect of lag, $F(6, 58) = 48.43, p < .001$ ($\eta^2 = .46$), and between subjects effect of group, $F(2, 58) = 7.19, p = .002$ ($\eta^2 = .20$). The Group $\times$ Emotion, $F(2, 58) = 2.17, p = .08$ ($\eta^2 = .07$), Group $\times$ Lag, $F(2, 58) = 1.10, p = .36$ ($\eta^2 = .04$), and Emotion $\times$ Lag, $F(2, 58) = .09, p = .54$ ($\eta^2 = .02$), interactions were nonsignificant. The inclusion of parental education as a covariate did not affect findings.

To follow-up the 3-way interaction and test specific hypotheses related to differences in T2 accuracy for emotional relative to neutral stimuli at early lags, we calculated a difference score of Emotional T2 Accuracy – Neutral T2 Accuracy averaged across lags 1–3. Pleasant and unpleasant stimuli were examined separately. Separate one-way ANOVAs indicated a significant group difference in the Unpleasant-Neutral contrast, $F(2, 58) = 8.16, p < .001$, as well as the Pleasant-Neutral contrast, $F(2, 58) = 5.46, p < .01$. For the Unpleasant-Neutral difference score, post hoc LSD contrasts indicated that LOW-NEG patients showed significantly higher difference scores (i.e., more AB attenuation) than CN ($p < .05$) or HI-NEG ($p < .001$), and there were higher difference scores for CN than HI-NEG ($p < .02$). For the Pleasant – Neutral difference score, LSD contrasts indicated that CN ($p < .01$) and LOW-NEG ($p < .01$) had significantly higher difference scores than HI-NEG patients; however, LOW-NEG and CN did not differ from each other ($p = .78$). As can be seen in Figure 2, results indicate that CN and LOW-NEG display the typical pattern of AB

attenuation for pleasant and unpleasant stimuli at early lags, as indicated by higher accuracy for emotional relative to neutral words across lags 1–3. This pattern of performance indicates that emotional stimuli have a bottom-up competitive advantage in CN and LOW-NEG patients. Additionally, the bottom-up advantage seen in LOW-NEG patients is greater than that seen in controls. In contrast, HI-NEG patients displayed poorer performance for emotional than neutral T2s, suggesting that the bottom-up competitive advantage is absent in these patients.

Within-group paired samples t-tests were conducted to directly test the impact of emotional stimuli on the AB and determine whether individual groups displayed the prototypical pattern of AB attenuation for emotional relative to neutral words. Controls did not differ in accuracy for unpleasant and neutral stimuli ($t = 0.62$, $p = 0.54$), but showed higher accuracy for both pleasant ($t = 2.95$, $p < 0.01$) and emotional (average of pleasant and unpleasant) ($t = 2.06$, $p < 0.05$) than neutral stimuli. HI-NEG showed no differences between neutral and unpleasant ($t = -1.2$, $p = 0.24$), neutral and pleasant ($t = -0.32$, $p = 0.75$), or neutral and emotional ($t = 0.83$, $p = 0.42$). LOW-NEG showed higher accuracy for unpleasant than neutral ($t = 2.24$, $p < 0.05$), pleasant than neutral ($t = 2.08$, $p < 0.05$), and emotional than neutral ($t = 2.15$, $p < 0.05$). Thus, HI-NEG failed to show AB attenuation for emotional stimuli, while CN and LOW-NEG did; however, AB attenuation for unpleasant stimuli was minimal in CN and the effect was strongest for pleasant stimuli.

Correlational analyses were calculated to examine potential relationships between task performance and specific symptom domains (see Table 2)¹. The Emotional T2 Accuracy – Neutral T2 Accuracy difference score at early lags (1–3) served as measures of task performance. Given evidence for the existence of Avolition-Anhedonia (AA) and Emotional Expressivity (EE) factors on the SANS (Blanchard & Cohen, 2006), we calculated AA and EE scores by averaging the Avolition and Anhedonia/Asociality items (AA domain) and the Restricted Affect and Alogia items (EE domain) including global scores. We also calculated the average scores across all SANS items, and examined correlations with BPRS factor scores for Positive and Disorganized symptom dimensions, as well as individual items for Depression and Anxiety. As can be seen in Table 2, the Unpleasant-Neutral difference score was negatively correlated with the SANS AA domain score and the SANS total suggesting that negative symptoms are associated with a reduced bottom-up advantage for unpleasant stimuli. The correlation with the EE negative symptom domain was nonsignificant. The test for significant differences in correlations between AA and EE was nonsignificant. There was a significant positive correlation between depression and the Unpleasant-Neutral difference score ($p = .05$), suggesting that greater depressive severity is associated with a greater bottom-up advantage for unpleasant stimuli. Correlations between the Unpleasant-Neutral difference score and BPRS Positive and Disorganized symptom dimensions were nonsignificant. Correlations between negative symptoms and the Pleasant-Neutral difference score were nonsignificant, but trending in the same direction as the Unpleasant-Neutral results.

Discussion

Consistent with hypotheses, results indicated that emotional stimuli presented in the T2 position attenuated the AB effect in controls and low negative symptom patients. In fact, unpleasant stimuli attenuated the AB effect in low negative symptom patients to a greater extent than controls, suggesting that these patients are particularly susceptible to having their attention reflexively drawn toward unpleasant information. In contrast, high negative

¹The decision to conduct both correlational and between-group analyses to examine the role of emotion-attention interactions and negative symptoms was made to accommodate competing views regarding the nature of negative symptoms, where there is no clear evidence as to whether a categorical or dimensional approach is most appropriate.

symptom patients did not show AB attenuation for emotional relative to neutral T2 stimuli, which is consistent with the hypothesis that these patients would fail to display a bottom-up competitive advantage for emotional stimuli.

When viewed in relation to the bottleneck theory described in the introduction, one interpretation of AB attenuation for emotional relative to neutral T2s, which was seen in our control and low negative symptom groups, is that emotional stimuli facilitate stage one attentional orienting, thereby allowing the representation of emotional T2s to survive their delayed stage two processing until after the processing of T1 is complete (see Anderson, 2005; Matthewson et al., 2008). However, it is also likely that emotional stimuli facilitate stage two activities and become subjected to enhanced working memory processes that facilitate accurate report at the end of the RSVP stream. Thus, controls and low negative symptom patients may show an attenuated AB in response to emotional stimuli as result of enhanced stage one orienting, stage two processes that facilitate encoding, or both processes in combination.

In contrast, high negative symptom patients may fail to show AB attenuation for T2 emotional stimuli because stage one attentional orienting is not fast or intense enough to enable emotional T2s to withstand the wait until T1 processing is completed. This explanation would suggest that the bottom-up competitive advantage that is typically seen for emotional stimuli is absent in high negative symptom patients, at least when emotional stimuli are presented within an environment that has multiple stimuli competing for selective attention. However, it is equally plausible that stage one orientation processes occur and emotional stimuli are detected, but subsequently fail to sufficiently activate encoding and consolidation processes at stage two, thereby keeping emotional stimuli from reaching awareness at the time of report.

Experiment 2

Overview—To follow-up the results of Experiment 1, we conducted a second experiment in a second sample of patients and controls using the T1 variant of the Emotional AB task. In this version, emotional words are presented in the T1, rather than T2 position, and the effect of attending to a T1 pleasant, unpleasant, or neutral word is examined in relation to accuracy for T2 neutral words at early and later lags. In healthy individuals, high arousal T1 unpleasant stimuli have been found to decrease the accuracy of T2 neutral stimuli falling within 500 ms of T1 (i.e., lags 1–3) (Matthewson et al., 2008; Stein et al., 2009; Schwabe et al., 2011). Importantly, this T1 effect has only been observed for high arousal unpleasant stimuli - it does not appear for moderate arousal unpleasant or pleasant stimuli. In contrast to the T2 paradigm, where the ability of emotional stimuli to capture bottom-up attention is indicated by the fact that emotional stimuli attenuate the AB effect, the influence of emotional stimuli on attention is reflected in an enhancement of the AB effect in the T1 version (i.e., T2 accuracy is lower following an emotional T1 than it is following a neutral T1). If results of our first experiment are reliable, then one would expect that a second sample of HI-NEG patients would also fail to show the typical emotional AB enhancement in the T1 version of the task and that LOW-NEG patients would show increased AB enhancement relative to controls. Furthermore, we predicted that AB enhancement would be true for controls and low negative symptom patients only for T1 high-arousal unpleasant words given that the effect of T1 emotional stimuli on T2 accuracy has been found to be specific to high arousal unpleasant stimuli in healthy individuals.

Method

Participants—Recruitment, diagnostic, and inclusion/exclusion procedures were identical to Experiment 1. Participants included 30 patients meeting DSM-IV-TR criteria for schizophrenia ($n = 25$) or schizoaffective disorder ($n = 5$) and 24 healthy controls (CN). Patients were also divided into High (HI-NEG) and Low Negative (LOW-NEG) symptom groups based upon a median split on the 22-item SANS total score using the procedures described in Experiment 1. The three groups did not significantly differ on age, parental education, gender, or ethnicity. HI-NEG and LOW-NEG patients significantly differed on the BPRS negative symptom factor score, but not on positive symptoms, disorganization, or the total scale score. HI-NEG and LOW-NEG patients were also prescribed a similar regimen of antipsychotic medications at the time of testing (see Table 3).

Measures—Participants completed the T1 version of the Emotional AB task. The T1 task differs from the T2 version conducted in Experiment 1 in that the emotional stimulus appears in the T1, rather than T2 position (see Figure 3). Task parameters were modeled after Anderson (2005) and Matthewson et al. (2008). Each trial consisted of 15 items, two targets (T1 and T2) and 13 distractors. T1 and T2 appeared in bright green while the distractor words appeared in black and were presented on a grey background. Stimuli were presented in uppercase and each item in the stream was presented for 175 ms and immediately followed by the subsequent stimulus. A total of seven lags were possible between T1 and T2, ranging from Lag 1 (no intervening items) to Lag 7 (6 intervening items). In the pleasant, unpleasant, and neutral T2 conditions, there were four trials for each combination of lag and condition, for a total of 84 experimental trials. There were also five practice trials. T1 appeared equally often in serial positions 2–5 of the 15-item stream. The serial position of T1 was crossed with T1–T2 lag and T1 type. Participants were asked to report the two green-colored targets that appeared within the stream of words. T1 consisted of three lists of 28 unpleasant, 28 pleasant, and 28 neutral words. T2 stimuli consist of 28 neutral words. Filler items were 60 neutral words. Words were selected from the ANEW stimulus set (Bradley & Lang, 1999). Pleasant, unpleasant, and neutral word conditions were equated for word length and frequency. T1 Pleasant and unpleasant words were significantly more arousing than T1 neutral words, but did not differ from each other in arousal. The three T1 conditions differed in valence, such that pleasant > neutral > unpleasant.

Results

One-way ANOVA indicated a significant difference in T1 total accuracy across groups, $F(2, 53) = 4.32$, $p < .02$. Post hoc LSD contrasts indicated that both HI-NEG ($p < .02$) and LOW-NEG ($p < .03$) had lower T1 performance than CN, but did not differ from each other ($p = .81$). A repeated measures ANOVA was used to examine potential differences in T1 performance per emotional condition across groups. Results indicated a nonsignificant T1 Emotion X Group interaction, $F(4, 51) = .60$, $p = .66$, although the within-subjects effect of Emotion, $F(2, 51) = 3.97$, $p < .03$, and between-subjects effect of group, $F(2, 51) = 4.32$, $p < .02$, were significant. One-way ANOVAs conducted separately for each emotion indicated group differences in T1 accuracy for pleasant, $F(2, 53) = 4.25$, $p < .02$, and neutral stimuli, $F(2, 53) = 5.83$, $p < .01$, but not unpleasant stimuli, $F(2, 53) = 2.39$, $p = .10$. Post hoc LSD contrasts for pleasant and neutral stimuli indicated that both HI-NEG and LOW-NEG had lower T1 accuracy than CN (p 's < 0.05), but did not differ from each other (p 's > 0.83). Thus, both patient groups demonstrated lower T1 performance than controls; however, there were no differences in T1 accuracy between HI-NEG and LOW-NEG groups or differences in the pattern of accuracy across emotions that might differentially influence interpretation of T2 accuracy results among groups.

T2 accuracy (neutral words) following correctly identified pleasant, unpleasant, and neutral T1 stimuli is presented in Figure 3. Differences in T2 accuracy were examined via a $3 \times 3 \times 7$ (Group [HI-NEG, LOW-NEG, CN] $\times$ Emotion [T1 Pleasant, Unpleasant, Neutral] $\times$ Lag [lags 1 through 7]) repeated measures ANOVA. The three-way Group $\times$ Emotion $\times$ Lag interaction was nonsignificant, $F(2, 53) = 1.22, p = .25$, as was the two-way Emotion $\times$ Lag interaction, $F(2, 53) = 1.25, p = .27$. There was a significant Emotion $\times$ Group, $F(2, 53) = 2.93, p < .03$ and Lag $\times$ Group interaction, $F(2, 53) = 3.24, p < .001$. The individual effects of lag, $F(6, 53) = 46.37, p < .001$ and group, $F(2, 53) = 6.51, p < .01$, were significant, but emotion was not, $F(2, 53) = 1.83, p = .17$.

To follow up the significant interaction effects and test for hypothesized differences in T2 accuracy following unpleasant T1 words, we calculated difference scores by subtracting each participant's mean accuracy for T2 neutral stimuli following T1 Emotional stimuli from the mean accuracy for T2 neutral stimuli following T1 neutral stimuli at early lags (1–3). Negative difference scores reflect the pattern of results typically seen in healthy people, and indicate enhancement of the AB effect at early lags following emotional relative to neutral T1s. One-way ANOVAs indicated significant group differences on the Unpleasant-Neutral difference score, $F(2, 53) = 5.38, p < .001$; however, the Pleasant-Neutral difference score was nonsignificant, $F(2, 53) = 2.64, p = .08$. Post hoc LSD contrasts indicated that LOW-NEG showed significantly more AB enhancement for unpleasant words than HI-NEG ($p < .01$) and CN ($p < .01$); however, there were no differences between HI-NEG and CN ($p = .55$). Thus, LOW-NEG showed significant modulation of the AB effect for unpleasant stimuli, while HI-NEG did not.

We also calculated difference scores for high and medium arousal unpleasant words to examine the hypothesized effect of T1 unpleasant stimulus arousal on T2 performance (see Figure 4). High and medium arousal unpleasant stimulus conditions were determined by taking a median split of the normative ANEW arousal ratings (combined male and female norms) for the unpleasant stimuli included in the experiment: mean arousal for high words = 7.5 ($SD = .28$); mean arousal for moderate words = 6.7 ($SD = .29$). One-way ANOVAs indicated a significant Group difference for the high arousal words, $F(2, 53) = 4.06, p < .03$, but not the moderate arousal unpleasant words, $F(2, 53) = 2.22, p = .12$. LSD contrasts on the high arousal difference score condition indicated that LOW-NEG showed more AB enhancement than HI-NEG ($p < .01$) or CN ($p < .04$); however, HI-NEG and CN did not differ ($p = .35$). Paired-samples t-tests indicated that CN and LOW-NEG showed poorer T2 accuracy following high arousal unpleasant than neutral T1s (p 's $< .05$); however, HI-NEG patients did not ($p = .68$). None of the groups showed a significant difference between moderate arousal and neutral stimuli. As can be seen in Figure 5, results indicate that high arousal unpleasant words enhanced the AB effect in LOW-NEG patients and CN, and this effect was not present in HI-NEG patients.

Within-group paired samples t-tests were conducted to directly test the impact of T1 emotional stimuli on T2 accuracy and to determine whether individual groups displayed the prototypical pattern of AB enhancement as result of high arousal unpleasant relative to neutral T1 words. Controls showed no differences in T2 accuracy between conditions with preceding T1 neutral and T1 unpleasant stimuli broadly defined ($t = -0.01, p = 0.99$), moderate-arousal unpleasant and neutral stimuli ($t = -1.5, p = 0.15$), or emotional (average of pleasant and unpleasant) and neutral stimuli ($t = -1.04, p = 0.31$). However, CN had lower T2 accuracy for stimuli preceded by high arousal T1 unpleasant than T1 neutral stimuli ($t = 1.98, p < 0.05$), supporting the hypothesized selective AB enhancement for high arousal unpleasant stimuli. CN also showed higher T2 accuracy for stimuli with preceding T1 pleasant than neutral words ($t = -2.4, p < 0.03$). LOW-NEG patients also displayed the prototypical selective AB enhancement for T2 stimuli preceded by high arousal T1

unpleasant stimuli compared to those preceded by T1 neutral stimuli ($t = 3.67, p < 0.01$), and differences in T2 accuracy between neutral and unpleasant stimuli broadly defined ($t = 4.07, p < 0.001$) and neutral and emotional stimuli ($t = 3.58, p < 0.01$). The pleasant vs. neutral ($t = 1.27, p = 0.23$) and moderate arousal unpleasant vs. neutral ($t = 1.46, p = 0.17$) contrasts were nonsignificant in LOW-NEG. In HI-NEG patients, all paired sample contrasts were nonsignificant: neutral vs. unpleasant ($t = -0.75, p = 0.47$), neutral vs. high arousal unpleasant ($t = 0.42, p = 0.68$), neutral vs. moderate arousal unpleasant ($t = -1.2, p = 0.22$), neutral vs. pleasant ($t = -0.22, p = 0.83$), neutral vs. emotional ($t = -0.62, p = 0.55$). Thus, results indicate that CN and LOW-NEG demonstrated the hypothesized effect of poorer accuracy for T2s preceded by high arousal unpleasant T1s, whereas HI-NEG patients showed no effects of T1 emotionality on T2 accuracy.

Correlational analyses indicated that the Unpleasant-Neutral difference score at early lags was significantly correlated with the SANS total score and the SANS EE domain, but not the SANS AA domain (see Table 4). Additionally, the high arousal unpleasant word difference score showed significant relationships with the SANS total and SANS EE domain, while the moderate arousal unpleasant word difference score did not. The tests for significant differences in correlations between the SANS EE and AA domains were nonsignificant for unpleasant words and high arousal unpleasant words. There were no significant associations with the pleasant-neutral difference score, and no significant relationships between task performance and Positive, Disorganized, Depressed, or Anxious symptoms rated on the BPRS.

Discussion

As hypothesized, unpleasant words enhanced the AB effect in controls and low negative symptom patients. However, this was only true of high arousal unpleasant T1 words, as moderate arousal unpleasant T1 words did not significantly differ from neutral T1s in their effect on T2 accuracy in either group. When interpreted through the lens of the two-stage bottleneck theory of the AB (Chun & Potter, 1995; Jolicoeur, 1999), these results may suggest that high arousal unpleasant words receive increased attention at stage two, thereby making too few resources available to accurately report T2 neutral words occurring close in time. Although unpleasant T1 words also likely affect stage one processing, we doubt that enhanced attentional orienting alone is sufficient to cause such a prolonged effect that it would impair accuracy for neutral T2s falling more than 500 ms after T1. In the case of low negative symptom patients, the most likely explanation is therefore that some combination of increased stage one orienting and stage two encoding and consolidation causes AB enhancement following unpleasant stimuli.

Also as hypothesized, high negative symptom patients showed no evidence of AB enhancement following unpleasant T1 stimuli. This was true of both high and moderate arousal unpleasant stimuli. The lack of a differential reduction in T2 accuracy following unpleasant compared to neutral stimuli suggests that emotional stimuli failed to influence stage one or stage two processing in the expected manner, which similar to Experiment 1, is consistent with the notion that the bottom-up advantage for emotional stimuli is reduced in high negative symptom patients. Given that high and low negative symptom patients did not differ in T1 accuracy for unpleasant stimuli, it is not that high negative symptom patients are simply insensitive to emotional content. Rather, it appears that in high negative symptom patients, emotional stimuli fail to enhance attentional orienting and encoding processes in a way that preferentially promotes the gating of those stimuli into awareness at the expense of other stimuli competing for selective attention.

General Discussion

Across two experiments we found evidence that emotional stimuli modulated the AB effect in the expected manner in controls and low negative symptom patients. In fact, in each experiment, the influence of unpleasant stimuli on attention was even more pronounced for low negative symptom patients than controls. This suggests that these patients are particularly susceptible to attending to aversive content in the midst of other stimuli competing for selective attention. In Experiment 1 this pattern of behavioral performance was associated with depression, and it was associated with anxiety at a trend level in Experiment 2. Although the correlations were not statistically significant in both experiments, these patterns of relationships are consistent with results often found in other psychiatric diagnoses, where it is known that the stimulus-driven, bottom-up attentional system is more affected by unpleasant stimuli in individuals with heightened anxiety and/or depression (Williams, Matthews, & MacLeod, 1996). Much like these other disorders, the influence of unpleasant stimuli on attention was present even when cognitive demands were highest (i.e., early lags) and the processing capacity to utilize attentional control was reduced (Fox, et al., 2005).

A different pattern of performance was observed in schizophrenia patients with elevated negative symptoms. Across both experiments, high negative symptom patients failed to show the expected patterns of AB modulation in response to emotional stimuli. Emotional stimuli therefore appear to have no more influence than neutral stimuli on stage one orienting or stage two encoding. These findings support the results of other experiments indicating that the bottom-up competitive advantage for emotional stimuli is reduced in high negative symptom patients (Strauss et al., 2008; Strauss et al., in preparation); however, they contradict other studies reporting behavioral and neural evidence for relatively intact emotion-attention interactions in patients (Anticevic et al., in press; Horan et al., in press; Strauss, Llerena, Gold, 2012). There are several important differences among these studies. One important difference relates to task design and stimulus parameters. Both Strauss et al. (2012) and Anticevic et al. (in press) examined the interaction between top-down attention and unpleasant stimuli, and the modified visual P300 task by Horan did not put emotional and target stimuli in concurrent competition for selective attention. It is possible that top-down emotion-attention interactions are intact, and that deficits are only seen when tasks index the interaction between emotional stimuli and bottom-up attention when target and affective stimuli are in competition for selective attention. Furthermore, the current study directly manipulated arousal level of stimuli and found arousal-related differences, whereas prior schizophrenia studies used stimuli that were only moderate in arousal and did not analyze arousal effects (Anticevic et al., in press; Horan et al., in press). The current findings and those of numerous prior studies on emotion-attention interactions (e.g., Anderson, 2005) suggest that arousal, rather than valence, is key in influencing attention. It will therefore be important for future studies to include stimuli of high, medium, and low arousal to examine these effects. There may also be important differences in stimulus type, as Anticevic et al. (in press) and Horan et al. (in press) used photographs, and we used words. Finally, symptom assessment differed across these studies, with differences in scale and analysis type. The current study and Anticevic et al. (in press) used the SANS, whereas Horan et al. used the BPRS. The SANS allows for an assessment of avolition/anhedonia domains, which may be more strongly related to emotion-attention deficits, whereas the BPRS does not. Additionally, we often find group differences in behavioral performance when between-group analyses are conducted on negative symptoms, such as those done here using a median split, even in the absence of significant correlations. Future studies may therefore want to examine the role of negative symptoms from both a categorical and dimensional framework. Finally, we suspect that timing parameters and task demands may determine whether emotional stimuli are evaluated sufficiently to generate an emotional experience

that is intense enough to bias attentional selection. Indeed, this appears to be the case in some recent studies where task parameters allowed for elaborative processing, and it was found that patients had normal or greater modulation of attention by emotional stimuli than controls (e.g., Anticevic et al., in press; Horan et al., 2010, in press; Strauss et al., 2012). In contrast, when completing a paradigm such as the emotional AB, emotional stimuli may not cross that threshold and evoke emotional experience because they are overwritten by competing stimuli within the RSVP stream. Whether patients display normal or diminished emotion-attention interactions may therefore be determined by the extent to which different task environments permit elaborative processing of emotional stimuli. In this regard, the AB task is quite different from tasks that allow for extended viewing and uninterrupted processing of emotionally salient stimuli, and may offer valuable insight into whether emotionally arousing stimuli influence attention in the midst of ongoing task-relevant processing of distractors competing for selective attention.

Acknowledgments

Research supported in part by US National Institutes of Mental Health Grants:

K23MH092530 to Dr. Strauss

R01MH080066 to Dr. Gold.

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Appendix

Emotional and Neutral Words used in T2 and T1 Emotional AB Tasks

T1 List for T2 Task/T2 List for T1 Task	Unpleasant	Pleasant	Neutral
TAXI	TUMOR	HAPPY	PAPER
BARREL	TENSE	LUCKY	TABLE
INK	NERVOUS	VICTORY	BUTTER
PIG	HATRED	FIREWORKS	MANTEL
CHAIR	AFRAID	BIRTHDAY	CABINET
TRUNK	MAD	PARTY	STATUE
APPLIANCE	TROUBLE	JOKE	BOWL
CLOCK	VIOLENT	LAUGHTER	VIOLIN
JOURNAL	ANXIOUS	TREASURE	BUS
UMBRELLA	CONFUSED	EXERCISE	MUSEUM
ENGINE	HATE	LUST	PAMPHLET
HISTORY	PANIC	FLIRT	COLUMN
LAWN	SCREAM	ADVENTURE	CORRIDOR
MATERIAL	BOMB	INTIMATE	BASKET
FINGER	FIGHT	FUN	HUMBLE
BUILDING	ANGER	JOY	CORK
TOWER	ANGRY	EROTIC	LAMP

T1 List for T2 Task/T2 List for T1 Task	Unpleasant	Pleasant	Neutral
WRITER	FIRE	PASSION	ELBOW
WINDMILL	BETRAY	KISS	HEADLIGHT
LIGHTBULB	TERRORIST	DESIRE	SALAD
MARKET	DANGER	CASH	MACHINE
TEACHER	MURDERER	ECSTASY	BANNER
FROG	ASSAULT	SURPRISED	ERRAND
BOOK	NIGHTMARE	ROMANTIC	BATHROOM
POETRY	PANIC	MIRACLE	BANDAGE
STREET	KILLER	EXCITEMENT	STOMACH
OFFICE	TERRIFIED	WIN	INHABITANT
ANKLE	ENRAGED	THRILL	WINDOW

T2 Emotional AB

Figure 1.

Example of Trial Sequence for T2 Emotional AB Task in Experiment 1 and T1 Emotional AB Task in Experiment 2

Note. A total of 15 words are presented within the RSVP stream, 13 displayed in black and two targets (T1 and T2) displayed in green.

Figure 2.
Proportion of Correctly Recalled T2 Pleasant, Unpleasant, or Neutral Words as a Function of Lag in Individuals with Schizophrenia and Controls

Figure 3.

Proportion of Correctly Recalled T2 Neutral Words as a Function of Lag in Individuals with Schizophrenia and Controls when Pleasant, Unpleasant, or Neutral Stimuli are in the T1 Position

Figure 4.
Proportion of Correctly Recalled T2 Words following a highly or moderately Arousing Unpleasant T1 Word as a Function of Lag in Individuals with Schizophrenia and Controls

Table 1

Experiment 2 Characterizing Data for Individuals with Schizophrenia and Controls

	HI-NEG (<i>n</i> = 17)	LOW-NEG (<i>n</i> = 16)	CN (<i>n</i> = 28)	Test Statistic	<i>p</i>
Age	40.9	40.0	39.8	$F = .10$	.90
Parental Education	11.6	14.4	14.0	$F = 7.8$	<.01
% Male	82.4%	43.8%	64.3%	$\chi^2 = 6.7$	.15
Race				$\chi^2 = 6.8$	.55
Caucasian	41.2%	56.3%	53.6%		
African-American	47.1%	43.8%	42.9%		
Asian	5.9%	0.0%	0.0%		
American Indian or Alaskan Native	5.9%	0.0%	0.0%		
Other	0.0%	0.0%	3.6%		
Antipsychotic Medications					
% Conventional	13.3%	28.6%	--	$\chi^2 = 1.03$	.39
% Atypical	86.7%	85.7%	--	$\chi^2 = .01$	.99
SANS Total	49.5	22.4	--	$F = 52.2$	<.001
BPRS Symptoms					
Positive	2.6	2.6	--	$F = .02$	.90
Negative	2.3	1.5	--	$F = 14.0$	<.001
Disorganized	1.4	1.4	--	$F = .17$	.68
Total	40.9	35.8	--	2.86	.10

Table 2

Correlations between Emotional AB T2 Task Performance at Early Lags and Clinical Symptom Severity in Individuals with Schizophrenia

	Unpleasant-Neutral Early Lags	Pleasant-Neutral Early Lags
SANS Total	-.41 [*]	-.22
SANS AA	-.45 ^{**}	-.28
SANS EE	-.28	-.12
BPRS Positive	-.18	-.05
BPRS Disorganized	-.05	.06
BPRS Depression	.38 [*]	.08
BPRS Anxiety	.11	.15

Note.

^{**}
p < 0.01,

^{*}
p < 0.05.

SANS = Scale for the Assessment of Negative Symptoms; SANS AA = Average of SANS Avolition, Anhedonia/Asociality items; SANS EE = Average of SANS Restricted Affect and Alogia items; BPRS = Brief Psychiatric Rating Scale

Table 3

Experiment 2 Characterizing Data for Individuals with Schizophrenia and Controls

	HI-NEG (<i>n</i> = 16)	LOW-NEG (<i>n</i> = 14)	CN (<i>n</i> = 24)	Test Statistic	<i>p</i>
Age	42.9	44.0	44.0	$F = .08$	.93
Parental Education	12.8	14.4	13.1	$F = 1.46$	.24
% Male	75.0%	71.4%	58.3%	$\chi^2 = 2.24$	.69
Race				$\chi^2 = 6.78$	.56
Caucasian	62.5%	64.3%	58.3%		
African-American	31.3%	28.6%	41.7%		
Asian	0.0%	0.0%	0.0%		
American Indian or Alaskan Native	6.3%	0.0%	0.0%		
Other	0.0%	7.1%	0.0%		
Antipsychotic Medications					
% Conventional	15.4%	14.3%	--	$\chi^2 = .01$	.94
% Atypical	93.8%	78.6%	--	$\chi^2 = 1.49$	.32
SANS Total	48.8	23.1	--	$F = 49.5$	< .001
BPRS Symptoms					
Positive	2.3	2.6	--	$F = .32$	.58
Negative	2.3	1.5	--	$F = 18.0$	< .001
Disorganized	1.4	1.2	--	$F = 1.3$	.26
Total	38.4	34.7	--	$F = 1.0$	.32

Table 4

Correlations between Emotional AB T1 Task Performance at Early Lags and Clinical Symptom Severity in Individuals with Schizophrenia

	Unpleasant-Neutral	Pleasant-Neutral	Hi-Arousal Unpleasant-Neutral	Mod-Arousal Unpleasant-Neutral
SANS Total	.44 *	.10	.42 *	.20
SANS AA	.26	.02	.17	.10
SANS EE	.37 *	.14	.48 **	.13
BPRS Positive	-.02	-.27	-.11	-.06
BPRS Disorganized	.06	.01	-.02	.05
BPRS Depression	-.05	-.19	.01	-.11
BPRS Anxiety	-.24	.06	-.29	-.01

Note.

**
p < 0.01,

*
p < 0.05.

SANS = Scale for the Assessment of Negative Symptoms; SANS AA = Average of SANS Avolition, Anhedonia/Asociality items; SANS EE = Average of SANS Restricted Affect and Alogia items; BPRS = Brief Psychiatric Rating Scale; Hi-Arousal = High arousal unpleasant stimuli; Mod-Arousal = Moderate Arousal Unpleasant stimuli.