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Differential Patterns of Association Between the Behavioral Approach System and an Emotion Regulation Task in Patients Diagnosed with Bipolar Disorder and Healthy Controls

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B.A., Connecticut College, 2008

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Abstract

Differential Patterns of Association Between the Behavioral Approach System and an Emotion Regulation Task in Patients Diagnosed with Bipolar Disorder and Healthy Controls

By Colleen M. Cowperthwait

Individuals with bipolar disorder display both emotion regulation (ER) deficits and Behavioral Approach System (BAS) hypersensitivity. We examined associations between ER and the BAS among bipolar and control individuals. We compared 11 bipolar and 11 demographically matched control individuals using self-report BAS sensitivity and ER measures and reaction time (RT) and accuracy on the Affective Stroop Task, which examines the impact of emotional stimuli goal-directed processing while completing a numerical Stroop task. Between-group analyses indicated that bipolar subjects have ER difficulties not attributable to manic or depressive symptoms. Between-group analyses indicated that bipolar and control subjects did not differ significantly on RT or accuracy of performance on the Affective Stroop Task. However, bipolar participants, but not control participants, were significantly slower to respond to incongruent trials than congruent trials, regardless of emotion. Regression analyses indicated that, among bipolar participants but not control participants, self-reported ER difficulties and BAS sensitivity differentially predicted RTs. Results suggest a differential pattern of association between the BAS and the ER system among bipolar and healthy individuals.

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Bipolar disorder is a serious, chronic, and debilitating psychological disorder characterized by significant morbidity and mortality. Bipolar disorder is associated with high cost-of-illness, including work impairment and years of life lost to death or disability (Kessler et al., 2006; Murray & Lopez, 1997). The lifetime prevalence of bipolar disorder is approximately 1.0% for bipolar I (BP-I), 1.1% for bipolar II (BP-II), and 2.4% for bipolar disorder-not otherwise specified (BP-NOS) (Kessler et al., 2005; Merikangas et al., 2007).

Behavioral and mood dysregulations, including high emotional reactivity, are characteristic of bipolar disorder (Hirshfeld-Becker et al., 2003). Individuals with bipolar disorder display both emotion regulation deficits and Behavioral Approach System hypersensitivity (Liu, 2010). The *emotion regulation* (ER) system is conceptualized as a constellation of cognitive systems involved in processing emotional stimuli and controlling emotional responses (Muralidharan, Yoo, Ritschel, Simeonova, & Craighead, 2010). The *Behavioral Approach System* (BAS) is a neurobiological system underlying aspects of motivation and personality traits (e.g., impulsivity), that also processes and responds to stimuli associated with reward and avoidance of punishment (Alloy & Abramson, 2010; Nusslock, Abramson, Harmon-Jones, Alloy, & Coan, 2009). Both the ER system and the BAS are implicated in initiating and regulating goal-directed behavior. There may be a constellation of personality traits and reward/failure sensitivities involving these two regulation systems that, together, contribute to the course of bipolar illness (Depue, Krauss, & Spoont, 1987; Urošević, Abramson, Harmon-Jones, & Alloy, 2008). The present study explores associations between the ER system

and the BAS, as well as the relationship of these systems to the presentation of bipolar illness.

Emotion Regulation

Emotion regulation can be defined as effortful control over one's emotions in order to achieve a particular goal (Muralidharan et al., 2010) and comprises many cognitive processes, including detection of environmental stimuli, socioemotional cue processing, selective attention, prepotent response inhibition, planning of behavior, executive function, and cognitive control processes (Dickstein & Leibenluft, 2006; Gratz & Roemer, 2004; McClure-Tone, 2009; Muralidharan et al., 2010). Neuroanatomically, the emotion regulation system includes the prefrontal cortex, amygdala, and striatum (Chang, Blasey, Ketter, & Steiner, 2003; Dickstein & Leibenluft, 2006; Eisenberg, Fabes, Guthrie, & Reiser, 2000; Hirshfeld-Becker et al., 2003; Phillips, Ladouceur, & Drevets, 2008).

More specifically, emotion regulation involves deploying attention in order to moderate mood and behavior (Rich et al., 2010). Appropriate emotional expressiveness and effortful emotional control through planning and directing attention characterize effective emotion regulation (Muralidharan et al., 2010). Consequently, irritability and high emotional reactivity, which are characteristic of bipolar disorder, suggest impairment of the emotion regulation system (Dickstein & Leibenluft, 2006). However, little is known about which specific processes within the emotion regulation system are implicated in bipolar disorder (Gruber, Harvey, & Gross, 2012).

Emotion regulation can be studied by examining components of the cognitive processes listed above, including cognitive control processes and the detection of both

emotional and non-emotional environmental stimuli (Dickstein & Leibenluft, 2006; McClure-Tone, 2009; Phillips et al., 2008). Few studies have examined which specific components of emotion regulation are implicated in bipolar disorder (Gruber et al., 2012). Compared to healthy controls, children, adolescents, and adults with bipolar disorder show deficits in socioemotional cue processing (e.g., accurate facial expression processing) that may negatively impact social functioning (McClure-Tone, 2009). In one study, children and adolescents with bipolar disorder exhibit impairment in accurately identifying and categorizing facial emotions when compared to healthy controls (Rich et al., 2006).

The relationship between emotion regulation and cognitive control is especially relevant when examining mood disorders. The ability to focus attention in emotional contexts is important for information processing and moderating cognition, mood, and behavior (Rich et al., 2010). Individuals with bipolar disorder show deficits in cognitive and behavioral flexibility, i.e., the ability to adapt to changing environmental stimuli and demands (McClure-Tone, 2009; Rich et al., 2010). For example, when compared to healthy controls, adolescents and adults with bipolar disorder exhibited deficits on non-affective tasks that require cognitive flexibility, such as the Wisconsin Card Sort Task (McClure-Tone, 2009). Individuals with bipolar disorder also show impairments in shifting and focusing attention on cognitive tasks with an affective component (Murphy et al., 1999; Rich et al., 2010) and differ from healthy controls in patterns of brain activation during both emotional and non-emotional Stroop tasks (McClure-Tone, 2009).

Individuals with bipolar disorder may preferentially attend to emotionally salient stimuli rather than task-relevant stimuli, thereby impairing goal-directed processing

(Blair et al., 2007; Rich et al., 2010). For example, individuals with abnormalities on a particular allele associated with mood disorders display preferential attention for anxious word stimuli (Beevers, Gibb, McGeary, & Miller, 2007). Further, compared children diagnosed with bipolar disorder, control children, and children with "severe mood dysregulation," a pediatric syndrome characterized by chronic anger and irritability, hyperresponsivity to negative emotional stimuli, distractibility, and psychomotor agitation, on a goal-directed behavioral task in the presence of positive, negative, and neutral pictures. Children with bipolar disorder were slower than children with severe mood dystregulation and less accurate than control children on this task (Rich et al., 2010). These findings suggest that individuals with bipolar disorder may display a unique pattern of deficits on tasks that require cognitive flexibility and selective attention to emotional stimuli (McClure-Tone, 2009).

In summary, the emotion regulation system comprises a variety of subprocesses, including selective attention, planning of behavior, and cognitive control processes (Muralidharan et al., 2010). Individuals with bipolar disorder display deficits on tasks tapping these domains, including appropriate attention to emotional stimuli (McClure-Tone, 2009), a process which is central to effective moderation of mood and behavior (Rich et al., 2010). However, the impact of emotion regulation on goal directed processing and behavior remains unclear (Blair et al., 2007). In order to evaluate a possible relationship between emotion regulation and trait-like goal-directed behavior in bipolar disorder, we will briefly review what is known about systems that regulate goal-directed behavior.

The Behavioral Approach System

The BAS is one of two psychobiological systems crucial to regulating behavior (Meyer, Johnson, & Carver, 1999; Nusslock et al., 2009). Specifically, it is hypothesized to regulate approach behaviors in response to rewarding stimuli in order to obtain rewards or avoid punishment (Hirshfeld-Becker et al., 2003; Nusslock et al., 2009). That is, the BAS interprets how rewarding the environment is and initiates approach and goal-directed behavior. The BAS is related to trait impulsivity, sensation seeking, high activity level, and the personality dimensions of Extraversion and Positive Emotionality (Alloy, Urošević, Bender, Wagner, & Abramson, 2009; Derryberry & Rothbart, 1997). Conversely, the *Behavioral Inhibition System* (BIS), is thought to regulate inhibition of behavior in response to novelty or threat (Derryberry & Rothbart, 1997; Nusslock et al., 2009). Alloy and colleagues hypothesize that the BAS regulates both positive and negative emotions, as well as reactions to events involving striving toward a goal or avoiding punishment. Consequently, individuals with a hyper-responsive BAS may be especially sensitive to reward (Alloy et al., 2008).

It is hypothesized that hypersensitivity or dysregulation of the BAS may be a risk factor for lifetime diagnosis of bipolar disorder as well as both (hypo)manic and depressive symptoms and mood episodes (Alloy et al., 2006; Depue et al., 1987; Hirshfeld-Becker et al., 2003; Nusslock et al., 2009; Urošević et al., 2008). According to the BAS dysregulation theory of bipolar disorder, individuals with bipolar disorder have an overly sensitive BAS that is hyperresponsive to BAS-relevant cues (e.g., life events related to goal attainment or reward, such as a final exam or professional promotion) (Johnson et al., 2000; Nusslock et al., 2009; Nusslock, Abramson, Harmon-Jones, Alloy,

& Hogan, 2007; Urošević et al., 2008). For example, both individuals with bipolar I disorder and individuals at clinical high risk for hypomania reported high levels of BAS sensitivity (Carver & White, 1994), or responsiveness to BAS-relevant stimuli (Nusslock et al., 2009). In a review of longitudinal predictors of bipolar diagnosis, Alloy et al. (2009) found that individuals with high BAS sensitivity were six times more likely to receive a bipolar disorder diagnosis than individuals with moderate BAS sensitivity (Alloy et al., 2006; Alloy, Urošević et al., 2009). Furthermore, a recent study using survival analysis determined that high BAS sensitivity predicted greater likelihood of mood episodes and shorter time to onset of mood episodes among euthymic individuals with bipolar disorder (Alloy et al., 2008).

Manic symptoms such as impulsivity, sensation seeking, euphoria, irritability, optimism, excessive self-confidence, decreased need for sleep, and distractibility may reflect BAS hyperresponsivity (Alloy et al., 2008; Depue et al., 1987). An excessive decrease in BAS activity in response to failure or nonattainment of a goal might result in depressive symptoms such as sadness, low energy, anhedonia, psychomotor retardation, and hopelessness (Depue et al., 1987; Nusslock et al., 2009). Therefore, high approach tendencies, BAS dysregulation, and hypersensitivity to reward and failure cues may be a risk factor for mood episodes and bipolar disorder.

Aims and Hypotheses of Current Study

The present study investigates emotion regulation and the Behavior Approach System in order to identify potential common components of these regulatory systems that together contribute to the course of bipolar illness. In order to examine how both ER and the BAS affect attention and behavior, we correlated performance on a cognitive task

involving emotionally-valenced pictorial stimuli with BAS sensitivity, including impulsivity and sensitivity to reward and failure. Given preliminary evidence that bipolar individuals exhibit emotion regulation deficits and may exhibit preferential attention to emotionally salient stimuli, it was hypothesized that: (i) compared to matched controls, bipolar subjects would exhibit longer reaction times and lower accuracy scores on a goal-directed cognitive task with emotionally-valenced pictorial stimuli; (ii) compared to matched controls, bipolar individuals would endorse more BAS sensitivity, more sensitivity to reward, and more emotion dysregulation; and (iii) BAS sensitivity would predict reaction times and accuracy scores on the emotion regulation task, indicating a stable relationship between these cognitive and neurobiological systems that may predict both approach behaviors and preferential attention to emotional stimuli among individuals with bipolar disorder.

Method

Participants

Participants in this study were sampled from the larger Family Environment and Emotion Regulation in Bipolar Disorder study, which investigates correlates of parental criticism on the course of illness in bipolar adults. To achieve the aforementioned aims, participants in the current study completed additional measures to those administered in the Family Environment study protocol. Table 1 presents the demographic data for the sample included in the present analyses.

Clinical participants were recruited from a residential treatment facility in Atlanta, Georgia. Bipolar participants must have been stabilized on a pharmacotherapy regimen of a mood stabilizer and/or atypical antipsychotic for at least seven days. In addition,

participants must not have met full criteria for a current manic or hypomanic episode or psychotic symptoms or imminent suicidality. Participants reporting a history of parental abuse or neglect, current or comorbid post-traumatic stress disorder, or borderline personality disorder were also excluded.

The bipolar sample included 10 Bipolar I participants and 1 Bipolar II participant. Bipolar participants were taking between one and five psychotropic medications (mean 2.6 ± 1.0), had been hospitalized between one and twenty-six times (mean 4.5 ± 7.7), and had attempted suicide between zero and three times (mean .8 ±1.2). The mean Global Assessment of Functioning (GAF) score was 50 (mean = 47.4 ± 5.7), indicating serious symptoms and/or impairment in functioning.

Control subjects were recruited from the Emory University, Georgia State University, and Atlanta communities via flyers and online advertising. Controls were matched for gender, age, and years of education. Control participants must not have had any past or present Axis I Disorder, according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV-TR) (American Psychiatric Association, 2000). Control participants also must not have had significant symptoms of mania or depression or history of parental abuse or neglect, and must not be currently taking any psychotropic medications.

Measures

Interview measures. The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) is a semi-structured interview designed to assess current and lifetime diagnoses of DSM-IV Axis I disorders (First, Spitzer, Gibbon, & Williams, 1995). It has demonstrated good test-retest (Kappa values range from 0.54 to 0.85) and inter-rater

reliability (Kappa values range from 0.61 to 0.83) (Lobbestael, Leurgans, & Arntz, 2011; Williams et al., 1992). The SCID was used to determine study eligibility. The Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II) is a semi-structured interview designed to assess for DSM-IV Axis II: Personality Disorder diagnoses (First, Spitzer, Gibbon, Williams et al., 1995). The Borderline Personality Module of the SCID-II was administered to determine eligibility for the subjects in the study. The Borderline Personality Disorder Module has demonstrated good test-retest (Kappa values range from .40 to .57) and inter-rater (Kappa values = 0.91) reliability (First, Spitzer, Gibbon, Williams et al., 1995; Lobbestael et al., 2011). Subjects who met criteria for Borderline Personality Disorder were excluded from the study.

The Young Mania Rating Scale (YMRS) is an 11-item clinician-administered interview measure used to assess the severity of manic symptoms over the past week. It has good inter-rater reliability and construct validity (Young, Biggs, Ziegler, & Meyer, 1978). Control subjects who scored eight or greater on the YMRS were excluded from the study. The Hamilton Depression Rating Scale (HDRS) is a 17-item clinician-administered interview measure used to assess the severity of depression symptoms over the past week. It has demonstrated good inter-rater reliability and construct validity (Hamilton, 1960). Control subjects who scored eight or greater on the HDRS were excluded from the study.

Self-report measures. The Beck Depression Inventory – 2nd edition (BDI-II) is a 21 item self-report questionnaire that assesses the severity of affective, motivational, cognitive, and somatic symptoms of depression over the past week. The BDI-II has demonstrated strong internal consistency ($\alpha = 0.93$) for young adults, test-retest

reliability (one-week reliability of 0.93), and construct validity (Beck, Steer, & Brown, 1996; Steer, Ball, Ranieri, & Beck, 1997).

The Behavioral Inhibition System/Behavioral Approach System Scales (BIS/BAS) are two self-report scales used to assess individual differences in the sensitivity of two motivational systems that underlie behavior, the behavioral inhibition system (BIS) and the behavioral approach system (BAS). The scales consist of 20 items on a 4-point Likert-type scale ranging from "strongly disagree" to "strongly agree." The scales comprise three BAS subscales: Reward Responsiveness (e.g., "When I get something I want, I feel excited and energized"), Drive (e.g., "I go out of my way to get things I want"), and Fun-Seeking (e.g., "I'm always willing to try something new if I think it will be fun"), and one BIS subscale (e.g., "I worry about making mistakes") (Carver & White, 1994). The BIS/BAS scales have demonstrated good construct validity, including associations with personality traits and performance on reaction time and incentive tasks (Alloy, Bender et al., 2009). All subscales have adequate internal consistency (α's range from 0.66 to 0.74) (Alloy et al., 2008) and test-retest reliability (two-month reliabilities range from 0.59 to 0.69) (Alloy et al., 2006).

The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) is a 48-item self-report questionnaire made up of a 24-item Sensitivity to Punishment (SP) scale and a 24-item Sensitivity to Reward (SR) scale. Each item on both scales is rated either "yes" or "no." The SP scale assesses reactivity to punishment and cognitive processes related to punishment and failure, and it measures individual differences in anxiety and the activity of the BIS (e.g., "Do you often refrain from doing something because you are afraid of it being illegal?"). The SR scale assesses individual differences

in impulsivity and sensitivity to specific rewards in a variety of situations (e.g., "Does the good prospect of obtaining money motivate you strongly to do some things?"). The SPSRQ has demonstrated good internal consistency (α's range from 0.75 to 0.83) (Alloy et al., 2006) and test-retest reliability (three month reliability of .87 for the SR scale and .89 for the SP scale) (Alloy et al., 2006). It has also demonstrated convergent and discriminant validity. The SP scale is positively correlated with other BIS measures and the personality dimension of Neuroticism. The SR scale is positively correlated with other BAS measures and the personality dimension of Extraversion and nonsignificantly correlated with other BIS measures (Cooper & Gomez, 2008; Torrubia, Ávila, Moltó, & Caseras, 2001).

The Difficulties in Emotion Regulation Scale (DERS) is a 36-item self-report questionnaire measuring individual's typical levels of difficulties with emotion dysregulation across various domains, including Nonacceptance of Emotional Responses (e.g., "When I'm upset, I become angry with myself for feeling that way"), Difficulties Engaging in Goal-Directed Behavior (e.g., "When I'm upset, I have difficulty concentrating"), Impulse Control Difficulties (e.g., "When I'm upset, I have difficulty controlling my behaviors"), Lack of Emotional Awareness (e.g., "When I'm upset, I acknowledge my emotions" (reverse scored)), Limited Access to Emotion Regulation Strategies (e.g., "When I'm upset, it takes me a long time to feel better"), and Lack of Emotional Clarity (e.g., "I am confused about how I feel"). Higher scores indicate greater difficulties in emotion regulation. The DERS has demonstrated high internal consistency ($\alpha = 0.93$, $\alpha > 0.80$ for each subscale), test-retest reliability (eight week reliabilities range

from 0.57 to 0.89 for all subscales), and convergent, construct and predictive validity of behavioral outcomes associated with emotion dysregulation (Gratz & Roemer, 2004).

Task. The Affective Stroop Task is a computer-based emotion regulation task, which examines the impact of positive and negative emotional stimuli on attention and goal-directed processing while completing a numerical Stroop task. Participants are presented with a 9-point grid containing some asterisks and some numbers, followed by a stimulus picture of positive, negative, or neutral emotional valence. This is followed by another a grid of numbers and asterisks, followed by the same emotional stimulus (for example, two 3's → picture of a snake → four 6's → picture of a snake). Subjects are instructed to indicate which grid contained more numbers, or greater numerosity, by clicking a button. On congruent trials, the larger number has greater numerosity in the grid. On incongruent trials, the smaller number has greater numerosity in the grid (see Figure 1) (Blair et al., 2007; Rich et al., 2010).

Procedure

Staff of the facility alerted the research team when new patients diagnosed with bipolar disorder were admitted, and a member of the research team consulted with the staff to determine whether the patient was appropriate for the study. The research team also reviewed medical records of individuals admitted to the facility since Spring 2011 to identify former patients who may qualify for study participation. A member of the research team contacted these former patients and conducted a phone screen to determine whether the patient was appropriate for the study. Current and former patients who were identified as potentially eligible for the study qualified for an in-person screen at the residential treatment facility to determine final study eligibility. Additionally, control

participants who were identified as potentially eligible for the study qualified for an in-person screening at Emory University to determine final study eligibility. A member of the research team obtained informed consent and permission to video record all interviews at the beginning of the session. In the case of clinical participants, a member of the research team also obtained permission to share any clinical information gathered during the study visit with the patient's clinician at the residential facility. An advanced level psychology graduate student on the research team administered the SCID and SCID-II Borderline Personality Disorder section, the YMRS, and the HDRS to determine the subject's final eligibility for the study. If the subject qualified for the study, the data collection took place on the same day as the diagnostic interview.

In addition to self-report questionnaires collected as part of the Family Environment and Emotion Regulation in Bipolar Disorder study, subjects completed the BDI-II in order to measure initial levels of depressive symptoms and the BIS/BAS and SPSRQ to assess trait-level behavioral tendencies. All subjects then completed the Affective Stroop Task. Following completion of the task, the following text appeared on the screen, regardless of the subject's performance on the task: "You have now completed the task. Percentile rank: 17%. Overall performance: Poor. Your performance places you in the bottom 17% of all participants who have completed this task. That is, out of 100 participants, 83 participants performed better than you." The subjects then completed self-report measures to assess current affective state and the DERS to assess emotional responsiveness.

After completion of all tasks and self-report measures, a member of the research team debriefed subjects about the study using the following script: "The feedback you

received at the end of the computer task was not related to your actual performance on the task. That feedback is given to all subjects in the study regardless of their performance. In reality, we do not currently have information about your performance on the task in relation to others who have completed it." The subjects were then asked, "When you received that negative feedback earlier, how upset were you on a scale of 1-10?" If clinical participants reported mild to moderate distress during or at the end of the study appointment, the researcher obtained permission from the subject to notify the participant's primary counselor at the residential facility. A member of the research team informed the participant's provider that the subject experienced mild to moderate distress during their participation in the study and advised vigilance for signs of continued distress or clinical deterioration. All participants were reimbursed for their time.

Data Analyses

Initial descriptive analyses using Pearson correlations were conducted to examine the associations between BIS/BAS scores, SPSRQ scores, DERS scores, and symptom levels (YMRS, HDRS, and BDI scores). To test hypothesis 1, analyses of covariance (ANCOVA) were used to examine group differences of the effects of emotion and task on mean reaction times and accuracy on the Affective Stroop Task, controlling for symptom scores (YMRS and HDRS) to insure that relationships between task performance and bipolar status were not due to current symptomatic state. To test hypothesis 2, ANCOVA was used to examine group differences in BIS/BAS, SPSRQ, and DERS scores, controlling for symptom scores. To test hypothesis 3, a series of hierarchical regression analyses were performed to examine whether self-reported emotion regulation difficulties, as measured by the DERS, and BAS sensitivity, as

measured by the BAS Total score and Sensitivity to Reward, predicted performance on the Affective Stroop Task. These analyses were first conducted among the whole sample, and then repeated separating the diagnostic groups in order to examine relationships between self-reported emotion regulation difficulties and BAS sensitivity and performance on the emotion regulation task that may be unique to individuals with bipolar disorder.

Results

Correlations between self-report measures and mood symptoms

Table 2 presents correlations between BIS/BAS scores, SPSRQ scores, DERS scores, and symptom levels in the entire sample. Higher clinician-rated, as measured by the HDRS, and self-rated, as measured by the BDI, depressive symptoms, were associated with higher sensitivity to punishment (SP), higher DERS Total (DERS-Tot), higher DERS Nonacceptance of Emotional Responses (DERS-Non), higher DERS Lack of Emotional Awareness (DERS-EA), higher DERS Limited Access to Emotion Regulation Strategies (DERS-Strat), and higher DERS Lack of Emotional Clarity (DERS-EC) scores. Higher BDI scores were also associated with higher DERS Impulse Control Difficulties (DERS-IC) scores.

Higher BAS total (BAS-Tot) and BAS-Drive (BAS-D) scores were associated with higher Sensitivity to Reward (SR) scores. There was no significant correlation between scores on the BAS total scale or any of the BAS subscales and scores on the DERS total scale or any of the DERS subscales. There was no significant correlation between SR scores and scores the DERS total scale or any of the DERS subscales.

Higher BIS scores were associated with higher SP scores. There was no significant correlation between BIS scores and scores on the DERS total scale or any of the DERS subscales. Higher SP scores were associated with higher DERS-Tot scores, higher DERS-Non, higher DERS Difficulties Engaging in Goal-Directed Behavior (DERS-GDB), higher DERS-IC, and higher DERS-Strat scores.

Group comparison on effects of task and emotion on mean reaction times and accuracy

Table 3 presents mean reaction times (RTs) and accuracy of responses by congruency, emotion, and diagnostic group. There was no significant difference in mean reaction time or accuracy of responses between bipolar participants and controls.

To examine the main effects of task and emotion and the interaction of task and emotion on reaction times, a 2 (task: congruent, incongruent) by 3 (emotion: negative, neutral, positive) repeated measures ANOVA was performed for each diagnostic group, controlling for symptom scores (YMRS and HDRS). Among control participants, there was no significant main effect of task ($F(1,8) = .51$, $p = .50$, $\eta_p^2 = .06$) or emotion ($F(2,16) = .92$, $p = .42$, $\eta_p^2 = .10$) or significant task by emotion interaction ($F(2,16) = 2.04$, $p = .16$, $\eta_p^2 = .20$) on mean RTs. Among bipolar participants, there was a significant Stroop effect, or main effect of task on mean RTs ($F(1,8) = 6.87$, $p = .03$, $\eta_p^2 = .46$), indicating that bipolar participants were significantly slower to respond to incongruent, relative to congruent, trials. There was no significant main effect of emotion ($F(2,16) = .21$, $p = .82$, $\eta_p^2 = .03$) or task by emotion interaction on mean RTs ($F(2,16) = .59$, $p = .57$, $\eta_p^2 = .07$).

To examine the main effects of emotion and task and the interaction of emotion and task on accuracy of responses, a 2 (task: congruent, incongruent) by 3 (emotion: negative, neutral, positive) repeated measures ANOVA was performed for each diagnostic group, controlling for symptom scores (YMRS and HDRS). Among control participants, there was no significant main effect of task on accuracy of responses ($F(1,8) = 1.18$, $p = .31$, $\eta_p^2 = .13$), although the main effect of task was significant ($F(1,10) = 7.14$, $p = .02$, $\eta_p^2 = .41$) when symptoms were not controlled. Control participants were less accurate on incongruent trials relative to congruent trials as a product of symptoms. There was a marginally significant main effect of emotion on accuracy of response ($F(2,16) = 2.97$, $p = .08$, $\eta_p^2 = .27$), however this marginal effect disappeared when the symptoms were not controlled. There was a significant task by emotion interaction ($F(2,16) = 4.06$, $p = .04$, $\eta_p^2 = .34$) such that neutral congruent trials were associated with greater accuracy of responses than neutral incongruent trials, but positive and negative congruent trials did not differ from positive and negative incongruent trials. That is, among control participants, responses to neutral stimuli followed a Stroop response pattern but responses to positive and negative stimuli did not.

Among bipolar participants, there was no significant main effect of task ($F(1,8) = .18$, $p = .68$, $\eta_p^2 = .02$) or emotion ($F(2,16) = .04$, $p = .97$, $\eta_p^2 < .01$) on accuracy of responses, although the main effect of task was marginally significant ($F(1,16) = 4.00$, $p = .07$, $\eta_p^2 = .29$) when symptoms were not controlled. In other words, bipolar participants were marginally less accurate on incongruent trials relative to congruent trials as a product of symptoms. Among bipolar participants, there was significant task by emotion interaction ($F(2,16) = 4.53$, $p = .03$, $\eta_p^2 = .36$) on accuracy of responses, such that

negative and neutral congruent trials were associated with greater accuracy of responses than negative and neutral incongruent trials, but positive congruent trials did not differ from positive incongruent trials. Among bipolar participants, responses to negative and neutral stimuli followed a Stroop response pattern but responses to positive stimuli did not.

Among bipolar participants there was a task by emotion interaction affecting accuracy such that bipolar participants were less accurate on negative incongruent relative to congruent trials and neutral incongruent relative to congruent trials, but their performance on positive trials was unaffected by congruency. Among control participants, there was a consistent task by emotion interaction affecting both reaction time and accuracy of responses such that control participants were slower and less accurate on neutral incongruent relative to congruent trials, but their performance on negative and positive trials was unaffected by congruency.

Group comparison on BIS/BAS, SPSRQ, DERS scores

Table 1 displays the respective mean and standard deviations of the BIS/BAS, SPSRQ, and DERS scores, as a function of diagnostic group. Controlling for initial symptom levels, bipolar participants did not differ from controls on the BAS total scale ($F(1,18) = 1.93$, $p = .18$, $\eta_p^2 = .10$) or on the any of the BAS sub-scales (all p values > .36). Bipolar participants endorsed marginally higher Sensitivity to Reward (SR) ($F(1,18) = 3.83$, $p = .07$, $\eta_p^2 = .18$) than did normal controls. The two groups did not differ on Sensitivity to Punishment (SP) ($p = .57$) or the BIS ($p = .52$) scale.

Controlling for initial symptom levels, bipolar participants reported significantly higher DERS total (DERS-Tot) scores ($F(1,18) = 5.45$, $p = .03$, $\eta_p^2 = .23$) than did

normal controls. Bipolar participants also scored significantly higher on the DERS Lack of Emotional Clarity (DERS-EC) subscale ($F(1,18) = 4.45$, $p = .05$, $\eta_p^2 = .20$) than did normal controls. Bipolar participants scored marginally higher on the DERS Impulse Control Difficulties (DERS-IC) ($F(1,18) = 3.88$, $p = .06$, $\eta_p^2 = .18$) and DERS Limited Access to Emotion Regulation Strategies (DERS-Strat) ($F(1,18) = 3.81$, $p = .07$, $\eta_p^2 = .18$) subscales than did normal controls.

Emotion regulation difficulties, BAS sensitivity, and performance on the Affective Stroop Task

Table 4 displays the results of the hierarchical regression analyses examining whether self-reported ER difficulties and BAS sensitivity were associated with performance on the Affective Stroop Task, controlling for symptom severity. In the entire sample, DERS Total (DERS-Tot) significantly predicted congruent/negative accuracy of responses ($p = .04$) and incongruent/negative accuracy of responses ($p = .02$). Individuals who self-reported greater difficulties with emotion regulation were less accurate on trials containing negative stimuli. There was no significant relationship between DERS-Tot and mean response times.

The hierarchical regression analyses were repeated separating the sample into diagnostic groups. Among control subjects, controlling for symptom severity, there was no significant relationship between DERS-Tot and mean response times or accuracy of responses. Among bipolar subjects, controlling for symptom severity, DERS-Tot significantly predicted incongruent/negative mean response times ($p = .03$), and marginally significantly predicted congruent/negative mean response times ($p = .06$), congruent/neutral mean response times ($p = .07$), congruent/positive mean response times

(p = .08), incongruent/neutral mean response times (p = .10), and incongruent/positive mean response times (p = .07). All relationships between DERS-Tot and accuracy of responses failed to meet significance. Among both bipolar and control subjects, DERS-Tot scores did not predict accuracy of responses. However, among bipolar subjects, but not control subjects, higher self-reported difficulties with emotion regulation predicted slower reaction times on the Affective Stroop Task, regardless of congruency or emotion.

When examining BAS sensitivity in the entire sample, controlling for symptom severity, BAS Total (BAS-Tot) was a marginally significant predictor of congruent/negative mean reaction time (p = .10), congruent/neutral reaction time (p = .06), congruent/positive mean reaction time (p = .06), incongruent/neutral mean reaction time (p = .05), and incongruent/positive mean reaction time (p = .06). There was no significant relationship between BAS-Tot and accuracy of responses. In the entire sample, higher BAS-Tot marginally predicted faster mean reaction times, but not accuracy of responses, on the Affective Stroop Task. When controlling for symptom severity, Sensitivity to Reward (SR) did not significantly predict mean reaction time or accuracy of responses on the Affective Stroop Task.

The hierarchical regression analyses were repeated separating the sample into diagnostic groups. Among control subjects, BAS-Tot did not significantly predict mean reaction time or accuracy of responses, and SR did not significantly predict mean reaction time or accuracy of responses. However, among bipolar subjects, controlling for symptom severity, BAS-Tot significantly predicted congruent/neutral reaction time (p = .03), congruent/positive mean reaction time (p = .03), incongruent/negative mean reaction time (p = .05), incongruent/neutral mean reaction time (p = .04), and incongruent/positive

mean reaction time (p = .04) and was a marginally significantly predictor congruent/negative mean reaction time (p = .07). BAS-Tot did not significantly predict accuracy of responses. SR did not significantly predict mean reaction time or accuracy of responses. Among bipolar subjects but not control subjects, higher BAS-Tot significantly predicted slower mean reaction times, but not accuracy of responses, regardless of congruency or emotion.

In summary, among bipolar subjects, but not control subjects, higher DERS-Tot predicted slower reaction times and higher BAS-Tot predicted faster reaction times on the Affective Stroop Task, regardless of congruency or emotion.

Discussion

The purpose of the present study was to examine the relationship between ER and BAS sensitivity in individuals with bipolar disorder. Hypothesis 1, that bipolar participants would exhibit longer reaction times and lower accuracy scores than control participants on the Affective Stroop Task, was not supported. However, although bipolar participants and control participants did not differ significantly on speed or accuracy of performance on a goal-directed task containing emotional stimuli, the groups had different trait-like responses on the task. Bipolar participants were significantly slower to respond to incongruent trials than congruent trials, regardless of emotion. Further, bipolar participants were less accurate on negative incongruent relative to congruent trials and neutral incongruent relative to congruent trials, but their performance on positive trials was unaffected by congruency. Control participants were slower and less accurate on neutral incongruent relative to congruent trials, but their performance on negative and positive trials was unaffected by congruency. Given the novelty of the use of the

Affective Stroop Task among individuals with bipolar disorder, there were no specific hypotheses about the differential effects of positive verses negative emotions on task performance. Future research using this task should focus on replicating and determining the significance of these differential effects of positive and negative stimuli.

The present findings are contradictory to prior empirical findings among undiagnosed adults. Evidence suggests that the presence of emotionally salient pictorial stimuli impairs goal-directed processing in healthy individuals (Blair et al., 2007). However, the present study found no effect of emotion on reaction time in bipolar or healthy individuals, or in analyses of the combined sample. These differing results between the current study and the previous findings may be partially due to the presence of mood symptoms among both groups. All analyses were conducted controlling for manic and depressive symptoms. However, when symptoms were not controlled, both bipolar and control participants were less accurate on incongruent trials than congruent trials. This relationship between task performance and mood symptoms may be an artifact of limited sample size, in that the addition of two covariates reduced power of the analyses to find a significant effect of congruency. However, this relationship may also indicate that mood symptoms negatively impacted task performance. This is the first examination of performance on the Affective Stroop Task among individuals with bipolar disorder. Further analysis of how bipolar diagnosis and mood symptoms affect performance on the Affective Stroop Task is warranted.

Hypothesis 2, that bipolar participants would endorse more BAS sensitivity, more sensitivity to reward, and more emotion dysregulation, was partially supported. Bipolar participants endorsed marginally more BAS sensitivity, as measured by the Sensitivity to

Reward scale but did not differ from controls on the BAS-Total scale. Bipolar participants also endorsed significantly more emotion dysregulation, as measured by the Difficulties in Emotion Regulation Scale.

The correlations between the BIS/BAS and SPSRQ scales are consistent with prior empirical findings about the relationship between these measures and the construct validity of the SR scale to measure BAS sensitivity (Torrubia et al., 2001). However, the null finding on the BAS scale is not consistent with prior empirical findings about the relationship of this measure of BAS sensitivity with bipolar disorder (Alloy et al., 2006). Previous empirical findings have linked dysregulation of the BAS and BAS-relevant cognitive styles with bipolar disorder, including retrospective and prospective risk for bipolar disorder and risk for mood symptoms and episodes (Alloy et al., 2008; Alloy et al., 2006). Results of the present analyses may be due to inadequate statistical power to detect some effects: there was a non-significant difference in the hypothesized direction on the BAS scale between diagnostic groups, but the effect size of this difference was moderate-to-large. A larger sample may reveal results across the BIS/BAS and SPSRQ scales that are in line with previous research.

Consistent with prior empirical findings, individuals with bipolar disorder displayed impaired emotion regulation (Gruber et al., 2012). Previous studies have demonstrated emotion regulation difficulties among individuals at risk for and with bipolar disorder, including difficulties identifying emotions (Rich et al., 2006), reappraising and suppressing emotions (Gruber et al., 2012), and engaging in goal-directed behavior in tasks with an affective component (Rich et al., 2010). The Difficulties with Emotion Regulation Scale (DERS) is associated with clinical diagnoses,

such as borderline personality disorder and panic disorder, and clinical symptoms, such as depression severity in adults and internalizing problems in adolescents (Neumann, van Lier, Gratz, & Koot, 2010). The present study provides preliminary evidence that this scale is associated bipolar disorder as well. Results also provide preliminary evidence of specific emotion regulation difficulties among bipolar individuals, including lack of awareness of emotions and difficulties acting in desired ways in the presence of emotions.

Hypothesis 3, that BAS sensitivity would predict reaction times and accuracy of responses on the emotion regulation task, was partially supported. Trait-like BAS tendencies, as measured by the BIS/BAS scale, but not the SPSRQ scale, were related to mean reaction times on the Affective Stroop Task, in that higher BAS was associated with faster reaction times among bipolar individuals. Trait-like BAS tendencies were not related to accuracy of responses, or particularly related to emotionally-valenced trials compared to neutral trials. To the extent that the BAS scale captures impulsivity, this association may be due to bipolar individuals' trait impulsivity, such that impulsivity leads them to react quickly to a goal-oriented task without taking emotional context into account.

However, the Sensitivity to Reward (SR) is also positively related to trait impulsivity (Torrubia et al., 2001). Although the BAS and SR scales were significantly correlated with each other, the SR was not related to reaction time or accuracy of performance on the Affective Stroop Task. This null finding may be due to the nature of the task itself. The task did not include immediate feedback to subjects about their performance, nor did it offer any intrinsic reward for speed or accuracy. Further analysis

of the relationship between the BAS and SR scales is warranted to elucidate what aspects of BAS sensitivity the BIS/BAS scale captures that the SPSRQ scale does not, and how these aspects relate to goal-directed processing in the context of emotional stimuli but not intrinsic rewards.

Self-reported emotion regulation difficulties predicted performance on the Affective Stroop Task. The current study provides preliminary support for the Affective Stroop Task as a measure of emotion regulation difficulties. Given the current findings and empirical evidence that individuals with bipolar disorder display deficits in behavioral tasks associated with subprocesses of the emotion regulation system (Rich et al., 2010), further analysis of the relationship between self-report and behavioral measures of emotion dysregulation is warranted.

Both self-reported emotion regulation and sensitivity of the BAS predicted performance on the Affective Stroop Task only among bipolar individuals, but not as hypothesized. It was hypothesized that BAS sensitivity and emotion dysregulation would have additive effects on performance on the behavioral task among bipolar individuals. High BAS and high self-reported emotion dysregulation uniquely affected bipolar individuals and significantly predicted performance on the Affective Stroop Task, but with opposite effects. Among bipolar participants higher BAS sensitivity was associated with faster reaction times, whereas higher DERS scores were associated with slower reaction times. These relationships may partially explain the null findings regarding group differences in mean reaction time on the Affective Stroop Task. There may be group differences between bipolar individuals and healthy individuals in how the groups

performed on the task, but these group differences are masked by the opposing influences of these two regulatory systems.

Finally, although scores on the DERS and on one measure of BAS sensitivity were significantly associated with bipolar disorder, the DERS and measures of BAS sensitivity were not significantly correlated with each other. These results, together with findings that ER difficulties and BAS sensitivity had differential effects on a cognitive task, suggest that the ER system and the BAS may not be working in concert to affect the course of bipolar illness, as hypothesized. The ER may be dissociable from BAS sensitivity among individuals with bipolar disorder. Further analyses of other indices of ER and BAS sensitivity, including biobehavioral and cognitive measures, may clarify the nature of the relationship between these two regulatory systems.

Study strengths and limitations

It is important to note the limitations of this study. The most notable limitation is the small sample size, which may have resulted in inadequate statistical power to detect some effects. However, we found moderate-to-large effects among even marginally significant results, indicating that increased sample size may yield significant results.

The use of a clinical sample of bipolar participants represents both significant strengths and limitations. All bipolar subjects were symptomatic and taking at least one psychotropic medication, whereas no control subjects were taking any psychotropic medications. Although symptom levels were controlled in all analyses, due to small sample size, it was impossible to control for possible effects of psychotropic medications between groups or control for different classes of psychotropic medications within the bipolar group. Also due to small sample size, potential confounds of clinical variables,

such as comorbidities and number of previous mood episodes, were not examined within the bipolar group. Further, generalizability of the results is restricted by the fact that all clinical participants attended the same treatment facility.

Finally, it is important to note that many of the measures and variables in the present analyses are highly correlated. Multicollinearity may lead to decreased reliability of the results. Further analysis with an increased sample size may increase reliability and clarify the relationship among variables.

Conclusion

Overall, the current findings suggest a differential pattern of association between the BAS and the ER system among bipolar and control individuals. Individuals with bipolar disorder exhibited trait-like ER difficulties. Self-report measures of BAS sensitivity and ER difficulties were each associated with bipolar disorder but were not related to each other. Further, among bipolar participants, BAS sensitivity and ER difficulties had differential effects on performance on the behavioral task. These relationships are not attributable to manic or depressive symptoms. Whether ER may be dissociable from BAS sensitivity among individuals with bipolar disorder requires further examination.

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Tables

Table 1. Demographic information and scales and symptom scores, as a function of diagnostic group

Table 2. Pearson correlations of BIS/BAS, SP/SR, and DERS scales and symptom scores

Table 3. Subject RTs and accuracies, as a function of diagnostic group

Table 4. Associations between BAS sensitivity and performance on the Affective Stroop Task

Table 1

Demographic information and scales and symptom scores, as a function of diagnostic group

	Bipolar (n=11)	Control (n=11)
Age (years)	26.45(4.99)	23.45 (2.51)
Sex	63.6% Female	63.6% Female
Ethnicity	72.7% Caucasian 27.3% African-American	81.8% Caucasian 18.2% African-American
Years of Education	14.77(1.66)	15.91(1.64)
YMRS	3.09(3.48)	0.91(0.70)
HDRS	4.64(4.88)	1.09(1.14)*
BDI	10.36(13.60)	1.18(1.40)*
BIS	20.64(3.91)	19.82(3.12)
BAS-Tot	41.36(4.70)	38.18(5.67)
BAS-D	11.36(2.38)	10.09(2.55)
BAS-FS	12.18(2.04)	11.18(2.09)
BAS-RR	17.82(2.82)	16.91(2.17)
SP	11.18(4.24)	9.00(2.05)
SR	11.45(2.98)	9.91(4.28)
DERS-Tot	80.90(21.77)	59.73(8.50)*
DERS-Non	13.00(4.94)	9.45(3.21)
DERS-GDB	14.27(4.34)	11.81(2.89)
DERS-IC	10.55(4.46)	7.45(1.21)
DERS-EA	15.55(5.11)	12.09(4.99)
DERS-Strat	16.09(6.11)	10.64(1.63)*
DERS-EC	11.45(2.98)	8.27(2.53)*

YMRS = Young Mania Rating Scale; HDRS = Hamilton Depression Rating Scale; BDI = Beck Depression Inventory; BIS = Behavioral Inhibition System; BAS-Tot = Behavioral Approach System – Total from the BIS/BAS scales; BAS-D = BAS-Drive subscale; BAS-FS = BAS-Fun-seeking subscale; BAS-RR = BAS-Reward Responsiveness subscale; SP = Sensitivity to Punishment; SR = Sensitivity to Reward; DERS-Tot = Difficulties in Emotion Regulation Scale (DERS) – Total score; DERS-Non = DERS-Nonacceptance of Emotional Responses subscale; DERS-GDB = DERS-Difficulties Engaging in Goal-Directed Behavior subscale; DERS-IC = DERS Impulse Control Difficulties subscale; DERS-EA = DERS-Lack of Emotional Awareness subscale; DERS-Strat = DERS-Limited Access to Emotion Regulation Strategies subscale; DERS-EC = DERS-Lack of Emotional Clarity subscale.
Means are reported with standard deviations in parentheses.
* $p < 0.05$

Table 2

Pearson correlations of BIS/BAS, SP/SR, and DERS scales and symptom scores

	YMRS	HDRS	BDI	BIS	BAS-Tot	BAS-D	BAS-FS	BAS-RR	SP	SR	DERS-Tot	DERS-Non	DERS-GDB	DERS-IC	DERS-EA	DERS-Strat	DERS-EC
YMRS	1																
HDRS	.186	1															
BDI	.297	.782**	1														
BIS	.372	.237	.420	1													
BAS-Tot	.143	.010	.130	.116	1												
BAS-D	.092	.001	.050	-.031	.873**	1											
BAS-FS	.009	.417	.066	-.174	.749**	.861**	1										
BAS-RR	.205	-.102	.173	.423*	.642**	.300	.088	1									
SP	.115	.518*	.566**	.498*	-.196	-.297	-.316	.141	1								
SR	-.183	-.145	-.158	-.199	.529*	.582**	.384	.231	-.074	1							
DERS-Tot	.004	.636**	.754**	.189	.105	-.001	.007	.218	.719**	.068	1						
DERS-Non	.076	.676**	.646**	.227	-.198	-.286	-.193	.022	.779**	-.080	.798**	1					
DERS-GDB	-.149	.298	.415	.226	.146	.097	.104	.128	.561**	.032	.656**	.395	1				
DERS-IC	-.025	.315	.478*	.031	-.045	-.161	.006	.059	.684**	.178	.821**	.628**	.586**	1			
DERS-EA	-.027	.516*	.587**	.008	.295	.339	.104	.206	.601	.601	.627**	.298	.105	.304	1		
DERS-Strat	.109	.523*	.697**	.265	.000	-.184	-.077	.247	.793**	.029	.902**	.794**	.646**	.842**	.317	1	
DERS-EC	-.011	.536*	574**	.090	.310	.201	.138	.345	.332	.049	.795**	.522*	.381	.450*	.792**	.573**	1

YMRS = Young Mania Rating Scale; HDRS = Hamilton Depression Rating Scale; BDI = Beck Depression Inventory; BIS = Behavioral Inhibition System; BAS-Tot = Behavioral Approach System – total from the BIS/BAS scales; BAS-D = BAS-Drive subscale; BAS-FS = BAS-Fun-seeking subscale; BAS-RR = BAS-Reward Responsiveness subscale; SP = Sensitivity to Punishment; SR = Sensitivity to Reward; DERS-Tot = Difficulties in Emotion Regulation Scale (DERS) – total score; DERS-Non = DERS-Nonacceptance of Emotional Responses subscale; DERS-GDB = DERS-Difficulties Engaging in Goal-Directed Behavior subscale; DERS-IC = DERS Impulse Control Difficulties subscale; DERS-EA = DERS-Lack of Emotional Awareness subscale; DERS-Strat = DERS-Limited Access to Emotion Regulation Strategies subscale; DERS-EC = DERS-Lack of Emotional Clarity subscale.

Table 3

Subject RTs and accuracies, as a function of diagnostic group

		Bipolar (n = 11)		Control (n = 11)	
Emotion	Task	RT	% correct	RT	% correct
Negative	Congruent	1043.20(92.50)	92.90(10.09)	1073.40(79.07)	95.45(8.31)
	Incongruent	1099.89(89.09)	88.07(9.77)	1086.32(83.35)	94.32(11.25)
Neutral	Congruent	1037.12(93.39)	94.32(11.25)	1040.54(82.38)	95.27(10.34)
	Incongruent	1069.35(99.39)	88.07(13.01)	1070.52(81.07)	91.48(9.43)
Positive	Congruent	1057.12(100.38)	89.77(11.10)	1072.00(85.86)	95.17(7.31)
	Incongruent	1054.53(89.26)	92.33(11.97)	1061.70(76.79)	94.03(10.03)

Table 4

Associations between BAS sensitivity and performance on the Affective Stroop Task

	Whole sample (n = 22)						Bipolar (n = 11)						Control (n = 11)					
	BAS-Tot		SR		DERS-Tot		BAS-Tot		SR		DERS-Tot		BAS-Tot		SR		DERS-Tot	
Task Measure	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*
C/G mean RT	-.353	-1.758	.022	.102	.156	.558	-.517	-2.081	-.293	-.649	.698	2.237	-.008	-.030	.350	1.497	-.236	-.883
C/N mean RT	-.395	-2.006	.014	.061	.260	.943	-.637	-2.852*	-.266	-.563	.713	2.175	-.017	-.067	.268	1.196	-.148	-.587
C/P mean RT	-.395	-2.018	-.005	-.021	.218	.789	-.619	-2.784*	-.530	.612	.671	2.029	-.004	-.018	.258	1.196	-.171	-.744
I/G mean RT	-.329	-1.637	-.088	.404	.238	1.128	-.579	-2.429*	-.276	-.594	.803	2.789*	.036	.142	.376	1.806	-.237	-.951
I/N mean RT	-.398	-2.065	-.012	-.053	.238	.876	-.587	-2.469*	-.290	-.623	.653	1.922	-.054	-.234	.246	1.173	-.152	-.648
I/P mean RT	-.397	-2.034	.002	.009	.256	.934	-.601	-2.509*	-.333	-.712	.703	2.110	-.058	-.240	.265	1.191	-.174	-.700
C/G % correct	.026	.114	-.041	-.175	.578	-2.181*	.305	.842	-.257	-.468	-.540	-1.209	-.197	-.657	.101	.330	-.368	-1.261
C/N % correct	.001	.006	-.010	-.045	-.416	-1.468	.357	.999	-.192	-.346	-.328	-.686	-.225	-.724	.072	.225	-.322	-1.021
C/P % correct	.137	.586	-.177	-.757	-.485	-1.716	.501	1.469	-.406	-.735	-.240	-.485	-.103	-.351	.015	.052	-.384	-1.396
I/G % correct	-.046	-.209	-.127	-.567	-.643	-2.625*	.171	.460	-.219	-.399	-.655	-1.561	-.163	-.675	.020	-.079	-.258	-1.060
I/N % correct	-.006	-.027	-.080	-.345	-.354	-1.239	.172	.458	-.149	-.267	-.221	-.456	-.167	-.583	-.027	-.091	-.248	-.847
I/P % correct	.036	.157	-.125	-.540	-.458	-1.648	.455	1.366	-.296	-.548	-.452	-.998	-.370	-1.178	-.146	-.431	-.476	-1.521

Note: Each row and BAS or SR column in Table 4 represents a separate analysis
BAS-Tot = Behavioral Approach System – total from the BIS/BAS scales; SR = Sensitivity to Reward; C/G = congruent/negative; C/N = congruent/neutral; C/P = congruent/positive; I/G = incongruent/negative; I/N = incongruent/neutral; I/P = incongruent/positive
*p < .05

Figures

Figure 1. Example trial sequences from the Affective Stroop Task.

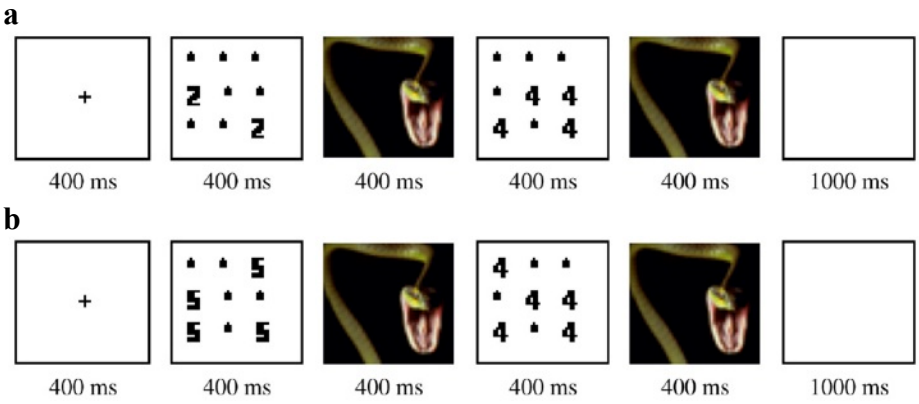

Figure 1. Example trial sequences from the Affective Stroop Task. (a) Negative congruent trial; (b) negative incongruent trial. Copied from Blair, K., Smith, B., Mitchell, B., Morton, J., Vythilingam, M., Pessoa, L. (2007). Modulation of emotion by cognition and cognition by emotion. *NeuroImage, 35*, 430-440.