DIFFERENTIAL EFFECTS OF NEGATIVE AND POSITIVE AFFECT ON CONTEXT PROCESSING

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

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ABSTRACT

Context processing is thought to be a central component of cognitive control involved in maintaining goals. Context processing impairments have been implicated in psychopathology, with suggestions that the interaction between context processing and the occurrence of emotions might be important for some mental disorders. However, the specific influence, if any, of briefly elicited negative and positive affect on context processing remains unclear. In this research, I used three separate tasks (i.e., the Preparing to Overcome Prepotency (POP) task, Stroop task, and AX-CPT task, respectively) to examine the influence of briefly elicited negative and positive affect on context processing in undergraduate students. In the first study, negative affect facilitated context processing; whereas positive affect impaired context processing. However, the influence of affect on context processing in this task may have been confounded by the influence of affect on decision processes. In contrast to the first study, the second and third studies found evidence that briefly elicited negative affect increased errors on context processing tasks. Conversely, positive affect did not have a significant effect on context processing. Overall, these results suggest that negative affect may disrupt context processing and the maintenance of task critical goals. An influence of negative affect on context processing could have important implications for aspects of psychopathology.

DIFFERENTIAL EFFECTS OF NEGATIVE AND POSITIVE AFFECT ON CONTEXT PROCESSING

Introduction

Many aspects of psychopathology appear to involve a loss of control. For instance, people who are diagnosed with schizophrenia exhibit disorganization symptoms involving poorly controlled thoughts and affective states (e.g., speaking in a tangential way or displaying emotions inappropriate to a situation). As another example, people diagnosed with bipolar disorder experience manic episodes involving difficulty controlling their thoughts (e.g., “flight of ideas”) and engaging in very reckless and disruptive behaviors. In addition, people diagnosed with depression have difficulty concentrating and making decisions and may also engage in suicidal thoughts and attempts. It seems likely that understanding the nature of psychological control and self-regulation could have important implications for understanding many types of psychopathology.

As these examples of psychological disorders seem to suggest, loss of psychological control could involve problems in cognition, in emotion, or problems in the interaction between cognition and emotion. For example, research in schizophrenia has shown that disorganization symptoms are associated with poor cognitive control (Kerns & Berenbaum, 2002). At the same time, disorganization symptoms also increase when discussing negative emotional topics (Docherty, Hall, & Gordinier, 1998). Moreover, people at risk for schizophrenia both exhibit poor cognitive control and report frequently experiencing intense negative emotions (Kerns, 2006). Potentially, understanding how affective states influence cognitive control could have important implications for understanding some aspects of psychopathology. However, given that cognitive control involves multiple component processes, it might be important for research to focus on how affective states specifically influence particular aspects of cognitive control.

A potentially central component of cognitive control is context processing (i.e., goal maintenance; Braver, Gray, & Burgess, 2007). Cohen and colleagues (Cohen, Braver, & O'Reilly, 1996) have defined context processing as the maintenance of internal representations or task context (i.e., important task critical information, such as rules, goals, instructions, or intentions; Cohen & Servan-Schreiber, 1992; Cohen et al., 1996). There is evidence that some aspects of psychopathology might be associated with poor context processing. For example, people with schizophrenia and their relatives perform poorly on context processing tasks (Becker, Kerns, MacDonald, & Carter, *under revision*; Cohen, Barch, Carter, & Servan-Schreiber, 1999), and poor context processing has been specifically associated with elevated disorganization symptoms (Barch, Carter, MacDonald, Braver, & Cohen, 2003; Cohen et al., 1999; Kerns & Berenbaum, 2002, 2003; Stratta, Daneluzzo, Bustini, Prosperini, & Rossi, 2000). Hence, context processing is an important component of cognitive control, and deficits in context processing might be involved in some aspects of psychopathology.

In addition to poor context processing, intense negative emotions have also been implicated in people at-risk for psychopathology involving losses of control (e.g., Kerns, 2006). Furthermore, certain affective states may exacerbate context processing deficits (e.g., increases in disorganization when discussing emotional topics). However, little previous research has examined whether and how context processing might be influenced by affective states. Therefore, the current research examined whether negative or positive affect disrupts (or perhaps even facilitates) performance on tasks involving context processing. At the same time, the current research also examined whether individual difference variables (e.g., levels of self-reported disorganization), were associated with the influence of affect on context processing. Potentially, understanding how affect influences context processing could help us better understand how poor psychological control is involved in some mental disorders. At the same time, it is hoped that the current research could help identify a specific behavioral paradigm that can be used to examine the influence of affect on context processing in people with schizophrenia and other types of psychopathology both behaviorally and neurally using fMRI.

In the remainder of the introduction, I will first review the construct of context processing and discuss how context processing is thought to be a central component of working memory and executive functioning. Second, I will discuss potential differences between three different types of affective states: affect, emotion, and mood. Third, I will discuss theories that have been proposed in the literature regarding the influence that affective states may have on context processing. Fourth, I will provide a summary of research examining the influence of affective states on social cognition, and I will discuss what this research suggests for how affective states might influence context processing. Fifth, I will review previous research on the influence of affective states on executive functioning, and in particular, I will review the few studies that specifically examined the influence of affect on context processing. Finally, I will conclude the introduction by outlining three studies that were conducted to examine the influence of briefly elicited affect on context processing.

Context Processing

Many models of working memory or executive control include the construct of a central executive (e.g., Baddeley, 2000; Cowan et al., 2005; Engle, Kane, & Tuholski, 1999; Norman & Shallice, 1986; Rougier, Noelle, Braver, Cohen, O'Reilly, 2005). For example, Cowan's model of working memory includes a central executive that is involved in directing attention and controlling voluntary processing (Cowan, 1999; Cowan et al., 2005). In the working memory model of Engle and colleagues (Engle et al., 1999), the central capacity of working memory is posited to be a controlled attention component which is necessary to maintain temporary goals. In their research, Engle and colleagues have found evidence that measures of working memory capacity are positively associated with performance in selective attention tasks that involve goal maintenance and overcoming an automatic or prepotent response (e.g., the Stroop, the antisaccade task).

Somewhat analogous to the concept of controlled attention is the concept of context processing posited by Cohen and colleagues to be an important component of executive control. Following Cohen and colleagues (Cohen et al., 1996; Miller & Cohen, 2001), I view context processing as involving the representation and maintenance of task context in working memory. Maintenance of important contextual information in the prefrontal cortex is thought to bias activity in other brain regions responsible for task execution (Miller & Cohen, 2001). Top-down biasing is thought to be important when needing to overcome automatic but situationally-inappropriate responses and when context must be maintained over delays (Cohen et al., 1996; Cohen & Servan-Schreiber, 1992), with context processing thought to allow for the achievement of goal-directed behavior, such as reaching a particular speech goal (Dell, Burger, & Svec, 1997; Kerns, Cohen, Stenger, & Carter, 2004b).

Similar to research by Engle and colleagues, one set of tasks that Cohen and colleagues have posited involve context processing are selective attention tasks (e.g., the Stroop color-naming task) which involve using task context information to overcome an automatic or prepotent response. For example, in the Stroop task, participants must maintain the specific task instructions to respond to the color in order to overcome the automatic response of reading the word. Therefore, if given the word “BLUE” printed in red ink, participants must maintain the task instructions to facilitate overcoming the tendency to read the word and instead make a correct response (i.e., “red”). Cohen and colleagues have argued that the Stroop task involves context processing to maintain the task goal of responding to the color of the word even when the color of the word may be incongruent with the word stimulus. In addition to the Stroop task, the current study also used two additional context processing tasks, the AX-CPT (continuous performance task) and the POP (preparation for overcoming a prepotent response). Both of these tasks were modified or developed by Cohen and colleagues to engage context processing. Behavioral, computational modeling, research with psychiatric and geriatric populations, and fMRI research has supported the involvement of context processing on these tasks (Barber & Carter, 2005; Barch et al., 2001; Braver et al., 2001; Cho, Konecky, & Carter, 2006; Cohen et al., 1996; Cohen et al., 1999; Cohen & Servan-Schreiber, 1992; Kerns, 2006; Becker, Cicero, & Kerns, poster presented in 2007*;* MacDonald & Carter, 2003; MacDonald et al., 2005). For example, performance on these tasks activates the dorsolateral PFC, and performance on these tasks is poorer in people with schizophrenia and in elderly individuals. At the same time, the amount of disorganization symptoms is associated with poor performance on these tasks.

Good context processing involves both the ability to maintain goal representations as well as the ability to rapidly update goal representations when context changes (O'Reilly, 2006; O'Reilly, Noelle, Braver & Cohen, 2002). It has been suggested that although both stable maintenance and flexible updating involve dopamine release, these two aspects of context processing might involve the effects of different types of dopamine receptors in the prefrontal cortex (Braver, Barch, & Cohen, 1999; Braver & Cohen, 2000; Cohen, Braver, & Brown, 2002), specifically D1 and D2 receptors, which might be involved in mutually antagonistic systems (Grace, 1991). Tonic dopamine release (especially involving D1 receptors) is thought to promote stable processing of activated cognitive representations in the prefrontal cortex, resulting in improved working memory maintenance. In contrast, phasic dopamine release (especially involving D2 receptors) might promote flexible updating of representations in the prefrontal cortex, resulting in working memory updating. As discussed below, these differences in tonic and phasic dopamine release may have important implications for the influence that negative and positive affect may have on context processing performance.

Affective States: Affect, Emotion, and Mood

Emotion theorists have made distinctions between various affective states, such as affect, emotion, and mood. There are strong similarities between these affective states. However, as can be seen in Table 1, there are also some potentially important differences between these affective states which might have implications for how they might interact with context processing.

Affect can be defined as a simple pleasant or unpleasant reaction (Payne, Cheng, Govorun, & Stewart, 2005), reflecting underlying processes that could be conscious or unconscious (Frijda, 1999; Russell, 2003). *Emotion*, on the other hand, can be defined as a conscious state in which affective states such as happiness, sorrow, anxiety, and anger are experienced based on personal relevance (Ortony, Clore, & Collins, 1988). Hence, as can be seen in Table 1, an important distinguishing feature of affect from emotion is that affect does not involve identification of a specific source or a specific subjective meaning (Payne, et al., 2005). Research involving affect often uses affect-eliciting stimuli such as emotionally valenced pictures (e.g., International Affective Picture System (IAPS) slides; Lang & Greenwald, 1988), emotional faces, and emotional words to create a brief, intense (Mitchell & Phillips, 2007) affective reaction. One methodological advantage of examining the influence of affect rather than emotion on cognition is that it is relatively easy to repeatedly and briefly elicit affect and examine its influence on an ongoing cognitive task. In contrast, it might be methodologically more difficult to repeatedly elicit personally-relevant emotions and examine their influence on an ongoing cognitive task. One study that did examine the influence of emotion on cognition used actual or threatened shock (Shackman et al., 2006), a procedure that would be extremely difficult (albeit not impossible), to use with psychiatric patients (emotion could also potentially be induced using idiosyncratic personally-relevant stimuli, although again this might be challenging during a lengthy ongoing cognitive task). For these reasons, I decided to focus on the influence of affect rather than emotion on context processing.

As can be seen in Table 1, in contrast to affect, *mood* is a long lasting affective state. Studies that examine the influence of mood on cognitive processes use mood-induction methods such as having participants write about a positive or negative event or watch an emotionally valenced movie clip. One advantage to examining the influence of mood on cognition is that methodologically it is rather easy to have a participant perform any cognitive task after a mood induction. However, one disadvantage to examining the effect of mood on cognition is that lengthy moods might involve more additional cognitive activity than briefly elicited affect. For example, negative moods have been found in some instances to elicit negative cognitive content that participants may attempt to suppress (e.g., Wenzlaff & Bates, 1998). Suppression of negative thoughts could drain cognitive control processes from performance of an additional cognitive task (Dalgleish & Yiend, 2006). Along similar lines, repairing negative moods has also been found to involve the engagement of executive control processes (Johnstone, van Reekum, Urry, Kalin, & Davidson, 2007; Ochsner et al., 2004; Schmeichel, 2007). Furthermore, a sustained positive mood might result in decreased task engagement and poorer cognitive task performance in general. Hence, if mood disrupts cognitive control task performance, it might be unclear whether this is due to the influence of mood per se on context processing or the influence of intrusive and distracting thoughts or of emotion regulation processes on context processing. In contrast, briefly elicited affect might involve less additional cognitive activity than mood induction. At the same time, induction of sustained negative moods might be more problematic in psychiatric patients who might have mood regulation deficits than the elicitation of briefly experienced affect.

Hence, in the current research, I examined the influence of briefly elicited affect on context processing. However, one issue for future research will be to extend this research and to examine whether similar results are obtained for emotion and mood. At the same time, in reviewing previous research on the influence of affective states on cognitive control, a potentially important issue is whether research involved briefly elicited affect (with presumably little extra cognitive activity) or mood (with presumably extra cognitive activity that could also have an effect on cognitive control task performance).

Possible Explanations for the Influence of Affective States on Context Processing

As I will review below, little previous research has directly examined the influence of affective states on context processing. Nevertheless, there has been some conjecture about the influence that negative and positive affective states may have on cognitive control or more specifically on the central executive (i.e., a construct that is thought to include context processing). One potential relevant issue for the hypotheses regarding the influence of affective states on cognitive control is whether the theories refer to briefly-elicited affect, to long-lasting mood, or to both. For instance, as previously mentioned, task-irrelevant thoughts elicited by affective states may have more of an impairing influence on cognitive control during long-lasting mood compared to briefly-elicited affect. I will review four hypotheses regarding the influence of affective states on cognitive control, the first three of which involve negative affect.

One explanation for how negative affective states can influence cognitive control is what I will refer to as the low serotonin hypothesis. The low serotonin hypothesis suggests that low serotonin function is associated both with negative mood and with decreased cognitive control (e.g., Mitchell & Phillips, 2007). This hypothesis predicts that negative affective states would impair cognitive control by lowering serotonin levels. The low serotonin hypothesis is supported by several pieces of evidence. First, a decrease in serotonin levels is followed by a transient worsening of affective states (Neumiester, 2003). Second, certain genotypes of serotonin receptor (5HT-1A and 5HT-2A) polymorphisms (via their harmful effects on serotonin uptake) have been associated with negative affective states (Ham et al., 2004). Third, acute tryptophan depletion (i.e., one way of lowering serotonin concentration) has been associated with an impairment in several components of cognitive control such as inhibition during a go/no-go task (e.g., Murphy, Smith, Cowen, Robbins, & Sahakian, 2002). Finally, some evidence suggests that it is low serotonin function in the prefrontal cortex (PFC; i.e., in regions associated with cognitive control) that is associated with negative affective states. For instance, research examining suicide and major depression found that reduced serotonin in the PFC (evidenced by the reduction of SERT binding) was associated with the inability to overcome suicidal thoughts (Arango, Underwood, & Mann, 2002). Hence, from this perspective, a negative affective state is associated with decreased serotonin function which may result in impairment of cognitive control (e.g., context processing). Furthermore, some research has suggested that the relationship between serotonin and cognition can be described as an inverted U function (e.g., Gallagher, Massey, Young, & McAllister-Williams, 2003; Luciana, Burgund, Berman, & Hanson, 2001). Moreover, it is unclear whether it is only negative mood that has this effect on serotonin function or if briefly-elicited affect has a similar influence.

In addition to the low serotonin hypothesis, a second hypothesis for how negative affective states could influence cognitive control is what I will refer to as the resource depletion hypothesis. The resource depletion hypothesis predicts that negative affective states will impair cognitive control. Negative affective states might disrupt cognitive control because they might evoke emotion regulation and because they might induce task-irrelevant thoughts. For instance, there is evidence that emotion regulation can involve the engagement of cognitive control (e.g., Ochsner, Bunge, Gross, & Gabrieli, 2002; Schmeichel, 2007). If affective regulation takes place when presented with a negative stimulus, then fewer cognitive control resources may be available to adequately perform a cognitive control task. At the same time, negative affect may initiate task-irrelevant thoughts. If these task-irrelevant thoughts are suppressed (e.g., Brewin & Beaton, 2002; Schmader & Johns, 2003), then actively suppressing task-irrelevant thoughts might result in decreased context processing resources devoted to the context processing task. Therefore, the resource depletion hypothesis suggests that negative affective states, maybe even briefly-elicited affect, may evoke emotion regulation or suppression of task-irrelevant thoughts, resulting in depletion of context processing resources and poorer context processing task performance.

Thus far, the two hypotheses previously discussed view negative affect as having an impairing influence on context processing. However, it is also possible that in some instances negative affect may improve context processing. A third hypothesis which I will call the performance monitoring hypothesis predicts that negative affect will help cognitive control in some instances by negative affect serving as a signal to increase context processing. The performance monitoring hypothesis is analogous to the conflict monitoring model. According to the conflict monitoring model, the occurrence of response conflict (and errors, which involve conflict) results in the recruitment of cognitive control to improve performance (Botvinick, Braver, Barch, Carter, & Cohen, 2001). Somewhat analogous to the conflict monitoring theory, it is possible that negative affective states may also be used as a signal to improve performance. For instance, research has suggested that errors might activate the anterior cingulate cortex (ACC) via a negative reinforcement learning signal involving the mesencephalic dopamine pathway, resulting in modified task performance (Holroyd & Coles, 2002). Furthermore, there is evidence that errors in performance can be associated with negative affective states and with activation of the rostral anterior cingulate, a brain region associated with emotional processing (Bush, Luu, & Posner, 2000). Moreover, there is evidence that negative affect increases the neural response to errors (Luu, Collins, & Tucker, 2000). This suggests that negative affect could serve in some situations as a signal to improve performance and perhaps to recruit context processing. Therefore, negative affect could potentially improve performance in context processing tasks because negative affect could serve as a signal for the need to engage cognitive control. However, this prediction is speculative, and it is unclear whether task-irrelevant affect would facilitate context processing.

Hence, there are at least three hypotheses that suggest how negative affective states may influence context processing. The low serotonin hypothesis suggests that negative affective states may have an impairing influence on context processing. However, this hypothesis appears to be relevant for long-lasting mood and may not be relevant for briefly-elicited affect. On the other hand, the resource depletion and performance monitoring hypotheses suggest that briefly-elicited affect could influence context processing either by disrupting or improving performance.

In addition to the three affect-cognition hypotheses on the influence of negative affective states, there is at least one hypothesis that proposes an influence of positive affective states on cognitive control which I will refer to as the dopamine hypothesis.

This hypothesis suggests that the influence that positive affective states have on cognitive control is mediated by dopamine release (Ashby, Isen, & Turken, 1999). The dopamine hypothesis of positive affective states predicts that positive affect will impair performance on some context processing tasks by reducing stable maintenance of goal information. In general, dopamine release occurs during periods of a mild positive affective state. For instance, research has shown that dopamine is released after the presentation of rewarding stimuli via the mesocorticolimbic system. In addition, drugs such as cocaine and amphetamines that mimic the effects of dopamine produce a positive affective state (e.g., Beatty, 1995). Therefore, positive affect could influence context processing as a result of dopamine release (i.e., specifically through the effect of D2 receptors) in the prefrontal cortex.

As mentioned earlier, D1 and D2 receptors are involved in different aspects of cognitive control. The difference between D1 and D2 receptors and their respective functions (i.e., maintenance versus updating) might be an important distinction in examining the influence of positive affective states on context processing (Grace, 1991; O'Reilly, 2006; O'Reilly et al., 2002). Whereas D1 receptors are involved in tonic dopamine release and promote stable maintenance, D2 receptors have been associated with phasic dopamine release and promote the updating of context representations. Additionally, D2 activity is strongly associated with reward processing (an aspect of positive affective states). Furthermore, as noted by Ashby and colleagues, two brain regions strongly associated with dopamine are the prefrontal cortex and anterior cingulate cortex, both of which exhibit increased activity during context processing tasks (e.g., Becker et al., *under revision*; Carter et al., 2000). Hence, from this perspective, positive affect may result in increased phasic dopamine release, resulting in decreased stable maintenance and increased flexible updating of representations in the prefrontal cortex. This hypothesis seems to suggest that positive affect could produce poorer performance when context processing (which is associated with prefrontal cortex) is needed to maintain a particular task set in order to overcome an upcoming prepotent response. At the same time, it is also predicted that positive affect could produce improved performance when updating of context representations is required (i.e., promoting increased cognitive flexibility). Furthermore, research suggests that the relationship between dopamine and cognition can be described as an inverted U function (e.g., Arnsten, 1997) which implies that the influence of a positive affective state depends on the level of arousal (i.e., its location on the curve; Cools, Barker, Sahakan, & Robbins, 2001). Therefore, the influence of positive affective states on context processing might depend on the baseline level of dopamine. However, overall, it is not clear whether the dopamine hypothesis predicts effects for briefly-elicited affect or for positive mood. For example, it has been suggested that the effects of dopamine on the prefrontal cortex might not occur rapidly (O'Reilly, 2006).

Hence, there are at least four hypotheses for how affective states may influence context processing. Importantly, these four hypotheses make different predictions for how negative affect and positive affect should influence context processing. In summary, based on the resource depletion hypothesis, briefly-elicited negative affect should impair context processing performance. However, according to the performance monitoring hypothesis, briefly-elicited negative affect should improve context processing performance. On the other hand, based on the dopamine hypothesis, positive affective states appear to impair goal maintenance but facilitate flexible updating of context representations. Thus, this hypothesis would predict that positive affect may impair context processing performance (i.e. stable goal maintenance).

I will now review evidence that support these different hypotheses to further clarify the influence that negative and positive affect may have on context processing. Initially, I will discuss the influence of affective states on social cognition which has been extensively discussed in the literature and then discuss more specifically the influence of negative and positive affective states on cognitive control and context processing.

Affective States and Social Cognition

Social psychologists have explored the influence of mood on social cognition in great depth to examine how mood influences the ways in which we think about situations and people or the ways we act around other people (e.g., people in happy moods tend to rely on stereotypes; Bless, Schwarz, & Wieland, 1996; Bodenhausen, Kramer, & Süsser, 1994). The general consensus in this literature is that negative and positive moods appear to have differential effects on social cognition (Bless, 2001; Clore, et al., 2001; Forgas, 2001; Forgas, Bower, & Krantz, 1984; Forgas, Bower, & Moylan, 1990; Schwarz, 2001).

In general, according to the social cognition literature, negative mood appears to facilitate the processing of complex information. According to motivation theories, people in a negative mood seem to process information systematically to help improve their negative state (Clark & Isen, 1982). On the other hand, functionally speaking, a negative mood may signal danger and recruit vigilant, systematic, and ruminative processing (Schwarz, 1990). More specifically, social cognition researchers have suggested that a negative mood may facilitate substantive processing (i.e., processing needed during complex and atypical tasks) and seems to improve people's ability to focus their processing on novel information (Forgas, 1992; Forgas, 2001). For example, a study examined the fundamental attribution error (i.e., assuming other's behavior is due to internal factors) by showing participants a situation where one person made a decision based on the coercion of another person. Individuals in a negative mood were able to avoid making the fundamental attribution error by focusing on the novel, situational details to determine the reason for the decision that was made (i.e., the person was coerced into making that decision). However, people in positive moods used their general knowledge structures and attributed the decision to an internal attribute (Forgas, 1998). Additionally, negative mood has been shown to facilitate the ability to focus on the specifics of a topic rather than on the overall topic (Bless, 2001). For instance, a persuasion study showed that sad individuals were more likely than happy individuals to attend to the specific quality of the arguments in the persuasive message rather than to the general, irrelevant theme of the message (Mackie & Worth, 1989; Bless, Bohner, Schwarz, & Strack, 1990; Bless, 2001).

On the other hand, according to the social cognition literature, positive mood appears to facilitate the use of general knowledge structures. According to motivation theories, people in a positive mood seem to process information heuristically to maintain their pleasant state by avoiding excessive effort (Clark & Isen, 1982). On the other hand, functionally speaking, a positive mood may provide favorable information about a situation and therefore indicate that little monitoring and processing effort is necessary (Schwarz, 1990). More specifically, social cognition researchers have shown that a positive mood facilitates the use of heuristics (i.e., general knowledge structures) and cognitive flexibility (Bless, 2001; Forgas, 2001; Forgas et al., 1984; Forgas et al., 1990; Isen, Johnson, Mertz, & Robinson, 1985). A specific example is a study that showed that people in happy moods tend to rely on stereotypes during social interactions (e.g., Bless et al., 1996). Furthermore, positive moods appear to facilitate the ability to focus broadly on a topic rather than on the specifics of a topic (Bless, 2001). For instance, in the persuasion study mentioned above, happy individuals were less influenced by the specific quality of the arguments in a persuasive message and instead were more influenced by the general but irrelevant theme of the passage (Mackie & Worth, 1989; Bless, 2001).

Hence, previous social cognition research has provided evidence for differential effects of negative and positive affective states on general cognitive processes. Consistent with the performance monitoring hypothesis but inconsistent with the resource depletion hypothesis, social cognition research suggests that negative affective states may improve cognitive ability. At the same time, consistent with the dopamine hypothesis, social cognition research suggests that positive affective states may impair cognitive ability. However, although some previous affect-social cognition research may have involved context processing, to my knowledge, the paradigms that are used in these studies are mostly judgment tasks and are relatively cognitively unconstrained. Therefore, although these tasks could have involved context processing, they could have involved many other cognitive processes as well. Therefore, the results suggest that negative affective states may facilitate general cognitive processes, but the specific effect of briefly-elicited affect on context processing remains unclear. At the same time, even if these tasks involved context processing, it is not clear whether the results are due to relatively better or poorer context processing or instead due to relatively greater likelihood of engaging in context processing. Furthermore, all of the above mentioned studies involved a mood induction as opposed to eliciting brief affective responses. Therefore, the influence that transient affect may have on context processing may differ from the influence of a mood state. Thus, based on social cognition research, it is unclear whether briefly-elicited affect has any specific influence on context processing.

Affective States and Cognitive Control

In addition to the many studies examining the influence of mood on social cognition, there have been a number of other studies that have examined the influence of affective states on working memory and cognitive control tasks that may involve context processing. In this section, I will discuss several areas of research that have examined the influence of affective states on working memory and cognitive control. Although these studies provide a basis from which to make predictions, overall it appears that research involving the influence of negative affective states on working memory and cognitive control is inconclusive and requires further examination. Alternatively, there is some evidence that positive affective states may result in increased cognitive flexibility. Some of these studies examining the influence of affective states will be discussed below in terms of the possible influence affect has on context processing or on other cognitive control processes (e.g., working memory storage, updating).

A couple of studies examined the influence of stress on working memory and found that stress impairs current working memory performance, and writing about stressful events improves working memory performance in the future (Klein & Boals, 2001a; Klein & Boals, 2001b). Specifically, in one study, participants that had experienced a higher level of recent life stress performed worse on Turner and Engle's

(1989) operation-span task (Klein & Boals, 2001b). Additionally, other research has shown that writing about stressful events subsequently improved working memory performance a few months after the participants had written about personal negative events (e.g., Klein and Boals, 2001a). These studies combined seem to imply that negative mood disrupts working memory. This conclusion is consistent with the resource depletion hypothesis mentioned above. Specifically, stress may recruit resources needed to perform working memory tasks and therefore, decrease the cognitive resources needed for adequate task performance. Furthermore, the release of this stress may in turn restore the resources necessary to once again perform the working memory task adequately. However, the specific influence that negative affective states may have on context processing is unclear given the complexity of working memory tasks.

In addition to examining the effect of stress on working memory, other research has focused on the relationship between cognitive load and suppression of depressive thoughts. Research has shown that when given a cognitive load, previously depressed individuals are less able to suppress negative thoughts. One study included people who were currently depressed, previously depressed, or non-depressed controls (Wenzlaff & Bates, 1998). Participants had to form sentences from sets of words that when unscrambled could form either positive or negative statements. In addition, half of the participants were given a cognitive load during this task. The results showed that previously depressed participants who were not given a cognitive load formed few negative statements, as few as never-depressed control participants. In contrast, during a cognitive load, the previously depressed participants produced a high number of negative statements, similar to the currently depressed participants. The results suggests that negative thoughts were accessible to previously depressed participants but that in the absence of a cognitive load that they were able to suppress these negative thoughts. A similar result has recently been found by Dalgleish and Yiend (2006). These results are consistent with the resource depletion hypothesis mentioned above that includes the notion that emotion regulation may reduce working memory resources. Additionally, consistent with Klien and Boals (2001b) research on stress and working memory, this research suggests that negative mood can disrupt working memory due to increased intrusions of negative thoughts. However, further research needs to address whether the influence of negative mood on working memory is only an effect of mood or whether transient negative affect could also have this detrimental effect on working memory and cognitive control performance. Moreover, as previously discussed, this research does not address the specific influence that negative affective states have on context processing.

Research has not only examined the influence of chronic mood states on working memory and cognitive control but also the influence that a long-lasting mood induction may have on these processes. Specifically, previous research has suggested that mood induction (using approach and withdrawal stimuli) has differential effects on the processing of verbal and spatial information (Gray, 2001; Gray, Braver, & Raichle, 2002; Shackman et al., 2006). In the studies conducted by Gray and colleagues (2001, 2002), participants viewed three different videos that contained approach/pleasant, withdrawal/unpleasant, and neutral material followed by either the verbal or spatial N-back task. The results showed that verbal performance was facilitated by the approach/pleasant stimuli; whereas, withdrawal/unpleasant stimuli facilitated performance in the spatial condition. These results appear to be inconsistent with the resource depletion hypothesis because approach/pleasant stimuli may detract from the resources needed to perform the verbal cognitive control task as is the case with spatial cognitive control and withdrawal/unpleasant stimuli. However, another study used a seemingly more complex variant of the N-back task where sets of multiple letters (instead of only one letter) were presented one right after the other, and only one area of the display was used to decide whether the current memorandum matched three trials previously (Shackman, et al., 2006). Shackman and colleagues (2006) found that induced anxiety by threat of a shock impairs performance in the visuospatial condition of the task but did not impair performance in the verbal condition. The reason for the discrepancy in these results and the results of Gray and colleagues is unclear and requires further examination. Although there is a discrepancy in results, both sets of results appear to be consistent with the resource depletion hypothesis. However, these effects may not be specifically due to context processing.

Overall, for research examining the influence of affect on cognitive control, there is fair evidence that negative mood tends to disrupt working memory task performance. However, it is unclear whether this would also be found for briefly-elicited negative affect. On the other hand, according to the one study examining positive mood, positive mood (i.e., approach/pleasant stimuli) may facilitate verbal working memory performance. However, thus far, the specific influence of transient positive affect on cognitive control remains unclear.

Affective States and Context Processing

Only six studies that I am aware of have specifically examined the influence of affective states on tasks thought to involve context processing. Three studies have examined the influence of affective states on the Stroop task and found contradictory results. In one study, Holmes and Pizzagalli (2007) examined individuals with elevated depressive symptoms (Beck Depression Inventory > 13) versus non-depressed individuals during performance in both a Stroop task and a Simon task (i.e., context processing tasks). Both groups received either negative or positive feedback regarding task performance in the previous block of trials. More specifically, participants were told that they were performing better or worse than participants who had already completed the study. The results showed that individuals with depression exhibited impaired post-error adjustments during both a Stroop task and a Simon task (i.e., context processing tasks) and post-conflict adjustments in the Stroop task during the negative versus a positive feedback condition (Holmes & Pizzagalli, 2007). Hence, this study suggests that negative affective states may impair context processing performance compared to positive affective states. Furthermore, these results are consistent with the resource depletion hypothesis (i.e., there may not have been enough resources available after the negative mood induction to perform the Stroop task properly). On the other hand, the results are inconsistent with the performance monitoring hypothesis which suggests that performance should improve after making errors. However, this study did not include a neutral condition to examine basic task performance and also involved the feedback condition which may function as a type of mood induction; therefore, the specific influence of negative affect is unclear.

In contrast, another study found that participants in an induced positive mood showed a trend ($p = 0.06$) towards an increased Stroop interference effect compared to participants in a neutral mood (Phillips, Bull, Adams, & Fraser, 2002). This study provides some support for the idea that positive mood disrupts context processing. These results appear to be consistent with the dopamine hypothesis of positive affect. However, this study involved induced positive mood. Therefore, it is not clear whether the results of Phillips and colleagues for a long-lasting positive mood would also be found for briefly-elicited affect. At the same time, Phillips and colleagues used a blocked version of the Stroop task with 4 different types of trial blocks: 1) naming the color of five printed X's, 2) reading words written in different colors, 3) naming colors in which words were written, 4) alternating between word reading and color naming (i.e., a mixed block). Previous research suggests that results found in blocked Stroop tasks may not be comparable to results using single-trial versions of the Stroop (i.e., with trial types varying within a block; Perlstein, Carter, Barch, & Baird, 1998) because the examination of prepotent inhibition may not be examined directly. Therefore, it is not clear whether the results of Phillips and colleagues would generalize to a single-trial version of a context processing task. Furthermore, this study did not examine whether negative affective states influence context processing.

In a third study, Kuhl and Kazén (1999) did not find an effect of positive or negative affect on Stroop performance. However, this particular study used emotional words as affective stimuli and only six words per positive, negative, and neutral prime set. Hence, it is possible that the affective stimuli were too weak to have an effect on context processing. In addition, the participants may have become desensitized to the affective stimuli since there were a small number of primes presented over numerous trials.

In addition to studies examining the Stroop task, two studies have examined the influence of affective states on the Eriksen flanker task (i.e., a center target with either compatible or incompatible distracters or flankers on either side of the target; Eriksen & Eriksen, 1974). Context processing is thought to be involved on this task to help participants selectively focus on the central stimulus and ignore distracting flankers (Botvinick et al., 2001). Overall, this research suggests that positive affective states may increase the flanker compatibility effect. However, the influence of negative affect still remains unclear. One study examining the Eriksen flanker task found that positive mood significantly increased flanker compatibility effects compared to negative and neutral moods; whereas, there was no significant effect of negative mood on the flanker effect (Rowe, Hirsh, & Anderson, 2007). This study provides further support that positive affective states may decrease context processing (i.e., stable goal maintenance). Similar to the results discussed by Phillips and colleagues, these results appear to be consistent with the dopamine hypothesis of positive affect. However, this study included induced mood as a within-subjects variable (i.e., each subject was induced with each mood condition). Therefore, it is unclear whether the same result would be obtained with briefly induced negative affect. Furthermore, in the negative mood induction condition, the authors speculated that the mild melancholic state produced by the music mood-induction method may not have had the intended effect and may have been too weak to influence context processing.

In a second study examining the influence of affect on context processing using a flanker task, Fenske and Eastwood (2003) conducted three studies involving negative, positive, and neutral target and flanker faces. Overall, this study found that negative target faces resulted in a reduced flanker compatibility effect (compatible or all negative face trials versus incompatible trials in which the negative face was surrounded by either neutral or positive faces), and positive target faces resulted in a larger flanker compatibility effect. Decreased interference with negative target faces may be consistent with the performance monitoring hypothesis which predicts that negative affect should improve context processing. However, in this task context, it is unclear whether negative affect could signal cognitive control rapidly within a trial. Moreover, there is evidence that negative stimuli might tend to attract attention in the absence of an effect on context processing (Pratto & John, 1991). Therefore, it is not clear how strongly this study suggests that negative affect might help context processing. At the same time, a larger flanker effect for positive affect seems consistent with the dopamine hypothesis as positive affect may result in poorer goal maintenance and an increased influence of distracting flankers. However, the specific reason for larger flanker effects with positive targets may not be due to poorer context processing. For example, Fenske & Eastwood (2003) argued that positive affect may widen attentional focus, which may happen independently of context processing. Consistent with this, in their first study, positive targets exhibited an incompatibility effect with neutral distractors even when neutral distractors were not part of the response set (i.e., responses to targets were either positive or negative). This type of stimulus conflict, as opposed to response conflict, may not strongly engage cognitive control (van Veen, Cohen, Botvinick, Stenger, & Carter, 2001).

One study has examined the influence of both negative and positive affective states on context processing using the AX-CPT (Dreisbach, 2006). Overall, consistent with the dopamine hypothesis of positive affect, this study found evidence that a positive affective state disrupts context processing. This study involved the presentation of emotionally valenced pictures during the performance of the AX-CPT. In the AX-CPT, participants first see a cue letter followed by a probe letter. The target is an X (probe) that was preceded by an A (cue), with all other probes being non-targets. Trials were presented randomly with the target trials (AX) occurring 70% of the time and the three sets of non-target trials occurring with the following frequency: 10% AY, 10% BX, and 10% BY; where "B" represents any non-A cue and "Y" represents any non-X probe. Given the high proportion of AX trials, a relatively automatic tendency develops to respond to the X as a target. Hence, context processing is thought to be necessary to overcome the prepotent response of responding to the X as a target on BX trials. Therefore, poor context processing should result in more BX errors. Moreover, good context processing should result in relatively more AY than BX errors because better maintenance of cue information (the letter 'A') should increase the expectation to respond to the probe as a target. Therefore, poor context processing should result in less AY errors but more BX errors. In the study by Dreisbach (2006), the positive, negative, and neutral stimuli (i.e., IAPS slides) were presented before each cue, and the valence conditions were manipulated between subjects. The elicitation of affect or mood in this study was unclear because it involved sustained presentation of a single affective state as opposed to a traditional mood induction. Furthermore, there were not significant differences in self-reported mood between conditions. Dreisbach (2006) did find evidence that positive affective stimuli resulted in poorer context processing (consistent with the dopamine hypothesis). Specifically, a positive affective state resulted in better

AY performance but worse BX performance. However, it is not clear whether these results for sustained processing of positive stimuli would also be found for briefly-elicited positive affect. In contrast, importantly Dreisbach did not report any significant effect of a negative affective state on context processing performance.

Based on the six studies examining the influence of affective states on context processing, the influence of negative affective states remains unclear. Specifically, consistent with the resource depletion hypothesis, one study found that negative mood (i.e., negative feedback for depressed individuals) impaired context processing during both a Stroop and a Simon task. On the other hand, consistent with the performance monitoring hypothesis, another study found that negative affect facilitated performance in an Eriksen flanker task resulting in a reduced flanker compatibility effect. However, three studies found no effect of negative affect on context processing. If negative affect influences context processing, this suggests that potentially, it could be a small effect. Moreover, most studies have not examined the influence of briefly-elicited negative affect.

In contrast to negative affect, it appears that in general, consistent with the dopamine hypothesis, positive affective states might decrease context processing. However, research on this topic is sparse and not entirely consistent across studies. Also, it is not clear whether the results in some of the above studies are due specifically to briefly elicited positive affect or to the broader effects of a longer-lasting positive mood.

Current Research

Based on the above literature review, it appears that it is still unknown whether and how briefly-elicited negative and positive affect influence context processing task performance. The current research examined the differential influence of briefly-elicited negative and positive affect on three context processing tasks to elucidate the effect of affect valence on context processing. Additionally, the current research examined whether the influence of affect on context processing would be associated with a greater amount of cognitive and behavioral disorganization (Kerns, 2006).

Study 1

Study 1 examined the influence of negative and positive affect on context processing using the POP (preparing to overcome prepotency) task in conjunction with IAPS slides. As previously mentioned, two competing hypotheses exist regarding the influence of negative affect on cognitive control. One hypothesis, the resource depletion hypothesis, would predict that negative affect may disrupt performance during context processing performance. Alternatively, the performance monitoring hypothesis would predict that negative affect may facilitate context processing. On the other hand, as previously discussed, the dopamine hypothesis of positive affect would predict that positive affect may impair stable goal maintenance resulting in more errors on trials with a relatively high context processing demand. However, the dopamine hypothesis makes a further prediction, that positive affect might facilitate updating of information and increase cognitive flexibility. Hence, the dopamine hypothesis seems to predict that positive affect might result in improved task switching.

Study 1 Methods

Participants

Sixty-seven undergraduate college students participated in Study 1 at the University of Missouri-Columbia. Students were recruited from an Introduction to Psychology class at the university. Each participant received research credit toward their psychology course for participating in this study. Forty males and 27 females with a mean age of 18.6 years participated in this study. The average education for this group of participants was approximately 12 years, and 88.1% of the participants were Caucasian.

Measures

Emotional POP (EPOP) Task. As can be seen in Figure 1, the POP task includes two different trial types: automatic trials (i.e., trials requiring an automatic response) and controlled trials (i.e., trials requiring context processing). During automatic response trials, participants saw a green color patch and were instructed to respond in same direction in which the arrow pointed, with responding in the direction of the arrow thought to be a prepotent response. During controlled trials, participants saw a red color patch and were instructed to respond in the opposite direction from where the arrow is pointing. Context processing is thought to be involved during the controlled conditions (i.e., during the presentation of the red color patch) because participants need to maintain the task set (i.e., to respond in the direction opposite of the arrow) in order to make a non-prepotent response and to suppress a prepotent response (i.e., responding in the same direction of the arrow). Hence, the dependent variable was controlled minus automatic errors (i.e., the POP effect), with higher scores reflecting poor context processing.

During the EPOP task, the green or red patch of color appeared for 250ms followed by the presentation of an affective picture for a total of 3s. The affective picture was presented for 3s to allow participants time to study the picture and to elicit an affective response. As can be seen in Figure 2, the affective pictures in the EPOP were comprised of pictures from the International Affective Picture System (IAPS) (Lang & Greenwald, 1988). The pictures were equated on extremity of valence and arousal. Participants were instructed to pay attention to the affective pictures at the outset of the EPOP task in preparation for a later memory task. Immediately following the affective picture, an arrow pointing to the right or to the left was presented for as long as 2s. The presentation of the arrow terminated once the participant responded. Participants were to respond either in the same direction in which the arrow pointed or the opposite direction with a button press using their right index finger to press the "1" key and their left index finger to press the "0" key. Participants were instructed to respond as quickly and accurately as possible.

Participants were first given a practice block of 40 trials where they saw a fixation for 350ms followed by an arrow in the center of the computer screen that pointed either to the left or to the right for a maximum of 2s. The purpose of this block of trials was to get the subjects accustomed to responding in the same direction in which the arrow pointed. This practice block was followed by a practice block for the EPOP task which contained 8 trials that were identical to those presented in the task. Once the participants understood the task, they completed 6 blocks of 36 trials of the EPOP task.

Memory Task. After the emotional POP, participants completed a memory task where they were tested on how well they remembered the emotional stimuli presented.

They were shown 30 pictures which included pictures the participants had seen (5 negative, 5 neutral, and 5 positive) and distracter pictures (5 negative, 5 neutral, and 5 positive). The participants were instructed to indicate whether or not they had seen those pictures in the previous task.

Self Report Questionnaires. Participants completed self-report questionnaires in order to assess current mood as well as to assess individual differences that may be associated with task performance (e.g., disorganization). The current mood questionnaire includes sixteen different emotions (i.e., 4 low-arousal negative emotions, 4 high-arousal negative emotions, 4 low-arousal positive emotions, and 4 high-arousal positive emotions; e.g., sad, depressed, happy, and elated) which are rated on a five-point scale based on how strongly the individual feels that particular emotion (0: not at all to 4: very strongly; Feldman Barrett & Russell, 1999).

Participants also completed the Cognitive Slippage Scale (CSS) which is a 35 item true/false questionnaire for the assessment of disorganization (e.g., confused thinking and speech deficits; Miers & Raulin, 1987). For instance, one item asks participants whether or not people are confused by what they say. The CSS has demonstrated construct validity in previous research (Kerns, 2006; Kerns & Becker, *under revision*), and the reliability for the current study was $\alpha = 0.88$.

Procedure and Data Analysis

Once written informed consent was obtained, the participants completed a demographic questionnaire. Participants then completed the practice blocks followed by the EPOP task. Once participants were finished with the task, they completed the memory task to verify that all participants were paying attention to the affective stimuli during the task. After the memory task, participants completed questionnaires programmed on the computer which assessed current mood and disorganization.

To examine differences in memory for negative, neutral, and positive stimuli, hit rates and false alarm rates were calculated, and false alarm rates were subtracted from hit rates resulting in a "corrected recognition" value (i.e., the proportion of correctly recognized stimuli) for each affect type. When examining the association between the individual difference variables and context processing performance after negative, neutral, and positive stimuli, Spearman's rho values were used due to the skewed individual difference variables.

Study 1 Results

Task performance

Error Rates. In a two (trial type: automatic/green versus controlled/red trials) by three (valence: negative, neutral, and positive) analysis of variance (ANOVA) examining error rates, there was a main effect of trial type (i.e., the POP effect), F (1, 66) = 6.00, $p <$ 0.05, with more errors on controlled (i.e., context processing) trials than on automatic trials but no main effect of valence, F (2, 132) = 0.02, p = 0.98. However, there was a significant interaction between trial type and valence, F (2, 132) = 6.25, $p <$ 0.005, as the POP effect was significantly smaller after the presentation of negative stimuli compared to both neutral (t (1, 66) = -2.13, $p <$ 0.05) and positive stimuli (t (1, 66) = -3.29, $p <$ 0.005). In addition, as can be seen in Figure 3, after the presentation of negative pictures, participants made fewer errors during context processing trials and more errors during automatic trials. On the other hand, after the presentation of positive pictures, participants made more errors during context processing trials and fewer errors during automatic trials).

In addition to examining the POP effect (i.e., automatic versus controlled trials), I examined performance when switching between trial types (i.e., switch cost). In a two (previous trial type: automatic versus controlled trials) by two (current trial: automatic versus controlled trials) by three (valence: negative, neutral, and positive) ANOVA examining error rates during switch trials, there was evidence of a switch cost, F (1, 66) = 89.33, $p < 0.001$, with participants performing worse on switch trials than on non-switch trials. However, the three-way interaction between previous trial, current trial, and valence was not significant, F (2, 132) = 0.14, $p = 0.87$. Therefore, valence did not affect the switch cost.

Reaction Times. In a two (trial type: automatic versus controlled trials) by two (valence: negative, neutral, and positive) ANOVA examining reaction times (RTs), there was a main effect of trial type, F (1, 66) = 58.24, $p < 0.001$, as participants were significantly slower during controlled trials (i.e., context processing trials). There was also a main effect of valence, F (2, 132) = 6.09, $p < 0.005$, with significantly longer RTs after negative pictures than after neutral or positive pictures. However, as can be seen in Figure 4, there was no interaction between trial type and valence, F (1, 66) = 0.24, p = 0.78.

In addition to examining the POP effect (i.e., automatic versus controlled trials), I examined performance when task switching. In a two (previous trial type: automatic versus controlled trials) by two (switch type: automatic versus controlled trials) by three (valence: negative, neutral, and positive) ANOVA examining reaction times during switch trials, there was evidence of a switch cost, F (1, 66) = 80.97, $p < 0.001$, with participants performing worse on switch trials than on non-switch trials. However, the three-way interaction between previous trial, current trial, and valence was not significant, F (2, 132) = 0.46, $p = 0.63$. Therefore, valence did not affect the switch cost.

Memory Task

Participants' memory for the negative pictures was significantly better than for the neutral and positive pictures, F (2, 132) = 3.87, $p < 0.05$ (corrected recognitions: mean for negative pictures = 0.83, SD = 0.19; mean for neutral pictures = 0.75, SD = 0.25; mean for positive pictures = 0.76, SD = 0.20).

Individual Differences

As can be seen in Table 2, there were no significant associations between error rates and individual difference variables. However, there was a tendency for positive mood to be associated with the POP effect after the presentation of negative stimuli. For additional results regarding the relationship between performance in the EPOP task and current mood as well as between EPOP task performance and individual difference variables, see Tables 1A and 2A in the Appendix.

Study 1 Discussion

Overall, there was a significant interaction between automatic and controlled processing (i.e., context processing) and valence. Specifically, when participants viewed a negative picture, they exhibited a smaller interference effect in error rates (i.e., no difference between errors in automatic versus controlled trials). In contrast, after viewing positive stimuli, participants exhibited a larger interference effect in error rates (i.e., more errors in controlled than automatic trials). However, reaction time results showed no significant interaction but showed a general slowing during trials that included negative stimuli. At the same time, memory was better for negative pictures. This is consistent with other research on emotion and memory as negative material tends to be better remembered than neutral information (Kensinger & Corkin, 2003). Hence, this study appears to provide some evidence that negative affect might facilitate context processing performance and that positive affect might impair context processing. At first glance, these results seem consistent the performance monitoring and dopamine hypotheses regarding the influence of affect on cognitive control but inconsistent with the resource depletion hypothesis.

When comparing the results of Study 1 with the predictions of the hypotheses regarding the influence of negative affect on cognitive control, the facilitative effect of negative affect on context processing is inconsistent with the resource depletion hypothesis. As previously mentioned, this hypothesis predicts that negative affect would impair context processing which did not occur in the current study. In contrast, the facilitative effect of negative affect on context processing is consistent with the performance monitoring hypothesis. More specifically, the performance monitoring hypothesis predicts that negative affect would facilitate performance during a context processing task. For instance, in the EPOP task, negative affect may have signaled the need for improvement in performance and the recruitment of context processing.

In addition to the results being seemingly consistent with the performance monitoring hypothesis, the results seem consistent with the dopamine hypothesis of positive affect. According to this hypothesis, positive affect impairs goal maintenance (i.e., context processing). This is consistent with a larger interference effect on positive trials than for neutral trials.

However, there are several pieces of evidence that may not be consistent with either the performance monitoring or dopamine hypothesis, suggesting that the smaller or larger interference effects for negative or positive affect may not be due to an influence on context processing. For example, the dopamine hypothesis also predicts that positive affect would facilitate task switching by allowing flexible updating of context representations. However, there was no significant effect of positive affect on task switching in the current study, suggesting that positive affect may not have had an effect on context processing. At the same time, interference effects appeared to be due not only to changes on controlled trials but also to changes on automatic trials, with participants being more accurate on positive automatic trials than on negative automatic trials. This suggests that the influence of negative and positive affect on the POP task may have been affecting some other cognitive process other than context processing.

Instead of the results suggesting a specific influence of affect on context processing, the results may indicate a general influence of affect on cognition. Based on the design of the task, the other cognitive factor that may have confounded the results in the task may have been a decision bias. Specifically, when participants responded to the automatic trials (i.e., the green trials) in the same direction of the arrow, this could be considered a "yes" (or a positive) response. The results showed that these "positive" responses were more accurate after the presentation of the positive pictures. On the other hand, when participants responded to the controlled trials (i.e., the red trials) in the opposite direction of the arrow, this could be considered a "no" (or a negative) response.

The results showed that these “negative” responses were more accurate after the presentation of negative pictures. Thus, the results for Study 1 could be a function of the “negative” and “positive” decision bias associated with valence. Therefore, it is unclear based on the EPOP task whether the results reflect the specific influence of negative and positive affect on context processing. To further examine whether negative and positive affect have a specific influence on context processing, I conducted a second study that did not involve the decision bias confound present in Study 1.

Study 2

Study 2 further examined the influence of negative and positive affect on context processing by using the Stroop color-naming task in conjunction with IAPS slides. In contrast to Study 1, Study 2 examined the influence of negative and positive affect on context processing without the confound inherent in Study 1 (i.e., the decision bias). The confound present in Study 1 was removed by using the Stroop task which involves responding to the colors of the four stimuli rather than making a dichotomous (i.e., yes/no) response. Hence, positive or negative affect should not bias making particular responses independent of context processing. Again, the resource depletion hypothesis predicts that negative affect should disrupt context processing. In contrast, the performance monitoring hypothesis predicts that negative affect should improve context processing performance. On the other hand, the dopamine hypothesis of positive affect predicts that positive affect may disrupt context processing performance.

Study 2 Methods

Participants

Fifty-three college students participated in the current study at the University of Missouri-Columbia. Students were recruited from an Introduction to Psychology class at the university. Each participant received research credit toward their psychology course for participating in this study. Thirty-one males and twenty-two females with a mean age of 19.04 years participated in this study. The average education for this group of participants was approximately 13 years (i.e., high school plus one year of college), and ninety-one percent of the participants were Caucasian. Three participants were dropped from the analyses due to poor performance in the neutral conditions relative to the other participants' performance in the affective conditions (i.e., error rates between 0.10 and 0.15). Therefore, the analyses included data from 50 participants.

Measures

Emotional Picture Stroop Task. As can be seen in Figure 5, participants were instructed to respond to the color in which the word is written and to ignore the word. The Stroop task involves two basic trial types: congruent and incongruent trials. Congruent trials consist of a color word (e.g., RED, GREEN, BLUE, YELLOW) that matches the color in which the word is written (e.g., the word RED in red ink). Congruent trials are considered to be automatic response trials. On the other hand, incongruent trials consist of a color word that does not match the color in which the word is written (e.g., the word RED in blue ink; correct response is blue). These trials are considered to be controlled response trials and to involve context processing, as goal maintenance is thought to be important for overcoming the prepotent response of reading the word (Cohen & Dunbar, & McClelland, 1990; Kane & Engle, 2003). Hence, the dependent variable was incongruent minus congruent errors (i.e., the Stroop effect), with higher scores reflecting poor context processing.

Before each Stroop stimulus, participants were first presented with a picture for 3s. As in Study 1, the pictures were either negative, neutral, or positive IAPS slides (Lang & Greenwald, 1988; Lang, Bradley, & Cuthbert, 1990). The pictures were equated on extremity of valence and arousal. Participants were instructed to pay attention to the pictures because they would be given a memory task towards the end of the study. Participants then saw one of four words (RED, GREEN, BLUE, and YELLOW) printed in one of the four colors for as long as 2s. To increase the need for goal maintenance, 70% of the trials within each block were congruent and 30% were incongruent (Carter et al., 2000; Kerns et al., 2004a). The participants were to respond by pressing the button that corresponded with the color of the stimulus (1=red, 2=green, 9=blue, 0=yellow). The presentation of the color-word stimuli terminated once the participant responded. The participants were instructed to respond as quickly and accurately as possible. Following the presentation of the color-word, there was an inter-trial-interval (ITI) of 1200ms.

Participants first completed a practice block of 20 trials where they saw a fixation for 500ms followed by the stimulus “XXXXX” that appeared in the center of the computer screen in the colors red, green, blue, or yellow for 2000ms. Participants were instructed to respond according to the color response mappings previously mentioned. The initial practice block was followed by another practice block for the emotional

Stroop task which contained 9 trials that were identical to those presented in the task. Participants then completed 3 blocks of 120 trials of the EPS task.

Memory Task. After the emotional picture Stroop task, participants completed a memory task as described in Study 1.

Self Report Questionnaires. Participants completed four self-report questionnaires in order to assess mood state as well as to assess individual differences that may be associated with task performance. As described in Study 1, participants completed a questionnaire on the computer assessing the participants' current mood state. Participants completed this questionnaire once in the beginning of the study and once after the memory task. Participants also completed the Cognitive Slippage Scale (CSS), as described in Study 1, to assess their level of disorganization. Reliability for the current study was $\alpha = 0.87$.

Additionally, participants completed the Beck Depression Inventory (BDI) which is a 21-item self-report measure that assesses for the presence and severity of depressive symptoms within the past week (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Total BDI scores indicate the following: scores of 0-13 are thought to indicate minimal depression, 14-19 mild depression, 20-28 moderate depression, and 29-63 severe depression. The most recent version of the BDI (i.e., BDI-II) has established construct validity (Beck et al., 1961, 1962), and reliability for the current study was $\alpha = 0.83$.

Finally, all participants completed two subscales from the International Personality Item Pool (IPIP) to assess neuroticism and extraversion (Goldberg, 1999). Participants were asked to rate on a 1-5 scale how accurately each item described them (from: 1 = very inaccurate to: 5 = very accurate). An example of a neuroticism item is:

"Get stressed out easily" and an example of an extraversion item is "Am the life of the party." Reliability for the current study was α = 0.84. In addition, a multi-trait multi-method model comprised of traits associated with neuroticism and extraversion and two methods showed both convergent and discriminant validity for the IPIP scales (Lim & Ployhart, 2006).

Procedure and Data Analysis

Once informed written consent was obtained, the participants completed a demographic questionnaire and the questionnaire assessing their current mood state. Participants first completed the two practice blocks. Once the participants understood the task, participants completed the emotional picture Stroop task followed by the memory task to verify that all participants were paying attention to the emotional stimuli during the task.

After the participants were finished with the memory task, they immediately completed the questionnaire assessing current mood for the second time during the study. The participants then completed the CSS, the BDI, and the neuroticism and extraversion subscales from the IPIP.

The memory task and the correlations between task performance and individual difference variables were analyzed as described in Study 1.

Study 2 Results

Task performance

Error Rates. In a two (trial type: congruent versus incongruent) by three (valence: negative, neutral, and positive) analysis of variance (ANOVA) examining error rates, there was a main effect of trial type (i.e., the Stroop effect), F (1, 49) = 64.60, $p < 0.001$, as performance during incongruent trials was worse than performance during congruent trials. However, there was no main effect of valence, F (2, 98) = 2.29, $p = 0.11$. Importantly, as can be seen in Figure 6, there was a significant interaction between trial type and valence, F (2, 98) = 3.86, $p < 0.05$, as performance during incongruent trials after the presentation of a negative stimulus was less accurate at the trend level than performance after a neutral stimulus (t (1, 49) = 1.97, $p = 0.054$) and significantly less accurate than performance after a positive stimulus (t (1, 49) = 2.28, $p < 0.05$).

Reaction Times. In a two (trial type: congruent versus incongruent) by three (valence: negative, neutral, and positive) ANOVA examining reaction times (RTs), there was a main effect of trial type, F (1, 49) = 301.70, $p < 0.001$, as participants were significantly slower during incongruent trials than during congruent trials, but there was no main effect of valence present, F (2, 98) = 1.32, $p = 0.27$. In addition, as can be seen in Figure 7, there was no interaction between trial type and valence, F (2, 98) = 0.28, p = 0.76.

Memory Task

Participants' memory for the neutral pictures was significantly worse than for the negative but not positive pictures, F (2, 98) = 3.92, $p < 0.05$ (Corrected recognitions: mean for negative pictures = 0.68, SD = 0.24; mean for neutral pictures = 0.57, SD = 0.24; mean for positive pictures = 0.60, SD = 0.27).

Individual Differences

As can be seen in Table 3, there was some evidence suggesting that current negative mood was associated with an increased Stroop effect after the presentation of negative stimuli. In addition, increased disorganization was associated with a larger Stroop RT interference after both negative and positive stimuli. On the other hand, disorganization was associated with a smaller Stroop error rate interference after neutral stimuli, an interesting but unpredicted pattern. Furthermore, as can be seen in Table 3, state depression (as measured by the BDI) was significantly negatively correlated with the Stroop effect following positive pictures for error rates but not for RTs. Additionally, neuroticism was correlated with Stroop effect for RTs after the presentation of positive stimuli at the trend level. Moreover, the Stroop effect for error rates and RTs following the presentation of positive pictures was correlated at the trend level with extraversion. As can be seen in Table 3, it is possible that associations for depression, neuroticism, and extraversion could reflect a speed-accuracy tradeoff. For additional results regarding the relationship between performance in the emotional picture Stroop task and current mood as well as between task performance and individual difference variables, see Tables 3A-6A in the Appendix.

Study 2 Discussion

Overall, in Study 2, there was some evidence that negative affect might impair context processing performance. After the presentation of negative stimuli, error rates increased during the incongruent trials (i.e., the trials requiring context processing). In addition, current negative mood was associated with poor context processing performance for reaction times (but not for error rates) after the presentation of negative stimuli. In contrast, positive affect did not appear to significantly influence context processing when compared to neutral trials. Hence, the results of Study 2 suggest a disruption of context processing performance during the presentation of negative affect but not positive affect.

These results provide some support for the idea that the results of Study 1 were not due to the specific influence of affect on context processing. In Study 2, with the removal of the decision confound, negative affect impaired context processing performance, in contrast to Study 1 where negative affect seemingly facilitated context processing. Additionally, in Study 2, positive affect did not impair context performance as seemed to be the case in Study 1. Instead, positive affect did not have a significant influence on context processing performance.

When comparing the results of Study 2 with the hypotheses regarding the influence of negative affect on cognitive control, the impairing effect of negative affect on context processing in the current study is consistent with the resource depletion hypothesis. As previously mentioned, this hypothesis predicts that negative affect would deplete the resources necessary to perform a context processing task and therefore would impair task performance. However, the impairing effect of negative affect on context processing is inconsistent with the performance monitoring hypothesis. As previously mentioned, the performance monitoring hypothesis predicts that negative affect would facilitate performance during a context processing task.

At the same time, the lack of significant effect of positive affect on context processing seems inconsistent with the dopamine hypothesis of positive affect. According to this hypothesis, positive affect would impair goal maintenance (i.e., context processing). However, there was no evidence that positive affect influenced context processing in Study 2.

In addition, these results are inconsistent with previous results found using the AX-CPT in which positive affect appeared to disrupt context processing performance (Dreisbach, 2006). However, that study used a between-subjects affect manipulation in which some participants only received positive pictures, which potentially could be considered to be a manipulation of positive mood rather than briefly-elicited affect. The differences between the results in the current study and the results of Driesbach (2006) could be a function of either the difference in mood manipulation (brief affect or longer mood) or the difference in task design (i.e., Stroop task versus AX-CPT task). Therefore, I ran a third study using the AX-CPT to examine the influence of affect on context processing. If only positive mood but not briefly-elicited positive affect disrupts context processing, then in Study 3 briefly-elicited, positive affect should not influence performance of the AX-CPT.

Study 3

Thus far, Study 1 and Study 2 have produced somewhat conflicting results. Presumably, the difference in results is due to the decision confound present on the POP task. To further examine this, Study 3 used the AX-CPT task in conjunction with IAPS slides to further elucidate the influence of negative and positive affect on context processing. The AX-CPT task was chosen for the current study for three specific reasons. First, although a different task from the Stroop, the AX-CPT also does not involve a decision confound like the POP and therefore could provide converging evidence for the influence of affect on context processing. Second, the AX-CPT is arguably the most well-validated measure of context processing (e.g., has undergone extensive modeling).

Finally, the AX-CPT is the same task used by Dreisbach (2006) which reported results inconsistent with those found in Study 2. By examining the influence of briefly elicited affect on the AX-CPT, I can determine whether the results from Study 2 were different from the results found by Driesbach because of task design differences or differences in affective manipulation (i.e., Driesbach examined the sustained presentation of positive pictures potentially resulting in a sustained positive mood). By manipulating briefly-elicited affect within subjects in Study 3, I was able to examine the influence of briefly-elicited affect on context processing.

Using the AX-CPT task, I compared the influence of affect on AY trials versus BX trials. More errors on AY trials are thought to reflect better context processing and an increased expectation to make a target response following an A cue. In addition, fewer errors on BX trials are thought to reflect better context processing, as participants are able to maintain the goal of only making a target response when viewing an X preceded by an A. Three different hypotheses predict how affect might influence performance during these trials. As previously mentioned, two competing hypotheses exist regarding the influence of negative affect on cognitive control. One hypothesis, the resource depletion hypothesis, would predict that the presentation of a negative picture would impair subsequent performance during BX trials and improve performance during AY trials. Alternatively, the performance monitoring hypothesis would predict that the presentation of a negative picture may serve as a signal to improve performance and engage context processing during BX trials. On the other hand, as previously discussed, the dopamine hypothesis of positive affect would predict that positive affect may impair context processing resulting in more errors during BX trials and fewer errors during AY trials.

Study 3 Method

Participants

Thirty-eight college students participated in the current study at the University of Missouri-Columbia. Students were recruited from an Introduction to Psychology class at the university. Each participant received research credit toward their psychology course for participating in this study. A total of twenty-seven males and eleven females with a mean age of 19.63 years participated in this study. The average education for this group of participants was approximately 13 years, and ninety-seven percent of the participants were Caucasian. Six participants were dropped from the analyses due to poor context processing performance during neutral trials. Specifically, one participant's performance was at less than chance for the AY condition, and the other participants' performance was poorer for BX than AY trials (i.e., poor context processing performance) during the neutral conditions. Therefore, the analyses included data from 32 participants.

Measures

Emotional AX-CPT Task. In the AX-CPT task, on every trial, participants see both a cue and a probe letter. The target is the letter X but only if the letter X was preceded by the letter A. All of the other letters are non-targets. As can be seen in Figure 8, the AX-CPT includes four different trial types: 1) AX trials (i.e., target trials); 2) AY trials (i.e., non-target trials) which include an A cue followed by any probe letter besides an A or an X; 3) BX trials (i.e., non-target trials) which include a cue that was neither an A or an X followed by an X probe; and 4) BY trials (i.e., non-target trials) which included any cue and any probe except for an A or an X. As previously mentioned, there were two trial types of interest: AY and BX trials. According to models of context processing (Braver et al., 2001), in AY trials, better context processing leads to greater AY errors because one would maintain the expectation that the X probes follow the A cues leading to a tendency to respond to the probe as a target. In addition, during BX trials, better context processing leads to fewer BX errors because when presented with a B cue, context processing is used to overcome the automatic response of responding to the X probe as a target. In contrast, poor context processing is expected to result in relatively better AY than BX performance. Hence, the dependent variable was BX minus AY errors, with higher scores reflecting poor context processing.

During the emotional AX-CPT, participants saw a series of letters appear one at a time in the center of a computer screen. Participants were instructed to make a target response only when they observed an X (probe) which was preceded by an A (cue). In addition, participants were instructed to make a non-target response if X followed any other letter (e.g., B) or if another letter besides X followed the letter A (e.g., Y). In this task, trials were presented randomly with the target trials (AX) occurring 70% of the time and the three sets of non-target trials occurring with the following frequency: 10% AY, 10% BX, and 10% BY. The cue was presented for 250ms and did not require a response. The cue was followed by the presentation of an emotional picture (i.e., one of the IAPS slides which were equated for extremity of valence and arousal) for 3s. Participants were instructed to pay attention to the pictures in preparation for the memory task given after every three blocks of the task. Following the emotional picture, participants were presented with a probe for 250ms, and they had 1500ms to respond to the probe. In addition, participants were given feedback when they made an error. Finally, there was an ITI of 1s. Participants were instructed to respond as quickly and accurately as possible.

Participants first completed 8 practice trials of the emotional AX-CPT task. Participants then completed a total of 900 trials (i.e., nine blocks of 100 trials), of the AX-CPT task: 300 positive trials, 300 negative trials, and 300 neutral trials.

Memory Task. After every three blocks in the emotional AX-CPT, participants completed a memory task where they were tested on how well they remembered the emotional stimuli presented. The memory task was the same as described in Study 1 with different pictures used in each of the three memory tasks. Three separate memory tasks were given in summary due to the length of the task (i.e., to provide breaks in performing the AX-CPT, and given the number of pictures seen, to sensitively test how much participants were paying attention to the picture).

Self Report Questionnaires. Participants completed the same four self-report questionnaires mentioned in Study 2. In the current study, the reliability for the CSS was $\alpha = 0.87$. The reliability for the BDI was $\alpha = 0.85$. Finally, the reliability for the IPIP scales was $\alpha = 0.80$. As previously mentioned, Spearman's rho values were used due to the skewed individual difference variables.

Procedure and Data Analysis

Once informed consent was obtained, the participants completed a demographic questionnaire and the questionnaire assessing their current mood. Participants then completed the emotional AX-CPT. This task took participants approximately an hour and a half to complete, and small breaks were given in between blocks in an attempt to reduce fatigue. After every three blocks of the emotional AX-CPT, participants completed a memory task to verify that all participants were paying attention to the emotional stimuli during the task.

Once the participants were finished with the last memory task, they completed the questionnaire assessing current mood for the second time. The participants then filled out the CSS, the BDI, and the neuroticism and extraversion subscales from the IPIP. As previously mentioned, Spearman's rho values were used due to the skewed individual difference variables.

The memory task and the correlations between task performance and individual difference variables were analyzed as described in Study 1.

Study 3 Results

Error Rates. In a two (trial type: BX trials versus AY trials) by three (valence: negative, neutral, and positive) analysis of variance (ANOVA) examining error rates, there was a main effect of trial type, F (1, 31) = 45.92, $p < 0.001$, with participants performing more poorly during the AY trials in comparison to the BX trials but no main effect of valence, F (2, 62) = 0.35, $p = 0.71$. Additionally, as can be seen in Figure 9, there was a trend resulting from the interaction between trial type and valence condition, F (2, 62) = 2.37, $p = 0.10$. Specifically, context processing performance was worse after the presentation of negative stimuli (i.e., less AY errors and more BX errors) compared to neutral (t (1, 31) = 1.91, $p = 0.07$) and positive stimuli (t (1, 31) = 1.79, $p = 0.08$) at the trend level.

Reaction Times. In a two (trial type: BX trials versus AY trials) by three (valence: negative, neutral, and positive) ANOVA examining RTs, as can be seen in Figure 10, there was a main effect of trial type, $F(1, 31) = 375.030$, $p < 0.001$, as participants performed significantly slower during the AY trials in comparison to the BX trials. However, there was no main effect of valence present, $F(2, 62) = 0.288$, $p = 0.75$ and no interaction between trial type and valence, $F(1, 31) = 0.994$, $p = 0.38$.

Memory Task

Memory Task 1. Participants' memory for the affective pictures was different at the trend level, $F(2, 62) = 2.65$, $p = 0.08$. When examining the pair-wise comparisons, the proportion of negative pictures correctly recognized was significant in comparison to the neutral pictures, $t(1, 31) = 2.35$, $p < 0.05$ (Corrected recognitions: mean for negative pictures = 0.75, SD = 0.30; mean for neutral pictures = 0.63, SD = 0.31; mean for positive pictures = 0.66, SD = 0.27).

Memory Task 2. Participants' memory for the affective pictures was different at the trend level, $F(2, 60) = 2.72$, $p = 0.07$. When examining the pair-wise comparisons, the proportion of negative pictures correctly recognized was significantly different from the positive pictures, $t(1, 31) = 2.35$, $p < 0.05$ (Corrected recognitions: mean for negative pictures = 0.83, SD = 0.25; mean for neutral pictures = 0.79, SD = 0.25; mean for positive pictures = 0.72, SD = 0.18).

Memory Task 3. Participants' memory for the affective pictures was not significantly different, $F(2, 58) = 1.25$, $p = 029$. In addition, the pair-wise comparisons did not show significantly better recognition for any of the affective pictures (Corrected recognitions: mean for negative pictures = 0.79, SD = 0.22; mean for neutral pictures = 0.84, SD = 0.21; mean for positive pictures = 0.85, SD = 0.19).

Individual Differences

As can be seen in Table 4, negative current mood was found to be significantly associated with the BX-AY difference in error rates following negative affective stimuli. Specifically, negative mood was associated with poor context processing performance after the presentation of negative pictures. Based on the correlations between task performance and the individual difference variables, it appears that disorganization was significantly correlated with the BX-AY difference in error rates following the presentation of positive stimuli. Specifically, better context processing after positive pictures was associated with more disorganization. In addition, as can be seen in Table 4, extraversion was significantly correlated with the BX-AY difference in RTs but not for error rates after positive pictures which could reflect a speed-accuracy tradeoff. For additional results regarding the relationship between performance in the emotional AX-CPT task and current mood as well as between emotional AX-CPT task performance and individual difference variables, see Tables 7A- 10A in the Appendix.

Study 3 Discussion

Overall, in Study 3, there appeared to be additional evidence that briefly elicited negative affect impaired context processing performance. After the presentation of negative stimuli, there was a relative increase in error rates in BX trials (i.e., trials requiring context processing for better performance), and there was a relative decrease in error rates in AY trials (i.e., trials that exhibit relatively poorer performance with good context processing). In addition, negative mood was associated with poor context processing performance after the presentation of negative stimuli (at least for error rates).

In contrast, positive affect did not appear to significantly influence context processing performance when compared to neutral trials. Hence, consistent with Study 2, the results of Study 3 suggest that briefly-elicited negative affect but not positive affect disrupts context processing performance. In addition, these results support the resource depletion hypothesis but not the performance monitoring or the dopamine hypothesis.

At the same time, the results of both Study 2 and Study 3 are inconsistent with the results from the study conducted by Driesbach (2006). This discrepancy between the current results and the results from the Dreisbach study appear to be a difference in manipulation of affective state (i.e., affect versus mood). Specifically, the influence of positive affective states found in the study conducted by Driesbach may reflect an effect of a longer lasting positive mood rather than an effect of briefly-elicited positive affect.

General Discussion

Overall, using well-validated context processing tasks, the current study found that negative affect impaired context processing in two different context processing tasks. To my knowledge, the current research is the first to demonstrate that briefly-elicited negative affect disrupts context processing performance. In addition, negative mood was also associated with impaired context processing performance after the presentation of negative affective stimuli. These results are consistent with the resource depletion hypothesis which suggests that negative affect detracts from the resources necessary to perform context processing tasks. In contrast, these results were inconsistent with the performance monitoring hypothesis which suggests that negative affect improves context processing performance.

At the same time, in addition to the examination of briefly-elicited negative affect, to my knowledge the current research is one of the first to examine briefly-elicited positive affect using two validated context processing tasks. Overall, it seemed that positive affect did not influence context processing. Hence, it appeared that briefly-elicited negative affect but not positive affect impaired context processing.

The impairing effect that negative affect had on context processing in the current study provides support for the resource depletion hypothesis. Specifically, performance in the emotional picture Stroop task during incongruent trials (i.e., trials requiring context processing) was impaired after the presentation of negative pictures. In addition, performance in the emotional AX-CPT task during the BX trials (i.e., trials requiring context processing) was impaired after the presentation of negative pictures. Furthermore, performance in the emotional AX-CPT task during the AY trials (i.e., trials exhibiting poor performance with good context processing) improved after the presentation of negative pictures.

In addition to briefly-elicited negative affect, negative mood was also associated with the disruption in context processing performance after the presentation of negative pictures. For instance, in the emotional picture Stroop task, participants' reaction times slowed during context processing performance after the presentation of negative pictures, and this slowing was associated with increased self-reported negative mood at the beginning of the study. Moreover, in the emotional AX-CPT task, increased error rates during context processing performance after the presentation of the negative pictures were associated with greater negative mood in the beginning of the study. This result provides further support for the resource depletion hypothesis.

According to the resource depletion hypothesis as well as the results of the current studies, there seem to be a few different ways in which negative affect could deplete the cognitive resources necessary to perform a context processing task. First, as previously mentioned, negative affect may initiate task-irrelevant thoughts which may serve as a distraction, and suppression of these task-irrelevant thoughts might impair cognitive control (Brewin & Beaton, 2002). Second, processing negative stimuli might induce emotion regulation. There is evidence that emotion regulation also involves cognitive control (e.g., Schmeichel, 2007). Hence, engaging in emotion regulation might decrease resources for performance of a context processing task. In summary, consistent with the resource depletion hypothesis, resources engaged in processing of negative pictures may have detracted from the resources needed to engage context processing resulting in poorer performance. However, further research is needed to examine the specific ways in which processing negative affective information results in resource depletion. At the same time, it is also the case that the influence of negative affect on context processing in Studies 2 and 3 were relatively small effects. It is possible that more direct manipulation of how people process negative affect (e.g., engaging in mood regulation; Ochsner et al., 2002) might result in larger effects of negative affect on context processing.

In addition to the consistency between the current study's results and the resource depletion hypothesis, the results of the present study are generally consistent with previous research examining the influence of negative mood on cognitive control. For instance, a number of studies have found evidence suggesting that negative moods (i.e., an affective state lasting minutes) disrupt working memory and cognitive control task performance (e.g., Dalgleish & Yiend; 2006; Holmes & Pizzagalli, 2007; Klein and

Boals, 2001b; Wenzlaff & Bates, 1998). On the other hand, at least two previous studies did not find an effect of negative mood on context processing (Dreisbach, 2006; Rowe et al., 2007). However, it is possible that this was due to the weak manipulation of negative mood in those studies.

Overall, given evidence of negative affect disrupting context processing, the current study suggests that negative affective states may play a role in the dysfunction of context processing. This has important implications for psychiatric patients (e.g., individuals with schizophrenia) who have deficits in context processing and may experience difficulty in regulating affective states. One future set of studies could be to examine whether people with schizophrenia exhibit an increased influence of affect on context processing. Furthermore, use of a task involving an effect of affect on context processing might be relevant for examining cognitive and emotional control in other psychological disorders, such as bipolar disorder, borderline personality disorder, and ADHD. Additionally, further research is needed to determine the differential influence that negative mood and negative affect have on context processing as well as the effects of specific types of affective states (e.g., anxiety, disgust, sadness) could potentially have differential effects on cognition. These results also have important implications for the neural mechanisms associated with the influence that negative affective states have on context processing. For instance, another future study could examine the neural correlates of the influence of affect on context processing using fMRI. In addition, future research could examine whether the influence of negative affect on context processing is mediated by levels of serotonin in the prefrontal cortex (Mitchell & Philips, 2007).

Additional concerns that should be addressed in the future regarding the resource depletion hypothesis and its relation to the influence of affect on context processing involve studying how people are actually processing the affective information. On one hand, negative affect could simply be attention-grabbing and deplete attention resources. On the other hand, negative affect may engage emotion regulation which in turn may deplete the resources necessary to adequately perform the context processing task. Furthermore, it will be important to examine whether the influence of negative affect is specific to context processing by conducting a study with a task that does not require context processing. However, it should be noted that in Study 3, negative affect did not lead to poor performance in general on the A-X CPT but instead specifically increased BX trial errors but relatively decreased AY trial errors.

In contrast with the resource depletion hypothesis, the performance monitoring hypothesis is inconsistent with the impairing effect of negative affect on context processing in the current study. Even though overall the results in the current study did not support the performance monitoring hypothesis, there are other instances that this hypothesis might be relevant. For instance, performance monitoring hypothesis may be relevant when affect is tied to task performance, such as when an error occurs. However, arguing against this, it has been found that people who are depressed exhibit decreased adjustments in performance after errors (Holmes & Pizzagali, 2007). It is still possible that milder (as opposed to severe) negative affect could facilitate context processing when it is perceived as task relevant.

In contrast to the influence of negative affect on context processing, positive affect did not appear to significantly influence context processing once the decision confound present in Study 1 was removed (although even in Study 1 no effect of positive affect on task switching was observed). The lack of a significant influence of positive affect on context processing is inconsistent with the dopamine hypothesis of positive affect which predicts that positive affect should impair context processing. This suggests that only positive mood, rather than briefly-elicited affect, may result in changes in context processing task performance. This is consistent with suggestions that changes in dopamine in the prefrontal cortex may not be rapid enough to facilitate rapid updating of goal representations (e.g., O'Reilly, 2006). Therefore, only longer-lasting positive affect may have an influence on context processing. The different influence that positive affect and positive mood have on context processing may account for the discrepancy in results between the current study and previous studies examining the influence of positive mood on context processing (e.g., Dreisbach, 2006). One issue for future research would be to directly compare in the same study the influence of sustained positive mood versus transient positive affect on context processing. Based on the current research, I would predict that only sustained positive mood but not transient positive affect would impair context processing performance.

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Tables

Table 1

Differences between Affect, Emotion, and Mood

Defining Characteristics of Affective States	Affect	Emotion	Mood
Length of Affective State?	Brief	Brief	Long
Personally Relevant?	No	Yes	No
Specific Source or Meaning?	No	Yes	Maybe
Stimuli Used?	IAPS slides Emotional faces Emotional words	IAPS slides with personal relevance	Mood induction: Writing or Movie clip
Extra Cognitions?	No	No	Yes
Integration into Cognitive Task?	Easy	Difficult	Easy
Safety with psychiatric patients?	Safe	Potentially Unsafe	Potentially Unsafe
Useful in fMRI Scanner?	Yes	Yes	Yes

Table 2

Correlations between the POP Effect and Individual Difference Variables

Trial Type	Valence	Negative Mood	Positive Mood	Disorganization
POP Effect Error Rates	Negative	0.03	0.16	-0.18
	Neutral	-0.02	0.21	0.01
	Positive	0.04	-0.08	0.03
POP Effect Reaction Times	Negative	012	0.15	0.04
	Neutral	0.02	013	-0.10
	Positive	-0.10	-0.03	0.02

Table 3

Correlations between the Stroop Effect and Individual Difference Variables

Trial Type	Valence	Negative Mood	Positive Mood	CSS	BDI	Neuroticism	Extraversion
Stroop Effect Error Rates	Negative	0.07	-0.17	-0.00	-0.09	0.19	0.15
	Neutral	0.13	0.04	-0.30†	0.05	0.03	0.10
	Positive	-0.20	0.17	-0.16	-0.32*	-0.13	0.24†
Stroop Effect RTs	Negative	0.24†	0.01	0.33†	0.06	0.22	-0.10
	Neutral	0.13	0.22	-0.02	0.13	0.02	-0.10
	Positive	0.19	-0.10	0.38*	0.15	0.27†	-0.27†

† Trend at $p < 0.11$; * Significant at $p < 0.05$

Table 4

Correlations between BX-AY difference and Individual Difference Variables

Trial Type	Valence	Negative Mood	Positive Mood	CSS	BDI	Neuroticism	Extraversion
BX-AY Error Rates	Negative	0.39*	-0.12	-0.25	0.16	-0.05	-0.09
	Neutral	0.20	0.17	-0.29	0.14	-0.18	0.24
	Positive	0.16	0.12	-0.37*	0.09	-0.29	0.18
BX-AY RTs	Negative	0.14	-0.07	-0.07	0.05	-0.25	-0.11
	Neutral	0.13	-0.12	-0.09	0.20	-0.08	-0.16
	Positive	0.09	-0.13	-0.14	-0.00	-0.03	-0.41*

* Significant at $p < 0.05$

Figures

Figure 1

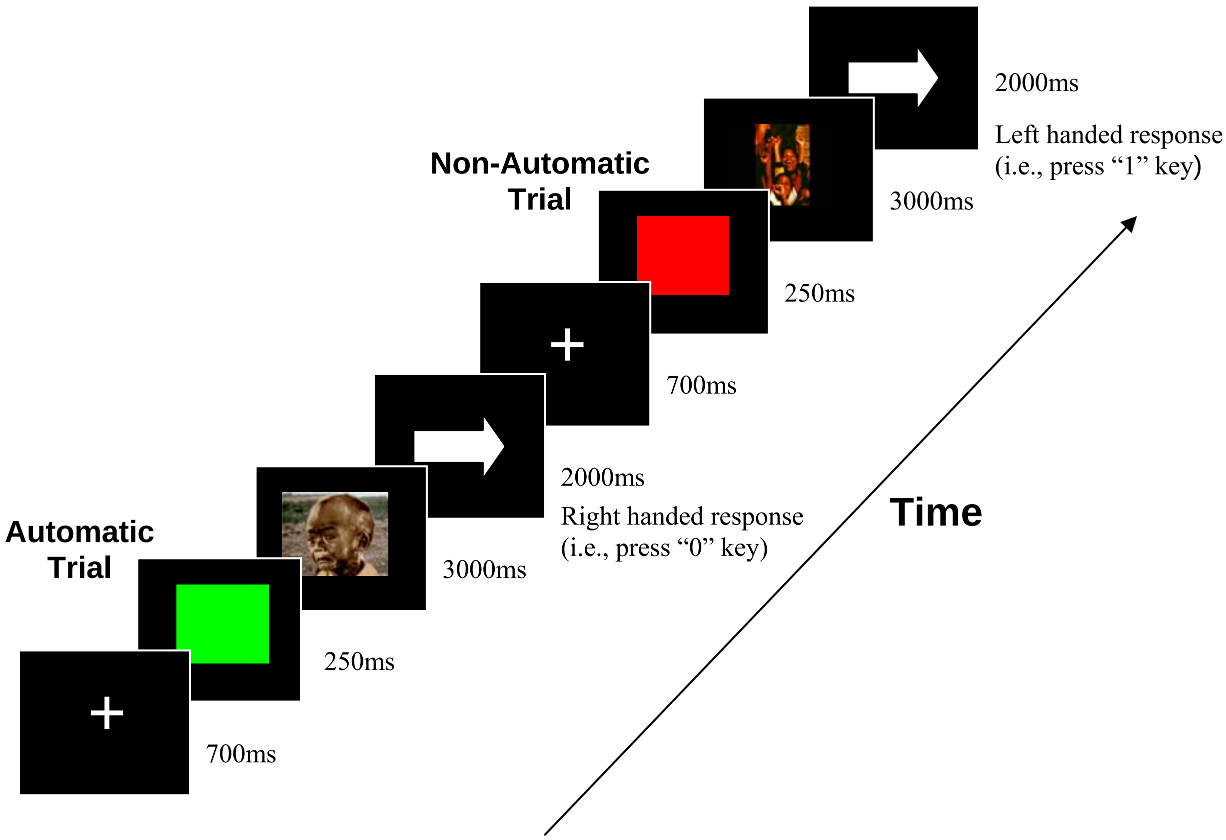


Figure 2

a) b) c)

Figure 3

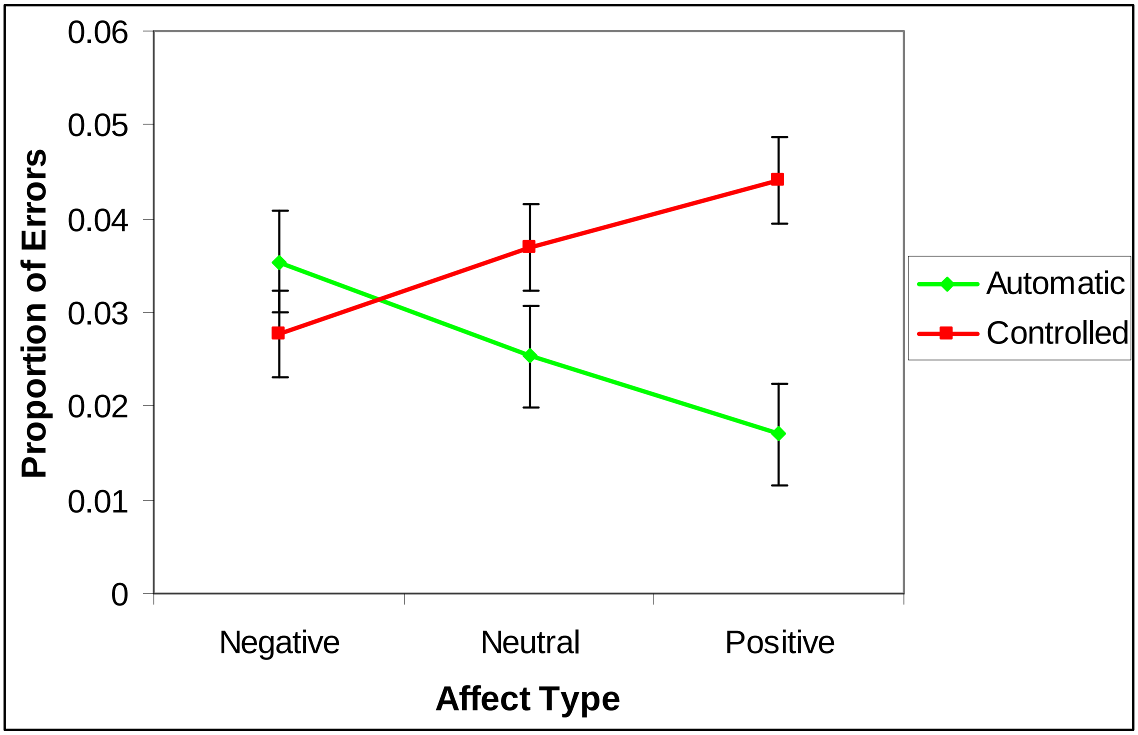
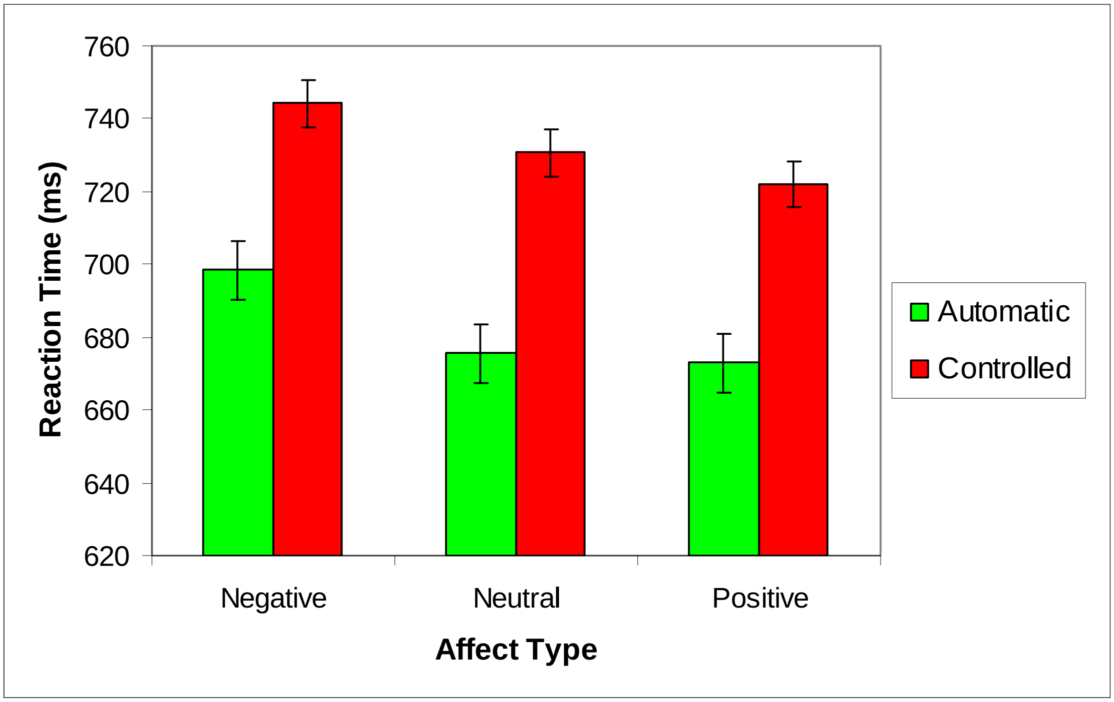

0.06
0.05
0.04
0.03
0.02
0.01
0
Proportion of Errors
Negative
Neutral
Positive
Affect Type
Automatic
Controlled

Figure 4



760
740
720
700
680
660
640
620
Reaction Time (ms)
Negative
Neutral
Positive
Affect Type
Automatic
Controlled

Figure 5

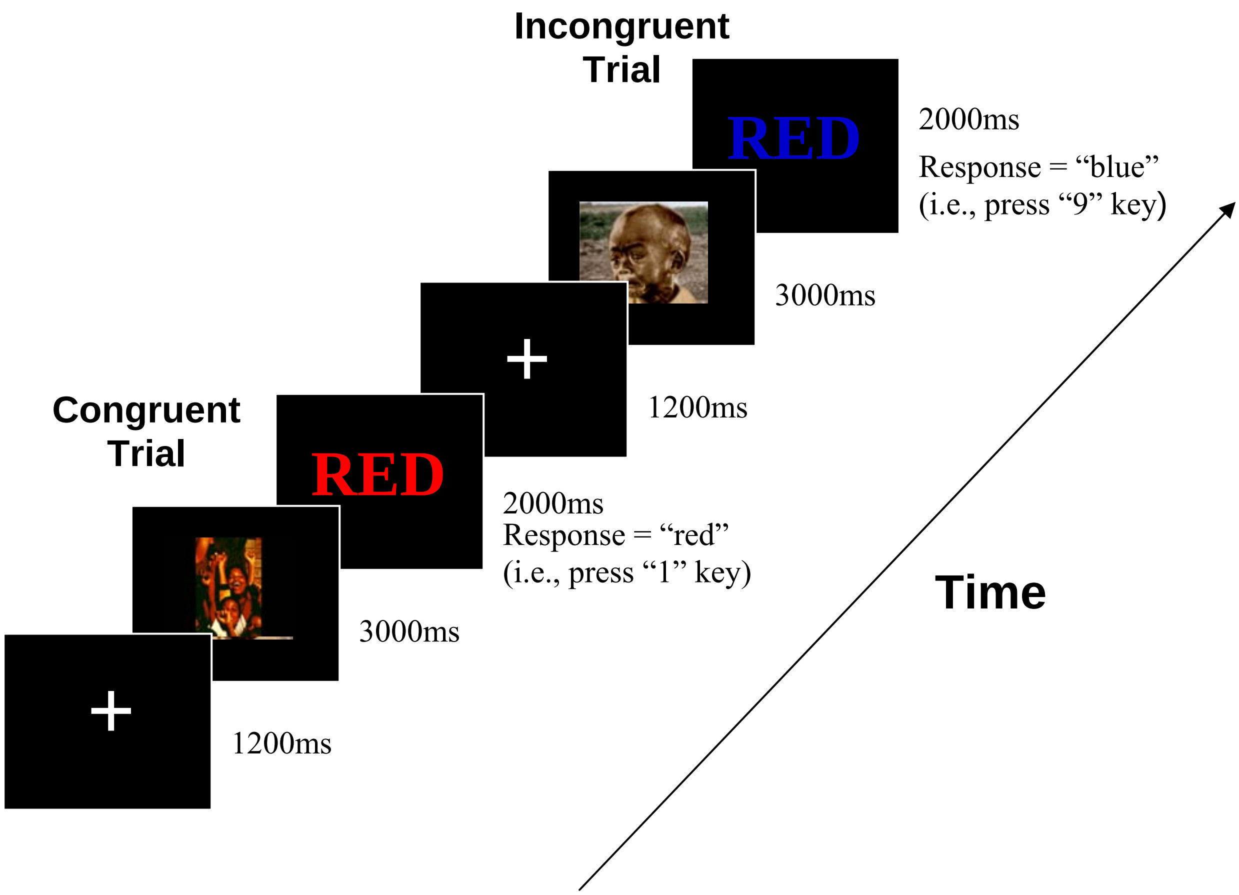

Incongruent
Trial
RED
2000ms
Response = “blue”
(i.e., press “9” key)
3000ms
+
1200ms
Congruent
Trial
RED
2000ms
Response = “red”
(i.e., press “1” key)
3000ms
Time
+
1200ms

Figure 6

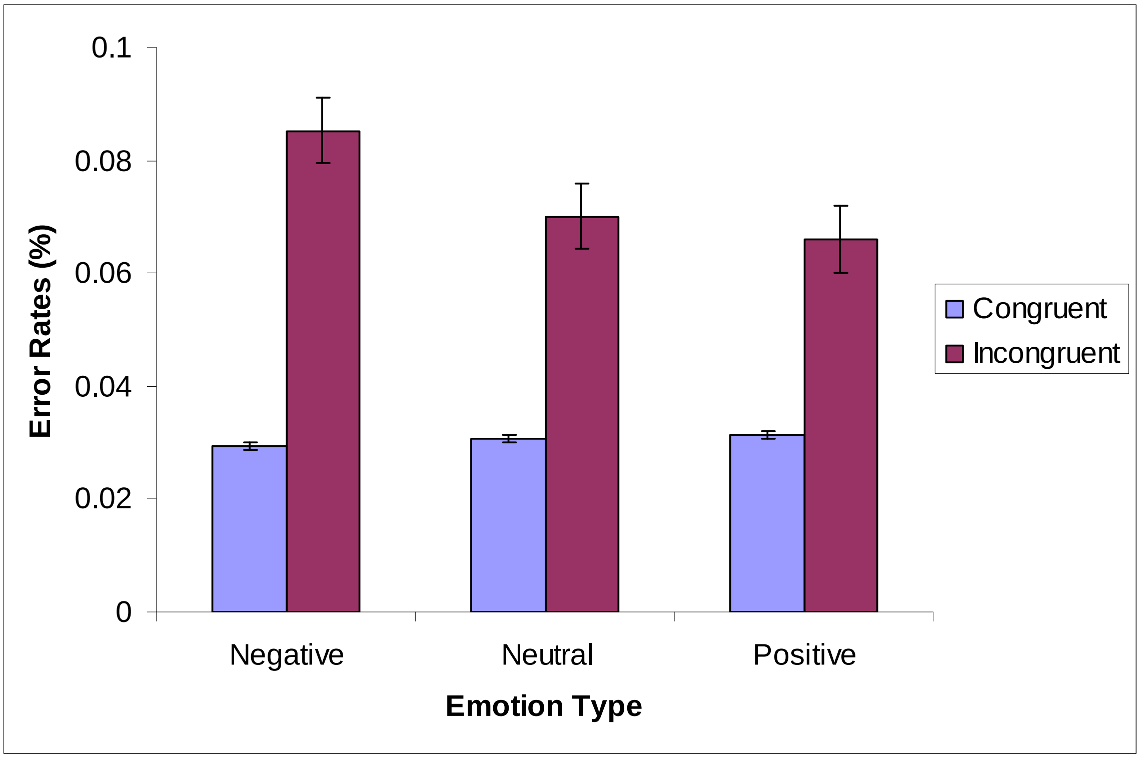
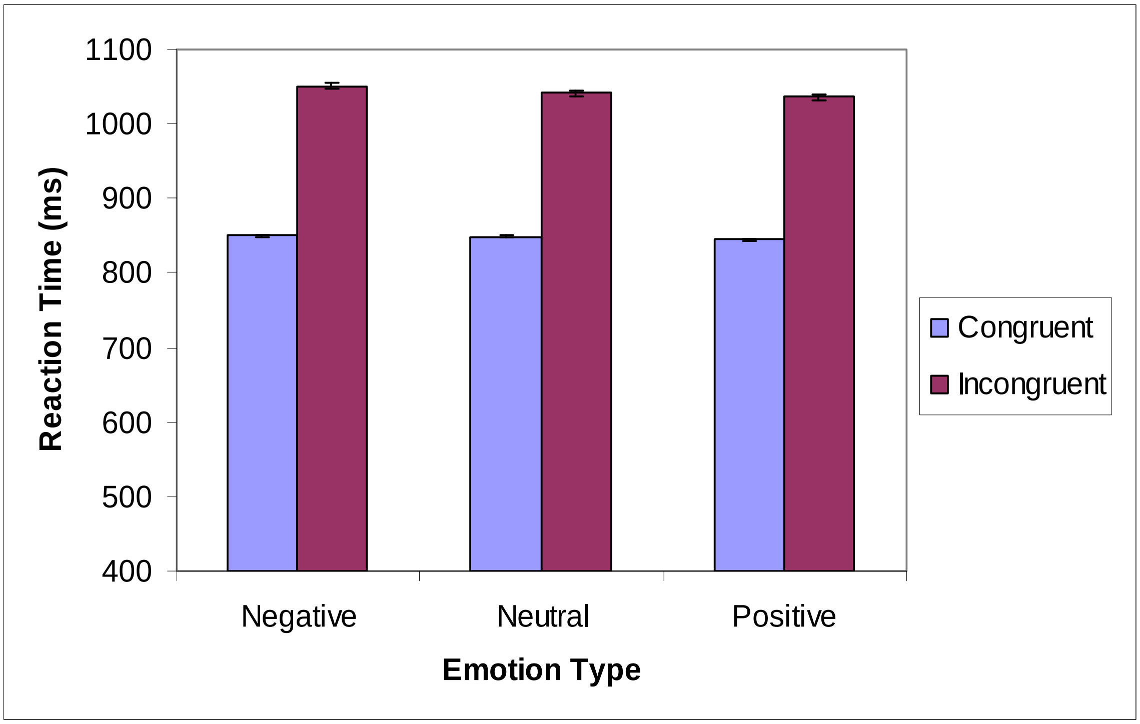

0.1
0.08
0.06
0.04
0.02
0
Error Rates (%)
Negative
Neutral
Positive
Emotion Type
Congruent
Incongruent

Figure 7



1100
1000
900
800
700
600
500
400
Reaction Time (ms)
Negative
Neutral
Positive
Emotion Type
Congruent
Incongruent

Figure 8

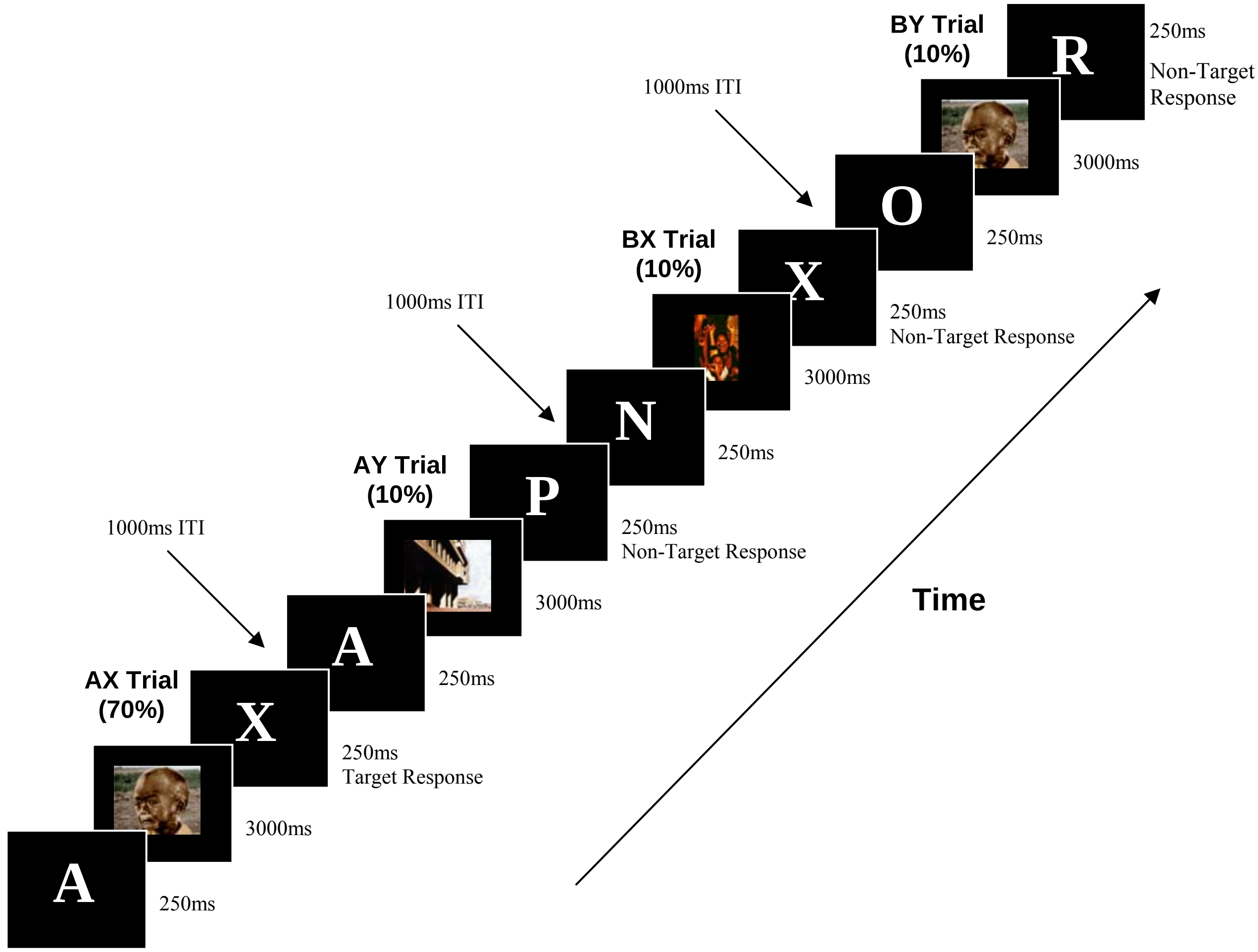

BY Trial
(10%)
R
250ms
Non-Target
Response
1000ms ITI
3000ms
O
250ms
BX Trial
(10%)
X
250ms
Non-Target Response
1000ms ITI
3000ms
N
250ms
AY Trial
(10%)
P
250ms
Non-Target Response
1000ms ITI
3000ms
A
250ms
Time
AX Trial
(70%)
X
250ms
Target Response
3000ms
A
250ms

Figure 9

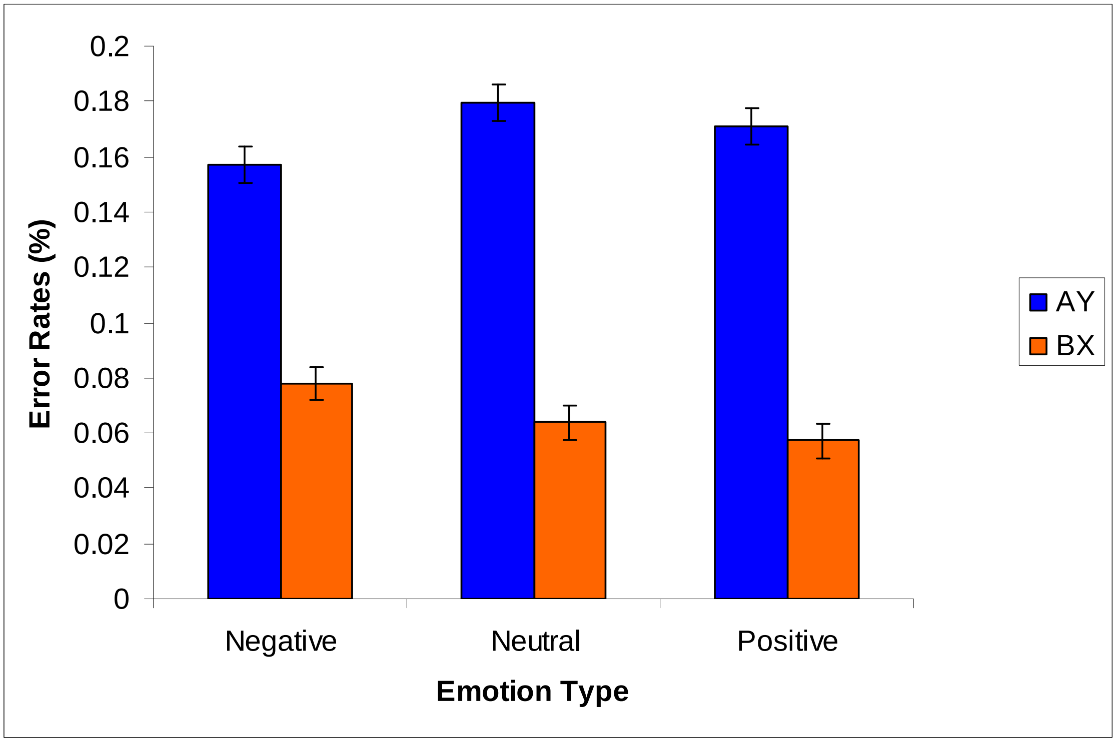
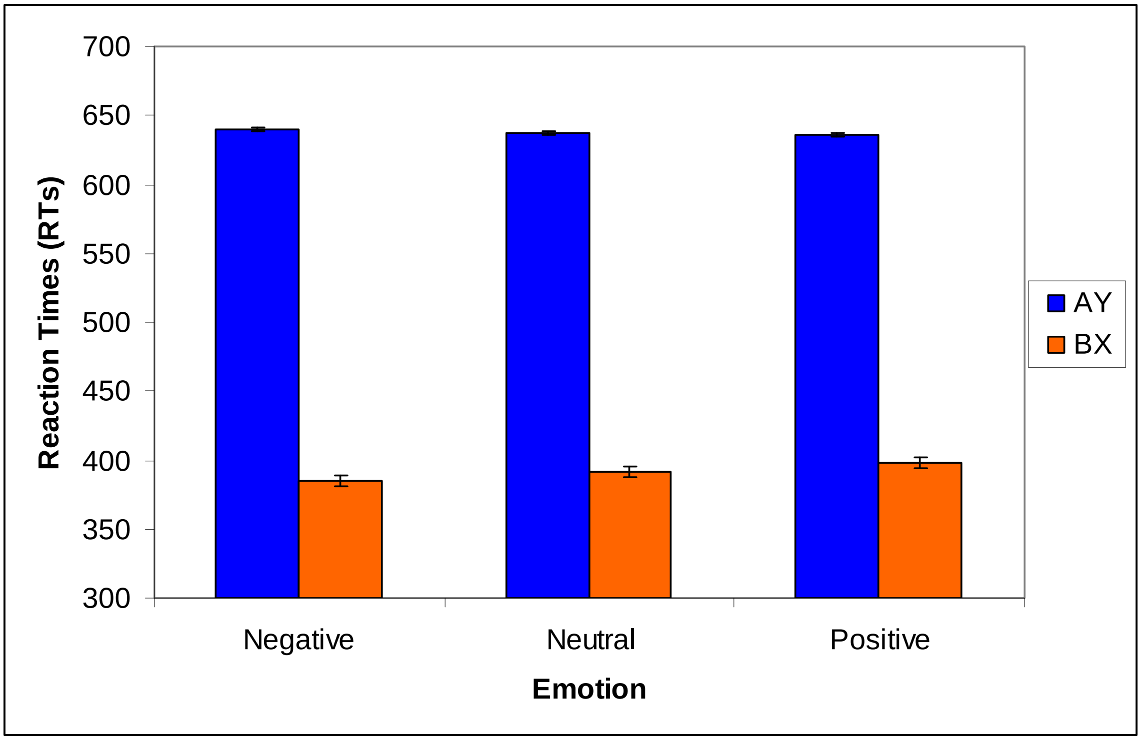

0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Error Rates (%)
Negative
Neutral
Positive
Emotion Type
AY
BX

Figure 10


700
650
600
550
500
450
400
350
300
Reaction Times (RTs)
Negative
Neutral
Positive
Emotion
AY
BX

Appendix Tables

Table A1

Correlations between Error Rates for EPOP Trial Types and Individual Difference Variables

Trial Type	Valence	Negative Mood State			Positive Mood State			Disorganization (CSS)		
		Low	High	Total	Low	High	Total	Low	High	Total
POP Effect	Negative	-0.04	0.07	0.03	0.04	0.19	0.16	0.08	0.18	-0.18
	Neutral	-0.12	0.09	-0.02	0.11	0.25	0.21	0.08	0.09	0.01
	Positive	0.02	0.08	0.04	-0.11	0.01	-0.08	-0.09	-0.07	0.03
Green	Negative	0.19	0.02	0.12	0.02	-0.05	-0.03	0.02	-0.05	0.14
	Neutral	0.13	-0.05	0.06	0.05	-0.13	-0.06	0.09	-0.07	-0.01
	Positive	0.02	-0.08	-0.05	0.20	0.01	0.11	0.24	0.36[†]	0.11
Red	Negative	0.01	-0.02	0.00	0.03	0.18	0.14	0.08	0.10	-0.10
	Neutral	-0.11	0.02	-0.04	0.13	0.21	0.19	0.16	0.10	-0.03
	Positive	0.00	-0.00	-0.01	0.05	0.07	0.04	0.11	0.08	0.05

[†] Trend at p = 0.06; Note: Categories within mood state: Low = low arousal, High = high arousal; Categories within Disorganization: Low = low half of disorganization scores after median spilt, High = high half of disorganization scores after median split

Table A2

Correlations between RTs for EPOP Trial Types and Individual Difference Variables

Trial Type	Valence	Negative Mood State			Positive Mood State			Disorganization (CSS)		
		Low	High	Total	Low	High	Total	Low	High	Total
POP Effect	Negative	0.20	0.04	0.12	0.08	0.13	0.15	-0.18	0.43*	0.04
	Neutral	-0.03	0.08	0.02	0.16	0.13	0.13	-0.07	0.30	-0.10
	Positive	-0.04	-0.13	-0.10	-0.13	0.07	-0.03	0.04	0.03	0.02
Green	Negative	0.07	0.12	0.11	-0.14	-0.44**	-0.34*	-0.09	-0.25	0.07
	Neutral	0.08	0.09	0.09	-0.11	-0.29*	-0.22	-0.12	-0.30	0.06
	Positive	0.10	0.10	0.12	-0.03	-0.33*	-0.23	-0.15	-0.10	0.10
Red	Negative	0.12	0.10	0.12	-0.08	-0.29	-0.23	-0.12	-0.07	0.10
	Neutral	0.06	0.10	0.09	0.03	-0.22	-0.12	-0.11	-0.21	0.04
	Positive	0.11	0.07	0.10	-0.16	-0.28	-0.28	-0.13	-0.09	0.12

* $p < 0.05$; ** $p < 0.01$; Note: Categories within mood state: Low = low arousal, High = high arousal; Categories within Disorganization: Low = low half of disorganization scores after median spilt, High = high half of disorganization scores after median split

Table A3

Correlations between Error Rates for Stroop Trial Types and Current Mood State

Trial Type	Valence	Negative Mood State			Positive Mood State		
		Low	High	Total	Low	High	Total
Stroop Effect	Negative	-0.08	0.04	-0.03	-0.11	-0.25†	-0.14
	Neutral	0.21	0.10	0.17	0.09	0.08	0.07
	Positive	-0.03	-0.29	-0.17	0.12	0.25†	0.20
Congruent	Negative	-0.10	-0.08	-0.11	-0.17	-0.05	-0.10
	Neutral	-0.04	-0.09	-0.10	-0.14	-0.11	-0.12
	Positive	0.03	-0.12	-0.04	-0.15	-0.15	-0.15
Incongruent	Negative	-0.05	-0.01	-0.05	-0.16	-0.22	-0.17
	Neutral	0.06	-0.01	0.03	-0.04	-0.02	-0.04
	Positive	0.01	-0.32*	-0.15	-0.03	0.16	0.02

† Trend at $p < 0.10$; * Significant at $p < 0.05$

Table A4

Correlations between Error Rates for Stroop Trial Types and Individual Difference Variables

Trial Type	Valence	Disorganization (CSS)	Depression (BDI)	Neuroticism	Extraversion
Congruent	Negative	-0.16	0.12	-0.13	-0.12
	Neutral	-0.23	0.22	-0.18	-0.01
	Positive	-0.10	0.27†	-0.25†	-0.11
Incongruent	Negative	-0.04	-0.07	0.08	0.08
	Neutral	-0.27	0.11	-0.05	0.05
	Positive	-0.18	-0.11	-0.22	0.13

† Trend at $p < 0.11$; * Significant at $p < 0.05$

Table A5

Correlations between RTs for Stroop Trial Types and Current Mood State

Trial Type	Valence	Negative Mood State			Positive Mood State		
		Low	High	Total	Low	High	Total
Stroop Effect	Negative	0.40**	-0.04	0.24†	-0.06	0.10	0.01
	Neutral	0.21	-0.03	0.13	0.12	0.28†	0.22
	Positive	0.28*	-0.00	0.19	-0.04	-0.05	-0.10
Congruent	Negative	-0.01	0.03	0.00	-0.22	-0.41**	-0.42**
	Neutral	0.06	0.04	0.05	-0.23	-0.39**	-0.41**
	Positive	0.03	0.03	0.03	-0.29*	-0.34*	-0.43**
Incongruent	Negative	0.19	-0.01	0.11	-0.20	-0.31*	-0.34*
	Neutral	0.21	0.02	0.15	-0.11	-0.12	-0.20
	Positive	0.19	0.03	0.14	-0.20	-0.28†	-0.35*

† Trend at $p < 0.11$; * Significant at $p < 0.05$; ** Significant at $p < 0.01$

Table A6

Correlations between RTs for Stroop Trial Types and Individual Difference Variables

Trial Type	Valence	Disorganization (CSS)	Depression (BDI)	Neuroticism	Extraversion
Congruent	Negative	-0.11	0.15	-0.04	-0.16
	Neutral	-0.08	0.15	0.03	-0.16
	Positive	-0.19	0.12	-0.13	-0.06
Incongruent	Negative	0.08	0.15	0.08	-0.16
	Neutral	-0.15	0.24†	0.02	-0.13
	Positive	0.03	0.22	0.08	-0.21

† Trend at $p < 0.10$

Table A7

Correlations between BX and AY Error Rates and Current Mood State

Trial Type	Valence	Negative Mood State			Positive Mood State		
		Low	High	Total	Low	High	Total
BX-AY	Negative	0.64**	0.14	0.39*	-0.03	-0.23	-0.12
	Neutral	0.35†	0.10	0.17	0.04	0.21	0.17
	Positive	0.39*	0.00	0.16	0.00	0.18	0.12
AY	Negative	-0.50**	-0.12	-0.27	0.02	0.20	0.10
	Neutral	-0.28	-0.12	-0.17	-0.06	-0.13	-0.16
	Positive	-0.39*	-0.03	-0.18	-0.09	-0.13	-0.19
BX	Negative	0.24	0.11	0.20	-0.04	-0.09	-0.07
	Neutral	0.01	0.02	0.04	-0.01	0.08	-0.00
	Positive	-0.13	-0.16	-0.18	-0.20	-0.12	-0.24

† Trend at $p < 0.11$; * Significant at $p < 0.05$; ** Significant at $p < 0.01$

Table A8

Correlations between BX and AY Error Rates and Individual Difference Variables

Trial Type	Valence	Disorganization (CSS)	Depression (BDI)	Neuroticism	Extraversion
AY	Negative	0.38*	-0.16	0.15	0.04
	Neutral	0.31†	-0.18	0.22	-0.19
	Positive	0.41*	-0.15	0.30†	-0.15
BX	Negative	0.10	0.04	0.22	-0.17
	Neutral	0.21	-0.06	0.21	-0.07
	Positive	0.29	-0.13	0.10	0.08

† Trend at $p < 0.11$; * Significant at $p < 0.05$

Table A9

Correlations between BX and AY RTs and Current Mood State

Trial Type	Valence	Negative Mood State			Positive Mood State		
		Low	High	Total	Low	High	Total
BX-AY	Negative	0.17	0.11	0.14	-0.02	-0.06	-0.07
	Neutral	0.17	0.06	0.13	0.01	-0.07	-0.12
	Positive	0.12	0.02	0.09	-0.11	0.07	-0.13
AY	Negative	0.11	-0.00	0.08	0.01	0.35†	0.25
	Neutral	0.06	-0.01	0.03	0.03	0.22	0.19
	Positive	-0.06	-0.15	-0.14	0.12	0.17	0.26
BX	Negative	0.07	-0.02	0.04	0.07	0.37*	0.29
	Neutral	0.10	-0.04	0.05	0.11	0.21	0.17
	Positive	0.12	-0.09	0.02	0.04	0.34†	0.22

† Trend at $p < 0.11$; * Significant at $p < 0.05$

Table A10

Correlations between BX and AY RTs and Individual Difference Variables

Trial Type	Valence	Disorganization (CSS)	Depression (BDI)	Neuroticism	Extraversion
AY	Negative	0.08	-0.17	0.11	0.25
	Neutral	0.17	-0.15	0.10	0.27
	Positive	0.07	-0.11	-0.08	0.43*
BX	Negative	0.14	-0.19	-0.13	0.25
	Neutral	0.20	-0.06	0.03	0.22
	Positive	0.02	-0.07	0.03	0.01

* Significant at $p < 0.05$