ERP MARKERS FOR THE AFFECTIVE RECRUITMENT OF COGNITIVE CONTROL: IMPLICATIONS FOR ATTENTION AND EMOTION REGULATION

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INTRODUCTION

The behavioral approach (BAS) and behavioral inhibition (BIS) systems are dimensions of affective style thought to influence the self regulation of attention and emotion via the recruitment of cognitive control. The interactive impact of affective reactivity and cognitive control on self regulation, however, is still poorly understood (Dennis & Chen, in press; Derryberry & Reed, 2002).

In the present study, event-related brain potentials (ERPs) in response to emotional distracters were measured as markers for the recruitment of cognitive control (in particular the N200). Neural processing efficiency models suggest that enhanced ERPs reflect increased distractibility and reduced cognitive efficiency, but only in those showing low BIS and BAS reactivity (Gray et al., 2005). We examined this hypothesis in relation to immediate attention performance following emotional distracters and in relation to long-term emotion regulation tendencies.

Predictions:

1) High BIS in particular may be associated with increased reactivity and enhanced neural responses to emotional distracters (Gray et al., 2005).
2) Attention performance will be most efficient in those showing an "optimal balance" between BIS/BAS reactivity and recruitment of cognitive control: low reactivity/low control or high reactivity/high control.
3) High BAS-sensitivity has been associated with expressive suppression, a relatively non-optimal emotion regulation strategy (Jackson et al., 2003). If neural processing efficiency accounts are correct, then those showing high BAS but low recruitment of cognitive control (reduced N200) will report the lowest use of expressive suppression.

METHOD

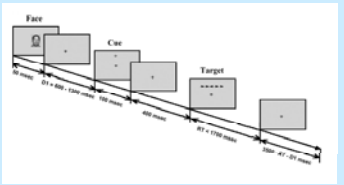
Participants. 36 non-disordered adults, aged 18-40.

Emotion regulation and BIS/BAS were measured via self-report using the 10-item ERQ (Gross & John, 2003) and BIS/BAS 24-item questionnaires (Carver & White, 1994).

The Attention Network Task (Fan et al., 2002). This 30-minute task is a combination of a cued reaction time and a flanker task that requires the subject to determine whether a central arrow points to the left or right. Executive attention was calculated as RT incongruent – RT congruent flankers. Thus, a higher score (conflict) indicates *decreased* executive attention efficiency.

Emotional Faces were 48 black-and-white photographs of fearful, sad, and happy faces (Tottenham et al., 2002).





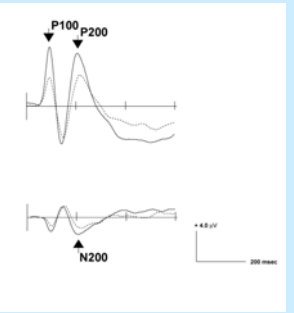
ERP recording and analysis

EEG activity was recorded via BioSemi 64 Ag/AgCl scalp electrodes, sampled at 512 Hz. Data were filtered with a low-cutoff frequency of .1 Hz and a high-cutoff frequency of 30 Hz. Stimulus-locked data was segmented into epochs from 200 msec before to 800 msec after stimulus onset.

PCA yielded three discrete time-windows for four components from 0-300 ms, which accounted for 97.2% of the total variance, and corresponded to timing and topographic distribution of the **P100** (maximum at 90 ms), **N140** (maximum at 140 ms), and the posterior **P200** and anterior **N200** (both maximum at 220 ms) (BESA 5.1; MEGIS Software GmbH, Munich, Germany).

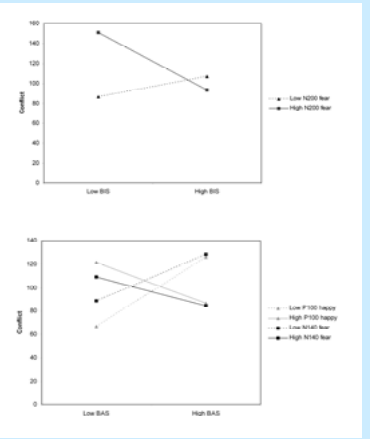
RESULTS

Figure 1. The high BIS-sensitive group showed an enhanced neural response to emotional faces. BAS was not associated with enhanced ERPs.



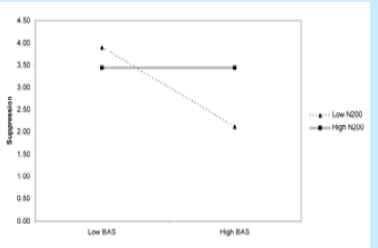
High (solid line) versus low (dashed line) BIS groups across all emotions for the P100 and P200 components (right posterior electrode PO8; top panel) and for N200 (right anterior electrode FC4; bottom panel).

Figure 2. The link between BIS/BAS and attention performance varied depending on the amplitude ERP responses following fearful and happy faces



As BIS and BAS increased, executive attention performance improved (reduced conflict), but only when ERP responses were reduced. BAS specifically interacted with P100 and N140 and BIS with N200.

Figure 3. The association between BAS and suppression varied depending on the amplitude of N200 following sad and happy faces.



The balance between BAS and N200 predicted suppression. BAS was negatively correlated with suppression, but only with reduced N200. Increased N200 responses were linked to report of greater expressive suppression.

Table 1. Correlations with mood symptoms between emotion regulation and neural efficiency

	Trait Anxiety	Depression
Total Sample (N = 36)		
Reappraisal	-.22	-.14
Suppression	.22	.34*
High N200 (N = 18)		
Reappraisal	.03	.16
Suppression	.53**	.64***
Low N200 (N = 18)		
Reappraisal	-.30	-.22
Suppression	.04	.22

ERPs followed sad and happy faces. *p = .05. **p < .05. ***p < .01.

To explore the clinical implications of emotion regulation strategies in combination with ERP measures of neural processing efficiency, we examined zero-order correlations between emotion regulation and non-clinical mood symptoms. As seen in Table 1, expressive suppression was significantly positively correlated with symptoms of anxiety and depression, effects which remained significant only for those showing high N200.

Summary

1) Under very mild emotional competition, high BIS participants showed enhanced ERP responses linked to affective processing and cognitive control.
2) "Optimal balance" hypotheses were supported: greater recruitment of relatively automatic (P100, N140) and voluntary (N200) processes was related to worse executive attention in low BAS- and BIS-sensitive participants, but with better performance in those showing high sensitivity. BAS was selectively sensitive to happy faces and with modulation of P100 and N140.
3) BAS was negatively correlated with suppression, but only when N200 was reduced, perhaps reflecting increased neural processing efficiency.
4) Correlations with mood symptoms suggest that the mental health consequences of emotion regulation depend on individual differences related to neural processing efficiency.
5) Overall, results suggest that ERPs reflecting the recruitment of cognitive control may be a marker for regulatory ability, but that this depends on individual differences in reactivity. Findings are consistent with models of the interplay between emotional reactivity and cognitive control in relation to attention regulation (Derryberry & Reed, 2002; Matthews & Mackintosh, 1998) and suggest that an "optimal balance" between the two may characterize adaptive functioning (Dennis & Chen, in press).

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