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# Attentional orienting toward social stress stimuli predicts increased cortisol responsivity to psychosocial stress irrespective of the early socioeconomic status

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Received 21 January 2009; received in revised form 28 August 2009; accepted 2 September 2009

## KEYWORDS

Stress reactivity;  
Attentional bias;  
Glucocorticoids;  
Cortisol;  
Socioeconomic status

**Summary** The principal aim of the study was to examine how the natural tendency to shift attention toward or away from social stress stimuli during a restful state, relates to the magnitude of cortisol elicited in response to a stressful context. It also assessed whether any relationship that did emerge between attentional biases and cortisol responsivity would be associated with the childhood socioeconomic status (SES). Twenty-five healthy normal controls rested for 45 min during which time they completed an adaptation of Posner's attentional orienting paradigm comprising social stress words as cues. Immediately following, participants were exposed to a public stressful speech task adapted from the Trier Social Stress Test (TSST). Results indicated that a rapid attentional engagement in the direction of social stress words prior to stress exposure related to a pronounced cortisol response to the stress task, while a slow attentional engagement toward social stress words was related to a weak cortisol response to the stress task. It was also found that fast engagers of social stress information displayed lower self-esteem than slow engagers. Groups did not differ in terms of their reported past SES. These findings demonstrate that attentional biases for social stress stimuli at rest predict the magnitude of cortisol likely to be elicited in response to a subsequent stressor. A natural tendency to rapidly shift attention toward social stress-related information may be the driving force behind cortisol reactivity when handling psychological forms of stress, independent of the early SES environment.

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## 1. Introduction

The attentional circuitry of the brain is hard-wired to detect features of the environment that have immediate survival value (Fenske and Raymond, 2006) and therefore segregates only the behaviorally significant aspects for deeper processing (Corbetta, 1998). This elaborate filtering and absorption of salient, relevant stimuli at the expense of comparably irrelevant elements is referred to as *selective attention* (Compton, 2003). The attentional hierarchy is arranged in distinct, inter-related networks which each orchestrate specific functions (Raz, 2004). The orienting subdivision is especially important to examine the framework of self-regulatory actions as it matures early in development (Posner and Rothbart, 2000) and regulates responses to stress (Rothbart et al., 1992; Derryberry and Reed, 2002).

The two fundamental components of orienting are characterized by a rapid transfer of attentional resources toward targets considered relevant, i.e., *engagement*, and away from stimuli deemed irrelevant, i.e., *disengagement* (Posner and Petersen, 1990). In mediating a flexible transfer of attention from one area of focus to another, the system inherently determines the extent to which attention is centered on negative versus positive information. For this reason, it is postulated to play a particularly pivotal role in the onset and modification of physiological responses to stress (Ellenbogen et al., 2006).

With respect to psychological stressors, the body's reaction is primarily driven by a subjective interpretation of the event as being threatening to well-being (Mason, 1968; Lupien et al., 2006). Once a threat is appraised, the ensuing physiological stress response is driven by the hypothalamic–pituitary–adrenal (HPA) axis and results in an increase in circulating glucocorticoids, a steroid hormone in humans referred to as cortisol (McEwen et al., 1986). In addition to variations precipitated by acute exposure to stress, cortisol also fluctuates according to a basal 24 h rhythm with peak levels in the morning and lowest concentrations at night (Reul and De Kloet, 1985). Frequent stress-induced activations of the HPA axis can generate pronounced or blunted basal levels of cortisol, which can predispose the manifestation of mental or physical illness (for a review, see McEwen, 1998).

Negative social evaluation in particular is known to reliably elicit pronounced elevations in cortisol (Dickerson and Kemeny, 2004) suggesting that perceiving a threat to the self-image is especially associated with physiological reactivity to stress (Gruenewald et al., 2004). A recent series of studies carried out by Dandeneau et al. (2007) illustrated that *subsequent* to stress exposure, an attentional system that continued to strongly engage toward facial expressions of rejection was correlated highly with pronounced cortisol reactivity to the previously encountered social stressor, this pattern being predominantly reflected in subjects with low self-esteem. Similarly, using the Stroop colour naming paradigm *prior* to stress, those subjects who were initially efficient at inhibiting threatening words (i.e., avoidant) (Roelofs and Elzinga, 2005) or faces (Roelofs et al., 2007) but became slower (i.e., vigilant) *during* stress had greater cortisol elevations following stress.

Whether the attentional bias extended to the disengagement component of attention is difficult to decipher from

these experiments, as each administered a task that does not explicitly tap into the patterns of attentional shifting. Spatial orienting tasks (Posner, 1980) are based on a reliable, well-validated paradigm specifically formulated to examine the flexibility of attentional shifting toward and away from neutral stimuli presented rapidly in different spatial locations. In modified versions (Stormark et al., 1995), an emotional stimulus constituting the cue is presented on one side of a display and the amount of time it takes subjects to detect a target that appears after the initial cue has disappeared, is measured. When the target occurs on the same side as the cue, it is a valid (i.e., engagement) trial and when appearing on the opposite side, it is referred to as invalid (i.e., disengagement).

A study that did use an orienting paradigm in the context of stress responsivity, assessed attention *during* a stress induction (Ellenbogen et al., 2006) and revealed that rapid disengagements, i.e., orienting attention away from the location of negative stimuli, was associated with lower cortisol levels post-stress. These findings illustrate that when examining stress and attentional mechanisms, using tasks that are capable of isolating both attentional engagement and disengagement processes are warranted (Broomfield and Turpin, 2005). It is also critical that studies exploring attentional biases employ the same paradigms in similar contexts in order to facilitate comparisons between studies and to examine whether comparable patterns are emerging across them.

Equally important to consider is that levels of cortisol influence attention (Skosnik et al., 2000). Research indicates that an acute rise in cortisol serves to magnify a general alertness for the detection of threatening information which can improve the encoding of emotional stimuli (Buchanan and Lovallo, 2001). It is therefore likely that investigations assessing attention solely during or following stress reflect the role of cortisol in heightening the attentional reserves in response to challenge, rather than an underlying tendency to do so in the absence of stress-induction. Together these findings underscore the importance of using a spatial orienting paradigm in a *restful* context in order to delineate how natural tendencies to shift attention toward or away from social threat information relate to cortisol reactivity.

Factors that shape the development of attentional biases are also worthy of exploration. Given that the orienting subdivision of attention is known to reach relative stability by a young age, it is likely that characteristics of the early environment may play an integral role in determining the flexibility of and overall nature of its functioning. In fact, adolescents living in low socioeconomic status (SES) environments have been shown to generate cognitive biases that deem ambiguous information threatening or hostile (Chen and Matthews, 2001). As well, in a pilot investigation, negative associations have been shown to be perceived as more probable in low SES youngsters, the latter also correlating with higher basal morning cortisol levels compared to high SES counterparts (Lupien et al., 2005). The observation that low SES youths interpret neutral information in negative terms suggests that an underlying attentional bias may similarly impact upon acute cortisol responses to stress in this group.

Considering these facts, the principal objective of the study was to examine whether naturally occurring attentional engagement toward or disengagement away from

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