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The Effect of Happiness and Sadness on Alerting, Orienting, and Executive Attention

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Objective: According to the attention network approach, attention is best understood in terms of three functionally and neuroanatomically distinct networks—alerting, orienting, and executive attention. An important question is whether the experience of emotion differentially influences the efficiency of these networks. **Method:** This study examines 180 participants were randomly assigned to a happy, sad, or control condition and undertook a modified version of the Attention Network Test. **Results:** The results showed no effect of happiness or sadness on alerting, orienting, or executive attention. However, sad participants showed reduced intrinsic alertness. **Conclusion:** This suggests that sadness reduces general alertness rather than impairing the efficiency of specific attention networks. *(J. of Att. Dis. XXXX X(X) XX-XX)*

Keywords: *emotion; alertness; ANT; happy; sad*

Emotions researchers often acknowledge an important link between emotional experience and cognitive processing. One line of thought is that emotional responses are, to some extent, characterized by distinct patterns of cognitive processing that characterize the emotional experience (Ekman, 1999; Scherer, 2005). Izard (1991), highlighting the functional aspects of emotions, describes emotion as "a feeling that motivates, organizes, and guides perception, thought and action" (p. 14). Attention is an important process to consider in this context. Indeed, several emotions researchers support the position that emotions alter attentional processes and influence how we respond to significant events (Fredrickson & Branigan, 2005; Frijda, 2005; Levenson, 2003; Scherer, 2005).

Much research relating to emotion and attention is concerned with attention to emotional information, irrespective of the current affective state of the individual (Calvo & Lang, 2004; Hansen & Hansen, 1988; Phelps, Ling, & Carrasco, 2006). Few studies have examined the idea that everyday emotional experience alters attentional processing irrespective of the valence of the stimulus that is being attended. Of the studies that have considered the influence of emotion on attention, most have been concerned with anxiety; specifically the relationships between trait anxiety or clinical anxiety and attention to threatening information (Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Georgiou et al., 2005; Mogg & Bradley, 1999b; Ohman, Flykt, & Esteves, 2001). The question of whether everyday emotional experiences, such as mild happiness and sadness influence attention needs to be addressed.

One difficulty with research on emotion and attention is that attention is often operationalized in different ways, which makes it difficult to see how various attention tasks are related. For instance, exogenous and endogenous cueing tasks, dot probe tasks, flanker and Stroop tasks each tap into subtly different aspects of attention. Recently, cognitive psychologists have suggested that attention is an umbrella term for a variety of psychological phenomena as opposed to a unitary concept (Styles, 2006). A consensus is now emerging that it is best viewed in terms of at least three functionally and neuroanatomically distinct networks. These are known as alerting, orienting, and executive attention (Posner & Fan, 2007; Posner & Petersen, 1990; Posner & Rothbart, 2007; Raz & Buhle, 2006). The Attention Network Test (ANT) has been developed to test the efficiency of these three networks (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Since its inception, the ANT has been

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used to examine the efficiency of attention networks in a variety of contexts (Halterman et al., 2006; Mezzacappa, 2004; Murphy & Alexopoulos, 2006; Redick & Engle, 2006; Rueda et al., 2004). A key question is whether or not the experience of emotion influences the efficiency of any or all of these networks, and whether different emotions are associated with distinct patterns of attentional processing.

Alerting

The alerting network is concerned with an individual's ability to increase and maintain response readiness in preparation for an impending stimulus. Two types of alerting can be distinguished—phasic alerting and intrinsic alerting (Sturm & Willmes, 2001). Phasic alertness reflects task-related preparedness and describes the rapid mobilization of resources to process an expected stimulus (Nebes & Brady, 1993). In the ANT, it is assessed by comparing reaction times to a target following a cue with reaction times to the same target when no cue is presented. In contrast, intrinsic alertness reflects general nonspecific excitability and is associated with fatigue and circadian rhythm. It is assessed by simple reaction time (RT) measures to an uncued target. Although both are related, the attentional network approach is concerned primarily with phasic alertness.[1]

Few studies have examined the link between emotions and alerting; even though changes in response readiness are characteristic of both of phasic alerting and emotional experience (Frijda, 2005; Frijda, Kuipers, & Terschure, 1989). Compton, Wirtz, Pajoumand, Claus, and Heller (2004) reported a significant correlation between negative affect (NA) and alerting (r = .27) at stimulus onset asynchronies (SOAs) of 500 milliseconds (ms) suggesting that negative affect is associated with increased readiness to respond to a target following a cue. In their study, NA was based on participants' responses to the Profile of Mood States (POMS) questionnaire and was composed of items such as anxiety, depression, anger, fatigue, and confusion. However, it remains unclear whether the association between NA and alerting relates to a specific emotion or to negative mood in general. No correlation was found between positive affect (PA) and alerting.

Motivational accounts suggest that emotion is organized around two motivational systems—appetitive and defensive (Bradley, Codispoti, Cuthbert, & Lang, 2001). The defense system is activated in threatening situations and promotes behaviors associated with withdrawal, attack, and escape. In contrast the appetitive system is activated in situations that promote survival and is associated with approach, nurturing and caregiving behaviors. From the motivational perspective, it is predicted that sadness, an emotion often characterized by withdrawal, will reduce alerting. Sadness tends to increase self focus (Sedikides, 1992) and might therefore reduce sensitivity or speed of response to external stimuli. In contrast, it is predicted that happiness should increase sensitivity to external information and thus increase the efficiency of the alerting network—happiness should activate the appetitive system facilitating approach behaviors.

Orienting

Orienting is the ability to select specific information from among multiple sensory stimuli (Raz & Buhle, 2006). It is sometimes referred to as scanning or selection and can be overt or covert (with or without eye movements). An important function of orienting is to provide a relative enhancement of a target at a particular location in comparison with other targets presented in the visual field. Much of the research to date on emotion and orienting is concerned with orienting to emotional information. Several researchers have shown that people tend to orient more quickly to emotionally relevant compared with emotionally irrelevant information and that people tend to spend longer looking at emotional information (Calvo & Lang, 2004; Nummenmaa, Hyona, & Calvo, 2006).

A parallel line of research is concerned with attentional capture by threatening stimuli and much evidence exists showing attentional biases for threatening information (Fox et al., 2002; Hansen & Hansen, 1988; Lundqvist & Ohman, 2005; Mogg & Bradley, 1999a; Ohman et al., 2001). In particular, there is evidence of enhanced attention to threat in high trait anxious individuals (Derryberry & Reed, 1998; Fox et al., 2001; Georgiou et al., 2005; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Mogg & Bradley, 1999b). Although these findings suggest that the experience of anxiety influences orienting, it remains unclear whether everyday experiences of other basic emotions influence orienting. It is also unclear whether specific emotions influence orienting irrespective of the valence of the information that is being attended.

According to the broaden-and-build theory of positive emotions, positive emotions broaden scope of attention and widen the array of thoughts and actions that come to mind in a given situation (Fredrickson, 1998, 2002; Fredrickson & Branigan, 2005). This broadening effect may be due to more rapid covert orienting of attention during the experience of positive emotion, or it could relate to impaired selective or executive attention. By examining the effect of a positive emotion on alerting, orienting and executive attention, it may be possible to tease apart these possibilities. There is some evidence that that PA is negatively correlated with orienting (Compton et al., 2004); however, in the Compton et al. study, the association between PA and orienting was only significant in some trials and further research is required.

Executive Attention

Executive attention (also referred to as selective and focused attention) reflects the individual's capacity to select relevant information and to ignore irrelevant information in order to facilitate the production of appropriate responses (Posner & Rothbart, 2007). It is often assessed by tasks that involve conflict, such as various versions of the Stroop and flanker tasks. In these types of tasks, the efficiency of executive attention is assessed by examining the costs associated with inhibiting irrelevant information while responding to a target. In a review of the literature on mood and executive function, Mitchell and Phillips (2007) concluded that positive mood tends to impair executive function whereas mild manipulations of negative mood have very little effect on cognitive control processes. They also suggest that the lack of findings relating to negative mood and executive function may be due to the tendency for negative mood manipulations to be fairly mild in nature. Generally, it is difficult to gain ethical approval for studies that involve eliciting intense negative affect in participants. Also, in many studies researchers examine overall negative mood and it remains unclear whether certain types of negative affective experiences influence executive processes (e.g., anger) whereas others might not (e.g., sadness). Despite this, their conclusion that mild negative affect does not impair executive function is supported by Rowe, Hirsch, and Anderson (2007) who found no effect of negative mood induced by music on inhibition costs in the Eriksen flanker task.

In relation to positive mood, Mitchell and Phillips (2007) report only one study that examined executive attention as opposed to other types of executive function. In that study, participants in the positive group showed a trend towards greater inhibition costs in the alternating Stroop task (Phillips, Bull, Adams, & Fraser, 2002). Phillips et al. suggested that happy mood might impair attentional switching and inhibition because attention is distracted by thoughts aimed at maintaining positive mood. The view that positive mood increases inhibition costs is indirectly supported by the broaden-and-build theory of positive emotion (Fredrickson & Branigan, 2005). If positive emotions broaden attention, a positive state should result in more distraction from adjacent nontarget information, compared with when broadening does not occur. In line with this, Rowe et al. (2007) reported that positive mood induced by music reduces inhibitory control and broadens attentional focus. However, other studies have failed to find a link between positive affect and broadening (Finucane & Whiteman, in press; Gasper, 2004; Gasper & Clore, 2002). Thus, evidence that positive mood increases attentional broadening, increases inhibition costs, and reduces the efficiency of the executive attention network, needs further examination.

Intrinsic Alertness

Although intrinsic alertness is not one of the three attentional networks explicitly described by Posner and colleagues (Fan et al., 2002; Posner & Fan, 2007), it is closely related to phasic alerting. In contrast to goal related preparedness assessed by phasic alerting, intrinsic alerting is associated with general nonspecific excitability (Raz & Buhle, 2006; Sturm & Willmes, 2001). Typically, tasks that have been used to assess intrinsic alertness are simple reaction time measures of responses to stimuli that are not preceded by a warning cue. There is some evidence for a link between negative emotions and slowed response times. Pereira et al. (2006) found that, in comparison with a control condition, response times in a simple target detection task were significantly slower for participants who were presented with negatively valenced images between trials. In contrast, RTs were faster when participants were presented with pleasant images. The authors suggested that slowed RTs were consistent with the experience of a defensive emotional state in response to viewing the negative stimuli. In a related clinical study, medication-free depressed patients did not differ from an age-matched control group on alerting and orienting; however, they did have slower overall response times, reflecting reduced intrinsic alertness (Pardo, Pardo, Humes, & Posner, 2006). The question of whether specific emotions such as happiness and sadness differentially influence intrinsic alerting has not been sufficiently explored in previous research. In the current study it was hypothesized that sad participants would have slower reaction times for uncued targets compared with participants in the control and happy conditions, reflecting a reduction in intrinsic alertness associated with the experience of sadness.

The Present Study

The primary goal of the present study is to test the general hypothesis that, compared with a control condition, the experience of happiness and sadness would be associated with differences in alerting, orienting, and executive attention. Specifically, it was predicted that happiness would facilitate phasic alerting and that sadness would impair phasic alerting. These predictions are based on motivational accounts of emotion which suggest that positive emotions activate the appetitive systems whereas negative emotions activate the defense systems. It was also predicted that happiness would impair executive attention in comparison with sadness or with a control condition based on previous findings that positive mood broadens attention and increases inhibition costs. It was expected that sadness would have no effect on executive attention in line with previous findings (Mitchell & Phillips, 2007; Rowe et al., 2007). Finally, it was predicted that sadness would slow RTs in comparison with the control condition.

Methods

Participants

A total of 180 individuals took part. The sample consisted of 122 females (68%) and 58 males (32%) with a mean age of 23.3 (*SD* = 3.8 years). All participants were university students and were recruited through the University of Edinburgh Careers Web site. They were paid £4 for taking part. In all, 64% of participants were European, 25% were Asian, 10% were from the United States or Canada, and 1% was African.

Design

A between-subjects design was used. Participants were randomly assigned to the happy, sad, or control condition on their arrival in the lab. The first participant and every third participant thereafter experienced the happy condition; the second participant and every third participant thereafter experienced the control condition, whereas the third participant and every third participant thereafter experienced the sad condition. The target emotions were elicited in participants by presenting them with happy, sad, or control images at regular intervals between ANT trials. The University of Edinburgh Psychology Ethics Committee granted ethics approval for the project.

Materials

Self-report measures. The Extended Positive and Negative Affect Schedule (PANAS-X): The PANAS-X (Watson & Clark, 1994) was used to assess baseline level of PA and NA. Internal consistency reliabilities (Cronbach's coefficient alpha) for both scales are high, generally ranging from .83 to .90 for PA and from .85 to .90 for NA. The scales also have very good convergent and discriminant validity (see Watson, Clark, & Tellegen, 1988).

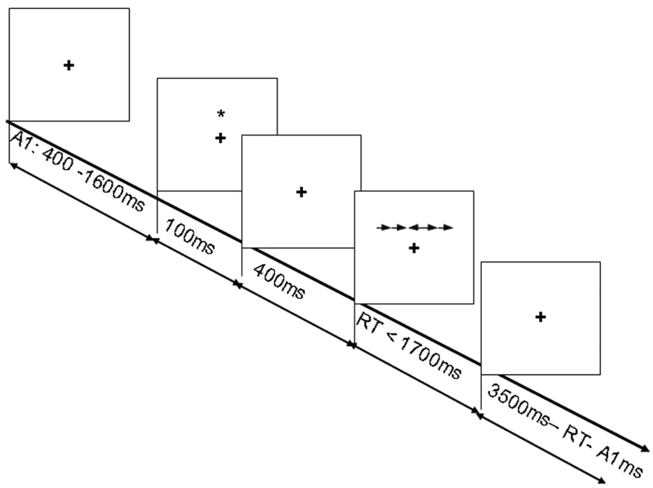
Basic emotions report. At two intervals between the ANT trials participants rated the extent to which they experienced happiness, sadness, fear, anger, and disgust on a 9-point scale where 0 represented *none at all* and 8 represented *a great deal*. The five emotion scales were presented in random order on the computer monitor. Such self-report measures of emotional experience are often used to assess the effectiveness of an emotion manipulation in studies of this type (e.g., Fredrickson & Branigan, 2005; Tamir & Robinson, 2007).

Emotion induction stimuli. Images from the International Affective Picture System (IAPS) were used to elicit happiness, sadness or a control state in participants (Lang, Bradley, & Cuthbert, 2005). In a previous study, Mikels et al. (2005) identified a set of IAPS images that elicited discrete emotions, or blends of discrete emotions. In the present experiment, images found to elicit sadness were presented to participants in the "sad" condition whereas images found to elicit a positive emotion were used in the "happy condition." For example, sad images included crying children, frail elderly people, and images of pollution and destruction whereas happy images included pictures of babies, friends, and cute animals. As not enough IAPS images eliciting a discrete positive emotion have been identified, the images in the "happy" condition consisted of images that have been shown by Mikels at al. to elicit amusement, contentment, excitement or a blend of these positive emotions. In the control condition, participants were exposed to neutrally valenced stimuli such as emotionally neutral faces and images of neutrally valenced scenes. Mean pleasure scores (based on a 0 to 8 point scale) for the IAPS images used were 7.7 (happy), 4.9 (neutral), and 2.5 (sad) conditions. Mean arousal scores were 4.7 (happy), 3.1 (neutral), and 5.3 (sad) conditions.

Modified Attention Network Test

Participants performed a modified version of the ANT (see Fan et al., 2002 for detailed description) presented via E-PRIME on a 17-inch monitor. Participants were presented with a target arrow, which was flanked by two arrows on both sides. On each trial, participants were required to identify the direction of the central arrow, as quickly and accurately as possible. They responded by

Figure 1
Example of an ANT Trial: Spatial Cue and Incongruent Flanker Conditions



Note: ANT = Attention Network Test; RT = reaction time.

pressing the "v" button if the centrally located arrow was pointing to the left and the "m" button if the target arrow was point to the right. On congruent trials the flanking arrows were pointing in the same direction as the target arrow, whereas on incongruent trials they were pointing in the opposite direction. Prior to the appearance of the target a center or spatial cue appeared in some trials whereas no cue appeared in others. Each trial consisted of (a) fixation cross (+;for a variable duration between 400 and 1600 ms), (b) cue (100 ms; no cue, center cue, or spatial cue), (c) second fixation cross (+; 400ms), (d) target and flanker arrows (up to 1700 ms), and (e) post-target fixation cross (variable depending on the participants' RT and the duration of the fixation cross). In total, each trial lasted 4 seconds (Figure 1).

Participants performed 144 trials in total (48 no cue, 48 center cue, 48 spatial cue). Half the trials contained congruent targets, whereas half contained incongruent targets. These were spread across two blocks, each containing 72 trials presented in a random order. The first trial in each block and every sixth trial was preceded by an IAPS image. Each image appeared on screen for 6 seconds and was followed by six ANT trials. On completion of each block of 72 trials during which participants viewed 12 IAPS pictures, participants were asked to rate how much happiness, sadness, fear, anger, and disgust they experienced while viewing the images during the previous block.

A measure of each attentional network was generated for each participant by comparing their performance in a baseline condition with their performance in another as outlined below. The alerting effect reflects the benefits associated with an external cue; the orienting effect reflects the benefits associated with a spatial cue whereas the executive attention effect represents the costs associated with inhibiting incongruent information.

Alerting effect = RT no cue (baseline) − RT center cue[2]

Orienting effect = RT center cue (baseline) − RT spatial cue

Executive attention effect = RT incongruent − RT congruent (baseline)

Test–retest reliabilities based on a sample of 40 participants (Fan et al., 2002) found that the executive attention measure is most reliable (0.77) followed by the orienting measure (0.61). Alerting is the least reliable measure with a test–retest reliability of .52.

Cartoon Task

On completion of the ANT, participants rated how funny they found 10 cartoons on a scale from 0 (*not funny at all*) to 10 (*very funny*). The goal of the cartoon task was mood repair for those in the sad condition.

Procedure

On arrival participants completed the PANAS-X. Next they carried out the modified ANT individually in a quiet cubicle. Participants sat approximately 60 cm viewing distance from a 17-inch screen and were instructed to respond as quickly and accurately as possible. After a practice consisting of 4 control images each of which were following by 6 ANT trials (24 trials in total), participants carried out the ANT. Participants in the happy condition viewed positive images between trials; those in the sad condition were exposed to sad images between trials whereas participants in the control condition saw neutrally valenced images. Finally, participants carried out the Cartoon Task. In total, the procedure took approximately 40 minutes.

Results

Data Preparation

Data for two participants were removed in advance of the analyses; one participant had an excessive numbers

Table 1
Mean Emotion Scores Reported by Participants During the Attention Network Test Task (*N* = 121)

Emotion	Neutral (*n* = 60)	Happy (*n* = 30)	Sad (*n* = 31)
Happiness			
Mean	2.95	6.43	0.39
SD	1.69	0.51	0.57
Sadness			
Mean	1.54	0.53	6.46
SD	1.64	0.69	0.85
Anger			
Mean	0.48	0.11	3.45
SD	0.97	0.31	2.02
Disgust			
Mean	0.67	0.46	3.67
SD	0.98	0.79	2.48
Fear			
Mean	0.67	0.17	3.58
SD	1.14	0.29	2.15

of errors (>20%), whereas the other had extreme scores on many of the dependent variables. Trials with errors were discarded from the reaction time analysis. Mean RTs for cue (cue: no, center, spatial) and flanker (congruent, incongruent) were calculated for each participant.

Emotion Manipulation Check

As it is vital that participants in each condition actually experienced the target emotion relevant to that condition, participants were retained in the happy and sad conditions if their self-reported emotion experience during picture viewing coincided with the target emotion for the condition to which they were assigned. Participants in the happy condition were included in the analysis if their self-reported score for "happy" was above the median "happy" score for all participants in the happy condition. Similarly, participants who experienced the sad condition were included in the analysis if their self-reported "sadness" during picture viewing was greater than the median sadness score for all participants in the sadness condition. This approach has been used previously to ensure that the groups that are being compared are sufficiently different in terms of emotion experienced (Bower, Monteiro, & Gilligan, 1978; Storbeck & Clore, 2005). This resulted in a final sample of 121 participants: 60 in the control condition, 30 in the happy condition, and 31 in the sad condition. A chi-square analysis showed that there was no association between condition and gender, $\phi = .1$, $p = .47$, indicating that males and females were distributed proportionately across each of the three conditions. The resulting groups were characterized by significantly different levels of happiness and sadness (see Table 1). The Mann–Whitney test revealed that happiness in the happy group (median = 6.3) was significantly higher than reported happiness of participants in the sad group (median = 0.3) or in the control condition (median = 3.0). Similarly, sadness reported in the sadness group (median = 3.0) was significantly higher than reported sadness of participants in the happy (median = 0.0) or control condition (median = 0.0). All *p*s <.01.

Baseline Positive and Negative Affect

Because of the nonnormal and skewed nature of the baseline positive and negative affect data, the Kruskal–Wallis test was used to compare baseline PA and NA in participants prior to performing the ANT. There were no significant differences in baseline levels of PA, $H(2) = 0.28$, $p = .87$; or NA, $H(2) = 3.44$, $p = .18$, across the three groups prior to ANT performance. Baseline levels of PA and NA did not predict alerting, orienting, or executive attention.

Attention Networks

Overall data. Initially a two- (flanker: congruent, incongruent) by three-way (cue: no cue, center, spatial) repeated-measures analysis of variance (ANOVA) was carried out on all RTs, irrespective of emotion condition to compare the overall pattern of results with that reported originally by Fan et al. (2002). In line with previous studies, the overall data revealed a significant main effect for flanker, $F(1, 120) = 578$, $p < .001$. RTs for incongruent trials were significantly slower than for congruent trials, reflecting the time costs associated with inhibiting interference from incongruent flankers on incongruent trials. As expected, there was also a main effect for cue, $F(2, 240) = 536$, $p < .001$. Pairwise comparisons revealed that reaction times were fastest in the spatial cue condition and slowest when no cue was presented in advance of the target. The main effects reported here reflect the general trends reported in Fan et al. as well as subsequent studies.

Alerting. The alerting effect was calculated for each participant by subtracting the participant's mean reaction time for no cue trials (baseline) from the center cue trials, irrespective of flanker type. A one-way ANOVA with alerting scores as the dependent variable and emotion condition (neutral, happy, sad) as the independent variable revealed no differences in alerting in the happy, sad, and control conditions, $F(2, 118) = 0.3$, p = nonsignificant (ns; Table 2).

Intrinsic alertness across each emotion condition can was assessed by comparing response times on uncued trials (Sturm & Willmes, 2001). A one-way ANOVA was

Table 2
Mean Reaction Times for Cue and Flanker Condition and ANT Scores (*N* = 121)

	Control (*n* = 60)		Happy (*n* = 30)		Sad (*n* = 31)	
	Mean (ms)	*SD*	Mean (ms)	*SD*	Mean (ms)	*SD*
Cue condition RTs						
No cue[a]	683	96	655	69	725	111
Center cue	649	91	626	68	693	107
Spatial cue	590	91	562	69	638	110
Incongruent flanker	692	99	660	71	741	131
Congruent flanker	589	87	567	68	629	90
Overall RT	641	91	614	66	685	108
ANT scores						
Alerting	34	25	29	34	32	37
Orienting	59	30	64	33	55	27
Executive	103	38	93	44	112	64

Note: ANT = Attention Network Test; RT = reaction time.
a. RTs in the "no cue" condition are used to assess intrinsic alertness.

carried out with RT in the no cue condition as the dependent variable and emotion (neutral, happy, sad) as the independent variable. There were significant differences in RTs to the uncued target $F(2, 118) = 4.3$, $p = .015$. Pairwise comparisons revealed that sad participants were significantly slower to respond to an uncued target compared with participants in the control and happy conditions (see Table 2).

Orienting. The orienting effect was calculated by subtracting each participant's mean RT for spatially cued trials from their mean RTs for the center cue (baseline) trials. Both the center and the spatial cue serve as a form of alerting cue, but the spatial cue provides information about the location of the target and requires participants to covertly orient their attention to the target location before the target appears. A one-way ANOVA with orienting scores as the dependent variable and emotion condition as the independent variable revealed no differences in orienting in the happy, sad, and control conditions, $F(2, 118) = 0.6$, p = ns (see Table 2).

Executive attention. The executive attention effect was calculated by subtracting mean RTs on for all congruent (baseline) trials from mean RTs for all incongruent trials. A one-way ANOVA with executive attention scores as the dependent variable and emotion condition as the independent variable revealed no differences in executive attention in the happy, sad, and control conditions, $F(2, 118) = 1.2$, p = ns.

Discussion

This study is the first to examine the effect of happiness and sadness on alerting, orienting, and executive attention. Additionally, this is one of the few studies to consider the effect of discrete emotions on intrinsic alertness. Happiness and sadness did not differentially influence the efficiency of alerting, orienting, and executive attention. However, sad participants showed a reduction in intrinsic alertness compared with happy participants and those in the control condition.

The efficiency of the alerting network did not differ for the happy, sad, and control groups. Overall, participants were quicker to respond to a stimulus following an external cue compared with no cue, showing a general phasic alerting effect. However, there was no evidence that phasic alerting scores differed for happy and sad participants and the hypothesis that happiness would facilitate phasic alerting was not supported. This suggests that generalized happiness, induced in a laboratory setting, has no effect on phasic alerting, supporting previous findings (Compton et al., 2004). One reason for this might be that it is difficult to elicit increased levels of happiness compared with the participants' baseline state in a lab environment. In general, people are fairly happy (Diener & Diener, 1996) and emotion manipulations that attempt to distinguish between "happy" participants and those in a "neutral" condition are often unsuccessful, for example, see Gasper (2004). However, self-reported happiness in this study was significantly higher than happiness for participants in the control condition. Based on this it appears that mild happiness was successfully elicited in participants but did not influence phasic alerting.

Happiness is a relatively undifferentiated emotion in comparison with other basic emotions (Power, 2006). It is possible that the type of happiness elicited in this experiment is closer to contentment or relaxing experiences. Other positive emotions which are more closely associated with engagement with the environment, such as amusement or joy, might have had an influence on alerting in comparison with the control condition. Further research on the effect of other specific positive emotions on alerting is required to assess whether or not this might be the case.

The present data also suggest that sadness does not influence alerting in comparison to a control condition. Mild sadness does not appear to influence an individual's ability to maintain a high state sensitivity to incoming information. This is inconsistent with Compton et al. (2004) who reported an association between NA and alerting (r = .27). However, in the Compton et al. (2004) experiment, NA contained diverse items such as anxiety, anger, depression, and fatigue. The present experiment is concerned specifically with sadness. It is possible that whereas sadness does not differentially influence phasic alerting in comparison with a control condition, measures of NA based on high arousal negative emotions might influence alerting. For instance, other basic emotions such as anger and fear might facilitate alerting given the pivotal role of these emotions in rapidly responding to the environment.

In contrast to phasic alertness, intrinsic alertness was reduced for sad participants compared with happy or control participants. This was evidenced by the longer response times in the no-cue condition for sad participants and suggests that sadness reduces general nonspecific excitability. Furthermore, sad participants had significantly slower overall RTs compared with the happy or control group. This is in line with Pereira et al. (2006) who found that participants had significantly slower responses in a visual detection task after viewing a sequence of unpleasant as opposed to control or pleasant pictures. These interference effects were thought to result from negative emotions induced by the negative image presentation, which in turn, resulted in withdrawal or avoidance processes. It is possible that the slower reaction times experienced by sad participants in the present experiment resulted from similar withdrawal or avoidance behaviors.

Another possibility is that sadness reduces intrinsic alertness as it causes the individual to look inwards, take stock of the current situation and reprioritize important goals. Sadness occurs with an appraisal of loss or failure and is associated with inaction, self-focus, and withdrawal (Power & Dalgleish, 1998; Sedikides, 1992; Wells & Matthews, 1994). In the present study, sadness was elicited by sad images that may tap into participants' own memories of loss, for example, sick children, frail elderly people, poverty, and destruction. Perhaps the reduction in intrinsic alertness or general response readiness results from increased self-focus and preoccupation with the individual's own experiences of sadness. This in turn would reduce attentional resource allocation on the attention task trials.

There were no differences in the efficiency of the orienting network for happy or sad participants compared with those in the control condition. This suggests that mild experiences of happiness and sadness do not influence orienting. Previous research has shown an effect of emotion, generally anxiety, on orienting to valenced stimuli. Anxiety is often associated with faster orienting to threatening stimuli, or slower disengagement from threatening stimuli. It is possible that sadness influences orienting to or from valenced stimuli, but that the effect of sadness on orienting irrespective of stimuli valences is not impaired.

The efficiency of executive attention did not vary across the three groups. Happy, sad as well as participants in the control group had similar executive attention scores—happy participants showed no more costs than sad or nonemotional participants in inhibiting irrelevant information. The finding that happiness did not impair executive attention is inconsistent with Rowe et al. (2007) who reported that happy mood elicited by music impaired visual selective attention. It is also inconsistent with the broaden-and-build theory. However, other studies have been unable to show a link between positive emotion and executive attention (Finucane & Whiteman, in press; Gasper, 2004; Gasper & Clore, 2002) and empirical evidence relating to positive affect and executive attention remains inconclusive. Further studies that elicit discrete positive emotions are required to understand whether some positive affective states impair executive attention whereas others do not. The evidence here suggests that mild happiness does not impair executive attention.

The hypothesis that sadness would impair executive attention in comparison with a control condition was not supported. However, this finding is consistent with Rowe et al. (2007) who found that negative affect induced by sad music had no effect on selective attention in comparison with the control state. Evidence for an effect of negative emotion on executive attention has been based primarily on studies of fear and anxiety (Basso, Schefft, Ris, & Dember, 1996; Derryberry & Reed, 1998). In line with Rowe et al. (2007) it is suggested that fear-related affective experiences may be necessary for attentional narrowing. The present experiment and the Rowe et al. (2007) study are the only two studies to directly test the effect of sadness on executive attention using a paradigm based on Erickson's flanker task. The results of both suggest that sadness does not impair executive attention—at least when the target is neutrally valenced.

The Attentional Network Approach

The present research study is the first to use the attention network approach to examine the effect of happiness and sadness on attention. This approach is particularly useful as it provides a theoretical framework for investigating the effect of emotion on attentional processing. Stroop, flanker, and spatial cueing paradigms have previously been used to examine emotion and attention; however adopting an attentional network approach could help researchers better understand the influence of emotion on distinct attentional processes. The attentional network test facilitates the examination of three underlying networks in one test. This allows for a distinction to be drawn between overall reaction times and measures that assess phasic alerting, exogenous orienting, executive attention, and intrinsic alertness.

Limitations

Manipulating emotion in a lab setting is difficult as individuals differ in terms of emotional reactivity, expressivity, the use of emotion regulations strategies, as well as appraisals of emotion eliciting stimuli. Self-report measures are often used to determine the degree to which participants actually experienced an emotional response. However, demand characteristics can influence self-reports such that some participants report higher levels of the target emotion than they actually experience. In future studies a within-subject design might be more suited to this type of study and would better control for demand characteristics across each condition. Another limitation concerns the intensity of the emotion manipulation. The experiment reported here examined the effect of mild happiness and sadness manipulations on each attention network. The use of more intense emotion manipulations, for instance, combining images and music, is also recommended.

Although the attention network test allows the assessment of the efficiency of three attention networks in one, the three-in-one test may result in increased variation in response times associated within each attention network, partly because each trial has an alerting, orienting, and executive attention component. Furthermore, the low reliability of alerting scores suggests that alerting might best be assessed separately, rather than as part of a task that simultaneously measures other networks. Future research examining the sensitivity of the ANT in determining attention network scores, in comparison with the sensitivity of a pure alerting, orienting, or executive attention task, would be useful.

Emotion in Context

In light of the current findings, an important consideration is whether or not distinct emotions would have influenced attentional networks had emotionally charged targets been used rather than arrows. Recently, Tamir and Robinson (2007) found that positive mood was associated with an attentional bias for positive compared with control and negative words. Daily experiences of PA were found to influence orienting to rewarding (but not neutral) stimuli. Their findings suggest that happy people are quicker to orient to rewarding stimuli or selectively attend to positive over negative or control information. Further research in this area might usefully consider the interaction been emotion and the valence of emotional information, particularly as both are intrinsically linked in everyday experience.

Conclusion

The present experiment is the first to examine the effect of induced happiness and sadness on attentional networks. Although sadness was found to reduce intrinsic alertness relative to a happy and control condition, the findings here suggest that lab-induced happiness and sadness do not differentially influence the efficiency of the phasic alerting, orienting, or executive attention network. This does not rule out the possibility that other emotions such as fear, anger, or amusement might influence the efficiency of these systems. Although happiness and sadness do not seem to influence alerting, orienting, and executive attention in context of neutral stimuli, a key question for the future concerns the degree to which experiences of mild happiness and sadness interact with emotionally valenced targets to influence attention.

Notes

1. The term “alerting” is used here to represent phasic alerting in line with the attentional network approach.

2. A double cue or center cue can be used to assess alerting. To reduce the total number of trials required, the center cue condition is used here, similar to Fan, McCandliss, Fosella, Flombaum, and Posner (2005).

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