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HAPPY BUT STILL FOCUSED: FAILURES TO FIND EVIDENCE FOR A MOOD-INDUCED WIDENING OF VISUAL ATTENTION

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ABSTRACT

In models of affect and cognition it is held that positive affect broadens the scope of attention. Consistent with this claim, previous research has indeed suggested that positive affect is associated with impaired selective attention as evidenced by increased interference of spatially distant distractors. However, several recent findings cast doubt on the reliability of this observation. In the present study we examined whether selective attention in a visual flanker task is influenced by positive mood induction. Across three experiments, positive affect consistently failed to exert any impact on selective attention. The implications of this null-finding for theoretical models of affect and cognition are discussed.

Keywords: attention; positive affect; attentional breadth; cognitive control

INTRODUCTION

In recent years, evidence from several domains in contemporary psychology has suggested that positive mood influences cognition and attention (Ashby, Isen, & Turken,1999; Frederickson, 2001). Derryberry and Tucker (1994) argued that emotions represent motivational states that yield specific effects on the attentional scope. Their model combines Easterbrook's (1959) notion that avoidance-related states, such as anxiety (i.e., tense arousal), narrow the focus of attention with the assumption that approach-related states, such as joy (i.e., elated arousal) broaden the attentional focus, which increases responsiveness to peripheral cues. Extending these earlier approaches, Fredrickson (2001) developed the Broaden-and-Build Theory of positive emotions. According to this theory, positive emotions broaden the perceptual and attentional scope, as well as the scope of mental representations and actions. Research of Frederickson and Branigan (2005) supporting this model has shown attentional broadening effects of discrete positive states of amusement and contentment using a global-local task to measure the attentional scope. Along similar lines, Gasper and Clore (2002) concluded that positive affective states foster global visual processing. More recently, Rowe, Hirsh, and Anderson (2007) found that positive moods resulted in broadened visual-spatial processing. The idea that positive affect creates attentional and cognitive broadening is widely accepted and supported (Frederickson & Branigan, 2005; Gasper & Clore, 2002; Rowe et al., 2007).

Despite the often-reported broadening function of positive affect on information-processing (Ashby et al., 1999), positive affect does not always lead to attentional broadening effects. For instance, Gable and Harmon-Jones (2008) found that approach motivation mediates the relationship between positive affect and the broadening of attention. Positive affects vary in the degree to which they are associated with approach motivation which refers to an urge or action tendency to go toward an object. Whereas positive affect low in approach motivational intensity (e.g., joy after watching a funny film) broadens the attentional scope (Frederickson & Branigan, 2005; Gable & Harmon-Jones, 2008), positive affect high in approach motivational intensity (e.g., desire while approaching an attractive object or goal) narrows the attentional scope (Gable & Harmon-Jones, 2008; Harmon-Jones & Gable, 2009). In studies on positivity and broadening prior to 2005, positive mood was induced by handing gifts, showing funny movies, playing happy music or by having participants recall pleasant memories. These manipulations likely evolved low approach motivation, with positive affect not being related to obtaining goals within the experimental context.

Interestingly, close inspection of the literature reveals that there are mixed findings with regard to the attentional broadening effects, even if the induced mood states were low in approach motivational intensity. On the one hand, attentional broadening effects of positive mood have been convincingly demonstrated. For instance, Rowe, Hirsh, and Anderson (2007) used a modified flanker task to examine attentional broadening in response to positive affect. The flanker task (Eriksen & Eriksen, 1974) is a well-established attentional task, where a centrally presented target is flanked on either side by response-compatible or response-incompatible stimulus elements. Irrelevant and incompatible flankers interfere with the response to the central target. By presenting flanking stimuli at three different distances (near, medium, far) from the middle target, Rowe et al. (2007) investigated whether positive affect influences visual attention by broadening the scope of attention. Rowe et al. (2007) found that the effect of spacing on flanker compatibility was influenced by mood. As flanker eccentricity increased, positive mood resulted in a more pronounced slowing relative to negative and neutral mood which means that the effect can be attributed to a widening of the attentional focus (Rowe et al., 2007). Similar findings have been obtained with other cognitive tasks such as different forms of global-local tasks (Fredrickson & Branigan, 2005; Gable & Harmon-Jones, 2010). On the other hand, a recent study with a much larger sample size than with Rowe et al. (2007) did not find any differences between positive and neutral mood conditions on flanker interference-effects (Martin & Kerns, 2010). In this study, low approach motivational film clips were used to induce mood states. Another recent study (Funicane, Whiteman & Power, 2010) failed to find effects of low approach motivational positive affects on the efficiency of selective attention, which refers to flanker interference-effects as measured with the Attention Network Task (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002). Finally, Johnson, Waugh, and Fredrickson (2010) found that affect increased attentional breadth measured with a global-local task and a covert attentional orienting task if it was accompanied by genuine smiles in participants. However, this effect occurred independently of the positive affect manipulation that this study also comprised of (presentation of funny videos and retrieving positive memories). Thus, the association between positive affect and attentional broadening seems more complex than most theories hold.

Given the importance of attentional broadening in theories of positive affect and the discrepant findings in this area, we set out to systematically examine whether positive affect broadens visual selective attention. The hypothesized broadening of selective spatial attention is a central tenet of theories on positive emotions in explaining why positive affect is associated with for instance better creative performance (Estrade, Young, & Isen, 1994), a facilitation of decision making (Isen, 2001; Estrada, Isen, & Young, 1997), and even enhanced stress resilience (Fredrickson, 2001). In the current study, we set up three experiments with a same experimental within-subjects-design in which we induced positive versus neutral and/or negative mood states. After each mood induction, attentional broadening was examined using a flanker task (Rowe et al., 2007) or the ANT (Fan et al., 2002) which contains a broader range of attentional measures. In Experiment 1, we performed a replication of the Rowe et al. (2007) experiment with similar mood inductions and flanker task. In Experiment 2, participants performed the same flanker task, but now in the context of a more ecologically valid mood-induction procedure. Finally, in Experiment 3 we examined whether the results of Experiment 1 and 2 would generalize to an alternative and well-validated measure of spatial orienting using the ANT (Fan et al., 2002). Anticipating the results, we consistently found that positive affect failed to influence visual selective attention.

EXPERIMENT 1

In Experiment 1, we replicated the study of Rowe et al. (2007). Because we were interested in the effects of positive affect, we used a within-subject design with a positive and neutral mood induction procedure (MIP) followed by a flanker task. In this task, participants are asked to selectively attend to a central target and ignore irrelevant flanking distracters. We expected that the positive compared with the neutral MIP would result in a broadening of attention, as reflected by more pronounced interference effects for distant flankers.

Method

Participants

Thirty-five undergraduate students of Ghent University participated in exchange for course credit. Two participants were excluded from further data-analyses because they responded at chance level on the attention task. Mean age of the remaining 33 participants was 19.27 (*SD* = 2.30). Most participants (87.9%) were female.

Material

Mood Induction. For the positive mood induction, participants listened to Bach's Brandenburg Concerto No. 3 (played by Hubert Laws) while retrieving a positive autobiographical memory. This procedure has been validated in previous mood research (Green, Sedikides, Saltzberg, Wood, & Forzano, 2003; Wood, Saltzberg, & Goldsamt, 1990). For the neutral mood induction participants read in a collection of historical facts about Belgium. Rating scales were administered to check the effectiveness of the MIP (see below). Participants rated their mood on nine-point visual analogue scales (VAS), anchored by end points "1: extremely unpleasant" and "9: extremely pleasant."

Flanker Task. The flanker task was programmed in the E-prime software package (Psychology Software Tools, Inc., 2001). The experiment was run on a laptop computer with a 60 Hz, 15-inch color monitor.

The spaced flanker task was programmed according to the specifications of Rowe et al. (2007). All stimuli were black, presented against a white background. Target stimuli and flankers were the letters N and H. All letters were capitals, presented in 18-point Courier New. On every trial, a fixation arrow (^) was presented in the middle of the screen. Imperative stimuli consisted of 5 letters, a target letter (N or H) flanked on both sides by the same pair of two identical letters (NN or HH). Spacing between the letters was manipulated, divided equally between near, medium, and far distances (0, 1 or 2 letter width). Responses were made by pressing one of two keys (target N: "s," target H: "h") with the left and right finger on an AZERTY keyboard.

Procedure

Participants were tested individually in a sound-attenuated lab at Ghent University. All participants were informed about the procedure and gave their written informed consent.

The experiment was conducted in one session. The participants performed the task after both MIPs. The order of MIPs was counterbalanced between participants. Participants rated their mood at three time points throughout the experiment. The first time point was before the MIP and flanker task. The remaining time points were immediately after the neutral and positive MIP. For the positive MIP, participants were instructed to listen to the music and generate a positive autobiographical memory for a period of five minutes. They were told to bring the experience as vividly as possible to mind and recall associated feelings just as they had experienced at that time. For the neutral MIP, participants had to read in a book with facts about Belgium for a period of 5 minutes.

After both MIPs, participants performed the flanker task. Participants were given 36 practice trials on the first out of two task blocks. Each task block consisted of 96 randomly presented trials, presented at varying intertrial intervals (500, 700 and 800 ms). Participants were instructed to identify the central letter as quickly as possible without sacrificing accuracy by pressing the corresponding key.

The sequence of events on a test trial consisted of a 1000 ms fixation arrow. Then a cue of five letters appeared for a 1000 ms or until a key press was made. Participants were seated at approximately 60 cm viewing distance from the computer screen to perform the flanker task. This distance was controlled by using a chin rest.

Results

Data Preparation

Results from two participants were excluded from the analyses because of an excessive number of errors (>50%). Trials with errors (M = 8.5%) and outliers with reaction times (RT) deviating >2.5 SDs from the mean RT (M = 1.0%) were analyzed separately.

Mood Induction

Scores on the VAS showed that participants reported the expected change in mood following MIP (Figure 1). Mood ratings were submitted to separate one-way ANOVAs with three levels of the mood induction factor (i.e., preinduction, post neutral MIP, post positive MIP). Valence ratings differed significantly depending on induction phase, $F(2,30) = 27.19$, $p < .001$, $\eta_p^2 = .64$. The mood did not change significantly relative to preinduction after neutral MIP, $t(32) = 1.53$, $p > .13$. The positive MIP resulted in significantly increased positive affect relative to preinduction, $t(32) = 4.07$, $p < .001$, and neutral MIP, $t(32) = 6.80$, $p < .001$. Equal results were obtained when the order of the MIPs was included as an additional factor in the ANOVA.

Attentional Breadth

Response time data were submitted to a 2 (mood: neutral, positive) x 2 (compatibility: compatible, incompatible) x 3 (spacing: near, medium, far) repeated measures analysis of variance (ANOVA). A highly reliable main effect of flanker compatibility, $F(1,32) = 130.16$, $p < .001$, $\eta_p^2 = .80$, revealed that responses were faster in compatible trials (M = 507, SD = 120) than in incompatible trials (M = 540, SD = 126). There was also a main effect of spacing, $F(2,31) = 62.67$, $p < .001$, $\eta_p^2 = .80$, with near flankers producing significantly slower responses (M = 545, SD = 121) than flankers at medium (M = 517, SD = 126), $F(1,32) = 79.76$, $p < .001$, $\eta_p^2 = .71$, and far distances (M = 509, SD = 122), $F(1,32) = 115.48$, $p < .001$, $\eta_p^2 = 0.78$. The effect of spacing interacted with flanker compatibility, $F(2,31) = 18.45$, $p < .001$, $\eta_p^2 = 0.54$, such that compatibility effects (incompatible minus compatible) were reduced with greater flanker distance. Near versus medium spacing revealed a 57.6% reduction in the effect of flanker compatibility, $F(1,32) = 33.04$, $p < .001$, $\eta_p^2 = .51$. Finally, there was no significant difference between medium and far spacing for the effect of flanker compatibility ($F < 1$).

In contrast with the hypothesized influence of positive affect on visual selective attention, there was no main effect of mood $F(1,32) = 1.15$, $p = .29$, $\eta_p^2 = .04$. Furthermore, the positive MIP did not result in greater flanker interference relative to the neutral MIP $F(1,32) < 1$ (see Table 1). The three-way interaction revealed that the effect of spacing on flanker compatibility was not influenced by mood, $F(2,31) = 1.29$, $p = .29$, $\eta_p^2 = .08$. Furthermore, no correlation was found between the amount of mood change and the amount of interference effect change ($r = .05$; $p = .80$).

Proportion error rates were submitted to a 2 (mood: neutral, positive) x 2 (compatibility: compatible, incompatible) x 3 (spacing: near, medium, far) repeated measures analysis of variance (ANOVA). A highly reliable main effect of flanker compatibility, $F(1,32) = 129.10$, $p < .001$, $\eta_p^2 = .81$, revealed that responses were typically more accurate in compatible trials ($M = .04$, $SD = .02$) than in incompatible trials ($M = .11$, $SD = .02$). There was a main effect of spacing, $F(2,31) = 9.60$, $p < .001$, $\eta_p^2 = .39$, with near flankers producing a significantly higher error rate ($M = .10$, $SD = .03$) than flankers at far distance ($M = .06$, $SD = .03$), $t(32) = 3.78$, $p = .001$. There was no significant difference between error rates of near and medium spaced trials ($M = .09$, $SD = .04$), $t(32) = .42$, $p > .05$. The effect of spacing interacted with flanker compatibility, $F(2,31) = 8.90$, $p = .001$, $\eta_p^2 = 0.37$, such that error rates of compatibility effects (incompatible minus compatible) were reduced with greater flanker distance (see Table 1). Furthermore, there were no effects of mood on error rates. First, there was no main effect of mood $F(1,32) = 1.73$, $p = .20$, $\eta_p^2 = .05$. Furthermore, there was no interaction effect with compatibility nor spacing (both $F(1,32) < 1$). The three-way interaction revealed that error rates of the effect of spacing on flanker compatibility was not influenced by mood, $F(2,31) < 1$.

Discussion

The results of Experiment 1 show that a positive MIP did not impair the ability to focus attention on a target and thus failed to increase the processing of spatially distant flanking distracters. It is important to mention that we found the expected effects of the MIP on the mood ratings. Furthermore, we replicated all the basic flankers effects reported by Rowe et al. (2007): highly significant main effects of compatibility, spacing, and an interaction effect. However, there was no higher-order interaction between mood, compatibility, and spacing. Furthermore, the correlation between the amount of mood change and the amount of interference effect change was not significant, which strengthens our null-finding. Finally, error rates were not influenced by mood.

Some aspects of this first experiment deserve consideration. A few methodological differences with the study of Rowe et al. (2007) should be noted. First, Rowe et al. (2007) controlled for both gender (an equal number of males and females) and time of testing (in between participants' peak and off-peak time of day). Gender differences have been found in selective attention (Merritt et al., 2007) as well as in the effects of mood manipulations (Westermann, Spies, Stahl, & Hesse, 1996) and attention is particularly vulnerable to time of day effects (Valdez et al., 2005). It is possible that such minor differences could affect the outcome of the task, supporting that the broadening of attention occurs under some very restricted conditions. Second, in the study of Rowe et al. (2007), the mood manipulation continued for a period of 10 minutes. Although in the current study the mood manipulation was briefer (5 minutes in total), we obtained similar results on the manipulation checks.

Finally, in the study of Rowe et al. (2007) the music component softly continued as participants performed the experimental task in the positive condition. However, there was no music component in the neutral condition. Because the difference in the presence of music between conditions could blur the broadening effects of positive mood (Olivers & Nieuwenhuis, 2005), we decided not to play the relevant music during the testing period.

As this is a null-finding we sought to further examine potential attentional broadening effects of positive affect. Although mood ratings differed significantly depending on induction phase with similar magnitude as reported in the study by Rowe et al. (2007), mean values indicated that participants were in a slightly positive mood after the neutral MIP. Therefore, we decided to run an experiment with a more ecologically valid and presumably stronger MIP that was still low in approach motivation.

EXPERIMENT 2

Because of our failure to replicate the findings of the broadening effect of positive affect on visual selective attention in Experiment 1, we decided to use a similar design, yet using a more involving and naturalistic MIP to elicit stronger positive mood. To maximize chances to find a modulation of attentional breadth by positive affect, we first induced stress by manipulating a personal concern that was highly goal-relevant for the participants and could evoke high-intensity approach motivation, which is thought to narrow attentional breadth (Chajut & Algom, 2003, Gable & Harmon-Jones, 2010). The second mood induction elicited positive affect through personally relevant positive feedback which is related to positive mood that is low in approach motivation (Frederickson, 2001; Gable & Harmon-Jones, 2010).

Method

Participants

Thirty-eight undergraduate students from Ghent University participated in a two hour multipart experiment in exchange for money (16 Euros). As we sought to elicit positive mood through personally relevant feedback (see below), we recruited psychology students from the 1st and 2nd grade who were interested in studying clinical psychology in the 3rd grade. Mean age of the participants was 20.14 (*SD* = 4.22). Most participants (81.6%) were female.

Material

Mood Induction Procedure (MIP). For the MIP, we used a performance task that contained uncontrollable and socially evaluative threatening elements that induced stress (Dickerson & Kemeny, 2004) to heighten the importance of feedback. This performance task consisted of a diagnostic interview which had to be performed by the participant with an actor having a background in clinical psychology. The participants were told that they had to use appropriate interviewing skills and that their performance was captured on video for possible use, after critical evaluation, in clinical psychology courses.

For the positive MIP, participants were given false positive feedback about their performance on the verbal interaction task. It has been shown that this procedure reliably results in moderate to large affective reactions (Nummenmaa & Niemi, 2004). All participants were told that they did very well, and that the actor, as a client, could feel at ease with the participant as a clinical psychologist. They were told that they created an open atmosphere that was stimulating to talk about problems. Finally, they were told that, given their excellent performance, it seemed that they would become a good clinical psychologist.

Mood Measure. The participants were given VASs consisting of a 100 mm horizontal line, on which they were asked to rate how tense (not tense at all – very tense) and how relaxed (not relaxed at all – very relaxed) they felt at the present moment.

Flanker Task. The flanker task was identical to Experiment 1. The task was run on a Windows XP computer with a 75 Hz, 17-inch colour monitor.

Procedure

The research protocol was approved by the local ethical committee. Written consent was obtained from the participants. The experiment was part of a larger study on the relation between information processing, and negative and positive mood. Participants were tested individually in a sound-attenuated lab at Ghent University. The lab was divided into three separate rooms; one for the attention tasks, one for the interview, and a third one for the positive MIP.

The experiment consisted of two separate parts. In the first part, unrelated to the present experiment, participants performed two attention tasks. After these tasks, participants were allowed to rest for several minutes. At the end of the resting phase, participants completed their first VAS. Then, an experimenter came in and brought them to another room for the interview. This room contained two chairs with a big camera pointing towards one chair and strong lights. Participants completed a second consent form in which they approved that their performance on the interview would be captured on tape and could be used in courses. Then they performed the interview for approximately two minutes. The actor did not provide any feedback, even if participants asked for it. After the interview, participants completed a second VAS immediately followed by the flanker task. After this task, participants were told to relax for a while. After several minutes, the experimenter provided standardized positive feedback about the interview. After this positive MIP they completed a third VAS, immediately followed by the same flanker task.

After the experiment, all participants were fully debriefed and asked if they were aware of the purpose of the MIP. Some of the participants reported to be aware, but all said that they were stressed by the interview and relieved after the positive MIP.

Results

Data Preparation

Trials with errors (*M* = 9.6%) and outliers with RTs deviating >2.5 SDs from the mean RT (*M* = 0.5%), were analyzed separately.

Mood Induction

Scores on the VASs showed that participants started with a positive mood and that they followed the expected change in mood considering the sequence of negative and positive MIPs respectively (see Figure 1). Mood valence scores were submitted to separate one-way ANOVAs with three levels of the mood induction factor (i.e., pre-induction, post interview, post positive MIP). Valence ratings for both variables tension and relaxation differed significantly depending on induction phase, $F(2,36) = 15.73$, $p < .001$, $\eta_p^2 = .47$ and $F(2,36) = 15.80$, $p < .001$, $\eta_p^2 = .47$, respectively. The initial baseline mood changed significantly after the interview for mood rating scores on tension, $t\ (37) = 5.14$, $p < 0.01$ and relaxation, $t\ (37) = 4.92$, $p < 0.01$. The positive MIP resulted in significantly increased positive affect relative to the preceding interview for scores on tension, $t\ (37) = 4.47$, $p < .001$, and relaxation, $t\ (37) = 5.68$, $p < .001$.

Attentional Breadth

RT data were submitted to a 2 (mood: negative, positive) x 2 (compatibility: compatible, incompatible) x 3 (spacing: near, medium, far) repeated measures ANOVA. A highly significant main effect of flanker compatibility, $F(1,37) = 171.63$, $p < .001$, $\eta_p^2 = .82$, revealed that responses were faster in compatible trials (*M* = 450, *SD* = 45) than in incompatible trials (*M* = 484, *SD* = 43) trials. There was also a main effect of spacing, $F(2,36) = 87.24$, $p < .001$, $\eta_p^2 = .83$, with near flankers producing significantly slower responses (*M* = 490, *SD* = 48) than flankers at medium (*M* = 461, *SD* = 43), $F(1, 37) = 111.79$, $p < .001$, $\eta_p^2 = .75$, and far distances (*M* = 450, *SD* = 43), $F(1, 37) = 177.24$, $p < .001$, $\eta_p^2 = .83$. The effect of spacing interacted with flanker compatibility, $F(2,36) = 14.41$, $p < .001$, $\eta_p^2 = .45$, such that compatibility effects were reduced with greater flanker distance. Near versus medium spacing revealed a 29.8% reduction in the effect of flanker compatibility, $F(1,37) = 6.56$, $p < .02$, $\eta_p^2 = .15$. Moreover, there was another 24.6% reduction in the compatibility effect in medium versus far distance, $F(1,37) = 9.83$, $p < .01$, $\eta_p^2 = .21$ (see Table 2).

There was a main effect of mood with RTs on the flanker task being higher in the negative (*M* = 477, *SD* = 52) compared to the positive condition (*M* = 458, *SD* = 37). Probably, this effect was due to the fixed order of the interview and positive MIP with practice effects from the first to the second administration of the flanker task. There was no interaction between mood and compatibility, $F(1,37) = 0.10$, $p = .75$, $\eta_p^2 = .0$. Most importantly, there was no significant three-way interaction between spacing, flanker compatibility, and mood, $F(2,36) = 1.59$, $p = .29$, $\eta_p^2 = .08$. Furthermore, the correlation between the amount of mood change and the amount of interference effect change was not significant ($r = .227$; $p = .50$).

Proportion error rates were submitted to a 2 (mood: neutral, positive) x 2 (compatibility: compatible, incompatible) x 3 (spacing: near, medium, far) repeated measures analysis of variance (ANOVA). A highly reliable main effect of flanker compatibility, $F(1,37) = 90.93$, $p < .001$, $\eta_p^2 = .71$, revealed that responses were typically more accurate in compatible trials (*M* = .04, *SD* = .03) than in incompatible trials (*M* = .12, *SD* = .03). There was a main effect of spacing, $F(2,36) = 28.28$, $p < .001$, $\eta_p^2 = .61$, with near flankers producing significantly a higher error rate (M = .13, SD = .04) than flankers at medium (M = .06, SD = .03), t (37) = 6.99, p < .001 and far distance (M = .06, SD = .03), t (37) = 6.88, p < .001. The effect of spacing interacted with flanker compatibility, F(2,36) = 4.59, p = .02, η_p^2 = 0.20, such that error rates of compatibility effects (incompatible minus compatible) were reduced with greater flanker distance (see Table 2). Furthermore, there were no effects of mood on error rates. First, there was no main effect of mood F(1,37) < 1. Furthermore, there was no interaction effect with compatibility (F(1,37) = 1.21, p = .28) nor spacing (F(1,37) < 1). The three-way interaction revealed that error rates of the effect of spacing on flanker compatibility was not influenced by mood (F(2,36) = 1.04, p = .36).

Discussion

In Experiment 2 we replicated the null-finding of Experiment 1 with a more ecologically valid MIP. Scores on the VASs showed that participants started with a positive mood and that they followed the expected change in mood considering the sequence of negative and positive MIPs respectively. After the positive MIP, ratings of positive affect returned to the positive baseline levels. Moreover, the main effects of the flanker task again attested to the validity of the task. That is, we observed all standard effects: an overall compatibility effect with slower responding to incompatible compared with compatible trials, a main effect of spacing with reaction times reducing with increased spacing, and an interaction effect between compatibility and spacing such that compatibility effects were reduced with greater flanker distance. Furthermore, the correlation between the amount of mood change and the amount of interference effect change was not significant, which strengthens our null-finding. Finally, error rates were not affected by the MIPs.

Some aspects of this second experiment deserve consideration. First, response times in Experiment 2 were about 50 ms shorter than in Experiment 1. This might be due to a larger size and higher refresh rate of the computer screen in Experiment 2. Second, a main effect of mood was found on RTs where responding was faster after positive MIP than after the interview. This is likely due to order effects with the second presentation of the flanker task after the positive MIP. One could argue that this response facilitation could have obscured attentional broadening effects during positive MIP. However, there was no interaction between mood and compatibility, which argues against this idea. It still remains possible that the second flanker task session might be the one with more focussed attention and this might have ran counter to an effect of the broadening attention by positive mood.

EXPERIMENT 3

One limitation of Experiment 1 and 2 was that we investigated selective visual attention by means of just one specific measure of spatial attention: the flanker task. In Experiment 3, we therefore sought for the inclusion of a broader range of attentional measures, so to increase our odds to find any impact of affective on visual attention. Human attention has been subdivided into at least three functionally and neuro-anatomically separate networks (Fan et al., 2002; Posner & Petersen, 1990). These networks have been claimed to drive three different types of attention, namely alerting, orienting, and selective attention. These types of attention might be differentially sensitive to mood manipulations, which is why we considered all three types in Experiment 3. To do so, we combined a mood manipulation with the ANT – the task that has been suggested to assess the three types of attentional networks (Fan et al., 2002).

Although the hypothesized role of positive mood on spatial attention has usually been measured in selective attention tasks – which according to Fan et al. (2002) would tap into the selective attentional network - the orienting network might be modulated in similar ways.

Some findings indeed suggest an affective influence on the ability to overtly attend to the spatial location of a stimulus. In the ANT this can be measured by comparing RTs to stimuli at spatially cued versus uncued positions. Consistent with the hypothesized role of positive affect in cognitive flexibility, it has been shown that positive mood improves the rapid covert orienting of attention (Johnson et al., 2010; Compton, Wirtz, Pajoumand, Claus, & Heller, 2004). However, given that these positive affect modulations have only been observed in some trials (Compton et al., 2004) or under specific smiling conditions (Johnson et al., 2010), whereas other studies have failed to find such an association (Moriya & Tanno, 2009; Finucane et al., 2010), further investigation of this issue is required.

The third, alerting function of attention refers to the ability to prepare and sustain alertness to process relevant signals. Task-related alertness can be measured in the ANT by comparing RTs to stimuli that are temporally forewarned versus not forewarned by a cue stimulus. Some studies have shown an association between negative affect and improved alertness efficiency, which is consistent with a norepinephrine modulation of sustained attention in negative affect (cf. Compton et al., 2004). Interestingly, improved alertness seems to be specific to negative mood states with moderate to high activation levels, given that modulation has been observed for self-reported negative affect (a general dimension of subjective distress, see Watson & Tellegen, 1985; Compton et al., 2004) and induced state anxiety (Pacheco-Unguetti, Acosta, Callejas, & Lupianes, 2010), but not for low-activation negative moods (i.e. sadness; Finucane et al., 2010). Moreover, these effects are not thought to be related to reduced positive affect (Compton et al., 2004), suggesting that improved alertness would be observed following negative mood induction only, but not following positive mood induction. This hypothesis was tested in Experiment 3.

To summarize, in Experiment 3 we examined whether the null-findings of Experiment 1 and 2 generalized to an alternative and well-validated measure of spatial orienting. Whereas the mixed results of previous studies might well predict null-results regarding mood effect on orienting and selective attention, a somewhat more consistent picture emerges from studies investigating the alerting function: alertness might be improved by negative mood, but not by positive mood inductions. In order to test these predictions, we measured the efficiency of the three attentional networks with the well-validated ANT (Fan et al., 2002), after having manipulated participants' mood using a mood induction procedure that includes a negative, neutral, and positive condition.

Method

Participants

Twenty-five students from Leiden University participated in three sessions of a 45-minutes experiment in exchange for money (12 euros) or course credit. Two participants were excluded from further data-analyses: one person made more than 20% errors on average, the other person reported to be unable to get in a negative mood. Mean age of the participants was 21.24 years (*SD* = 3.79). Most participants (73.9%) were female.

Material

Mood Induction. Film fragments were combined with the instruction to get in a particular mood using Velten statements. This combination of procedures has been reported to be an effective method for the induction of mood states (Westermann, Spies, Stahl, & Hesse, 1996). Following a 3-minute film fragment of movie clips (cf. van Wouwe, Band, Ridderinkhof, 2011) from The Little Mermaid (happy condition) and The Lion King (sad condition), or a Falling Sticks movie (neutral condition; Rottenberg, Ray, & Gross, 2007), 16 translated Velten mood induction statements adapted from an earlier validated set (Jennings, McGinnis, Lovejoy, & Stirling, 2000) were presented on the computer monitor for at least 20 seconds each. From the Velten task on, background music from the movie fragments (with the vocals removed) was played softly throughout the experimental session via headphones. In order to check the induction manipulation, participants were to rate their mood on a 9 x 9 valence x arousal grid (Russell, Weis, & Mendelsohn, 1989) by placing a single checkmark somewhere in the grid. The valence score is taken as the number of the square checked, with squares numbered along the horizontal dimension (unpleasant feelings – pleasant feelings), counting from 1 to 9, starting at the left. The arousal score is taken as the number of the square checked, with squares numbered along the vertical dimension (sleepiness – high arousal), counting from 1 to 9 starting at the bottom. Ratings were given on a grid occasionally presented on the monitor during the experiment.

Attentional Network Test (ANT). A standard adult version of the ANT implemented in E-prime was run on a computer with a 60 Hz, 15-inch color monitor (see Fan et al., 2002, for details). The ANT combines the standard arrow flanker task with a cued reaction time task. In the ANT, participants have to decide as quickly and accurately as possible whether an arrow flanked on both sides by two distracting arrows is pointing left or right using an index finger response on the buttons “z” or “/” of a QWERTY keyboard. On any trial, the set of arrows can be presented either above or below fixation point. Before the presentation of the arrows, a cue may be used to direct the attention of the participants. Three different types of cue are used, as well as a no-cue condition. Alerting is defined as the ability to make use of a temporally informative cue and is evaluated by comparing RTs of the no-cue condition to RTs of the double cue condition (a cue above and below fixation at the two possible target locations). Orienting is the ability to make use of a spatially informative cue above and beyond a temporally informative cue. Orienting is evaluated by comparing RTs of the center cue condition (where the cue is presented at fixation) to RTs of the condition with the single spatially informative cue that appears where the target arrow will appear. Finally, selective attention (the ability to ignore incompatible distractors) has been evaluated by comparing RTs of trials in which the distracter arrows are incompatible with RTs of trials in which the target arrow and the distracter arrows are compatible.

Procedure

The research protocol was approved by the local ethical committee. Written consent was obtained from all participants. Participants were tested individually in a lab booth at Leiden University during three sessions at the same time of day, separated by at least one week (*M* = 9 days). Before the first session, instructions about the mood rating procedure and how to perform the task were given. Each session started with a baseline mood rating, and was followed by a short practice block of 24 ANT trials. Then the MIP started (positive, negative, or neutral condition; order balanced across subjects), and was followed by three blocks of 96 ANT trials separated by self-paced breaks. During the experiment, seven mood ratings were obtained at the following time points: at the beginning of the experiment (baseline), following the practice trials, halfway and at the end of the MIP, and after each task block.

Results

Data Preparation

Following standard practice (Fan et al., 2002), behavioral efficiency scores were calculated for each attentional network separately. The compatibility effect measuring the breadth of attention was calculated by subtracting the mean correct RT of all compatible flanking conditions, summed across cue types, from the mean RT of incompatible flanking conditions. The orienting effect was calculated by subtracting the mean RT of the spatial cue conditions from the mean RT of the center cue. The alerting effect was calculated by subtracting the mean RT of the double-cue conditions from the mean RT of the no-cue conditions.

Mood Induction

Baseline grid scores indicated that participants started the sessions in a slightly positive and aroused mood. Valence ratings showed that the MIP successfully induced the expected change in mood (see Figure 1). A 3 (mood: negative, neutral, positive) x 7 (timepoint) repeated measures ANOVAs yielded an interaction between mood and timepoint for valence, $F(12,264) = 22.12$, $p < .001$, $\eta_p^2 = .50$, but not for arousal, $F(12,264) = 1.53$, $p > .10$, $\eta_p^2 = .07$. Follow-up tests including the average mood ratings before and after the task blocks (i.e., timepoints 3 to 6, see Table 3) showed a monotonic function for valence: scores for the negative condition were lower than for the neutral condition, $t\ (22) = 6.80$, $p < .001$ which, in turn, were lower than those for the positive condition, $t\ (22) = 6.78$, $p < .001$.

Selective attention, Orienting, and Alertness

In order to test effects of mood on RTs, ANT difference scores of the three attentional networks were submitted to a univariate repeated measures ANOVA (see Table 4). Although the ANT produced a reliable main effect score for selective attention, $F(1,22) = 275.29$, $p < .001$, $\eta_p^2 = .92$, there was no evidence of mood modulating this effect, $F(2,44) = 0.08$, $p > .90$, $\eta_p^2 = .004$. Similarly, an ANOVA including all levels of compatibility (i.e., compatible, neutral, and incompatible flankers) as factor did not reveal any modulatory effect of mood, $F(4,88) = .189$, $p > .90$, $\eta_p^2 = .01$. The ANT also produced a robust orienting effect, $F(1,22) = 215.55$, $p < .001$, $\eta_p^2 = .91$, without any influence of mood on this measure, $F(2,44) = 1.55$, $p > .20$, $\eta_p^2 = .07$.

However, analyses of the alerting effect, *F*(1,22) = 110.52, *p* < .001, η_p^2 = .83 revealed a trend towards a mood modulation, *F*(2,44) = 2.84, *p* = .069, η_p^2 = .12. Follow-up tests showed that there was a significant increase of alertness for the negative in comparison to the neutral condition, *t* (22) = 2.82, *p* = .01. This suggests that increased alerting is driven by negative affect. Note that this effect is not fully specific to negative emotions as in the overall analysis, the effect of positive, neutral, and negative mood on the alerting effect did not reach significance with positive affect having similar but non significant effects on alerting.

Analyses on proportion error rates (see Table 4) revealed a main effect for selective attention, *F*(2,21) = 1.87, *p* = .18 with typically higher error rates in incongruent trials (*M* = .08, *SD* = .06) compared to congruent (*M* = .01, *SD* = .01) and neutral trials (*M* = .01, *SD* = .01). There was no evidence of mood modulating this effect, *F*(4,19) < 1. Furthermore, mood did not influence error rates in the orienting effect, *F*(2,21) = 1.51, *p* > .23 and in the alerting effect, *F*(2,21) = 1.41, *p* = .27.

Discussion

We successfully replicated the finding of Experiment 1 and 2: no effect of positive mood on selective attention was observed in the ANT, even though the mood induction procedure was successful. Moreover, attentional orienting, another measure of spatial attention, was also not affected by participants' affective state. These findings corroborate our finding that spatial attention is not generally modulated by positive mood. On the other hand, temporal alertness was sensitive to mood changes. Confirming previous studies, alerting efficiency was found to be improved in negative mood but not in positive mood (in comparison to the neutral condition). This finding is not only consistent with earlier observations (Compton et al., 2004; Pacheco-Unguetti et al., 2010), but it also reinforces the conclusion that the null-effects regarding spatial attention are reliable and cannot be attributed to reduced sensitivity of the attentional measures to mood effects.

GENERAL DISCUSSION

In a series of three experiments using different paradigms and mood induction procedures, performed in two different labs, we could not find any evidence for a modulation of attentional breadth by positive mood. These results are important for future theorizing on the role of mood on attentional processes. Although some work has found evidence for attentional broadening by positive mood states (Rowe et al., 2007), more recent papers are now suggesting that these effects cannot always be observed but are restricted to certain conditions. Although recent studies have provided qualified conclusions regarding initially reported effects of mood on the global-local task (i.e. Gasper & Clore, 2002; Fredrickson & Branigan, 2005; qualified by Gasper, 2004; Huntsinger et al., 2010; Johnson et al., 2010), no such qualifications have been reported so far for the effect of positive mood on the flanker task, as described by Rowe et al. (2007). Here we have demonstrated for the first time, that mood does not consistently influence flanker task performance, even with a task identical to that used by Rowe et al. (2007). Selective attention was also not found to be modulated in the ANT, which is consistent with earlier findings (Moriya & Tanno, 2009; Funicane et al., 2010).

As these are essentially null-findings, it is important to consider the reliability of the present findings. There are several features of the present experiments that attest to this issue. First, the null-finding generalized across various MIPs, one comparable to that used by Rowe et al. (2007) and two other well-established and often-employed MIPs. Each of the MIPs was successful as indicated by changes in mood ratings. Second, all three of the present experiments showed reliable flanker effects and the first two experiments were able to reproduce the known modulation of the flanker effects through spacing. Finally, the null-findings obtained in Experiment 1 and 2 generalized to another, well-validated measure of selective attention, the ANT.

Another important issue to consider is statistical power. Although the sample sizes of the individual experiments were comparable to those reported in previous work, they were not large. If we assume an effect size of d = .2 (a small effect according to the conventions of Cohen, 1988), the power to detect an interaction of mood and flanker interference was .49 in Experiment 1, .50 in Experiment 2, and .42 in Experiment 3. The corresponding power when a medium effect is assumed (d=.5) amounts to .99, 1.00, and .99 respectively. Thus, it remains possible that our study lacked statistical power to capture the effect of positive mood on selective attention. Therefore, in order to increase our power, we pooled our data together in a random effects model with a meta-analytic technique (Borenstein, 2009), in which we compared an attentional broadening index of the positive conditions with those of the less positive conditions (neutral and/or negative) for each study. The data of the meta-analysis revealed an overall effect size of .012 across our studies, consistent with our null-finding.

Thus, taken together, the present null-finding appears reliable and it is important to consider the theoretical implications of this finding for empirical research and theoretical models of the relationship between positive affect and attention. First, it is becoming increasingly clear that the effects of positive mood on attention are dependent on several mediating processes. One of these processes is motivational salience of positive information as only positive information low in approach motivation seems broaden the attentional scope (Gable & Harmon-Jones, 2008, 2010). However, given that in the present study the MIPs were low in approach motivation, other factors seem to be at play as well.

A tentative explanation for differences between studies on mood-induced attentional broadening might be the task-relevance of peripheral spatial information. Whereas the flankers were truly task-irrelevant in the present study, the nominally irrelevant information is more integrated with the task-relevant information in other tasks, such as the global-local task (where relevant local information is a structural part of the irrelevant global information). Accordingly, it might be easier to ignore irrelevant information in tasks like the flanker task, thus working against potential mood effects. Future research should therefore not only consider whether mood is high or low in approach motivation, but also take into account the importance of applying a broad versus narrow attentional window for the task at hand.

At a theoretical level, the present findings are not in line with theories predicting that positive affect is associated with a broadening of attention (Fredrickson, 1998). On the one hand, our present findings do not rule out that positive affect can serve an important role in broadening attention in principle (e.g., Frederickson & Branigan, 2005; Gable & Harmon-Jones, 2010, Phillips et al., 2002). On the other hand, however, it seems clear that the influence of positive mood on attention is mediated by additional, insufficiently understood processes that require further study. This seems particularly important as the broadening function of positive mood is considered crucial in explaining the association between positive mood and higher-level processes such as creativity (Baas, De Dreu, & Nijstad, 2008), stress resilience (Frederickson, 2001), and health (Burton & King, 2009).

There are several limitations of our study that deserve some consideration. First, most of the MIPs used here are known to have only a brief effect on affect. It is therefore possible that mood induction was effective during parts of the task only and that this explains why positive mood failed to influence visual attention. However, the same mood-induction techniques were used in most of the studies that reported reliable effects of positive mood induction on attention. Moreover, we have used different MIPs in an attempt to create situations with ecologically valid strong positive affect. Thus, despite the possibility of short-term effects of positive mood, the discrepant findings between the current and previous studies require an explanation.

Second, as other researchers before us, we conceptualized attentional breadth with respect to the size of the focus of visual attention. Accordingly, we are not able to draw any conclusions about the influence of positive mood on attentional breadth in broader terms and/or with respect to other perceptual modalities.

In sum, in three experiments we consistently failed to replicate previous findings suggesting that positive affect broadens spatial attention. These null-findings suggest a not-yet-understood, mediating role of additional factors and, thus, call for further research on the interaction between positive affect and visual attention.

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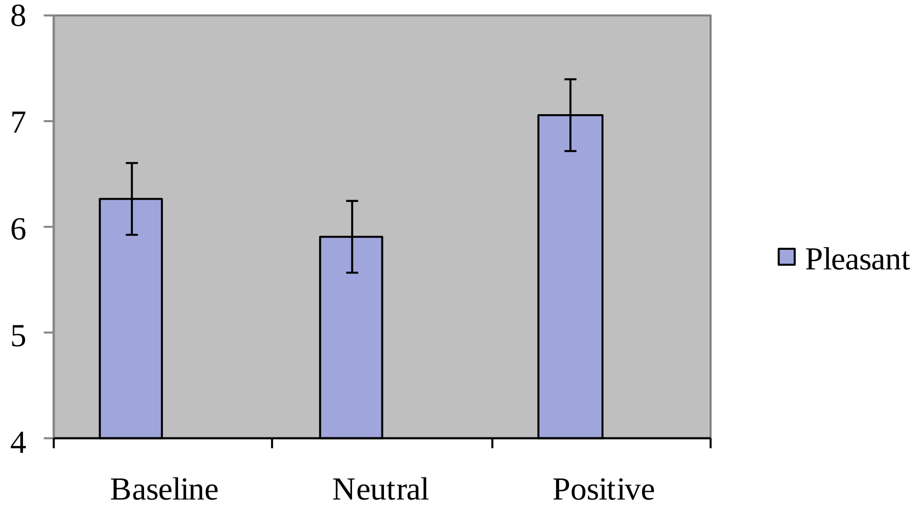
FOOTNOTES

[1]We also used the outlier analyses of Rowe et al. (2007) in which response times > 1000 ms were considered as outliers. Results were comparable.

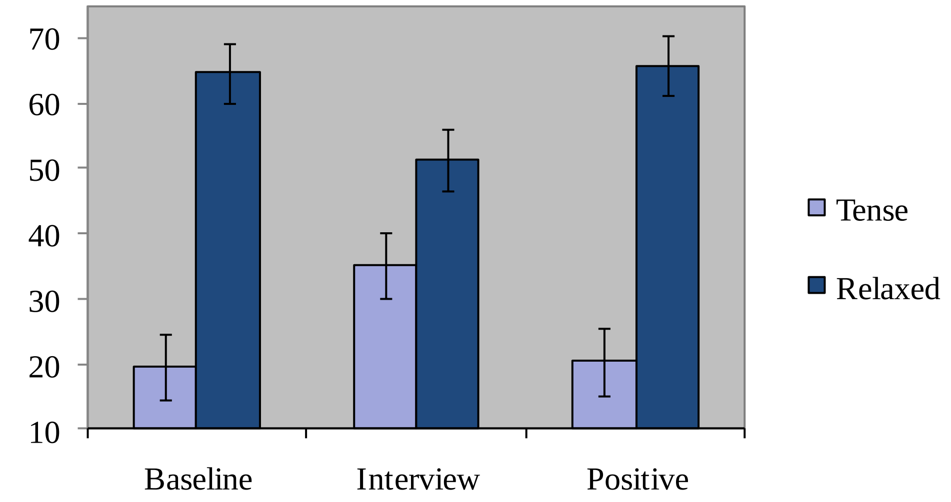
FIGURES

Figure 1. Mood ratings (Means ± SE) on VASs for Experiment 1, 2 and 3. Experiment 1: From 1 extremely unpleasant to 9 extremely pleasant. Experiment 2: from 0=not at all tense/relaxed to 100=very tense/relaxed. Experiment 3: Mood ratings on a 9 x 9 valence x arousal grid.

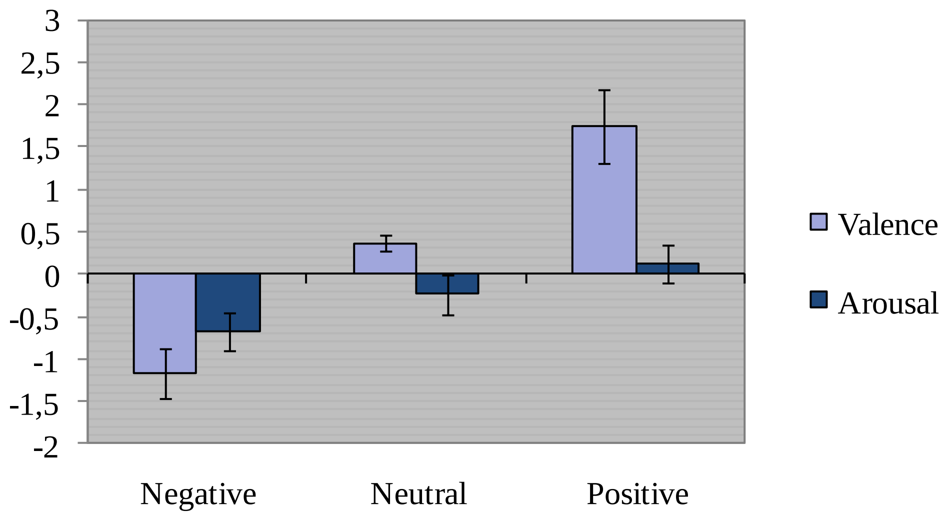
Experiment 1



Experiment 2



Experiment 3



TABLES

Table 1: Mean reaction times and error rates for flanker conditions and compatibility effects (N = 33) (Experiment 1).

	Positive			Neutral		
	Mean	SD	ER: M	Mean	SD	ER: M
Compatible trials RTs (ms)						
Spacing Near	516	134	.04	519	127	.04
Spacing Medium	501	125	.04	510	143	.04
Spacing Far	491	111	.05	505	137	.03
Incompatible trials RTs (ms)						
Spacing Near	568	117	.16	575	119	.14
Spacing Medium	525	130	.15	532	119	.14
Spacing Far	519	118	.09	523	134	.08
Compatibility Effect RTs (ms)						
Spacing Near	52	32	.12	56	41	.11
Spacing Medium	26	34	.11	21	46	.09
Spacing Far	28	21	.05	17	30	.05

Note:
RT = Reaction time; ER = proportion error rate

Table 2: Mean reaction times and error rates for flanker conditions and compatibility effects (N = 38) (Experiment 2)

	Positive			Negative		
	Mean	SD	ER: M	Mean	SD	ER: M
Compatible trials RTs (ms)						
Spacing Near	457	44	.07	477	64	.06
Spacing Medium	436	42	.04	454	51	.02
Spacing Far	431	39	.03	449	51	.04
Incompatible trials RTs (ms)						
Spacing Near	506	41	.19	520	62	.19
Spacing Medium	468	39	.08	487	53	.10
Spacing Far	448	41	.08	475	52	.09
Compatibility Effect RTs (ms)						
Spacing Near	52	32	.11	56	41	.12
Spacing Medium	26	34	.04	21	46	.08
Spacing Far	28	21	.05	17	30	.06

Note:
RT = Reaction time; ER = proportion error rate

Table 3. Mood ratings (Experiment 3).

Dimension	Induction condition	Time point						
		Baseline	1	2	3	4	5	6
Pleasure	Negative	0.83	0.83	-1.22	-1.65	-1.26	-1.04	-0.70
	Neutral	0.83	0.78	-0.17	0.30	0.26	0.30	0.61
	Positive	0.39	0.57	2.17	2.26	1.83	1.74	1.17
Arousal	Negative	0.48	0.87	0.70	-0.61	-0.48	-0.70	-0.91
	Neutral	0.57	0.91	0.78	-0.09	-0.26	-0.35	-0.26
	Positive	1.00	0.96	1.43	0.96	0.26	-0.43	-0.30

Note: Seven mood ratings were obtained at the following time points: at the beginning of the experiment (baseline), following the practice trials (1), halfway (2) and at the end of the MIP (3), and after each task block (4 -6).

Table 4. Mean reaction times for cue and flanker conditions and ANT scores (N=23) (Experiment 3).

	Negative			Neutral			Positive		
	Mean	SD	ER: M	Mean	SD	ER: M	Mean	SD	ER: M
Cue condition RTs (ms)									
No cue	540	44.4	.03	529	50.5	.03	532	61.8	.03
Center cue	503	45.2	.04	492	46.9	.03	488	59.1	.04
Double cue	490	44.9	.05	489	44.8	.03	484	60.8	.03
Spatial cue	452	45.6	.03	449	44.1	.02	444	59.0	.03
Flanker condition RTs (ms)									
Congruent	473	43.8	.01	465	44.7	.01	462	56.2	.01
Incongruent	556	51.1	.08	548	53.9	.07	547	73.2	.08
Neutral	465	37.0	.01	460	40.6	.01	456	49.5	.01
ANT efficiency scores (ms)									
Attentional breadth	83	25.8	.07	83	32.0	.06	85	31.1	.07
Orienting	52	22.2	.01	44	19.3	.01	44	21.2	.02
Alerting	51	22.9	.02	40	24.2	.01	48	26.1	.01

Note: ANT = Attentional Network Test;
RT = Reaction time; ER = proportion error rates