Journal of Articles in Support of the Null Hypothesis
Vol. 7, No. 1

www.jasnh.com

The Effect of Positive Affect Induction via Metta Meditation on the Attentional Blink

Michelle Burgard
Christopher J. May
Carroll University

The attentional blink (AB) is a reduced ability to detect a stimulus presented too quickly (~500ms) after a previously detected stimulus. Mindfulness meditation reduces the AB, and has been explained in terms of the altered attentional resource allocation skills of meditators (Slagter et al., 2007). However, mindfulness meditation also increases positive affect (Davidson et al., 2003), and positive affect has been shown to reduce the AB (Olivers & Nieuwenhuis, 2006). Thus, a positive-affect focused meditation (Metta) may also reduce the AB. While brief practice of Metta meditation prior to engaging in an AB task failed to significantly reduce the AB, these results are useful in determining an approximate effect threshold, currently unknown with respect to meditation (Carmody & Baer, 2009).

The attentional blink, coined by Raymond, Shapiro, & Arnell (1992), refers to a failure to detect a second target in a rapid serial visual presentation (RSVP) of stimuli if a first target was detected within a brief window of time (~500ms) prior to the second target (see Figure 1). It as if, after registering the first target (T1), attention "blinks," thereby missing the second target (T2). Olivers and Nieuwenhuis (2006) advance two hypotheses to explain the attentional blink: the overinvestment hypothesis and the positive affect hypothesis.

According to the overinvestment hypothesis, the investment of attentional resources into the detection of T1 diminishes available resources for the detection of T2. T2 will only be reliably detected once attentional resources are no longer dedicated to the detection of T1. The overinvestment hypothesis predicts that if participants can lessen the attentional resources devoted to T1, more will be available for T2, and the attentional blink would be attenuated. This is indeed the case, as demonstrated by numerous experiments (Olivers & Nieuwenhuis, 2006). In a particularly noteworthy recent example, the attentional blink was shown to be attenuated by those adept in Vippassana meditation (Slagter et al., 2007). In this type of meditation, the practitioner deliberately directs their attention to present cognitions, emotions, and sensations, but attempts to avoid engaging in discursive thinking about those objects of awareness. This has been described as "bare" attention, because the practitioner attends to, but does not become engrossed in, particular mental contents. Success with Vippassana medtation takes practice. For this reason, meditation is often conceptualized as a type of attentional training (Lutz et al., 2009; Slagter et al., 2007, Wallace, 2006). Slagter et al. (2007) demonstrated that those with extensive training in maintaining bare attention detected T2 much more often. Per the overinvestment hypothesis, because practitioners could decrease the attentional resources dedicated to perceiving T1, more remained for the successful detection of T2.

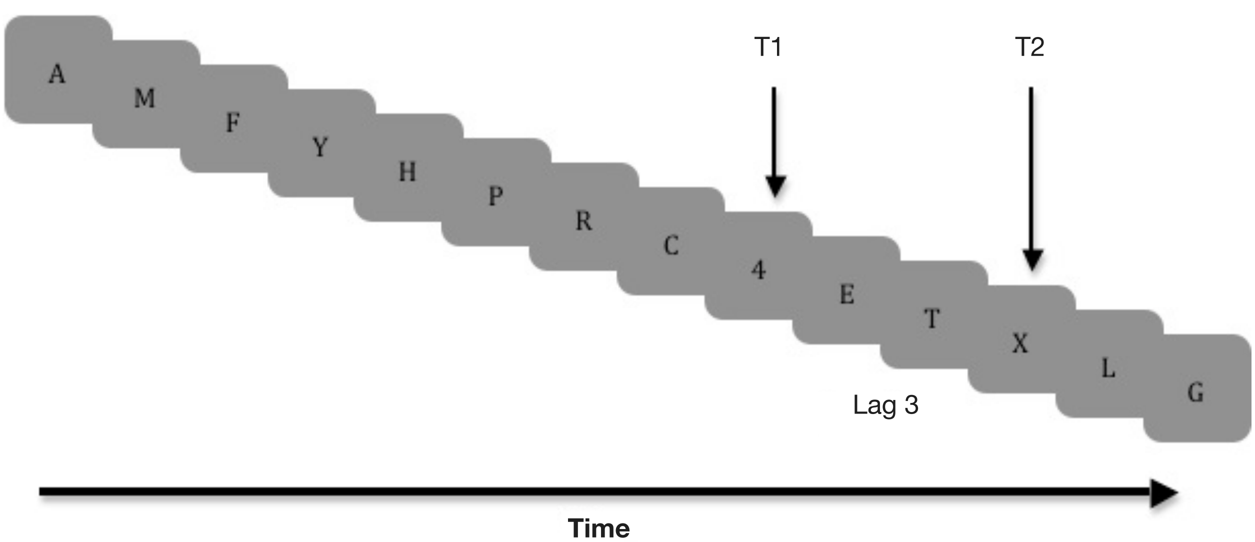

Figure 1. *Rapid serial visual presentation (RSVP) task. Each letter/digit is presented for 50 ms, with a 50 ms interval between stimuli. The first target (T1) is a digit (2-9), which always appears in the 9th position. The second target (T2), an "X" appearing on 50% of the trials, appears either in the 12th position (Lag 3) or in the 17th position (Lag 8). After the final stimulus, participants are instructed to report the identity of T1 and whether or not an "X" (T2) followed.*

According to Olivers and Nieuwenhius' (2006) positive affect hypothesis, positive emotion may enhance detection of T2. The positive affect hypothesis is complementary to, rather than competitive with, the overinvestment hypothesis. Positive affect has been shown to increase perceptual/cognitive flexibility (Dreisbach & Goschke, 2004; Tan, Jones, & Watson, 2009), which could, in turn, reduce the attentional blink. Olivers and Nieuwenhuis (2006) provided direct support for this hypothesis, demonstrating a reduced attentional blink for participants shown pictures, such as babbies, puppies, and smiling children, intended to induce positive affect. Jeffries, Smilek, Eich, and Enss (2008) also found an effect of induced positive affect on the attentional blink. In their induction, participants listened to music and ruminated on valence-congruent life events. Similar attentional blink attenuation results have been found by other investigators as well (Langley, Rokke, Stark, Saville, Allen, & Bagne, 2008; Keil, Ihssen, and Heim, 2006). Indeed, the reduced attentional blink found in Vipassana meditators (Slagter et al., 2007) may also involve positive affect. Davidson et al. (2003) found that mindfulness meditation (similar to Vipassana meditation) increases positive affect. This increase was demonstrated both behaviorally, with altered scores on a mood scale, and physiologically, with a shift in hemispheric EEG laterality to the left, previously shown to be associated with positive affect (Tomarken, Davidson, Wheeler, & Doss, 1992). Changes in the attentional blink, therefore, may not be due solely to the cultivation of bare attention, but may be mediated by increased positive affect as well.

In line with the positive affect hypothesis, metta (or "loving-kindness") meditation should also diminish the attentional blink. Metta is a technique that directly focuses on emotions, specifically the cultivation of positive affect. In this type of meditation, the practitioner calls to mind the image of a loved one, focuses on the feelings of love they have for that person, and directs certain intentions toward that person. For example, the meditator may repeat phrases such as "May you be well," "May you be happy," and "May you be free from suffering," while focusing not on the words per se, but on the feeling behind the genuine desire that their loved one be well, happy, and free from suffering. In extended versions of this practice, the meditator progressively changes the imagined person to whom such intentions are sent to people that less naturally evoke feelings of compassion, and indeed may even evoke negative emotions. Metta meditation thus provides a way to both amplify positive affect, and attenuate negative affect (for more, see Ekman, Davidson, Ricard, & Wallace, 2005; Wallace, 2006).

The hypothesis that metta meditation may reduce the attentional blink is supported neurophysiologically as well. Lutz, Greischar, Rawlings, Ricard, & Davidson (2004) found that metta meditation increases gamma-band (25-42 Hz) EEG power. Gamma-band activity co-varies with the conscious awareness of stimuli, such that neural activity oscillating at gamma frequencies is thought to be critical for that conscious awareness (see Lee, Williams, Breakspear, & Gordon, 2003; Ward, 2003. In Lutz et al. (2004), gamma power increased during metta for both long-time meditators and novices (with a larger power increase for the long-time practitioners). Fell, Klaver, Elger, & Fernandez (2002) provide strong evidence for the hypothesis that a suppression of gamma EEG activity may be responsible for the attentional blink. With this suppression, T2 is not brought into awareness. Gamma suppression is putatively caused by cortical mechanisms corresponding to the P300, an event-related potential thought to index attentional allocation (see Polich & Kok, 1995). In short, attentional resources allocated to T1 are reflected in P300 amplitude, while the lack of resources remaining to process T2 is reflected in reduced subsequent gamma activity. Interestingly, Vipassana meditators in Slagter et al. (2007) had smaller P300s in response to detecting the first target. Meditators reduced attentional blink, then, may have been mediated by higher gamma-band neural oscillation, relative to controls.

Collectively, available behavioral and neurophysiological data strongly suggest that metta meditation should attenuate the attentional blink. In the present study, we examine the hypothesis that metta meditation will have a similar effect on the attentional blink as exposure to pleasant pictures (Olivers & Nieuwenhuis, 2006), listening to positive music (Jefferies et al., 2008), and mindfulness meditation (Slagter et al., 2007). Such a finding would be significant not only in adding to the accumulating evidence of the beneficial psychological and physiological consequences of meditation, but also in encouraging the practice of meditation, since, anecdotally, many beginning meditators find metta meditation easier, more engaging, and more rewarding than mindfulness meditation.

Method

Participants

Thirty-nine participants were recruited from psychology courses at Carroll University. To examine the unique contribution of positive affect, control subjects received guided relaxation. Since metta meditation can be relaxing, the influence of relaxation needs to be parceled out. Relaxation may reduce the attentional blink, per the overinvestment hypothesis. However, a difference between those in the meditation and relaxation conditions would provide further supportive evidence for the positive affect hypothesis. Twenty participants (8 men, 12 women, $M_{age} = 21.7$) were randomly assigned to a relaxation condition and 19 subjects (8 men, 11 women, $M_{age} = 21.6$) to a metta meditation condition. All participants were right-handed, had normal or corrected-to-normal vision, and had no reported history of neurological disorder. Participants were compensated $10/hour.

Materials

Participants in the relaxation condition followed along with two audio (mp3) guided relaxation files (University of Wisconsin-Madison University Health Services Clinic; http://forms.uhs.wisc.edu/relaxation.php). One was a longer guided relaxation, lasting 8:16, which participants listened to immediately prior to beginning the experimental trials. The second was a shorter guided relaxation (2:53), which participants listened to during each of the four breaks between trial blocks. The guided relaxation instructed participants to progressively relax parts of their body.

Participants in the metta meditation condition also followed along with two audio (mp3) guided meditation files (Diana Winston, UCLA Mindful Awareness Research Center; http://marc.ucla.edu/body.cfm?id=22&oTopID=22). Again, one was a longer guided meditation, lasting 9:30, which participants listed to before the first experimental trial, and the second was a similar, shorter (3:00) guided meditation, which participants listed to during the breaks between trial blocks. The guided meditation encouraged participants to send and feel heart-felt emotions of loving-kindness.

A RSVP task (Figure 1) was created with SuperLab 4.0. The letters A through Z (except B, I, O, Q, S, & X) were randomly presented, without duplication. Letters were black and appeared on a grey background. The first target (T1) was a randomly selected number between 2 and 9 and was always presented in the 9th position. The second target (T2) appeared in 50% of the trials, at either position 12 (3 positions after T1, - "Lag 3") or position 17 (8 positions after T1- "Lag 8"). T2 was always an "X". There were two different trial lengths, a 14 stimuli RSVP sequence (Lag 3 trials) and a 19 stimuli RSVP sequence (Lag 8 trials). In both Lag 3 and Lag 8 trials, two letter stimuli followed T2, if it was presented. Letters and digits were presented for 50 ms[1], with an inter-stimulus interval of 50 ms[2]. The inter-trial interval varied between 200-300ms. At the conclusion of each trial, participants were prompted to enter the identity of T1, and whether or not there was a subsequent T2 (an "X"). All trials began with a central fixation cross, appearing for 1780 ms. Participants saw a total of 260 trials: 65 trials with T2 at Lag 4, 65 trials with T2 at Lag 8, and 130 trials with no T2. Trials were randomly grouped into five blocks of 52 trials, wherein each block contained 13 trials with T2 at Lag 4, 13 trials with T2 at Lab 8, and 26 trials with no T2.

Procedure

Prior to the experiment, participants practiced the RSVP task (12 trials, independently generated) and were encouraged to continue practicing until they felt comfortable. Participants then listened to either the guided relaxation or guided metta meditation. The experimenter emphasized the importance of engaging with the guided programs, and left the room so that participants would not feel self-conscious. At the conclusion of the guided programs, participants began the RSVP task. During breaks between blocks, participants engaged in the shorter relaxation/metta meditation programs.

Results

To verify that those in the metta meditation condition were in a physiologically different state than those in the relaxation condition, the sympathovagal balance between groups was compared. ECG from the first block of trials was excluded for two subjects, and from the entire experiment for one subject, due to poorly connected electrodes. Experimental condition correlated with sympathovagal balance (r = -.250), such that those in the meditation condition (M = 3.46, SD = 1.05) had marginally significant decreases in sympathovagal balance, relative to those in the relaxation condition (M = 3.92, SD = 0.8), $t(33)$ = 1.484, p = .074, one-tailed. Thus, meditators had a demonstrably different pattern of heart rate variability than those in the relaxation condition.

The practical significance of any difference between groups in the attentional blink first requires that both groups detected a substantial number of T1s, which is indicative of effort, and that there was no difference between them. Both groups had very high accuracy in detection of T1, with those in the meditation condition having a slightly higher accuracy (M = 94.1%) than those in the relaxation condition (M = 92.6%). This difference, however,

1 SuperLab 4.0 synchronizes the onset of a stimulus with the onset of the monitor's refresh cycle. The offset of a stimulus is similarly constrained to occur at the offset of a refresh cycle. We used a Dell Dimension 9200 Desktop PC running Windows XP, with a monitor refresh rate of 60Hz or 16.666 ms. RSVP stimuli were presented for three cycles, or 49.998 ms.

2 The inter-stimulus interval was implemented in SuperLab 4.0 by using a "digital output" event. This event sends a signal to Biopac MP35 indicating the subsequent onset of a stimulus. Transmission of the signal takes 50 ms, during which time the screen is blank.

was not significant. A 2 (Lag Interval) × 2 (Condition) mixed factorial ANOVA revealed no significant difference between condition, $F(1, 35) = 1.30$, $p = .261$. There was also not a significant difference in T1 detection between Lag 3 trials and Lag 8 trials, $F(1, 35) = .063$, $p = .803$. This is as expected, since lag interval should only effect the detection of T2.

The attentional blink is derived by examining the difference between lags in the accuracy of T2 detection, assuming T1 was correctly identified. This is done to selectively isolate an attentional "blink", rather than a more pronounced lapse in attention. An attentional blink here would be seen in a diminished T2 detection accuracy at lag 3, relative to T2 detection accuracy at lag 8. As expected, a 2 (Lag Interval) × 2 (Condition) mixed factorial ANOVA revealed a significant main effect for Lag Interval, $F(1, 35) = 88.45$, $p < .001$, partial $\eta^2 = .72$. T2 accuracy was substantially lower at lag 3 ($M = 50.4\%$, $SD = 20\%$) than at Lag 8 ($M = 78.2\%$, $SD = 14.6\%$). However, there was not a significant main effect for condition, $F(1, 35) = .114$, $p = .738$. The average accuracy across both lags for meditators was 65.2% and for those in the relaxation condition, 63.5%. As illustrated in Figure 2, both meditators and those in the relaxation group clearly exhibit the standard attentional blink. Contrary to our hypothesis, however, there is no difference between groups in their attentional blink. In fact, the meditation group was slightly (though non-

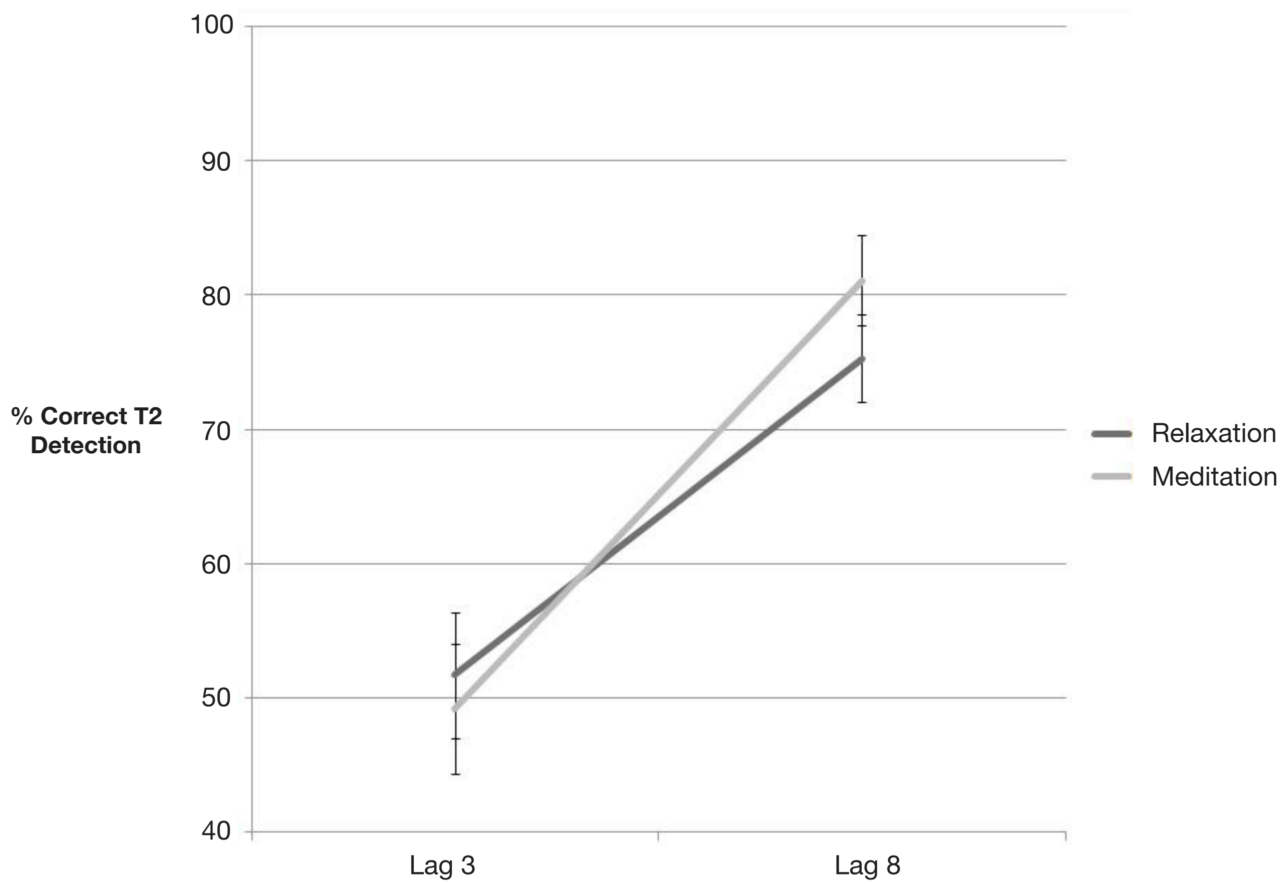

Figure 2. *Mean accuracy (with standard error bars) in the detection of the second target (T2), if the first target was correctly identified, for Lag 3 (250 ms after the first target) and Lag 8 (750 ms after the second target). The accuracy difference between Lags 3 and 8, for those in both the relaxation and meditation conditions, is the standard attentional blink.*

significantly) worse at indentifying the presence of the second target at lag 3.

Discussion

Despite behavioral and neurophysiological indication that metta meditation, a positive affect induction technique, may attenuate the attentional blink, we did not find evidence to reject the null hypothesis. Several possibilities may account for this failure. It may be the case that metta did have an effect on the attentional blink, but so did relaxation, and so there was no detectable difference between the two. This is unlikely, however, as T2 detection accuracy in the present study is consistent with typical results at lag 3 (Shapiro, Arnell, & Raymond, 1997). Alternatively, an attentional blink difference may have been masked by a confound with task-switching. To identify T1 (a digit), participants could have used an attentional set whereby they ignored all letter distracters, until a digit appeared. In contrast, to detect the presence or absence of T2 (an "X"), participants may have adopted an attentional set in which each letter in the stream following T1 was monitored. This type of task-switch additively increases the magnitude of the AB (Chun & Potter, 2001). It is possible, then, that metta meditation and relaxation had opposing effects on the costs associated with attentional capture by T1 and the costs associated with task-switching, thereby resulting in similar attentional blink magnitudes. While no research to date lends weight to this possibility, it is nonetheless one which must be addressed in future research. Finally, metta-induced positive affect may simply not have an impact on the attentional blink. Given previous findings, however, that positive affect inductions do alter the attentional blink (Jeffries et al., 2008; Keil et al., 2006; Langley et al., 2008; Olivers & Nieuwenhuis, 2006), this conclusion would be premature.

More practice with metta meditation may be required to observe an attenuating effect. This possibility is supported by the comparison between groups on sympathovagal balance, which was only marginally significant. In Lutz et al. (2004), control participants engaging in metta meditation were able to generate significant increases in gamma-band power, relative to baseline. These participants practiced metta one hour/day for a week prior to the experiment. Perhaps additional practice of metta meditation, therefore, would lead to more robust differences. Carmody and Baer (2009), in finding no significant differences between mindfulness meditation studies as a function of practice hours, call for the systematic study of the effects of practice time. Even less is known about the effects of differing practice times of metta meditation, since metta has received comparatively much less attention than mindfulness meditation. The current findings, therefore, are valuable in helping to pinpoint an effect threshold. While same day guided meditation may not be sufficient, a week of practice may be. Determining an effect threshold (which, of course, would be approximate rather than absolute) would be valuable in enabling empirically-based proscriptive advice on the practice of meditation for cognitive and emotional well-being.

References

Davidson, R.J., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S.F., Urbanowski, F., Harrington, A., Bonus, K., & Sheridan, J.F. (2003). Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine, 65,* 564-570. doi: 10.1097/10.PSY.0000077505.67574. E3.

Dreisbach, G., & Goschke, T. (2004). How positive affect modulates cognitive control: Reduced preseveration at the cost of increased distractibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30,* 343-353.

Carmody, J., & Baer, R.A. (2009). How long does a mindfulness-based stress reduction program need to be? A review of class contact hours and effect sizes for psychological distress. *Journal of Clinical Psychology, 65(6),* 627-638. doi: 10.1002/jcip.20555.

Chun, M.M., & Potter, M.C. (2001). The attentional blink and task switching within and across modalities. In K. Shapiro (Ed.), *The limits of attention: Temporal constraints on human information processing* (pp. 20-35). New York, NY: Oxford University Press.

Ekman, P., Davidson, R.J., Ricard, M., & Wallace, B.A. (2005). Buddhist and psychological perspectives on emotions and well-being. *Current Directions in Psychological Science, 14(2),* 59-63.

Fell, J., Klaver, P., Elger, C., and Fernandez, G. (2002). Suppression of EEG gamma activity may cause the attentional blink. *Consciousness and Cognition, 11,* 114-122.

Jefferies, L.N., Smilek, D., Eich, E., & Enns, J.T. (2008). Emotional valence and arousal interact in attentional control. *Psychological Science, 19(3),* 290-295.

Keil, A., Issen, N., & Heim, S. (2006). Early cortical facilitation for emotionally arousing targets during the attentional blink. *BMC Biology, 4(23).* doi: 10.1186/1741-7007-1-23.

Langley, L.K., Rokke, P.D., Stark, A.C., Saville, A.L., Allen, J.L., & Bagne, A.G. (2008). The emotional blink: Adult age differences in visual attention to emotional information. *Psychology and Aging, 23(4),* 873-885.

Lee, K., Williams, L.M., Breakspear, M., & Gordon, E. (2003). Synchronous gamma activity: a review and contribution to an integrative neuroscience model of schizophrenia. *Brain Research Reviews, 41,* 57-78.

Lutz, A., Greischar, L.L., Rawlings, N.B., Ricard, M., & Davidson, R.J. (2004). Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Procedings of the National Academy of Sciences, 101(46),* 16369-16373.

Lutz, A., Slagter, H.A., Rawlings, N.B., Francis, A.D., Greischar, L.L., & Davidson, R.J. (2009). Mental training enhances attentional stability: Neural and behavioral evidence. *The Journal of Neuroscience, 29(42),* 13418-13427. doi: 10.1523/JNEUROSCI.1614-09.2009.

Olivers, C.N.L., & Nieuwenhuis, S. (2006). The beneficial effects of additional task load, positive affect, and instruction on the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance, 32(2),* 364–379.

Polich, J., & Kok, A. (1995). Cognitive and biological determinants of P300: An integrative review. *Biological Psychology, 41(2),* 103-146. doi: 10.10.16/0301-0511(95)05130-9.

Raymond, J.E., Shapiro, K.L., & Arnell, K.M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? *Journal of Experimental Psychology: Human Perception and Performance, 18(3),* 849-860.

Shapiro, K.L., Arnell, K.M., & Raymond, J.E. (1997). The attentional blink. *Trends in Cognitive Sciences, 1(8),* 291-296.

Slagter, H.A., Lutz, A., Greishar, L.L., Francis, A.D., Nieuwenhuis, S., Davis, J.M., & Davidson, R.J. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology, 5(6)*: e138. doi:10.1371/journal.pbio.0050138.

Tan, H.K., Jones, G.V., & Watson, D.G. (2009). Encouraging the perceptual underdog: positive affect priming of nonpreferred local-global processes. *Emotion, 9(2),* 238-247.

Tiller, W.A., McCraty, R., & Atkinson, M. (1996). Cardiac coherence: A new, noninvasive measure of autonomic nervous system order. *Alternative Therapies, 2(1),* 52-65.

Tomarken, A.J., Davidson, R.J., Wheeler, R.E., & Doss, R.C. (1992). Individual differences in brain asymmetry and fundamental dimensions of emotion. *Journal of Personality and Social Psychology, 62,* 676-687.

Wallace, B.A. (2006). The attention revolution: *Unlocking the power of the focused mind*. Boston, MA: Wisdom Publications.

Ward, L.M. (2003). Synchronous neural oscillations and cognitive processes. *Trends in Cognitive Sciences, 7(12),* 553-559.

Correspondence regarding this article should be addressed to
Christopher J. May,
Life Sciences Department,
Carroll University,
100 N. East Ave., Waukesha, WI, 53186.
E-mail: cmay@carrollu.edu

Received: 3.5.2010
Revised: 4.7.2010
Accepted: 4.8.2010