

AN ABSTRACT OF THE THESIS OF

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Title: Attentional Bias Toward Facial Emotion Expression: Orienting vs. Disengagement

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The present study examined involuntary attentional bias toward facial emotion expression. Particularly, the study examined two different attentional components for emotional processing, namely, orienting vs. disengagement. A cueing paradigm using two cue presentation times (250ms and 350ms) was used to determine if attention would be involuntarily captured by an irrelevant emotional facial cue. Participants were asked to search for a target emotion face (fearful vs. happy) and identify whether the box containing the target face was red or green. Cue validity effects were observed for both fearful and happy face cues only for the 350ms cue presentation time; orienting Index scores were consistent with these findings. Thus, attention toward the irrelevant emotional face cues was primarily driven by attention orienting, but only under conditions where there was sufficient time to process the emotions. Disengagement scores at the 250ms cue presentation revealed that participants had difficulty disengaging their attention from happy facial expression cues when the happy face target appeared in the opposite location of the cue. Taken together, the present findings suggest that both negativity bias and positivity bias occurred involuntarily.

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Attentional Bias Toward Facial Emotion Expression: Orienting vs. Disengagement

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Nicole Martin

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Nicole Martin, Author

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Introduction

It is difficult to imagine a life without emotion. We live for them, often structuring our lives toward events that bring us pleasure and joy, while avoiding situations that cause us pain and sadness. And yet, one of the most difficult questions in the field of affective science seems to be one of the simplest: what *is* an emotion? But the questions don't stop there. How do we pay attention to one's facial emotion expression? Does processing emotion expression require attentional resources? All of these questions brought about an exponential increase in the research of emotion and attention.

It has been argued that our ability to process emotion is critical for human survival and the human experience (Gross & John, 2003). Our ability to perceive and distinguish emotions, at least primary emotions, is hardwired as Ekman (1992) demonstrated in his cultural studies. We recognize key features of our environment, and then make decisions about whether we should engage or avoid various social situations (Gross, 2014). As such, how we attend to, interpret, and react to one's facial emotion expression has varying consequences for both intrapersonal experiences and interpersonal experiences (Gross & John, 2003).

It's important to understand how individuals process emotions because of the consequences it can have on their cognitive abilities, behavior, and mental health (Gross, 2002; Gross & Levenson, 1997; MacNamara, Ochsner, & Hajcak, 2011; Moser, Most, & Simons, 2010). For example, Richards and Gross (2000) examined the impact of individual differences in reappraisal and suppression on memory.

Individual differences in reappraisal and suppression were measured using the Emotion Regulation Questionnaire (ERQ), while memory was assessed using two distinct measures; the first being a self-report measure of memory for conversations, and the second an objectively scored free-recall test for emotion regulation episodes over a two-week period with daily reports. They found that individuals who scored higher in suppression reported having worse memory than those who scored lower. They also performed worse on an objective memory test in which they were asked to recall events that they had listed in their daily diary of emotion regulation episodes. In contrast, individuals who scored high in reappraisal had no effects on either the self-report or objective memory tasks. Research has suggested that there are distinct individual differences in regulating emotions, namely, cognitive reappraisal and suppression (Gross, 1998, 2014; Gross & John, 2003).

The following introduction section provided an overview of Emotion and Regulation. Then, the next section focused on one specific component of emotion processing, that is, attention. An overview regarding how attention modulates emotion processing was discussed, which led to the justification for, and description of the present study.

What is an Emotion?

Before we can understand the process of emotion regulation and how to use it effectively, we must first understand what emotions are, why they occur, and how they affect our behaviors. Emotions occur within an individual, and they are influenced both psychologically and physiologically (Levenson, 1994). These biologically based reactions often arise as an adaptive response to some situation

relevant to an individual's goals (Gross & Thompson, 2007). These goals can be biologically based, socially based, self-focused, etc. Because many goals are active congruently, there is competition between them in terms of which one gets our immediate attention; as a result, the goal of primary interest is what dictates the experienced emotion at the time (Gross, Sheppes, & Urry, 2011).

Emotions affect individuals both psychologically and physiologically (Levenson, 1994). When an emotion enters awareness, depending on the active goal, our attention is shifted and relevant associations are called forward so an appropriate evaluation can be made (Gross, 2014; Levenson, 1994; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Emotions are multi-faceted in that during an emotional experience, an individual's subjective, behavioral, and physiological features can change (Mauss et al., 2005). For example, during an argument, if one is feeling angry his or her facial expressions might change due to muscle contractions (e.g., furrowed brow). A voice's pitch may be altered, the autonomic nervous system (fight or flight) could become activated, and endocrine activity could ensue.

Gross' Model of Emotional Regulation

One commonly accepted view of emotional regulation is Gross' processing model of emotional regulation, which suggests that the emotion generation process occurs in a particular sequence over time (Gross, 1998a, 1998b, 2001, 2014; Gross & Thompson, 2007). The modal model of emotion demonstrating the sequence of how individuals experience an emotion is illustrated in Figure 1. It is believed that when individuals experience emotion, the process progresses through this modal model sequence.

There are four stages to the process model, and our emotions can be regulated at each of them. The first stage is situation; the process begins with a situation (real or imagined) that is emotionally relevant to the individual. The second stage is attention; the individual attends to the emotional stimuli. The third stage is appraisal; the individual evaluates and interprets the emotional situation. And the fourth stage is response; an emotional response is generated giving rise to coordinated changes in experiential, behavioral and physiological response systems (Gross, 1998b). The process model of emotional regulation contends that each of the four points in the emotion generation process can be subject to regulation in five ways: situation selection, situation modification, attention deployment, cognitive change, and response modulation (Gross, 1998b). These strategies can be viewed in relation to the modal model of emotion generation from Urry and Gross (2010), in Figure 2.

Situation. The first way emotion can be regulated is through situation selection. Situation selection refers to an individual's choice in approaching or avoiding certain people, places or objects that cause an emotional response in order to regulate his or her emotions. One such example would be taking a different route to class in order to avoid seeing a prior significant other after a break-up. Alternatively, an individual can choose to approach or engage with the emotionally relevant situation; this is commonly seen in facing fears, individuals intentionally place themselves in a situation that might cause discomfort (the emotional response).

Certain situations, though seemingly emotional, do not necessarily induce the expected emotional response; this is due to emotional regulation by situation modification. Situation modification involves active effort by the individual to modify a situation in order to alter its emotional impact. One such example is seen in comedic relief; individuals inject humor in order to elicit laughter and lighten the mood of an otherwise tense situation. Another example is to create physical distance between the individual and the stimulus creating the unpleasant feeling. For example, a parent chaperoning a field trip might be viewed as embarrassing to the child, and as such the child responds by maintaining a distance and sticking with friends.

Attention. Attentional deployment is a second way emotions can be regulated. This process involves directing one's attention toward or away from the emotional situation. There are several strategies that can be employed in order to change one's attentional focus such as, distraction and thought suppression. Distraction is considered to be an early selection strategy, which involves diverting one's attention away from an emotional stimulus and focusing more on non-emotional aspects. Distraction methods can be seen as early in infants when they move their gaze away from the emotion-eliciting stimulus in order to decrease stimulation (Thompson & Lagattuta, 2006). Inhibition is another form of attentional deployment; it is the process of deliberately redirecting one's thoughts/attention away from the distressing emotional content (Campbell-Sills et al., 2014). Ironically, while inhibition may provide temporary relief, it might end up creating even more

unwanted thoughts (Wegner & Zanakos, 1994). This is typically seen when an individual is directed to *not* think of a specific mental image; for example, many individuals report visualizing a polar bear when instructed to *not* think of a white bear.

Appraisal. Cognitive change is the process by which individuals change how they appraise a situation so as to alter its emotional meaning. Reappraisal is considered to be a late selection and adaptive strategy, meaning it is developed over time, and involves reinterpreting the meaning of an event so as to alter its emotional impact (Gross, 1998b). An easier way to think of it is the idea of not making mountains out of mole hills, and looking at the bigger picture. Reappraisal employed during the viewing of negatively valenced images has been shown to decrease the negative emotional experience; however, this can only be seen to an extent (Gross, 1998b). With extremely negative images the reduced physiological response is not as noticeable; one possible explanation is that it does not require as much cognitive effort to translate the images as being negative. Thus, in more complex situations (situations requiring greater cognitive effort) reappraisal is seen as having a greater response in regulating emotion (Gross, 1998b; Jackson, Malmstadt, Larson & Davidson, 2000).

Response. One of the last areas of emotion regulation is with response modulation. Response modulation involves direct attempts to influence the experiential, behavioral and physiological response systems (Gross, 1998b). It is

worth noting that the fourth stage is not considered to be the final stage of the process model. This is due to the fact that the process model is considered to be a feedback loop; an emotional response (stage four) can lead to a change in situation (stage one). For example, referring back to the snake in the grass example, one's original situation is being in the presence of the snake, they see the snake (attention), evaluate the situation as being dangerous (appraisal), and then run (response); in running the individual has now changed their current situation to being away from the snake and out of danger.

Emotion Regulation

In the broadest sense, *emotion regulation* refers to individuals' ability in processing emotional information from environment and controlling his or her emotional, behavioral, or physiological experience. That is, individuals are capable of influencing what emotions they process and when they process them (Gross, 1998b, 2001). Emotion regulatory processes may be automatic or controlled, conscious or unconscious and may have their effects at one or more points in the emotion generative process (Gross, 1998b, 2014; Mauss, Cook, Cheng & Gross, 2007). As an emotional situation unfolds corresponding to the modal model, specific emotion regulation strategies can be employed at each point throughout the emotion generation process (Gross & John, 2003; Gross & Thompson, 2007).

According to Gross and his colleagues (e.g., Gross, 1998; Gross & Munoz, 1995; Gross & Thompson, 2007), there are two main types of emotion regulation processes that occur during the emotion generation process: *antecedent-focused* and

response-focused. Antecedent-focused emotion regulation strategies can be understood as regulatory processes that occur before an appraisal of the emotion; the emotional response is altered before it happens (Gross 1998a, 2014; Gross & John, 2003; Gross & Thompson, 2007). Response-focused emotion regulation strategies typically occur after an emotional response has been elicited, and involves an individual regulating the emotional, physiological, or behavioral reaction already in process.

Antecedent-focused emotion regulation occurs early in the emotion generation process, *before* an emotional response occurs. These strategies can be initiated by the individual (e.g., avoiding a negative situation; Thompson & Lagutta, 2006). There are four separate strategies, which can be employed to intervene in the emotion generation process before the emotional response occurs. They include situation selection, situation modification, attentional deployment, and cognitive change (Gross & John, 2003; Gross, 2002). In other words, individuals with the use of antecedent-focused emotion regulation tend to allocate their attention involuntarily to emotionally valenced stimuli before any emotion responses activated.

In contrast to the above described processes of emotion regulation, response-focused emotion regulation occurs *after* the emotion has been generated. Expressive suppression, the inhibition of an *outward* emotional response, is one example of response-focused emotion regulation. Expressive suppression has a direct relationship to our emotional experiences and is significant in communication studies (Butler et al., 2003). Individuals who suppress their emotions are often seeking to control their

actions in order to maintain a positive social image; for example, stifling a laugh at an inappropriate time or maintaining a neutrally composed face (poker face) so as not to give away the negative (or positive) feelings of emotion. However, research has shown that expressive suppression may have negative social consequences, is positively correlated with many psychological disorders, and is associated with worse interpersonal outcomes (Butler et al., 2003; Gross, 1998b, 2002).

Overall, individuals engaging in antecedent-focused emotion regulation strategies have been found to be more effective at modifying their subjective experience of emotion, better able to repair their mood, more likely to experience and express positive emotion, and less likely to experience and express negative emotions (Gross, 1995, 2014; Gross & John, 2003; Gross & Levenson, 1997; John & Gross, 2004). On the contrary, individuals who more often engage in response-focused strategies experience greater bouts of depression, less satisfaction with life, decreased optimism, and more pessimistic views about the future (Gross & John, 2003). In sum, individuals engaging in response-focused emotion regulation tend to use suppression to inhibit ongoing emotional related behaviors.

Processing Facial Emotion Expression

The present study focused on the first two stages of Gross' processing model of emotional regulation (Gross, 1998a, 1998b, 2001, 2014; Gross & Thompson, 2007), namely, situation and attention. As mentioned earlier, many studies have demonstrated the usefulness of our emotions as being innate and valuable tools in our learning and development (Ekman, 1992; Thompson & Lagattuta, 2006). Infants are

capable of shifting attention away from unpleasant stimuli as well as distinguishing between the faces of their mothers and strangers within hours of birth (Thompson & Lagattuta, 2006; Rothbart, Posner, & Kieras, 2006). From an evolutionary standpoint, emotional facial expressions are an essential communication medium, and as such, much of the cognitive, developmental and communicative research has been devoted to studying how we process emotional facial expressions (Ekman, 1992; Gross 1998b; Thompson & Lagattuta, 2006).

Given the profound social significance of emotion it isn't surprising how efficient individuals are at perceiving facial expressions. Several experimental studies have examined patterns of attentional allocation to emotional versus neutral stimuli and found that emotional facial expressions capture attention to a greater degree than neutral facial expressions (Eastwood, Smilek, & Merikle, 2001; Fox, Russo, & Dutton, 2002; Holmes, Bradley, Nielsen, & Mogg, 2009). However, within the emotional facial expression processing, negative facial expressions (perceived as direct or indirect threat) have a greater effect over positively perceived facial expressions (Eimer, Holmes, & McGlone, 2003; Hajcak, MacNamara, & Olvet, 2010).

Eimer and colleagues (2003) examined all six of our basic emotional expressions (i.e., happy, sad, fearful, angry, surprised, and disgusted) to examine whether or not facial expressions are processed when they are no longer considered task-relevant. During the stimulus presentation participants were presented with two identical faces, a pair of vertical gray lines, and a white fixation point. The identical faces were placed one on each side of the vertical gray lines, and the vertical gray

lines were presented close to the fixation point. For 12 blocks participants indicated with a left-hand or right-hand button press whether the facial expressions were emotional or neutral in nature; the vertical gray bars were irrelevant during this task. In the other 12 blocks participants were instructed to focus on the vertical lines and indicate whether the lines were different or identical in length; here the emotional expressions were irrelevant. Results showed that when the facial expressions were relevant, response times were faster for emotional expressions compared to neutral expressions. Response times to the line length identification task were independent of the facial expressions, meaning the facial expressions did not interfere with the line task.

Involuntary Attention Bias in Emotion Regulation

Most research surrounding emotion regulation has focused on how people explicitly or voluntarily regulate their emotions (Gross & Levenson, 1997; Hajcak & Nieuwenhuis, 2006; MacNamara, Ochsner, & Hajcak, 2011; Mocaiber et al., 2010; Moser, Hajcak, Bukay, & Simons, 2006). A typical procedure involves participants being presented with a task that involves processing stimuli under two different conditions – 1) react naturally or 2) regulate their emotional response using a specific strategy dictated by the researcher. In conditions where participants are instructed to regulate their emotional response, specific instructions of how to do so are provided with time to practice beforehand until understanding is achieved. The problem is that these methods rely heavily on self-report measures, which are incredibly subjective. Further, it's difficult to parse out whether or not the observed effects are a result of

the assigned emotion regulation strategy, or from a different point in the emotion generative process altogether.

Data from multiple measurements indicate that emotional stimuli automatically capture our attention, as such it would seem more beneficial to examine the automaticity and non-automaticity of emotional perception as they relate to the emotion regulation process (Mogg & Bradley, 1999; Öhman, 2002; Shaw, Lien, Ruthruff, & Allen, 2011). As noted earlier, previous studies have primarily focused on deliberate, task-oriented emotion regulation strategies (explicit emotion regulation), or how emotion regulation is affected when individuals are explicitly trained and told which method they should use to regulate their emotions; emotion regulation is driven by explicit goals. So far little is known about the automatic response individuals have to emotional stimuli, with no prompt or training (implicit emotion regulation). The degree to which emotion regulation is considered explicit or implicit is dependent on multiple factors, including the stimulus, task, context, individual differences, psychopathology, and time (Gross & Levenson, 1993; Ochsner & Gross, 2014).

In a study by Shaw et al. (2011) the perception of emotion in happy, and angry, faces were examined to determine whether or not this required central attentional resources – in other words, is the process of detecting emotion automatic, or does it require cognitive effort? To address this question Shaw et al. (2011) employed the use of a dual-task paradigm to examine whether individuals are able to direct their attention to a face expressing a target emotion while still responding to a previous task. Participants performed an auditory discrimination task (Task-1),

followed by a gender discrimination task with a pre-specified face emotion (Task-2); specifically, angry faces or happy faces. In addition to the behavioral data (response time in regard to auditory/visual tasks), an electrophysiological component, the N2pc effect (short for N2-posterior-contralateral; Luck & Hillyard, 1990) was added in order to provide a more online measurement to emotion processing. The N2pc, occurring 170-270ms after stimulus onset, is an increase negativity over posterior scalp contralateral to an attended stimulus. It has been used as an index of spatial attention allocation. So, while behavioral measures (e.g., accuracy and response time) can provide some basic information, the N2pc effect provides both temporal (when) and spatial (where) information regarding attention (Eimer & Holmes, 2007; Eimer, Holmes, & McGlone, 2003; Eimer & Kiss, 2007; Hajcak, MacNamara, & Olvet, 2010; Holmes, Bradley, Nielsen, & Mogg, 2008).

Shaw et al.'s (2011) results showed that the N2pc effect elicited by angry faces occurred regardless of SOA. In other words, the N2pc effect was still observed at the short 50-ms SOA (50ms), which is during the time that Task-1 is still being processed. This suggests that the participant's attention automatically shifted to the angry facial expression, even though their primary attention was still being given to the non-emotional, auditory discrimination of Task-1. It follows then that negative emotions attract spatial attention involuntarily (i.e., the negativity bias).

A similar study was conducted by Lien, Taylor and Ruthruff (2013) to re-examine the claim of an attention bias toward fearful faces. However, unlike Shaw et al.'s (2011) dual-task study, Lien et al. (2013) used a cueing paradigm to examine

whether negativity bias still occurs even when facial emotions were irrelevant to the task. In the first experiment, participants were instructed to search a target display for a letter (L or T) in a specific color (e.g., red or green). The target was preceded by a non-informative cue display, which contained colored boxes (one in the target color and one in the distractor color) or emotional faces (fearful and neutral). Each cue could appear in the same location as the target (considered as a valid cue) or in a different location (invalid cue). The N2pc elicited by the cue was used to determine if attention was captured involuntary. Their results indicated that only the target color cue captured participants' attention; there was no capture present during the task-irrelevant fearful face cue. This suggests that negative stimuli (in the form of the fearful faces) do not inherently capture our attention when they are irrelevant to the current task.

In Experiment 2, Lien et al. (2013) changed the goal of the participants' task. Instead of searching for a letter in a specific color, they were instructed to search for a fearful target face and identify the gender (male or female) while ignoring the neutral face; thus, the fearful face became the cue. The target was still preceded by the display of a fearful and neutral face, but this was considered irrelevant to their task as in the first study. Results from the second experiment showed a strong N2pc effect for the same fearful faces indicating attention capture. Their results suggest that the key determinant of attention capture is based on task relevance as opposed to perceived threat.

The Present Study

The present study examined involuntary attentional bias toward facial emotion expression. Particularly, we aimed to examine two different attentional components for emotional processing, namely, orienting vs. disengagement. It should be noted that previous studies have primarily focused on deliberate, task-oriented emotion regulation strategies, or how emotion regulation is affected when individuals are explicitly trained and told which method they should use to regulate their emotions; emotion regulation is driven by explicit goals. So far little is known about the automatic response individuals have to emotional stimuli with no prompt or training. Thus, we focused on the first two processing stages (situation and attention) of emotion regulation – how attention is captured involuntarily to specific emotional expression. We are specifically interested in the attentional deployment aspect of the emotion regulation process model as emotional stimuli cannot be appraised or suppressed without attention capture to begin with.

The present study followed Lien et al.'s (2013) design from Experiment 2 with two major modifications. One of the changes we made was to reduce the number of items in the search array. Rather than four peripheral boxes (top-left, bottom-left, top-right, and bottom-right), we used two peripheral boxes (one in each hemifield). Second, we employed two cue onset presentation lengths (250ms and 350ms) intermixed within blocks. The purpose in having two different cue presentation lengths was to address one of the questions from Lien et al.'s study. While their results demonstrated the importance of irrelevant stimuli needing to match the participants' task set in order to capture attention, their cue presentation time

remained unaltered. As such, it's still possible the cue presentation time does in fact affect attention capture by irrelevant, emotional stimuli. There is conflicting evidence about the amount of time required for conscious affective evaluation; some research indicates a rapid evaluation, as early as 50ms after stimulus onset, while others demonstrate a much longer presentation time is required for the facial expression to be processed and capture attention (Adolphs, 2002; Holmes et al., 2009; Lien et al., 2013; Shaw et al., 2011). If attention capture is dependent on the cue presentation length, we expect there to be significant differences in participant RT's.

We also utilized a cuing paradigm in the present study. Within a cueing paradigm a cue is presented a pre-determined amount of time before the target is presented (see Figure 3 for an example). If the cue and the target positions are the same, then the cue is said to be *valid*; however, if the cue and target position are mismatched (not in the same location), the cue is said to be *invalid*. Participants typically are told to ignore cues (irrelevant to the task). The logic behind the design is that if the cue captures attention involuntarily, then response to the relevant task should be faster when the cues are perceived as valid and slower when the cue is invalid. The difference in the response times between valid and invalid cues is known as the *cue validity effect*. If the cue validity effect is evident, then we can reliably conclude that attention has been captured by the cue; if no difference is observed, then attention has not been captured.

Attentional Bias Toward Emotional Cues

As mentioned previously, several studies have demonstrated that emotional facial expressions capture attention to a greater degree than neutral facial expressions (Eastwood, Smilek, & Merikle, 2001; Fox, Russo, & Dutton, 2002; Holmes, Bradley, Nielsen, & Mogg, 2009). Within the emotional facial expression processing, negative facial expressions (perceived as direct or indirect threat) have a greater effect over positively perceived facial expressions (Eimer, Holmes, & McGlone, 2003; Hajcak, MacNamara, & Olvet, 2010). More specifically, research has demonstrated that angry faces in particular delay attention disengagement, but other negative/threatening emotion expressions have not been investigated in detail. It's possible with longer cue presentation times we may observe a delayed attention disengagement because participants will have been able to process the facial emotion expression to a deeper semantic level.

In order to critically evaluate how attention process is modulated by different emotional expression, we derived two indices using Salemink and colleagues' (2007) approach. Attentional bias is determined through an orienting index score (*orienting toward stimuli*) and a disengaging index score (*disengaging from stimuli*).

The Orienting Index (OI) was calculated for valid trials only by subtracting the mean RT for the target appearing in the emotional face cue location (t[F,N] or t[H,N]) from the mean RT for the target appearing in the neutral face cue condition (t[N,N]):

$$\text{Fearful Orienting Index} = t[\text{N,N}] - t[\text{F,N}]$$

$$\text{Happy Orienting Index} = t[\text{N,N}] - t[\text{H,N}]$$

where the target (t) appears in the emotional face cue location (F=fearful cue; H=happy cue; N=neutral cue). A positive score on the orienting index indicates faster response to target faces appearing after emotional face cues compared to neutral faces, suggesting that the emotional cue captures attention involuntarily and then subsequently facilitates the target processing when the target appears in the same location (i.e., valid trials only).

The Disengaging Index (DI) was calculated for invalid trials only by subtracting the mean RT for the target appearing in the neutral face cue location in the presence of the neutral face cue (t[N,N]) from the mean RT for the target appearing in the neutral face cue location in the presence of the emotional face cue (t[N,F] or t[N,H]).

$$\text{Fearful Disengaging Index} = t[\text{N,F}] - t[\text{N,N}]$$

$$\text{Happy Disengaging Index} = t[\text{N,H}] - t[\text{N,N}]$$

where the target (t) appears in the neutral face cue condition (F=fearful cue; H=happy cue; N=neutral cue). A positive score on the disengaging index indicates slower responses to target faces when it appears in the neutral cue location in the presence of emotional face cues (t[N,F] or t[N,H]) comparing to in the presence of other neutral cues (t[N,N]). This would suggest that the emotional cue captured attention initially. Then when the target appears in the opposite location (invalid trials), it takes longer for participants to disengage their attention from its location.

We argue that if attention process is modulated by emotion valence, then we expect to observe OI and DI to be modulated by different facial emotion expressions. That is, negativity bias would produce larger OI and/or DI toward fearful face cues

than happy face cues, whereas positivity bias would produce larger OI and/or DI toward happy face cues. By decomposing the attention process to orienting (OI) and disengagement (DI), it allows us to uncover mechanism(s) that drives attentional bias.

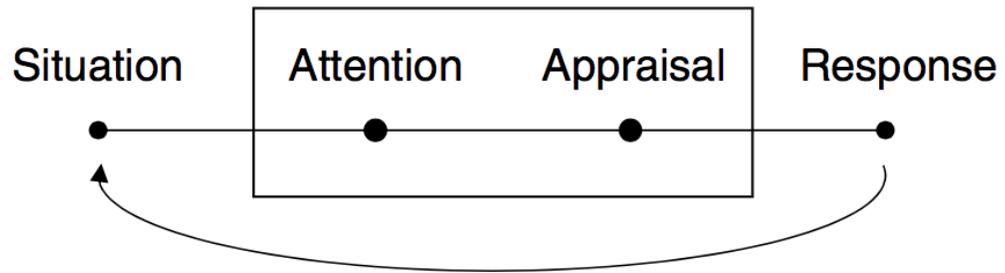


Figure 1. “Modal model” of emotion (reprinted from Gross, Sheppes, & Urry (2011))

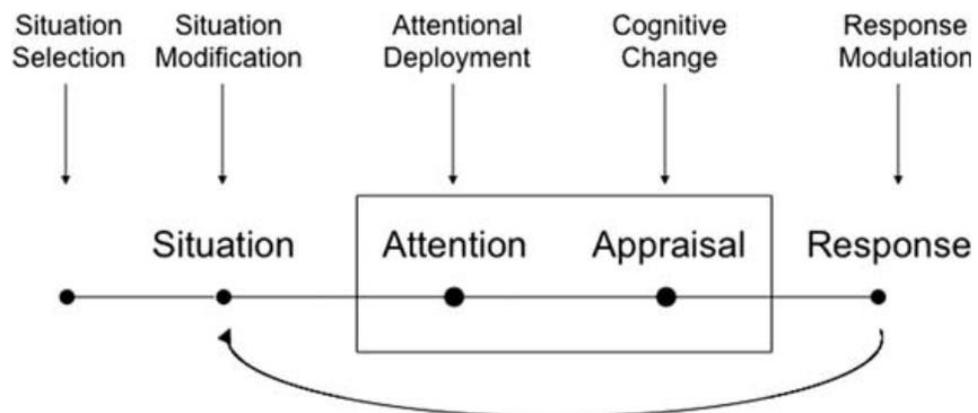


Figure 2. Sample of the emotion regulation process (reprinted from Gross, Sheppes, & Urry, 2011)

Experiment

The present study examined involuntary attentional bias toward facial emotion expression. Participants indicated the color of the box containing the target emotional face. The goal was to determine how attention process is modulated by emotional valence.

Method

Participants

Forty-four undergraduate students from Oregon State University participated for one hour in exchange for extra course credit. All reported having normal or corrected-to-normal visual acuity. Participants also demonstrated normal color vision using the Ishihara Test to check for color blindness. Data from 5 participants were excluded from the final analysis (2 participants did not complete the study and 3 participants had accuracies lower than 80%). The remaining 39 participants (27 female and 12 male) had a mean age of 20.56 (range: 18-33). Thirty-two participants were right handed and 7 left handed.

Apparatus and Stimuli

Stimuli were displayed on 19-in. ViewSonic monitors and presented at a distance of approximately 55-cm. Within each trial, three stimulus events were presented in succession: the fixation display, the cue display, and the target display. The fixation display consisted of a white central plus sign (1.15° width x 1.15° length x 0.30° thick) and two white peripheral boxes (5.61° width x 6.96° height x 0.21° thick). The cue display consisted of the fixation plus sign and two peripheral boxes. Each peripheral box was equidistant from the fixation point (6.23°). Each box was

5.61° width x 6.96° height with thin white lines. For 1/3 of the trials, one peripheral box contained a happy face and the other contained a neutral face (the [H,N] cue condition). For another 1/3 of the trials, one peripheral box contained a fearful face and the other box contained a neutral face (the [F,N] condition). For the remaining 1/3 of the trials, both boxes contained neutral faces (the [N,N] condition) with the restriction that the faces were never identical to each other. The emotional faces served as a cue. The cue was uninformative; meaning, each irrelevant face does not predict the target location (50% chance). In the [N,N] cue condition, the cue was a dummy variable.

The target display consisted of the fixation plus sign, two colored peripheral boxes (red, CIE [Yxy]: 21.63, 0.62, 0.32, vs. green, CIE [Yxy]: 14.67, 0.30, 0.60). One happy and one fearful faces appeared inside each box. Participants were asked to look for a happy face in one session and a fearful face in another session, with the order of the sessions randomly determined. The cue and the target locations were randomly determined with each of the two locations being equally probable. There were a total of 48 grayscale images of faces (24 male and 24 female), with equal numbers (16 faces each) expressing fearful emotion, happy emotion, and neutral emotion. The face stimuli were adopted with permission from the Cohen-Kanade AU-Coded Facial Expression Database (Kanade, Cohen, & Tian, 2000).

Design and Procedure

As shown in Figure 3, each trial began with the presentation of the fixation display for 1000ms. The cue display then appeared for either 250ms or 350ms, counterbalanced within subjects, before being replaced by the fixation display for

50ms. Then, the target display appeared for 200ms. The interval between the onset of the cue display, and the onset of the target display was either 300ms or 400ms depending on the cue presentation condition. Participants were asked to search for a happy face or a fearful face in different sessions, with the order of the sessions being randomly determined between participants. Their task was to indicate whether the box containing the target face in the target display was red or green by pressing the “Q” key with their left index finger for red or the “P” key with their right index finger for green. Feedback (a tone for an incorrect response or the fixation display for a correct response) was presented for 100ms. The next trial began with the same 1000ms fixation display. Speed and accuracy were emphasized equally. In each session, participants completed one practice block of 24 trials each and 6 regular blocks of 64 trials each (a total of 768 experimental trials with 384 trials). Participants completed the two sessions within a single visit to the lab and were given breaks between blocks and sessions.

Results

Overall Data Analyses

We excluded trials from analysis if RT was less than 100ms or greater than 2,000ms (2% of trials). Error trials were excluded from RT analyses. Analysis of variance (ANOVA) was used for all statistical analyses. Both response time (RT) and proportion of error (PE) data were analyzed as a function of target valence (fearful vs. happy), cue valence (fearful vs. happy), cue time (250ms vs. 350ms), and validity (valid vs. invalid). Note that the cue in the neutral cue [N,N] condition was a dummy variable. Therefore, we excluded those trials from the overall data analyses. All

variables were within-subject variables. An alpha level of .05 was used to ascertain statistical significance. Reported confidence intervals were based on a 95% confidence interval, shown as the mean \pm the confidence interval half-width. Tables 1 and 2 show the mean RT and PE respectively for the 250ms cue presentation conditions; while Tables 3 and 4 show the mean RT and PE for the 350ms cue presentation conditions.

For RT data, a significant interaction between Target Valence and Cue Valence was observed, $F(1,38) = 4.45, p < .05, \eta^2_p = .10$. When participants were asked to search for a fearful face (target), they responded 12ms slower when the cue type was fearful compared to when the cue type was happy (Cohen's $d = 0.2$). However, when they were searching for happy faces (target), participants responded 4ms faster when the cue type was fearful compared to happy. When the cue type was fearful, participants responded 30ms slower when they were searching for fearful (target) faces compared to when they were searching for happy (target) faces (Cohen's $d = 0.3$). A significant four-way interaction between Target Valence, Cue Valence, Cue Time, and Validity was also observed, $F(1,38) = 4.45, p < .05, \eta^2_p = .10$. For the 250ms cue presentation condition, the cue validity effect was reversed for both fearful cue and happy cue when participants were searching for fearful faces (at the 95% confidence interval: -18 ± 21 ms vs. -19 ± 28 ms, respectively). However, the cue validity effect was negligible for both fearful and happy cue when participants were searching for happy faces (-4 ± 19 ms vs. 1 ± 20 ms, respectively). When the cue was presented for 350ms, however, the cue validity effect was positive for the happy cue (8 ± 22 ms) and negative for the fearful cue (-9 ± 22 ms) when participants were

searching for fearful faces. The pattern was opposite when participants were searching for happy faces; that is, the cue validity was positive for the fearful face cue (14 ± 19 ms) but negative for the happy cue (-13 ± 16 ms). No other effects on RT were found to be significant.

For PE data, no effects were found to be significant.

Orienting Index (OI) vs. Disengagement Index (DI)

The OI and DI scores on RT were analyzed as a function of target valence (fearful vs. happy) and cue valence (fearful vs. happy) separately for each cue time (250ms and 350ms). Figures 4 and 5 show the OI and DI scores on RT for the 250ms and 350ms cue presentation respectively.

For the OI scores, no effect was significant at the 250ms cue presentation time. The interaction between target valence and cue valence on the OI index approached to be significant at the 350ms cue presentation time, $F(1, 38) = 3.41$, $p = .07$, $\eta_p^2 = 0.08$. When participants searched for a fearful target face, the OI was larger for happy face cues (4 ± 2 ms) than fearful face cues (-12 ± 1 ms); Cohen's d for the difference in OI is 0.3. The pattern was opposite when participants searched for a happy target face: the OI was smaller for happy face cues (-4 ± 1 ms) than fearful face cues (9 ± 1 ms); Cohen's d for the difference in OI is 0.2.

For the DI scores, the interaction between target valence and cue valence was significant at the 250ms cue presentation time, $F(1, 38) = 5.00$, $p < .05$, $\eta_p^2 = 0.12$. When participants searched for a happy target face, the DI was larger for happy face cues (6 ± 1 ms) than fearful face cues (-7 ± 1 ms), suggesting that participants had difficulty in disengaging attention from processing happy face cues when searching

for a happy target face; Cohen's d for the difference in DI is 0.3. No such pattern was found when searching for a fearful target face (DI was 0 ± 2 ms and -17 ± 2 ms for fearful cues and happy cues, respectively). For the 350ms cue presentation time, no effect was found to be significant.

General Discussion

The purpose of the present study was to determine if the attention process is modulated by emotional valence through the use of OI and DI indices and whether they are modulated by different emotional facial expressions. We adopted the cueing paradigm used by Lien et al. (2013) with a couple of modifications. First, we only used two peripheral boxes (one in each hemifield). Second, we had two cue onset presentation lengths (250ms and 350ms) intermixed within blocks. In each trial, there were two irrelevant faces (one emotional [fearful or happy] and one neutral) in the cue display, followed by two emotional faces in the target display (fearful and happy). Participants were asked to search for a happy face or a fearful face in different sessions and identify whether the box containing the target face in the target display was red or green. The use of the cueing paradigm allowed us to examine whether irrelevant emotional face cues captured attention involuntarily. Furthermore, if the attention process (orienting vs. disengagement) is influenced by emotional valence, then we expect to observe OI and DI to be modulated by different facial expressions of the cues.

Summary of Main Findings

We found that at the 350ms cue presentation time, the cue validity effect was large for the fearful face cue when searching for happy target faces (14 ± 19 ms), but

was small for the happy face cue when searching for fearful target faces (8 ± 22 ms). Consistent with these findings, the OI was also larger for fearful face cues (8 ± 1 ms) when searching for happy target faces, but smaller for happy face cues (4 ± 2 ms) when searching for fearful target faces. Thus, attention toward those irrelevant face cues was primarily driven by attention orienting. These patterns were not observed at the 250ms cue presentation time. We argue that both fearful and happy facial expressions are capable to capture attention involuntarily even when they were irrelevant to the task. Furthermore, both negativity bias and positivity bias seem to occur only when there was sufficient time to process emotions. That is, longer exposure durations enhance perceptual and semantic processing of facial emotional cues, enabling the representations to exceed the threshold required to trigger attentional capture.

Interestingly, the DI scores revealed that at the 250ms cue presentation time, the DI was larger for happy face cues (6 ± 1 ms) when searching for a happy target face. No such pattern was found when searching for a fearful target face. These findings suggest that participants had difficulty disengaging their attention from happy face cues and reorienting to the subsequent target location when the target appeared in the opposite side of the cue. Although previous studies have supported the delayed attention disengagement view, they examined only angry faces (Belopolsky, Devue, & Theeuwes, 2011). The present study suggests that attention disengagement also occurs for other facial emotions, such as happy.

Inhibition of Return Effect

One of our more notable findings is the observed negative cue validity effect at the 250ms cue presentation time, which indicates that response times for invalid trials were shorter compared to valid trials. Typically, if the cue captures attention involuntarily, then response to the relevant task should be faster when the cues are perceived as valid and slower when the cue is invalid. However, our results indicated the opposite to be true. This isn't to say that attention wasn't captured. It's possible that attention was in fact captured briefly at the onset of the cue, but redirected back to the neutral position before the target appeared (Remington, Folk, & Mclean, 2001; Theeuwes, Atchley, & Kramer, 2000).

Inhibition of Return (IOR) is one potential explanation for our results. IOR demonstrates that participants are sometimes slower to respond to the target when the cue appears in an identifying location (valid trial) compared to when it is presented at a new location. The IOR phenomenon was first described by Posner and Cohen (1984) who discovered that contrary to their expectations, while RTs to targets were initially faster in valid cue locations, after a period of around 300ms (interval between onset of cue display and onset of target display), RTs to targets in valid cue locations were longer than invalid cue locations.

In an IOR study, a location "cue" is presented to one of two peripheral locations. After a variable time interval following the onset of the cue, the target is presented with equal probability of being at the cued location (valid trial) or at the uncued location (invalid trial). When the cue-target stimulus onset asynchrony (SOA) is shorter than 150-200ms, responses are *faster* for targets appearing in the cued

location compared to when they appear in the uncued location. However, when the SOA is longer than 200ms, responses are *slower* for targets appearing in the cued location compared to the uncued location.

In the present study, our SOAs were either 300ms or 400ms depending on the cue presentation time, 250ms and 350ms respectively. As a result, the RTs for our invalid trials were shorter compared to the valid trials, which would explain the absence or even the reverse of the cue validity effect.

Behavioral Measures vs. Electrophysiological Measures

The purpose of our experiment was to examine *involuntary* attentional bias toward facial emotional expressions. Our interests stem from the fact that a majority of research focuses on the interaction between *voluntary* attentional processes and controlled processing of emotional stimuli (for a review, see Hajcak et al., 2010). However, one of our limitations stems from the fact that we are relying solely on behavioral data to determine if attention capture has occurred and where attention is being allocated – either orienting toward the stimuli or disengaging from the stimuli. Using an electrophysiological measure in conjunction with our cueing paradigm would provide stronger evidence of orientation toward and disengagement from the stimuli.

Recently, electrophysiological measures (i.e., brain activity) have been used extensively in research to understand the interaction between automatic and controlled processing of emotional stimuli (for a review, see Hajcak, MacNamara, & Olvet, 2010). For instance, P300 and the late positive potential (LPP) have been used to study emotion regulation. The P300 is a positive component ERP that peaks in

amplitude approximately 300ms to 500ms after stimulus onset (Linden, 2005). First described by Sutton and colleagues (1965), the P300 has commonly been investigated with “oddball” paradigms in which a less frequent target (“oddball” or unexpected) is presented along with more frequent, standard/expected stimuli; the individual is then tasked with responding to only the targets and ignoring the standards.

The LPP is a waveform similar to the P300 appearing with a peak wave amplitude slightly later than the P300, between 400ms to 1,000ms (up to 6s later even) after stimulus onset and has been found in multiple studies to be larger following the presentation of both pleasant and unpleasant images and words compared to neutral images and words (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Cuthbert, Schupp, Bradley, McManis, & Lang, 1998; Hajcak, MacNamara, & Olvet, 2010; Hajcak & Olvet, 2008). Like the P300 component, it is believed that the LPP wave amplitude is representative of the arousal difference between viewing an expected stimulus, followed by an unexpected (“oddball”), or motivationally relevant stimulus (Cuthbert et al., 2000; Cuthbert et al., 1998; Schupp, Cuthbert, Bradley, Cacioppo, Ito, & Lang, 2000). In some of the emotion regulation studies, several neutral images are displayed, which become the expected stimuli, and are then followed by the emotional stimuli, which is now processed as the “oddball” or unexpected stimuli, thus eliciting the LPP effect.

While the P300 and LPP components have been used reliably in several studies relating to emotion regulation, there are some concerns that arise. First, differentiating between the experimental effects of the P300 versus the LPP component would seem problematic given their overlap during the 300ms to 1,000ms

time range. In addition, the type of oddball tasks used to test the effects of emotion regulation, task related demands and instructions dictate which stimuli are relevant; participants are told what to look for and how they should be regulating their emotions.

However, there are issues with using these two particular components. First, differentiating between the experimental effects of the P300 versus the LPP component would be difficult due to their overlap during the 300ms to 1,000ms time range. Also, the P300 and LPP components have been shown to be modulated by task related demands and instructions dictating which stimuli are relevant; as such, the elicited reaction is not indicative of automatic, involuntary processes, so it's possible that the reported temporal observations from previous studies (e.g., Thiruchselvam, et al., 2011) involving the attention and reappraisal components of emotion regulation could occur at an earlier time. This would be consistent with data from multiple measurements that demonstrate the automatic capture of our attention by emotional stimuli, which occurs much earlier than 300ms (Batty & Taylor, 2003; Blau, Maurer, Tottenham, & McCandliss, 2007; Shaw et al., 2011; Lien et al., 2013).

Several experimental studies have examined patterns of attentional allocation to emotional versus neutral stimuli and have demonstrated the capacity for threat-related stimuli to attract attention (Eimer & Holmes, 2007; Eimer, Holmes, & McGlone, 2003; Holmes, Bradley, Nielsen, & Mogg, 2009). ERP measures, in particular the N170 (face-specific ERP component) and N2pc components, were used in many of these studies in order to further investigate the role of spatial attention in the processing of emotionally significant event. Because of their high temporal and

spatial resolutions, they are well suited for studying the time course of emotional processes and investigating whether and when the processing of emotional stimuli is modulated by selective attention. Across all of the experiments, emotional faces were found to trigger an increased ERP positivity relative to neutral faces. Furthermore, in comparison to the P300 and LPP components, the emotional expression effect occurred considerably early, ranging from 120ms to 180ms post-stimulus onset, depending on whether or not the emotional faces were presented with or without competing non-face stimuli (Eimer & Holmes, 2002; 2007; Eimer et al., 2003). Since our interest is specifically in the attentional deployment aspect of the emotion regulation process model, the N2pc and Pd components are considerably better ERP components to use for determining orientation toward and disengagement from the stimuli.

The N2pc effect is an ERP measured as the amplitude difference between each side of the occipital and parietal lobes. The N2pc component reflects spatial attentional selection of cue stimuli appearing in the left or right visual field. This allows us to determine whether or not a participant is attending to the emotional stimuli or not. The N2pc component can be observed approximately 170-270 milliseconds after the initial onset of the stimulus. So, while behavioral measures (e.g., accuracy and response time) can provide some basic information, the N2pc effect provides both temporal (when) and spatial (where) information regarding attention, and has been widely used as a sensitive and specific index of attention capture in several studies involving attention capture by emotion (Hajcak,

MacNamara, & Olvet, 2010; Holmes, Bradley, Nielsen, & Mogg, 2008; Eimer & Holmes, 2007; Eimer & Kiss, 2007; Eimer, Holmes, & McGlone, 2003).

The Pd component reflects active attentional suppression (Sawaki & Luck, 2011; Sawaki & Luck, 2010), and was first described in detail by Hickey, Di Lollo, and McDonald (2009) in which they asked participants to indicate the shape of a target stimulus (square or diamond) in the presence of a distractor stimulus in a different location. The Pd component was observed in the ERP waveform as a more positive voltage at contralateral scalp sites than at ipsilateral scalp sites and dependent on the location of the distractor stimulus – larger when the distractor was in the upper field and smaller when it was in the lower field. The onset typically begins 150-250ms after the stimulus, but also depends on the stimulus salience. There were three key findings that suggest the Pd component to be reflective of active suppression of a distractor stimulus. First, the Pd component was observed contralateral to the distractor. Second, the polarity of the Pd component is opposite of the N2pc component – positive instead of negative. And third, the Pd component disappeared when participants were asked to detect only the presence of the target item as opposed to discerning its identity, which reduced the need to suppress the distractor.

Future Directions for Research

ERP Study of Emotion Processing

As described above, using behavioral techniques only to assess the allocation of attention is not entirely effective because they are an indirect measurement tool, and not as sensitive to the different temporal dynamics of attention capture.

Therefore, it would be prudent to perform the present experiment a second time while

utilizing electrophysiological measures; specifically, N2pc and Pd ERP components. ERPs can be used as a direct measurement of attention allocation due to its ability to record effects otherwise invisible to researchers at specific time frames after stimulus presentation. The N2pc component is specifically related to shifts of visual/spatial attention and able to provide both temporal (when) and spatial (where) information regarding the visual/spatial shifts in attention. In addition to the N2pc component, the Pd component would also be used as a reflection of suppression.

Individual Differences

There are several factors that can influence emotion regulation strategies and attentional biases, many of which are simply individual characteristics of the participants ranging from gender, participant anxiety levels, affect, or personality traits. While many participant variables can be considered extraneous, it's still important to note the potential role they play in individuals' emotion regulation strategies and attentional biases. Not surprisingly, one of the most influential extraneous variables that is difficult to control for is gender. As it relates to the present study, research has shown that females produce more accurate discriminations when classifying emotions (higher rate of correct classification) compared to their male counterparts (Ekman, Levenson, & Friesen, 1983; Thayer & Johnsen, 2000). Where men struggled with distinguishing one emotion from another, females had more difficulty with gender classification – lack of discrimination between male and female expressions of the same emotion (Ekman, Levenson, & Friesen, 1983; Thayer & Johnsen, 2000). Participants in the present study were only tasked with identifying target emotions and not gender. Due to the relatively large percentage of female

participants, and the already established gender differences as it relates to emotion, perception of emotional faces, and emotion regulation, it's possible the high accuracy and lack of difference between emotional cues and cue presentation length is due to the existing gender differences. While the proportion of females to males (2:1) in our study is representative of Oregon State's School of Psychological Science as well as Lien et al.'s (2013) study of a similar design, it would be worth investigating any potential gender differences with this design in the future.

In addition to gender differences, an abundant amount of research has demonstrated that high-anxious individuals show greater attentional capture by threat-relevant information, with slowed reaction times and an increased number of errors compared to low-anxious individuals (MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1998; Mogg, Garner, & Bradley, 2007). This bias operates in early aspects of processing (e.g., situation selection and attention allocation) (Mogg & Bradley, 1998). However, as much as we know about how anxiety can have a detrimental effect on emotion regulation and attentional biases, treatment options are limited. More research is needed to determine some of the causal effects behind the emotion dysregulation. Are individuals with anxiety simply less competent in applying other adaptive strategies, or do they just need attentional retraining to train attention away from the threat?

As we learn more about these individual differences, applying them to develop individual-level interventions for teaching healthier patterns of emotion regulation is important for a functioning society (Gross & Munoz, 1995). Interventions can range from creating simple instructional materials, classroom-based

interventions for teachers to help students, and even parenting classes designed to increase awareness of the importance of emotion and effective emotion regulation – this is especially important given the co-regulation that occurs during childhood development (Thompson, 2014).

Conclusions

Through the use of a cueing paradigm task, the present study investigated the relationship between involuntary attentional bias toward emotional facial expressions, and emotion regulation. The study examined two different attentional components for emotional processing: orienting and disengagement. Two cue presentation times (250ms and 350ms) were used to determine if attention would be involuntarily captured by an irrelevant emotional facial cue. Cue validity effects were observed for both fearful and happy face cues, but only for the 350ms cue presentation time; Orienting Index scores were consistent with these findings. These results indicate that attention toward irrelevant emotional face cues were primarily driven by attention orienting, but only under conditions where there was sufficient time to process the emotions. Disengagement scores at the 250ms cue presentation revealed that participants had difficulty disengaging their attention from happy facial expression cues when the happy face target appeared in the opposite location of the cue. The present findings suggest that both negativity biases and positivity biases occur involuntarily.

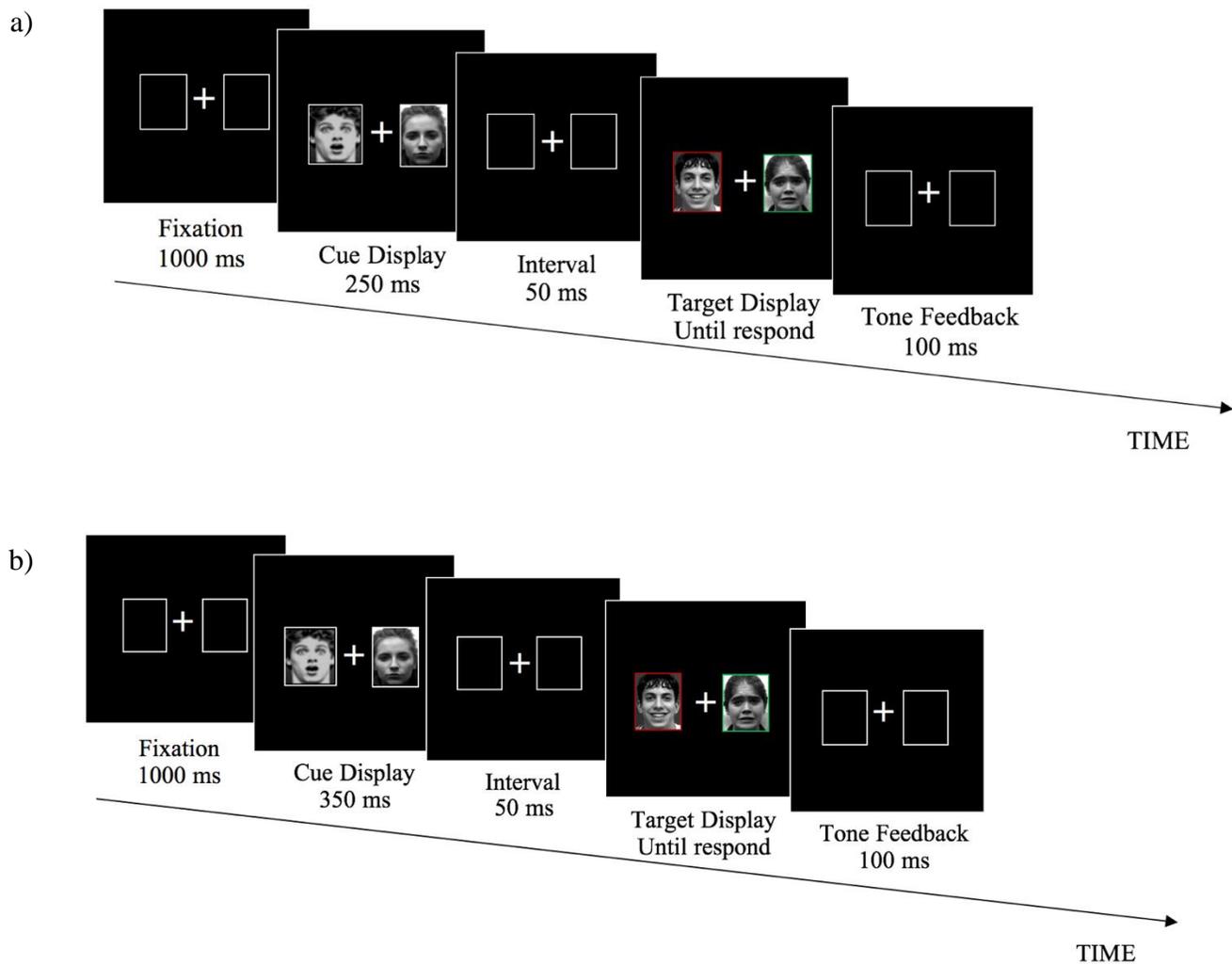


Figure 3. Example event sequence for the cueing paradigm. Figure 3a shows the cue display for 250ms; Figure 3b shows the cue display for 350ms. In the experiment participants were asked to search for either fearful or happy faces, between sessions, and determine the color of the box (red or green).

<i>Target</i>	<i>Cue</i>	<i>Cue Validity</i>		<i>Cue validity effect</i>
		<i>Valid</i>	<i>Invalid</i>	
Fearful	Fearful	928 (27)	910 (25)	-18 (10)
	Happy	912 (25)	893 (23)	-19 (14)
	Neutral	910 (22)	910 (22)	0 (0)
Happy	Fearful	888 (26)	884 (23)	-4 (9)
	Happy	895 (26)	896 (25)	1 (10)
	Neutral	891 (23)	891 (23)	0 (0)

Table 1. Mean response times (RT) in milliseconds as a function of cue type (fearful vs. happy) and cue validity (valid vs. invalid) for 250ms cue presentation. (Standard Error of Means are shown in Parentheses).

<i>Target</i>	<i>Cue</i>	<i>Cue Validity</i>		<i>Cue validity effect</i>
		<i>Valid</i>	<i>Invalid</i>	
Fearful	Fearful	0.081 (0.011)	0.077 (0.010)	-0.004 (0.011)
	Happy	0.084 (0.012)	0.081 (0.010)	-0.003 (0.008)
	Neutral	0.077 (0.010)	0.077 (0.010)	0.000 (0.000)
Happy	Fearful	0.078 (0.009)	0.073 (0.010)	-0.005 (0.009)
	Happy	0.077 (0.009)	0.073 (0.010)	-0.004 (0.008)
	Neutral	0.082 (0.010)	0.082 (0.010)	0.000 (0.000)

Table 2. Mean proportion of errors (PE) as a function of cue type (fearful vs. happy) and cue validity (valid vs. invalid) in Experiment 1 for 250ms cue presentation. (Standard Error of Means in Parentheses).

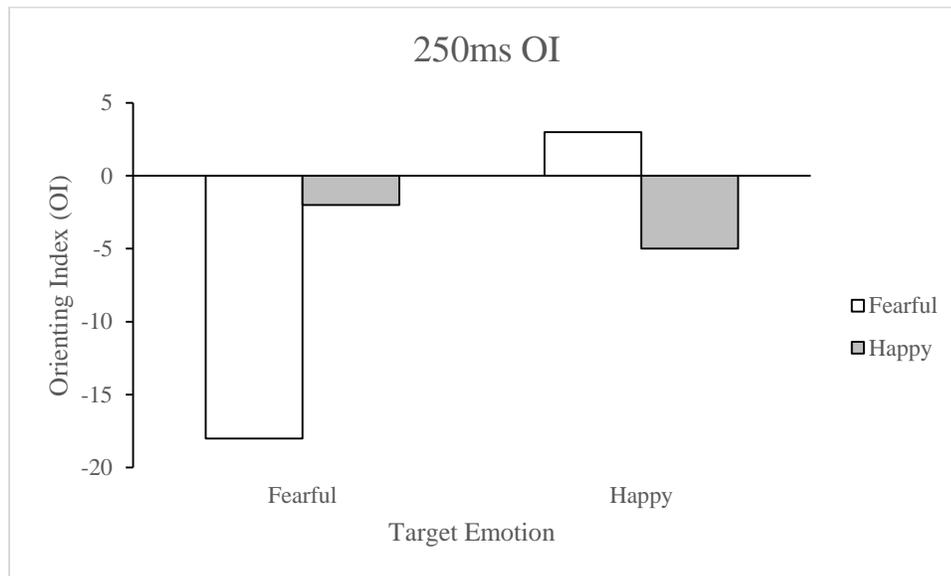
<i>Target</i>	<i>Cue</i>	<i>Cue Validity</i>		<i>Cue validity effect</i>
		<i>Valid</i>	<i>Invalid</i>	
Fearful	Fearful	918 (25)	909 (27)	-9 (11)
	Happy	902 (24)	910 (26)	8 (11)
	Neutral	906 (24)	906 (24)	0 (0)
Happy	Fearful	879 (24)	893 (25)	14 (9)
	Happy	891 (25)	878 (24)	-13 (8)
	Neutral	887 (25)	887 (25)	0 (0)

Table 3. Mean response times (RT) in milliseconds as a function of cue type (fearful vs. happy) and cue validity (valid vs. invalid) in Experiment 1 for 350ms cue presentation. (Standard Error of Means in Parentheses).

<i>Target</i>	<i>Cue</i>	<i>Cue Validity</i>		<i>Cue validity effect</i>
		<i>Valid</i>	<i>Invalid</i>	
	Fearful	0.073 (0.010)	0.087 (0.012)	0.014 (0.011)
Fearful	Happy	0.080 (0.011)	0.077 (0.009)	-0.003 (0.011)
	Neutral	0.074 (0.008)	0.074 (0.008)	0.000 (0.000)
	Fearful	0.078 (0.011)	0.079 (0.012)	0.002 (0.013)
Happy	Happy	0.073 (0.010)	0.079 (0.010)	0.006 (0.009)
	Neutral	0.069 (0.009)	0.069 (0.009)	0.000 (0.000)

Table 4. Mean proportion of errors (PE) as a function of cue type (fearful vs. happy) and cue validity (valid vs. invalid) in Experiment 1 for 350ms cue presentation. (Standard Error of Means in Parentheses).

a)

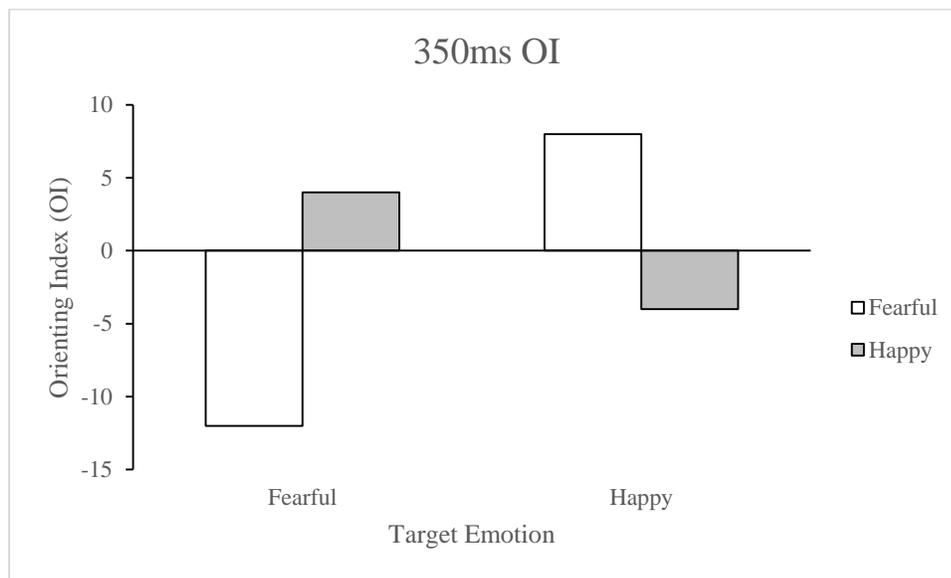


b)



Figure 4. Calculated orienting index (Figure 4a) and disengaging index (Figure 4b) by target emotion for the 250ms cue presentation.

a)



b)

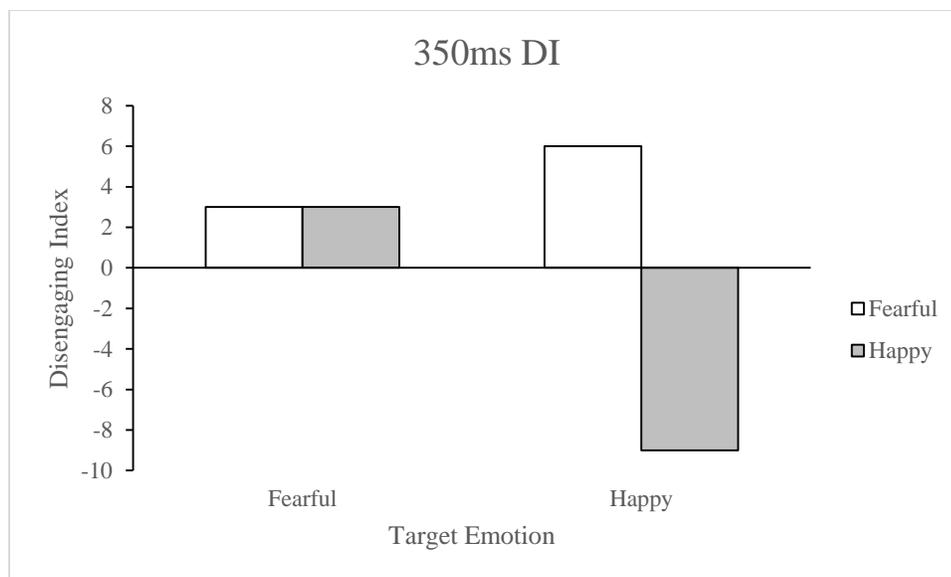


Figure 5. Calculated orienting index (Figure 5a) and disengaging index (Figure 5b) by target emotion for the 350ms cue presentation.

References

- Adolphs, R. (2002). Recognizing emotion from facial expressions: psychological and neurological mechanisms. *Behavioral and cognitive neuroscience reviews*, *1*(1), 21-62.
- Batty, M., & Taylor, M. J. (2003). Early processing of the six basic facial emotional expressions. *Cognitive Brain Research*, *17*(3), 613-620.
- Belopolsky, A. V., Devue, C., & Theeuwes, J. (2011). Angry faces hold the eyes. *Visual Cognition*, *19*, 27-36. doi: 10.1080/13506285.2010.536186
- Blau, V. C., Maurer, U., Tottenham, N., & McCandliss, B. D. (2007). The face-specific N170 component is modulated by emotional facial expression. *Behavioral and Brain Functions*, *3*(7), 1-13.
- Butler, E., Egloff, B., Wilhelm, F., Smith, N., Erikson, E., & Gross, J. (2003). The social consequences of expressive suppression. *Emotion*, *3*, 48-67.
- Cannon, W. (1927). The James-Lange theory of emotion: A critical examination and an alternative theory. *The American Journal of Psychology*, *39*, 106-124. doi: 10.2307/1415404
- Campbell-Sills, L., Ellard, K.K., & Barlow, D.H. (2014) Emotion regulation in anxiety disorders. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 393-412). New York: The Guilford Press.
- Casey, H., Rogers, R., Burns, T., & Yiend, J. (2013). Emotion regulation in psychopathy. *Biological Psychology*, *92*(3), 541-548. doi: 10.1016/j.biopsycho.2012.06.011
- Cuthbert, B. N., Schupp, H. T., Bradley, M. M., Birbaumer, N., & Lang, P. J. (2000). Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report. *Biological psychology*, *52*(2), 95-111.
- Cuthbert, B. N., Schupp, H. T., Bradley, M., McManis, M., & Lang, P. J. (1998). Probing affective pictures: Attended startle and tone probes. *Psychophysiology*, *35*(03), 344-347.
- Eastwood, J. D., Smilek, D., & Merikle, P. M. (2001). Differential attentional guidance by unattended faces expressing positive and negative emotion. *Perception & psychophysics*, *63*(6), 1004-1013.
- Eimer, M., & Holmes, A. (2007). Event-related brain potential correlates of emotional face processing. *Neuropsychologia*, *45*(1), 15-31.

- Eimer, M., & Holmes, A. (2002). An ERP study on the time course of emotional face processing. *Neuroreport*, *13*(4), 427-431.
- Eimer, M., Holmes, A., & McGlone, F. P. (2003). The role of spatial attention in the processing of facial expression: an ERP study of rapid brain responses to six basic emotions. *Cognitive, Affective, & Behavioral Neuroscience*, *3*(2), 97-110.
- Eimer, M., & Kiss, M. (2007). Attentional capture by task-irrelevant fearful faces is revealed by the N2pc component. *Biological psychology*, *74*(1), 108-112.
- Eftekhari, A., Zoellner, L., & Vigil, S. (2009). Patterns of emotion regulation and psychopathology. *Anxiety Stress Coping*, *22*(5), 571-586. doi: 10.1080/10615800802179860
- Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*, 169-200.
- Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, *221*, 1208-1210.
- Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition & Emotion*, *16*(3), 355-379.
- Gross, J. (1998a). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, *74*(1), 224-237.
- Gross, J. (1998b). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, *2*(3), 271-299.
- Gross, J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*, *39*(3), 281-291. doi: 10.1017.S0048577201393198
- Gross, J. (2010). Emotion regulation. In M. Lewis, J. Haviland-Jones & L. Barrett (Eds.), *Handbook of emotions* (3 ed., pp. 497-512). New York: The Guilford Press.
- Gross, J. (2014). Emotion regulation: Conceptual and empirical foundations. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 3-20). New York: The Guilford Press.

- Gross, J., & John, O. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85, 348-362.
- Gross, J. J., & Muñoz, R. F. (1995). Emotion regulation and mental health. *Clinical psychology: Science and practice*, 2(2), 151-164.
- Gross, J., Sheppes, G., & Urry, H. (2011). Emotion generation and emotion regulation: A distinction we should make (carefully). *Cognition and Emotion*, 25(5), 765-781.
- Gross, J., & Thompson (2007). Emotion regulation: Conceptual foundations. In J. Gross (Ed.), *Handbook of emotion regulation* (1st ed., pp. 3-24). New York: The Guilford Press.
- Hajcak, G., MacNamara, A., & Olvet, D. M. (2010). Event-related potentials, emotion, and emotion regulation: an integrative review. *Developmental neuropsychology*, 35(2), 129-155.
- Hajcak, G., & Nieuwenhuis, S. (2006). Reappraisal modulates the electrocortical response to unpleasant pictures. *Cognitive, Affective, & Behavioral Neuroscience*, 6(4), 291-297.
- Hajcak, G., & Olvet, D. M. (2008). The persistence of attention to emotion: brain potentials during and after picture presentation. *Emotion*, 8(2), 250.
- Hickey, C., Di Lollo, V., & McDonald, J. J. (2009). Electrophysiological indices of target and distractor processing in visual search. *Journal of cognitive neuroscience*, 21(4), 760-775.
- Holmes, A., Nielsen, M. K., Tipper, S., & Green, S. (2009). An electrophysiological investigation into the automaticity of emotional face processing in high versus low trait anxious individuals. *Cognitive, Affective, & Behavioral Neuroscience*, 9(3), 323-334. doi:10.3758/CABN.9.3.323
- Holmes, A., Bradley, B. P., KRAIGH Nielsen, M., & Mogg, K. (2009). Attentional selectivity for emotional faces: Evidence from human electrophysiology. *Psychophysiology*, 46(1), 62-68.
- Jackson, D., Malmstadt, J., Larson, C., & Davidson (2000). Suppression and enhancement of emotional responses to unpleasant pictures. *Psychophysiology*, 37, 515-522.
- John, O. P., & Gross, J. (2004). Healthy and unhealthy emotion regulation: Personality processes, individual differences, and life span development. *Journal of Personality*, 72(6), 1301-1334.

- John, O. P., & Eng, J. (2014). Three approaches to individual differences in affect regulation: Conceptualizations, measures and findings. In J. Gross (Ed.), *Handbook of emotion regulation* (2nd ed., pp. 321-345). New York: The Guilford Press.
- Joormann, J., & Siemer, M. (2014). Emotion regulation in mood disorders. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 413-427). New York: The Guilford Press.
- Koole, S. (2009). The psychology of emotion regulation: An integrative review. *Cognition and Emotion*, 23(1), 4-41. doi: 10.1080/02699930802619031
- Koole, S., & Fockenberg, D. (2011). Implicit emotion regulation under demanding conditions: The moderating role of action versus state orientation. *Cognition and Emotion*, 25(3), 440-452. doi:10.1080/02699931.2010.544891
- LeDoux, J. (1995). Emotion: Clues from the brain. *Annual Review of Psychology*, 46, 209-235. doi: 10.1146/annurev.ps.46.020195.001233
- Levenson, R. W. (1994). Human emotion: A functional view. The nature of emotion: Fundamental questions, 123-126.
- Lien, M.-C., Taylor, R., & Ruthruff, E. (2013). Capture by fear revisited: An Electrophysiological investigation. *Journal of Cognitive Psychology*, 25, 873-888.
- Luck, S. J. (2005). An introduction to the event-related potential technique. Cambridge, MA: MIT Press.
- Luck, S. J., & Hillyard, S. A. (1990). Electrophysiological evidence for parallel and serial processing during visual search. *Perception & psychophysics*, 48(6), 603-617.
- MacLeod, C., & Grafton, B. (2014) Regulation of emotion through modification of attention. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 508-528). New York: The Guilford Press.
- MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of abnormal psychology*, 95(1), 15.
- MacNamara, A., Ochsner, K.N., & Hajcak, G. (2011). Previously reappraised: The lasting effect of description type on picture elicited electrocortical activity. *Social, Cognitive, & Affective Neuroscience* 6(3), 348-358.

- Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion*, *5*(2), 175.
- Mauss, I.B., Cook, C.L., Cheng, J.Y.J., & Gross, J.J. (2007). Individual differences in cognitive reappraisal: Experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology*, *66*, 116-124.
- McRae, K., Gross, J., Weber, J., Robertson, E., Sokol-Hessner, P., Ray, R., Gabrieli, J., & Ochsner, K. (2012). The development of emotion regulation: An fMRI study of cognitive reappraisal in children, adolescents and young adults. *Social Cognitive and Affective Neuroscience*, *7*, 11-22.
doi:10.1093/scan/nsr093
- Mennin, D.S., & Fresco, D.M. (2014). Emotion regulation therapy. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 469-490). New York: The Guilford Press.
- Mocaiber, I., Pereira, M. G., Erthal, F. S., Machado-Pinheiro, W., David, I. A., Cagy, M., ... & de Oliveira, L. (2010). Fact or fiction? An event-related potential study of implicit emotion regulation. *Neuroscience Letters*, *476*(2), 84-88.
- Mogg, K., & Bradley, B. P. (1999). Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. *Cognition & Emotion*, *13*(6), 713-740.
- Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour research and therapy*, *36*(9), 809-848.
- Mogg, K., Garner, M., & Bradley, B. P. (2007). Anxiety and orienting of gaze to angry and fearful faces. *Biological psychology*, *76*(3), 163-169.
- Moser, J. S., Most, S. B., & Simons, R. F. (2010). Increasing negative emotions by reappraisal enhances subsequent cognitive control: a combined behavioral and electrophysiological study. *Cognitive, affective, & behavioral neuroscience*, *10*(2), 195-207.
- Moser, J. S., Hajcak, G., Bukay, E., & Simons, R. F. (2006). Intentional modulation of emotional responding to unpleasant pictures: an ERP study. *Psychophysiology*, *43*(3), 292-296.
- Öhman, A. (2002). Automaticity and the amygdala: Nonconscious responses to emotional faces. *Current directions in psychological science*, *11*(2), 62-66.

- Ochsner, K. N., & Gross, J. J. (2014). The neural bases of emotion and emotion regulation: A valuation perspective. *Handbook of emotional regulation, 2nd ed.* New York: Guilford, 23-41.
- Ochsner, K. & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences, 9*, 242-249.
- Posner, M. (1980). Orienting of attention. *The Quarterly Journal of Experimental Psychology, 32*(1), 3-25. doi: 10.1080/00335558008248231.
- Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. *Attention and performance X: Control of language processes, 32*, 531-556.
- Remington, R. W., Folk, C. L., & McLean, J. P. (2001). Contingent attentional capture or delayed allocation of attention? *Perception & Psychophysics, 63*, 298-307.
- Richards, J. M., & Gross, J. J. (2000). Emotion regulation and memory: the cognitive costs of keeping one's cool. *Journal of personality and social psychology, 79*(3), 410.
- Riediger, M., & Klipker, K. (2014). Emotion regulation in adolescence. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 187-202). New York: The Guilford Press.
- Rimé, B. (2007). Interpersonal emotion regulation. In J. Gross (Ed.), *Handbook of emotion regulation* (1 ed., pp. 466-468). New York: The Guilford Press.
- Rothbart, M., Posner, M., & Kieras, J. (2006). Temperament, attention and the development of self-regulation. In K. McCartney & D. Phillips (Eds.), *Blackwell handbook of early childhood development*. (Ch. 17, pp. 338-357). Malden, MA: Blackwell Publishing.
- Salemink, E., van den Hout, M. A., & Kindt, M. (2007). Selective attention and threat: Quick orienting versus slow disengagement and two versions of the dot probe task. *Behaviour Research and Therapy, 45*, 607-615.
- Sawaki, R., & Luck, S. J. (2012). Active suppression after involuntary capture of attention. *Psychonomic Bulletin & Review, 20*, 296-301. doi: 10.3758/s13423-012-0353-4
- Schachter, S., & Singer, J. (1962). Cognitive, social and physiological determinants of emotional state. *Psychological Review, 69*, 379-399.
- Schupp, Cuthbert, Bradley, Cacioppo, Ito, & Lang, 2000

- Shaw, K., Lien, M.-C., Ruthruff, E., & Allen, P. A. (2011). Electrophysiological evidence of emotion perception without central attention. *Journal of Cognitive Psychology, 23*, 695- 708.
- Sheppes, G. (2014). Emotion regulation choice: Theory and findings. In J. Gross (Ed.), *Handbook of emotion regulation* (2 ed., pp. 126-139). New York: The Guilford Press.
- Thayer, J. H. & Johnsen, B.H. (2000). Sex differences in judgement of facial affect: A multivariate analysis of recognition errors. *Scandinavian Journal Of Psychology, 41*(3),
- Thiruchselvam, R., Blechert, J., Sheppes, G., Rydstrom, A., & Gross, J. J. (2011). The temporal dynamics of emotion regulation: an EEG study of distraction and reappraisal. *Biological psychology, 87*(1), 84-92.
- Theeuwes, J., Atchley, P., & Kramer, A. F. (2000). On the time course of top-down and bottom-up control of visual attention. In S. Monsell & J. Driver (Eds.), *Attention & performance XVIII* (pp. 105–124). Cambridge, MA: MIT Press.
- Thompson, R. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development, 59*(2/3), 25-52.
- Thompson, R. A., & Lagattuta, K. H. (2006). Feeling and understanding: Early emotional development. In K. McCartney & D. Phillips (Eds.), *Blackwell handbook of early childhood development*. (Ch. 16, pp. 317-337). Malden, MA: Blackwell Publishing.
- Wegner, D., & Zanakos, S. (1994). Chronic thought suppression. *Journal of Personality, 62*, 615-640.
- Yang, J., Zeng, J., Meng, X., Zhu, L., Yuan, J., Li, H., & Yusoff, N. (2013). Positive words or negative words: Whose valence strength are we more sensitive to? *Brain Research, 1533*, 91-104.
- Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition and Emotion, 24*(1), 3-47. doi: 10.1080/02699930903205698