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Fixing our focus: Training attention to regulate emotion

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Abstract

Empirical studies have frequently linked negative attentional biases with attentional dysfunction and negative moods; however, far less research has focused on how attentional deployment can be an adaptive strategy that regulates emotional experience. We argue that attention may be an invaluable tool for promoting emotion regulation. Accordingly, we present evidence that selective attention to positive information reflects emotion regulation, and that regulating attention is a critical component of the emotion regulatory process. Furthermore, attentional regulation can be successfully trained through repeated practice. We ultimately propose a model of attention training methodologies integrating attention-dependent emotion regulation strategies with attention networks. While additional interdisciplinary research is needed to bolster these nascent findings, meditative practices appear to be among the most effective training methodologies in enhancing emotional well-being. Further exploration of the positive and therapeutic qualities of attention warrants the empirical attention of social and personality psychologists.

Keywords

emotion regulation; attention; attention training; selective attention; meditation

Attention is a most valuable instrument that serves as a telescope through which we select, bring into focus, and magnify the stimuli we experience in our world (Wallace, 1999). In *Principles of Psychology,* William James writes, “My experience is what I agree to attend to. Only those items which I notice shape my mind - without selective interest, experience is an utter chaos” (1890, p. 402). As James suggests, without our ability to use attention as a tool to hone specific aspects of our experience, we would be lost in superfluous information. Salient sensory, emotional, and mental information is filtered, processed, and analyzed through various attentional processes, which can be automatically or consciously regulated (Calvo & Nummenmaa, 2007). Clearly, what we attend to can shape our experiences, good or bad. How successful individuals are at influencing their attentional processes can dictate their subsequent affective experience and behavioral trajectories. Although individual differences exist in the ability to regulate attention, recent literature has suggested that the processes involved in attentional regulation can be trained and improved through repeated practice (Lutz, Slagter, Dunne, & Davidson, 2008; Rueda, Rothbart, Saccomanno, & Posner, 2007). If attention can be trained, then it may be used to actively guide individuals’ emotion regulation processes and downstream behavior, ultimately enhancing subjective well-being. That is, people could learn to selectively attend to specific types of information in the service of optimizing their emotional experience.

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This paper considers how attention can be trained as a way to regulate emotional experience. We will first examine the role of attentional deployment as an emotion regulation strategy. Accordingly, we will present evidence that selective attention patterns not only reflect emotion regulation, but that they can also actively influence the emotional response process. We will draw evidence from a wide array of cognitive, experimental, and clinical sources including studies that investigate gaze patterns, implicit learning, clinical interventions, and meditative practices. Reviewing relevant literature on attention training methodologies, we will attempt to integrate the findings from these different subdisciplines. Most importantly, using Posner and Petersen's (1990) attentional networks as a foundation, we propose a new model of attention training methods that elucidates what unique types of attention-based emotion regulation strategies comprise different training techniques as well as what components of attentional processes may be recruited and modified by each type of training. Next, we consider which method of training attention can be used to most optimally improve emotion regulation. Although not frequently investigated in social psychological research, one type of attention training method, meditative practice, stands out in our model as being particularly promising in improving emotion regulation. Ultimately, we suggest that further interdisciplinary research between clinical, cognitive, social, developmental, and contemplative fields will help to both elucidate the mechanisms behind how attentional processes may facilitate emotion regulation and clarify which types of training methods may work most effectively for specific populations.

The Role of Attention in Emotion Regulation

Defining Emotion Regulation

In this paper, we utilize a functionalist perspective in which emotions are viewed as adaptive, behavioral, and physiological response tendencies enhancing individuals' physical and social fitness (for a review see Keltner & Gross, 1999; cf. Barrett, 2006). These response tendencies are malleable, transient, and may be modulated by individuals; in others words, they can be regulated (Gross, 1998).

The goal of emotion regulation need not only be to decrease negative emotion and increase positive emotion; depending on the situation, one may wish to increase or initiate negative emotion and stop or decrease positive emotion (Gross, 1998; Tamir, Chiu, & Gross, 2007). Therefore, the interplay of *how* individuals transition between negative and positive states may be critical in defining successful emotional regulation (Diamond & Aspinwall, 2003). For instance, positive emotions facilitate psychological and physiological recovery from negative emotional experiences (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000). Emotion regulation might therefore be best defined as maintaining desirable emotional states and terminating undesirable emotional states (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Gross, Richards, & John, 2006; Larsen, 2000). For most individuals across most settings this would involve maintaining high levels of positive affect and low levels of negative affect, or increasing levels of positive affect when they are low and decreasing levels of negative affect when they are high (cf. Tamir, 2009). Experiencing more frequent positive emotions and less frequent negative emotions would therefore constitute more effective or successful emotion regulation (e.g. Carstensen et al. 2000; Diener, Sandvik, & Pavot, 1991). Several studies have found that maintaining a high ratio of positive affect relative to negative affect (2.9 or more positive to negative emotional interactions) constitutes optimal emotional functioning of individuals, married partners, and business teams (Gottman, 1994; Fredrickson & Losada, 2005; Schwartz et al., 2002; Schwartz, 1997). However, too much positivity (a positivity ratio of 11.6 or higher) may have aversive emotional effects since certain forms of negative emotion may promote emotional growth and flourishing (Fredrickson & Losada, 2005), and particular negative states may have immediate instrumental value (Tamir, 2009).

Gross outlines five emotion regulatory processes, which can each encompass a multitude of distinct regulatory strategies: situation selection, situation modification, attentional deployment, cognitive change, and response modulation (for a review see Gross, 1998). He further distinguishes between antecedent-focused strategies occurring before the full generation of an emotional response, and response-focused emotion regulatory strategies that are used after. Antecedent-focused regulatory strategies may be more adaptive than response-focused strategies and may require less resources, time, and energy to initiate because they occur early in the emotion generative process (Mauss, Bunge, & Gross, 2007a; Schutte, Manes, & Malouff, 2009).

Attentional Deployment

Attentional deployment[1] is an antecedent strategy where different attentional processes are recruited to shape affective experience. In this paper we explore whether attention allocation can be trained and if training can improve emotion regulation. In the emotion regulation literature, attentional deployment broadly involves selectively attending to certain aspects of situations. Different attentional processes may have more or less influence on generating, maintaining, or modifying different emotional responses. Gross (1998) has identified three primary strategies of attentional deployment: distraction, concentration, and rumination. These categorizations are not comprehensive, but rather serve as an initial starting point in attempting to delineate unique functions and mechanisms by which attention deployment processes may work in the service of emotion regulation.

One primary strategy of emotion regulation, attentional distraction, involves shifting attention from one aspect of a situation (or goal) to another aspect of the situation or entirely away from the situation altogether (Gross, 1998). An example of effective distraction may be in shifting attention to a positive thought (“I performed well on this aspect of the task.”) in lieu of a current negative one (“I did not perform well enough on this task.”). Another deployment strategy delineated by Gross (1998), concentration, involves fully utilizing cognitive resources within an activity. In concentration an individual actively chooses what they want to mentally focus on in order to regulate their emotions (e.g. the source and triggers of their emotions). As part of concentration meditation practices, individuals selectively focus sustained attention on an object such as their breathing, a sound, or a visual stimulus (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007). When attention wanders from the object of meditation (e.g. attention is drawn from attending to the breath to attending to thoughts), an individual disengages from the distracter (i.e. the thought) and returns their attention to the object of meditation (i.e. the breath).

Rumination involves directing attention selectively inward towards feelings and the consequences of certain feelings (Gross, 1998). Ruminating on negative emotions for long periods of time can lead to clinical conditions such as depression or anxiety disorders (Nolen-Hoeksema & Morrow, 1993). However, rumination may not always necessarily lead to negative affect (Kross, Ayduk, & Mischel, 2005) and in the context of positive emotion, rumination may be beneficial. Ruminating on positive emotional experiences, defined as savoring, may prolong the affective benefits of those positive emotions (Bryant, 2007). However, excessive rumination on the positive may also be maladaptive if attentional resources are not appropriately allocated and environmental dangers are overlooked. Importantly, there are many other types of attentional deployment processes that do not fit

[1]This paper focuses specifically on strategies of emotion, not mood, regulation, although moods can result from repetitive emotional states. Nonetheless, in defining mood regulation Larsen (2000, p. 133) identifies a similar regulatory stage to attentional deployment deemed “attention to affect-relevant stimuli in the environment” where individuals attend to, encode, and process affective information. Thus, there may be some overlap in our discussion of emotion regulation strategies that is also relevant to more general mood regulation.

within these three primary strategies and that have not been systematically described and investigated (e.g. maintaining a state of awareness without any attentional focus, employing selective attention to information of a particular valence - positive or neutral). This paper will further elaborate on some of the attentional processes that have been used so far in training interventions to modify patterns of attentional deployment. In addition, we will later discuss how these attentional processes can be mapped on to the three primary strategies of distraction, concentration, and rumination.

Why Attend to Attention? Attentional Deployment versus Other Regulatory Strategies

Attentional deployment was initially chosen as the focus of the current review because it is a relatively nascent field within emotion regulation that seemed to warrant further exploration. However, other good reasons to focus on attention in the context of emotion regulation quickly became apparent. First, as an early antecedent-focused regulatory process, attentional deployment may hold great promise as a strategy that curtails the unfolding of subsequent negative emotional experiences. Attentional deployment may be, in some contexts, a more automatic regulatory strategy (Jackson et al., 2003; Mauss et al., 2007a; Mauss, Cook, & Gross, 2007b) requiring less cognitive effort to enact (and therefore being more cognitively efficient) than other regulatory strategies.

Attentional deployment may also be an extremely versatile regulatory process. To the degree that attentional deployment can be an automatic regulatory strategy, it may be more extensively used as a “first line of defense” since it requires minimal cognitive effort. Furthermore, attentional regulation can also be enacted in some form at any stage of the emotion generative process (Koole, 2009). Recently, researchers have found that when distraction is employed late in the emotion generative process (after an emotional response has manifested) it can still be effective in helping individuals effectively regulate their emotions (Sheppes & Meiran, 2007; Sheppes & Meiran, 2008). Moreover, attentional deployment may be both a regulatory strategy itself as well as a component of other regulatory strategies such as reappraisal, suppression, and certain cognitive change and response-focused strategies. For example, during reappraisal portions of the dorsal prefrontal cortex (PFC), implicated in selective attention, are activated, as well as portions of the dorsal anterior cingulate cortex (ACC), which seem involved in monitoring control processes (Ochsner & Gross, 2008).

Attentional deployment may in fact serve as a precursory “gateway” strategy for other emotion regulatory processes. For example in order to reappraise a negative situation, attention must disengage from the negative information or interpretation and reorient towards finding or creating evidence for an alternative interpretation. Further research that combines attentional deployment with other regulatory strategies such as reappraisal may help to elucidate what aspects of attentional deployment are recruited (e.g. selective attention, executive control) to facilitate different regulatory strategies across different situations (Ochsner & Gross, 2005; Ochsner & Gross, 2008).

If attentional deployment is used successfully in conjunction with reappraisal in helping individuals regulate their emotions (e.g. individuals orient their attention towards aspects of a situation that allows them to adequately reappraise its meaning) then these strategies may augment each others’ efficiency, thereby reinforcing the likelihood of being enacted as a future strategy-combination. However, if individuals cannot successfully reorient their attention to reconstruct a reappraisal strategy (e.g. they cannot visually find information to aide the story formation or they cannot disengage from negative material) then they may have to enlist an additional strategy (e.g. suppression) to attempt to regulate their emotional experience. Put differently, how successful individuals are using other regulatory strategies may be influenced by how successful they are at deploying their attention.

Attentional deployment may nonetheless sometimes be a maladaptive regulatory strategy. Kross and Ayduk (2008) had participants recall a depressive experience and then regulate their emotions with one of three conditions: analyzing their feelings from a self-distancing perspective, analyzing their feelings from a self-immersed perspective, or using a distracting strategy. Immediately after the training the self-distancing and distraction strategies were most effective at reducing negative affect; however, at one and seven days after the manipulation, the self-distancing manipulation group was the most buffered (experiencing less negative affect and fewer recurring thoughts). Using distraction as a regulatory strategy may have immediate short-term benefits, but also may have aversive long-term consequences.

Another aversive consequence may be that using distraction as a regulatory strategy has some cognitive costs (Sheppes & Meiran, 2008). Distraction may impair memory processes. If distraction requires processing extraneous information (e.g. to reduce the encoding of negative information), working memory capacity may be depleted. However, relative to cognitive reappraisal, using distraction as a regulatory strategy preserves self-control resources (Sheppes & Meiran, 2008) and elicits less sympathetic physiological activation and consequences (Sheppes, Catran, & Meiran, 2009). So while costly, distraction may be less costly than other possible strategies. While further research is needed to more fully elucidate the relationships between attentional deployment and other emotion regulatory strategies, preliminary evidence suggests that attending to attention holds much promise for facilitating emotion regulation.

Evidence of Attention as a Form of Emotion Regulation

Selective attention has evolved as one mechanism through which individuals can filter the plethora of sensory stimuli in their environments at any given moment (Parkhurst, Law, & Niebur, 2002). Because our attentional resources are limited, it is likely that the salient stimuli that capture our attention will also direct our future choices and behaviors (Pashler, Johnston, & Ruthruff, 2001). Which stimuli individuals find to be salient is not merely random or accidental but is related to person-level variables such as motivation (Fiske, 1995). Isaacowitz (2006) has argued that individuals seek out visual stimuli congruent with their goals and avoid incongruent stimuli. Goal-congruent gaze has been demonstrated in certain groups possessing positive affective profiles, such as optimists and older adults: these groups display distinctive gaze patterns away from negative and favoring positive stimuli (Isaacowitz, 2005; Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b). Both individuals' motivations and their emotional state can influence their attentional patterns (Tamir & Robinson, 2007); yet the converse is also true: what individuals pay attention to affects their emotions and goals. Below we will review evidence suggesting that links between affect and attention are ultimately bidirectional: while affect clearly impacts attention, regulating attention also influences affect.

It is first necessary to make a distinction between emotion regulation *processes* and emotion regulation *outcomes*. Emotion regulation outcomes (e.g. whether or not one reaches their hedonic goals, a positive regulatory outcome) are distinct from emotion regulatory processes (e.g. where an individual looks, how they reappraise an event, and other strategies that may be used in the service of emotion regulation). Using a particular emotion regulation process *could* but does not necessarily lead to positive emotion regulation outcomes. This distinction is important because we contend that attentional deployment, itself, can be an emotion regulatory process that potentially leads to positive emotion regulation outcomes. We will refer to emotion regulation processes and strategies interchangeably because strategies may be the behavioral manifestations of the processes, but will keep regulatory processes distinct from outcomes. Figure 1 provides a schematic representation of the components we consider

in attempting to link attention training to emotion regulation outcomes via emotion regulation processes: starting from the left, different types of attention training methods (detailed later in the paper in Table 1) may modify (arrow A) different attention-based emotion regulation strategies in unique ways (discussed in more detail in Table 2), thus potentially influencing emotion regulation outcomes (arrow B). The emotional experience, expression, and neurobiological effects of these outcomes may then in turn, through experience, influence how attention is used for regulatory purposes (arrow C), though these reciprocal effects are beyond the scope of this paper. Throughout the paper we will provide evidence linking multiple components of this figure, ultimately arguing that attentional training can affect both attention processes and emotion regulation outcomes. In the following section we will review evidence that attentional processes influence the experience of affect.

Bidirectional Links between Selective Attention and Affect

Attention toward positive information may work in the service of maintaining individuals' positive moods. How an individual feels often acts as a good indicator of the motivational significance of their goal pursuits (see the affect-as-information model: Schwarz, 1990). That is, in order to determine whether information is important, a person may rely on their affect at the time. The hedonic contingency model (HCM) proposes that individuals seek out stimuli in their environments that are congruent with their current affective state (Wegener & Petty, 1994). Therefore, individuals motivated to attain and preserve positive moods would direct their attention to mood-facilitating stimuli (Isaacowitz, 2006). Over time, this attentional preference toward positive information may become habitual. One study suggests that mood maintenance has become an automated response due to over-learning (Handley, Lassiter, Nickell, & Herchenroeder, 2004).

A recent study suggests that positive, automatic biases may also occur such that individuals who experienced higher daily positive mood states showed heightened selective attention towards positive, rewarding words in a dot probe task (Tamir & Robinson, 2007). Goetz, Goetz, and Robinson (2007) specifically propose that positive emotions make individuals more sensitive towards rewarding stimuli in their environments and that the repetition of this preference creates stronger memory-encoding pathways for similar positive stimuli in the future (e.g., Clark & Isen, 1982). Another explanation is that experiencing positive affect initiates an approach tendency, which may in turn lead individuals to be more likely to attend to subsequent positive information (Carver, 2001; Tamir & Robinson, 2007; Watson, Wiese, Viadya, & Tellegen, 1999).

Positive emotions may also enlarge individual's breadth of attention (e.g. taking in more of the world around them as well as broadening attentional allocation to internal conceptual space – expanding the "spotlight": Fenske & Eastwood, 2003; Fredrickson, 1998; Rowe, Hirsh, & Anderson, 2008; Wadlinger & Isaacowitz, 2006, cf. Gable & Harmon-Jones, 2008) and increase their attentional flexibility (Ashby, Isen, & Turken, 1999). Broadened attention towards positive information may facilitate emotion regulation by helping individuals to see opportunities for reward in their environment. Greater attentional flexibility may promote emotion regulation through easier disengagement from irrelevant negative information and more frequent shifts of attention towards positive information. Individuals with better attentional flexibility may also be able to use other emotion regulation strategies like reappraisal more quickly and effectively.

The experience of positive affect itself may increase individuals' selective attention preferences for positive information and these positive attentional preferences may improve individuals' mood. Yet even in the absence of positive affect, attentional processes can still impact how individuals regulate their emotions. A number of studies have provided

evidence that attention itself, even in the absence of positive emotions, may act to direct emotion regulation (Compton, 2000; Ellenbogen, Schwartzman, Stewart, & Walker, 2006; Rueda, Posner, & Rothbart, 2004). Attentional dysfunction has been shown to lead to persistent negative mood states, indicative of unsuccessful emotion regulation[2] (Compton, 2000; Ellenbogen et al., 2006). For instance, in one study, individuals who were slow to disengage their attention in an orienting task showed increased negative affect in response to a subsequent distressing film clip (Compton, 2000). Thus an inability to shift attention effectively may contribute towards experiencing prolonged negative affect. In another study, depressed individuals were slower than control participants to disengage their attention from all types of stimuli while engaged in a stress task (Ellenbogen et al., 2006). Supporting the idea that dysfunction in attentional disengagement may contribute to unsuccessful regulation, individuals who were currently or formerly depressed selectively attended to sad faces, rather than neutral or happy faces, in a dot-probe task (Joormann, & Gotlib, 2007). The above research suggests that maladaptive attentional biases may exist beyond the period of the actual depressive episode and may heighten vulnerability for future depressive episodes.

Other studies have shown that individuals may engage certain early, automatic attentional processes in an effort to regulate their emotion. In these studies, individuals were given some instructions to regulate their emotions, and then the researchers assessed the role of attention during regulation, using measures such as LPP or eye tracking. For example, when participants were instructed to down-regulate their emotional response to pleasant, highly-arousing images (e.g., view the pleasant image from a detached perspective or imagine it gets worse), they showed an attenuation of late positive potential (LPP) magnitudes (Krompinger, Moser, & Simons, 2008). This neural response, representative of attentional processing, was modulated within 325ms of stimulus delivery. These results may reflect a general disengagement of attentional processing from the arousing components of highly relevant, positive stimuli. In other words, individuals were using attentional processes to regulate their emotions. In another study, researchers manipulated the motivational state of young adults as they watched a series of images by varying the task instructions across three conditions: 1) to regulate their emotions while watching the images, 2) to focus on acquiring information about the images, or 3) to just attend to the images naturally as if watching television (Xing & Isaacowitz, 2006). Individuals motivated to regulate their emotions attended less to negative images than positive images, and looked less at all stimulus types (negative, positive, neutral) than the other conditions, suggesting that gaze serves as a mechanism through which individuals can regulate their emotions (Xing & Isaacowitz, 2006). Specifically, the young adults may have been using distraction as a regulatory strategy (Gross, 1998).

Interestingly, it has been suggested that older adults may be especially likely to use distraction as a regulative strategy. In one study, researchers instructed a sample of older women to decrease their emotional responses to negative pictures (van Reekum et al., 2007). Specifically, they told participants use one of two cognitive reappraisal strategies while viewing the images: to either imagine the depicted visual scene was not real, or to imagine that the outcome was better than it looked in the image. Participants instructed to decrease their negative emotion while viewing negative images (as opposed to the increase negative emotion or naturally attend to the images conditions) looked less at the entirety of the negative images, despite the researchers' insistence not to look away from the images (van Reekum et al., 2007). The older women also looked less at the most relevant objects in the images and made more frequent saccades around the negative images, with larger distances

[2]Successful emotion regulation may sometimes require feeling and attending to salient negative emotional states and stimuli. However, in these experiments, participants were attending to irrelevant negative stimuli.

between saccades than in the other two conditions. This suggests that the older adults, in an effort to decrease their negative emotions while viewing the images, were scanning around the image more, looking particularly at the extremities and least relevant parts of the picture. Put another way, the older adults were using multiple attention strategies (e.g. looking away from negative components of images, looking around the images more) while reappraising the images. Van Reekum (2007) proposes that this was in an attempt to construct a new reappraisal narrative. The results of this study therefore indicate that, under certain conditions, attentional deployment may be an active component of cognitive reappraisal. Alternatively, attentional deployment and reappraisal may sometimes be distinct: in an experiment where gaze was held constant, Urry (2010) found that cognitive reappraisal nonetheless uniquely affected individuals' ratings of their emotional experience.

Very few studies have used real-time measurements of emotion to establish evidence for a *causal* relationship between attentional processes directing emotion regulatory outcomes (arrow B). The studies summarized above assessed regulatory processes (box 2) only and did not explicitly measure regulatory outcomes (box 3), such as changes in self-reported affect during the experimental tasks (cf. Urry, 2010). Therefore, these studies can only offer indirect evidence for attention guiding emotion regulation. However, a few other recent studies have included assessments of participants' affect while also measuring their attentional deployment. These studies, though small in number, begin to establish an even more direct link (arrow B) between attention and emotion regulation. We next review studies that provide further evidence for attentional deployment acting as a regulatory *process* (box 2), and in a few cases also provide evidence linking the regulatory processes to outcomes (arrow B).

One study has demonstrated that older adults selectively activate positive gaze preferences when they are in a bad mood, looking towards positive faces and away from negative ones (Isaacowitz, Toner, Goren, & Wilson, 2008). Older and younger adults were eye-tracked in real-time to a series of synthetic, emotional face pairs (happy, sad, angry, or fear paired with neutral) while continuously rating their mood on a potentiometer slider. Participants were classified into mood conditions by their initial slider rating. When participants started in a negative mood, younger adults showed mood-congruent gaze patterns towards angry and afraid faces; however, older adults showed mood-incongruent gaze patterns away from angry and sad faces and towards happy faces. This evidence suggests that older adults' gaze did not reflect their mood state but rather that they used gaze as an active strategy to regulate their mood (Isaacowitz et al., 2008).

Individual difference variables, such as the overall efficiency of the attentional system, may influence how they use attention to regulate their emotion. Isaacowitz, Toner, and Neupert (2009) assessed how older adults use positive gaze preferences to regulate their moods. They analyzed the differences in individuals' mood changes while viewing a variety of synthetic, emotional faces. Positive gaze preferences helped older adults avoid mood declines during the task, but only for those with high-functioning executive control networks. While this experiment is suggestive of an important attention-emotion regulation link for certain individuals (i.e., this is a rare case in which arrow B is directly tested), additional research is needed to further delineate and clarify the influence of different individual difference factors on attentional deployment tactics and their real-time influence on emotional experience and regulation. Isaacowitz and colleagues (2008) argue that older adults use gaze as a regulatory tool to a greater extent than younger adults because it requires less cognitive effort than a number of other regulatory processes (Knight, Seymour, Gaunt, Baker, Nesmith, & Mather, 2007; Mauss et al., 2007b; Washburn & Putney, 2001).

Feeling good and regulating mood are highly prioritized goals for older adults (Carstensen, Mikels, & Mather, 2006). Compared to younger adults, older adults appear to show improved emotion regulation abilities (Carstensen et al., 2000; Gross, Carstensen, Pasupathi, Tsai, Götestam Skorpen, & Hsu, 1997). These enhanced abilities may partially result from age-related changes in emotional information processing (Carstensen & Mikels, 2005). Specifically, older adults are said to exhibit an age-related "positivity effect", because they attend more to, and have better memory for, positive relative to neutral or negative information than their younger counterparts (Carstensen & Mikels, 2005; Kennedy, Mather, & Carstensen, 2004). This attentional shift may reflect a change in the prioritization of different types of goals. With age, individuals shift from prioritizing, and thus paying more attention to, informational goals to prioritizing emotion regulation goals thereby reallocating their attentional resources to regulate their emotions and optimize their positive affect. Only older adults who have adequate cognitive resources (e.g. sufficient levels of cognitive control) may be able to enlist positive biases in memory or attention that could facilitate emotion regulation (for a review see Kryla-Lighthall & Mather, 2009; Mather & Knight, 2005). One recent study demonstrated that older adults can compensate for age-related declines in executive control areas (bilateral dorsolateral prefrontal cortex and the anterior cingulate) by spontaneously recruiting other brain areas, such as middle and medial frontal regions (Gutchess et al., 2007).

If older adults show preferences for positive information that emerge naturally as they age, then the question arises as to whether these attentional changes can be accelerated in younger or middle-aged adults via attentional training. If individuals can learn how to use their attention as a regulatory tool, then they may show increased efficacy in regulating their emotions, just as older adults and other individuals possessing positive affective profiles do. Exploring how to generate and train these attentional preferences in different populations may shed light on how to use them as effective instruments for emotion regulation. Yet before assessing how different training procedures might work in changing emotion regulation processes and outcomes in different populations, we need to evaluate whether attentional processes themselves can change.

Attentional Plasticity

The first step in demonstrating that attentional processes can be trained for emotion regulation is to determine whether attention is plastic (i.e. malleable) and trainable. Several studies suggest that the answer to this question is affirmative and that attentional processes can become more efficient with practice. It is important to note that individual differences in attentional abilities (e.g. attentional control) exist starting as early as infancy (Fox & Calkins, 2003). Individuals have different baselines in their ability to regulate voluntary attentional control (Derryberry & Reed, 2002). For example, highly trait anxious undergraduate students, who had good attentional control (as assessed by self report on the Attentional Control Scale), were better able to disengage their attention (at 500ms) from a threatening location and refocus their attention on a safe location on a visual cueing response-time task. Highly trait anxious students with poor attentional control had trouble disengaging their attention from the threatening location. There are also individual differences in the plasticity of attention. In another study, individual differences in readiness to acquire a bias towards threat cues experimentally predicted naturalistic bias and heightened anxiety in a later stress task (Clarke, MacLeod, & Shirazee, 2008). These findings may suggest individual differences in how malleable some individuals' attentional regulation abilities are, even if training is generally effective.

One piece of evidence for plasticity of attention comes from the observation that individuals can adapt their attentional abilities to fit with environmental circumstances (Newman, Keller, & Just, 2007; Sarter, Mumaw & Wickens, 2007; Slagter et al., 2007; Vidnyánszky &

Sohn, 2005). For example, within many occupations there are attentional experts: fighter pilots, doctors, taxi drivers, volleyball players, chess masters, and mail sorters. Polk and Farah (1995) found that Canadian mail sorters' attentional skills were easily transferable to sorting the US mail because the US zip codes consisted of familiar elements (i.e., numbers); whereas US mail sorters could not effectively sort Canadian mail as Canadian zip codes contained novel elements (i.e., letters). Task repetition can automate specific behaviors that can be generalized to other behaviors (Bargh & Chartrand, 1999). However, how easily a behavior becomes automatic is largely dependent on whether the external event is synchronized with specific internal feelings (e.g. positive feelings or high arousal feelings, Shiffrin & Dumais, 1981).

As individuals repeat specific attentional patterns and preferences over time, orienting towards or away from certain stimuli may become habitual (Rothbart, Ziaie, & O'Boyle, 1992). These habitual attention preferences may influence individuals' subsequent emotions. For example, attentional preferences to negative information can be trained and untrained (Derryberry & Reed, 2002; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Mathews, Mogg, & Kentish, 1995). These changes in attentional preferences may be underscored by changes in neural activation. Monk and colleagues (2004) modified an attentional-orientation task (from Posner, 1980) so that visual probes followed facial emotion cues (angry and happy faces). The facial cues were then experimentally masked to limit the timeframe in which they could be perceived. The researchers speculated that, in this masked condition healthy participants with repeated practice would eventually learn to avoid threatening information (angry faces). This prediction was congruent with prior findings that showed healthy participants, in a non-masked condition, demonstrated aversion to angry faces (Fox, Russo, Bowles, & Dutton, 2001). Thus, if these time-related shifts were produced, healthy individuals would gradually become more aware of the threatening stimuli and start to regulate their attention away from the threatening information. This pattern of findings would be indicated by an increase in neural activation due to repetitive priming (as repeated exposure allows a near-threshold stimulus to have progressively greater access to awareness).

Monk and his colleagues found that the healthy participants in the masked condition did exhibit gaze biases away from the threatening information over time. Using fMRI, the researchers specifically found that the behavioral learning/plasticity (change in gaze) was associated with increased activation in the right occipito-temporal cortex. These findings suggest that there were increased neurophysiologic responses when healthy adults adapted, via attention-oriented processes, to threatening cues. Davidson, Jackson, and Kalin (2000) have found experience-induced changes suggestive of neuroplasticity in regards to the effects of stress on neural circuitry. In a range of settings (e.g., occupational, lab attention tasks) attentional abilities have therefore been found to be malleable and trainable to some extent.

Evidence of attentional plasticity created through training has been demonstrated in older adults as well. Older adults have demonstrated more difficulty in attempting to perform dual tasks, which suggests the decline of attentional control skills (Hartley, 2001; McDowd & Shaw, 2000). However, Bherer, Kramer, and Peterson (2005) recently found that older adults could be trained through attentional regulation processes to show equivalent performance to young adults on dual-tasks which required similar motor responses. They found that this increase in performance could then later generalize to new tasks involving attentional control (Bherer et al., 2005). Several studies have demonstrated that executive attention skills can be trained in children, younger adults, older adults, and individuals with attentional disorders (Bherer, Kramer, Peterson, Colcombe, Erickson, & Becic, 2006; Kerns, Esso, & Thompson, 1999; Posner, Sheese, Odludas, & Tang, 2006; Rueda et al. 2004). All

these populations demonstrate adequate attentional plasticity to learn new attentional regulation skills (Bherer et al., 2005; Bherer et al. 2006). Not only do attentional training paradigms improve individuals' attentional regulatory processes, but below we will review evidence that different training paradigms improve individuals' abilities to regulate their emotions. If these training effects endure over time, then attentional deployment may be an effective tool in facilitating emotion regulation.

Training Attention to Improve Emotion Regulation

Researchers have developed several types of attentional training (AT) methodologies. First, we will first attempt to classify these training paradigms within a model that integrates AT methods with the attentional substrates and the emotion regulation processes and outcomes that training may modify. We will then describe why this model is important and how the unique components of the model interrelate. Next, we will illustrate in detail the methodology used with each training technique and provide evidence concerning how specific types of training may improve emotional functioning. Returning to our process diagram (see Figure 1), we will examine how each training method affects regulatory strategies involving attentional processes (arrow A) and then later explore how these changes in process affect emotion regulation outcomes (arrow B), improving regulation. Finally, we will address limitations and challenges to attention training methods and provide future directions suggesting what types of training may be most effective. Table 1 presents empirical AT studies and links them to the emotion regulation processes or outcomes that were assessed. Studies were selected that incorporated an intervention or experimental manipulation and also investigated whether attention training methods facilitate emotion regulation processes or improve regulation outcomes as a result of training (i.e. whether they assessed affect). To be able to explore specifically *how* these training interventions may modify different attentional processes that act in the service of emotion regulation, a new model is needed.

Constructing a Model of Attention Training Methods: Integrating Emotion Regulation Strategies and Attentional Networks

We now propose a functional attention training model of attention-based emotion regulation strategies and how these strategies might be modified by training. Why is such a model needed? On the most basic level, having a model that further clarifies attentional constructs allows cognitive, social, and clinical researchers to work within a more common and unified nomenclature. However, this is not just an issue of word choice; there are serious ambiguities concerning how training works and what attentional processes and emotion regulation strategies might be changed by specific types of training. Therefore, the key purpose of our model is to provide a hypothetical framework as to what specific attentional processes (i.e. alerting, orienting, and executive control processes) are affected by specific training techniques in the service of emotion regulation. Clearly describing such a model is necessary to facilitate more directed future research aimed at finding out what attentional processes are modified with different types of attentional training (arrow A) and what active ingredients (i.e. the mechanisms of working memory capacity, attentional control) may lead to successful and lasting training effects.

The current model clarifies and informs many issues regarding how selective attention influences affect. First, the model provides a context to assess how different training methods may uniquely affect attentional processes in each of the attentional networks. Investigating these processes will provide insight into what mechanisms are responsible for changes in attentional plasticity allowing training effects to endure. Pairing emotion regulation training strategies with specific attentional networks allows for future investigation into what mechanisms create attentional flexibility, stability, broadening,

narrowing, as well as the neurobiological correlates of these mechanisms. Knowing these mechanisms, in turn, would allow researchers to optimize intervention design creating more effective and customized training. For example, Isaacowitz et al. (2009) found that positive gaze preferences helped older adults avoid mood declines if they had high-functioning executive control networks. This may indicate that individuals with more low-functioning executive control networks may benefit most from gaze-based training (i.e. dot probe) training techniques because these adults may not already exhibit positivity biases in their gaze. In addition, these adults may benefit from training techniques that improve executive function. The most effective attention training interventions will take into account individual difference variables and then pair training techniques with individuals based upon what mechanisms the technique modifies.

The model further allows us to speculate how attention training may affect other emotion regulatory processes that sometimes include facets of attentional deployment, such as cognitive reappraisal. Knowing how attentional deployment works in parallel with (or differently than) reappraisal may allow interventions to be maximized to strengthen their effect. In addition, if clinical psychologists know what aspects of attentional dysfunction or maladaptive attentional patterns exist in their clients, then they can use this model to best target what type of training intervention might be most effective for certain clinical populations. In an effort to further improve emotion regulation, this model also lets us begin to address the more practical question of whether different types of attention training can successfully generate lasting positive attentional and emotional profiles in individuals over time. A positive threshold of attention may exist where paying attention to the positive is optimal only to a certain degree. Our model is therefore important because it establishes a framework to allow researchers to address research questions that are both conceptual (e.g. which attentional processes are being changed by what mechanisms) in nature as well as applied (what training methods may have the most therapeutic benefits). The new model is outlined in Table 2.

Specific types of attentional training methods are listed in the first column: cognitive gaze training tasks (dot-probe and visual search training), clinical attention training methods (i.e. auditory attention training), and meditative practices (concentration, insight, and loving-kindness). This list of methods is not intended to be exhaustive, but rather concentrates on training techniques that have been argued to directly influence and improve individuals' emotion regulation.

Along the bottom row of the model, the three types of attention networks are specified: alerting, orienting, and executive control as well as an abbreviated description of their primary functions. Posner and Petersen (1990) have defined attention as a complex, cognitive system containing three independent, but related, network stages: alerting, orienting, and executive control. The alerting network heightens internal awareness and maintains sufficient neural activation enabling the attention system to make a fast response (Callejas, Lupiàñez, Funes, & Tudela, 2005). The orienting network guides our focus towards selective and salient inputs, thereby augmenting attentional processing. The executive control network resolves conflict among different neural systems competing for control, facilitates the deconstruction of habitual responses, and directs planning, error detection, decision-making, and novel-response formation functions (Norman & Shallice, 1986; Posner et al., 2006).

It is important to highlight that within the field of attention there is not universal agreement concerning the nature and components of attention (see also Broadbent, 1958; Desimone, 1999; Desimone & Duncan, 1995; Müller, Malinowski, Gruber, & Hillyard, 2000; Treisman, 2006) and that the model presented in this review seem to best fit the current

objective of assessing how attentional deployment regulates emotion. It is also important to note that although interrelated, the alerting, orienting, and executive control networks act mostly independently (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Fan, McCandliss, Sommer, Raz, & Posner, 2002) although some specific exceptions have been found (cf. Callejas, et al., 2005; Fuentes & Campoy, 2008). Therefore it is *not* necessarily accurate to think of the three networks as stages in a process model of attention, but rather as concurrent processes that inform one another (Barrett & Bar, 2009). However even if a particular type of training modifies all three networks, they may be modified in *different* ways, and this may differentially predict regulatory outcomes. We attempted to be comprehensive, rather than selective, in creating this model and therefore indicated ways in which all networks *could* possibly be modified by training. To stimulate further research, we explicitly state how different types of training may modify *each* network, rather than limit our predictions to just the one network that is the most likely modified.

Importantly, a row identifying similar attentional constructs further clarifies what distinct attentional terminology aligns with the three primary attentional networks (for example, the orienting network consists of attentional selection and scanning constructs). This specification of the model is critical because within the attention literature, a variety of disparate terms are used that may share common meanings. This feature of the model was derived from Raz and Buhle's (2006) review of the specific components of attentional networks, which provided an extension of Posner's original categorization of the networks. In addition to proposing a unified attentional nomenclature, they also integrate several theoretical standpoints that support the existence of the three separate networks and identify the specific neuroanatomical structures lending further support for unique attentional networks. Adding these components allows us to make more specific training – attention links.

Within the remaining cells of the model, different types of attention-based emotional regulatory strategies are listed. These strategies are educated, mostly a priori, conjectures deduced from the limited body of literature on training methodologies. Therefore, although future research is needed to add more definitive support or modify these demarcations, the model may be a quite valuable starting point for hypothesis-testing about training effects on emotion regulation. The model illuminates what attention-based regulation strategies, within each attention network, are likely to be involved in each of the training methods. Breaking these strategies and their underlying attentional processes into distinct categories both creates a clearer picture of how they are impacted by training and allows for them to be better empirically tested. For example, dot-probe training is likely to influence the orienting network (Bradley, Mogg, & Millar, 2000; Posner & Petersen, 1990). Training might affect orienting by biasing individuals' first gaze fixations toward positive information, increasing the amount of time that they look at positive information, or increasing the quantity of saccades towards positive information. Alternatively, dot probe training may also influence the executive control network by increasing the probability that a negative or neutral first fixation is followed by a subsequent positive fixation; this would indicate improved attentional disengagement from negative information and reorientation towards positive information.

This model also identifies more general training categories that share similar types of attention-based regulatory strategies. We found it useful to attempt to classify these broad-based training categories according to Gross's (1998) three primary strategies of attentional deployment: concentration, distraction, and rumination, so this is included in the model as well. Concentration and insight meditative practices best correspond with the strategy of attentional concentration. These practices require individuals to engage their cognitive resources in maintaining a state of either attentional focus or awareness (in concentration

practice maintaining focus on an object; in insight practice on maintaining a state of awareness without focus). Concentration may utilize all the attentional networks as it requires an attentional readiness component (alerting), selective attention (orienting), and the ability to inhibit competing stimuli from entering attention (executive control). Dot probe training and visual search training (i.e. find-the-smile training) are best categorized within the strategy of attentional distraction. All of these training methods require individuals to shift their attention towards or away from affective information. Distraction involves recruitment predominantly of the orienting network, to direct selective attention, and the executive control network, to reconcile conflicting information (Posner & Petersen, 1990; Raz & Buhle, 2006). Clinical auditory attention training (ATT) incorporates aspects of distraction and concentration. Individuals must first shift their attention to nonemotional information (i.e. sounds) and then shift attention between forms of nonemotional information. Individuals must also concentrate on maintaining their attention on one sound and then concentrate on listening to multiple sounds. Finally, another type of training method, loving-kindness meditation (LKM), seems to most closely fit the strategy of rumination (albeit *positive* rumination), although it incorporates aspects of concentration as well. Rumination most likely predominantly involves the orienting network (Posner & Petersen, 1990). Positive rumination may be indicative of a well-functioning orienting system (i.e. one that does not get entwined in negative thoughts or reactivity); however, maladaptive rumination (or depressive rumination) may indicate that the orienting system is not functioning optimally (i.e. one cannot disengage from repetitive negative thoughts).

The current model also includes some speculation about the level of cognitive effort required for different training procedures. Different emotion regulation strategies require varying amounts of cognitive effort and have different cognitive costs (e.g. Richards & Gross, 2000; Sheppes & Meiran, 2007; Sheppes & Meiran, 2008; Wenzlaff & Bates, 2000). The level of cognitive effort and costs involved in initiating various strategies may be important determinants of their effectiveness. The model predicts that training strategies focused on distraction, which use implicit learning tasks to automatically reorient attention, will require the least amount of cognitive effort. Strategies that require high levels of concentration will require the highest amounts of cognitive effort (Erber & Tesser, 1992), and strategies that combine multiple categories, such as ATT (distraction, concentration) or LKM (rumination, concentration), likely require a moderate amount of cognitive effort. Cognitive costs differ between regulatory strategies. Full attentional resources must be devoted to meditative practices so an individual cannot concentrate on other or multiple tasks (Brown, Ryan, & Creswell, 2007). Even distraction may have some cognitive costs in impairing memory functions (Sheppes & Meiran, 2008).

A distinction should be made between the amounts of cognitive effort required for the acquisition of a strategy (e.g. learning to focus attention on an object) versus the effort required for the execution of a regulatory strategy (i.e. employing a learned strategy such as meditation); when we discuss cognitive effort in the text, we are referring to both acquisition *and* executive effort, unless otherwise stated. Strategies based on distraction may require less effort to acquire and less effort to execute relative to strategies based on concentration. Concentration-based strategies may require more effort to acquire initially and more effort to execute over time (see Table 2); however, for some individuals concentration may still be an extremely effective regulatory strategy.

Below we will describe several types of attentional training techniques, connecting each to the model and its components and providing evidence on how each type of training may facilitate emotion regulation. It is important to note that some of the training interventions outlined in the studies below assess hedonic-based emotion regulation outcomes (e.g. feeling good, Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; reducing stress levels, Carmody &

Baer, 2008; Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007) while others assess regulatory processes (e.g. how long one perseveres through difficult situations, Johnson, 2009; how one deploys their attention when exposed to stressors, Wadlinger & Isaacowitz, 2008). However, not all of the following intervention studies assessed both regulatory processes and outcomes simultaneously; this is a limitation of the research to date. Successful changes in regulatory outcomes cannot necessarily be inferred from changes in regulation processes (or vice versa); therefore future research would need to test these links. Importantly, many other mechanisms may moderate the relationship between regulatory process and outcome such as social support, social desirable responding, or the experience of enhanced positive emotional states. Thus, the available evidence presented below that demonstrates AT procedures successfully modifies attentional processes and/or regulation outcomes must be interpreted conservatively. After we review types of attention training methods, we will finally discuss what our model can tell us about the role of attention in emotion regulation.

Training Gaze Patterns

The first type of training methodology we consider uses behavioral tasks to train individuals' gaze patterns. Research in cognitive psychology has employed AT methodologies incorporating dot probe, flanker, and emotional Stroop tasks that train individuals to either implicitly or automatically reorient their attention towards certain affective stimuli. Stimuli for these training methodologies may include various images or words, typically presented in pairs -one each of a neutral and emotional valance. In a dot-probe task, prototypic stimuli may include the word pair "death" (anxiety-inducing) and "decal" (neutral) adjacently appearing on a computer screen for 1000ms. After these words disappear, a visual probe appears on the screen (such as a pixilated arrow) and participants have to determine the direction the arrow is facing. During the training, an individual's attention is drawn away from the negative word and redirected toward the neutral word by having the probe appear consistently, for the majority of trials, behind the location of the neutral word. How well an individual is able to perform on these tasks (i.e., response time) acts as an indicator for whether attentional biases have changed in the expected direction or not. In a successful manipulation an individual learns to automatically disengage from negative cues and reorient their attention consistently toward neutral ones (Mohlman, 2004). The length of performance on these tasks is typically 10–20 minutes and may involve multiple training sessions (Dandeneau et al., 2007; MacLeod et al., 2002; Wadlinger & Isaacowitz, 2008). Studies using these tasks have shown that attention can be successfully trained towards certain affective information, suggesting that practice with tasks can reduce the influence of negative emotional information (or increase the influence of positive emotion information) on attention. What remains to be seen is whether these skills transfer to more general tasks and how long the effects last. Below we will explore how gaze patterns can be trained, in the service of emotion regulation, towards neutral (away from negative) information and analogously toward positive (away from neutral) information.

Training attention towards negative information—Individuals can be trained to allocate their attention toward negative stimuli in their environment and this type of training results in increased emotional susceptibility to subsequent negative stimuli (MacLeod et al., 2002). However, individuals trained to attend towards neutral stimuli do not demonstrate this susceptibility towards negative stimuli (Amir, Beard, Burns, & Bomyea, 2009; Amir, Weber, Beard, Bomyea, & Taylor, 2008; MacLeod et al., 2002; Schmidt, Richey, Buckner, & Timpano, 2009). In this study, undergraduate students attempted to complete several unsolvable anagram puzzles under timed conditions with failure feedback while being videotaped to elevate their stress level and elicit negative emotion. Next, participants were trained to selectively attend to negative or neutral words in word-pairs through a dot-probe

attentional training paradigm, like the one described in the previous section, incorporating nearly 800 trials. Finally, participants completed another group of unsolvable puzzles under the same conditions as the first set to determine whether their levels of emotional vulnerability had changed as a result of the attention training. Individuals in the attend-negative condition showed attentional vigilance for negative information at the end of the training task, a similar attention pattern as expected from highly anxious individuals. In addition, they reported being in significantly worse negative moods, than the attend-neutral group, in their post-test stress task as compared to their pre-test stress scores. Trained selective attention to negative information reduces individuals' abilities to successfully regulate their emotions, resulting in heightened sensitivity to negative emotions.

Amir and his colleagues (2009) used a modified dot-probe task to train individuals' attention towards neutral and away from negative words. Schmidt et al. (2009) used a similar procedure to train attention towards neutral and away from negative faces. Participants included individuals with generalized anxiety disorder (Amir et al., 2009) and with season affective disorder (Schmidt et al., 2009). Training consisted of 8 total sessions (completed bi-weekly) lasting approximately 15–20 minutes each. GAD participants who received the attend-neutral training demonstrated an attenuated attentional bias to negative (i.e. threatening) words (as assessed by response time bias scores) and demonstrated less self-rated and clinician-rated anxiety symptoms as compared to the attention control condition (Amir et al., 2009). Similarly, SAD participants in the attend-neutral condition showed reductions in trait anxiety after training as compared to the attention control condition (Schmidt et al., 2009).

Training attention towards positive information—Several studies have investigated whether training attentional patterns to positive or rewarding information can influence affective states or lead to successful emotion regulation (Dandeneau et al., 2007; Goetz, Robinson, & Meier, 2008; Johnson, 2009; Wadlinger & Isaacowitz, 2008). In the first study, researchers designed a visual probe task (comparable to a visual search task) that involved repeatedly ignoring information associated with a social threat and instead searching for information relaying positive social acceptance (Dandeneau et al., 2007). Participants, who were undergraduate students, were divided into three conditions: train-acceptance, control, and exposure. Train-acceptance participants were presented with a grid of 16 different faces, fifteen frowning faces and one smiling face, and were instructed to click on the accepting face as quickly as possible with a mouse. Control participants were presented with schematic flowers and instructed to click on a five-petal flower amongst images of seven-petal flowers. Exposure participants were instructed to simply look at a grid of 16 frowning faces. Participants completed their assigned training task online for five days performing 112 training trials each session. After this period, train-acceptance participants reported feeling less stressed about an upcoming exam, and after completing the exam they felt less anxious and more competent in their academic abilities (Dandeneau et al., 2007).

This visual probe training task was then administered to a group of telemarketers, individuals who frequently face social rejection. Train-acceptance participants reported higher self-esteem, lower stress, and higher self-confidence after just five consecutive days of training. In addition, they had lower levels of cortisol and received higher objective performance evaluations than their peers in the exposure and control conditions (Dandeneau et al., 2007). This research demonstrated that training attention to positive information helped individuals regulate their emotions in daily tasks; however, it did not address whether these regulation improvements resulted from generalized attentional preferences towards positive stimuli after the training.

In the second study, Wadlinger and Isaacowitz (2008) explored whether positive visual attentional preferences could be trained and if this training would result in future attentional deployment towards positive stimuli. Undergraduate students were eye-tracked through a visual stress task where they viewed a set of highly negative images, which provided a baseline measure of attentional deployment. Gaze away from unpleasant, stressful images served as an indicator of successful emotion regulation (e.g., Isaacowitz, 2005; Isaacowitz et al., 2006b; Xing & Isaacowitz, 2006). As suggested above, looking away from irrelevant negative stimuli may be a distraction strategy that helps individuals effectively maintain a positive or neutral emotional state when presented with negative information. After the tracking to images, participants were experimentally trained to selectively attend to positive or neutral information using a dot-probe training paradigm; that is, half of the participants were in the train-positive condition, while the other half were in the train-neutral condition (see MacLeod et al., 2002). Finally, participants were eye-tracked through another series of highly negative visual images.

Prior to the attention training, there were no significant differences in the quantity of time participants in the two conditions viewed the negative images at baseline; however, a significant difference emerged in the amount of time they viewed the negative pictures after training. Participants in the train-positive condition viewed the negative images in the second visual stress task significantly less than the baseline task, appearing to have learned a strategy of attentional avoidance toward negative stimuli. In contrast, the average looking times of the train-neutral participants suggested that they viewed the negative pictures more after the training. Importantly, the trend for train-neutral participants to look more at negative post-test images compared to their baseline looking behavior suggests that negative stimuli in general remain salient and attention-catching even during the second stressor task. These findings suggest that preferences toward positive information can be successfully trained and that these positive preferences can be effectively generalized to subsequent visual information. Individuals in the train-positive condition shift their attention away from the negative components of the images, demonstrating gaze patterns indicative of successful emotion regulation (Isaacowitz, 2006; Isaacowitz et al., 2006a, 2006b).

A third study has found that training goal-directed attention towards positive stimuli facilitates effective emotion regulation (Johnson, 2009). Undergraduate participants first completed baseline measures of state anxiety and frustration. Next, they performed an anagram stress task followed by another state anxiety and frustration measure. Participants then completed a dot-probe attention task where they were assigned to either a goal or no goal condition. The dot-probe task consisted of responding to probes that appeared randomly behind happy-angry face pairs. In the goal condition participants were instructed to focus their attention on the happy faces and were told that the appearance of the probe would be completely random; therefore, they should keep their focus on the happy faces no matter where the probe appeared. Participants in the no goal condition were simply instructed on how to complete the dot-probe task. After the dot-probe, participants completed a third state anxiety and frustration measure, and after that a final anagram stress task. Finally, a fourth state anxiety and frustration measure was administered.

Participants in the goal condition, who deployed attention toward positive faces and away from angry faces, showed almost three times significantly lower state frustration scores from before to after the second anagram stress task (after the training) as compared to those in the no goal condition. Moreover, individual differences in participants' ability to attend to the positive faces predicted how long they persisted in attempting to complete the anagram stress task. Participants better at attending to the happy faces persevered longer on the stress task. Importantly, this study demonstrated that individuals are able to pursue regulatory

goals under stressful conditions and that selective attention is a successful regulatory strategy (Johnson, 2009).

Training techniques that modify gaze patterns may work through a number of mechanisms. Because individuals experiencing negative emotions tend to bias their attentional patterns towards negative stimuli (Beevers & Carver, 2003; Bradley, Mogg, & Lee, 1997; Caseras, Garner, Bradley, & Mogg, 2007; Eizenman et al., 2003; MacLeod, Mathews, & Tata, 1986; Mathews, Ridgeway, & Williamson, 1996; Mogg, Mathews, & Eysenck, 1992; Mogg, Millar, & Bradley, 2002), learning to avoid them instead may prove adaptive by preemptively evading the negative emotion they may elicit. Attentional training to positive information may facilitate heightened preference for positive material; thereby, this process may promote avoidance of ensuing negative information. Training positive attentional preferences may modify the alerting network, creating attentional vigilance for positive information, as well as the orienting network, directing selective attentional preferences towards positive information. Repeated exposure to sizeable amounts of positive stimuli may effectively redirect attentional guidance mechanisms towards positive representations, making negative representations less accessible. In relation to Gross's (1998) three types of attentional regulatory processes, these training methods likely best fall under the category of attentional distraction. Regulation strategies involving distraction have been shown to be effective even when engaged late in the regulatory process (e.g. Sheppes & Meiran, 2008); therefore, using gaze strategies like "looking happy" may be both cost-effective and adaptive (Allard, Wadlinger, & Isaacowitz, 2009).

The positive repetition priming generated by this type of training may facilitate later encoding of positive information in naturalistic circumstances (surfing the web, reading the paper, watching television) for certain positive affective information. Positive priming may also make other positive emotional goals and emotion regulatory strategies (e.g. positive reappraisal) more accessible (Johnston, 2009). Another mechanism of avoiding negative information may be through mood maintenance (Wegener & Petty, 1994). By repeatedly attending to positive information individuals may be better able to regulate their mood, with positive mood acting as a moderator for its own self-preservation (Fredrickson & Joiner, 2002). One final potential mechanism may be that individuals learn to adaptively take in just the minimal amount of information needed from a negative image to decode its meaning, rather than visually ruminating on its negative details. Selective inattention to negative information could be the result of an effortful process such as disengagement of goal-irrelevant cues (e.g., negative images that might create a bad mood) or thought suppression.

While these gaze training methodologies require individuals to direct their visual attention towards information of a particular emotional valence, other attentional training methodologies do not require the orientation of visual gaze patterns and instead often require individuals to direct their internal attention towards neutral, instead of emotional, stimuli. Research investigating these attentional training methodologies has utilized clinical interventions targeted at reducing symptoms in clinical samples as well as meditative interventions aimed at ameliorating stress in nonclinical samples. Below we will review several clinical and meditative attention training methods as well as evidence that these training techniques also improve individuals' abilities to regulate their emotion.

Clinical Training Methods

Clinical AT methods involve the disengagement of attention from negative emotional information and reorienting attention towards processing neutral information. Individuals are taught to disengage self-focused attention from interoceptive (e.g., internal, cognitive-emotional) cues and reorient their attention towards exteroceptive (e.g., external, sensory) cues (Mohlman, 2004). Many emotional disorders feature dysfunctional information

processing such as attentional patterns towards maladaptive information, automatic activation of negative self-beliefs and appraisals, intrusive thoughts, and high self-focused attention (MacLeod, Mathews, & Tata, 1986; Mogg et al., 2002; Papageorgiou & Wells, 1998; Watson & Purdon, 2008; Wells & Mathews, 1996). Individuals with certain clinical disorders, such as anxiety or depression, allocate more resources and energy towards emotional processing, leaving fewer available for cognitive processing and flexibility. Individuals with emotional disorders often lack the knowledge that they can focus and shift their attention to control their emotions (Mohlman, 2004). Therefore, if individuals can be effectively trained to reorient their maladaptive attentional patterns towards more neutral content, they may be able to more effectively control their emotional states. This is in contrast to desensitization approaches (e.g., Street & Barlow, 1994) that try to make negative stimuli themselves more neutral through repeated exposure.

Wells (1990) developed the first clinical AT paradigm (ATT), which trains individuals to reallocate their attention from emotional to neutral information processing through the use of three auditory tasks. Participants are first asked to focus and sustain their attention on one environmental cue (e.g., a metronome ticking) and then selectively shift their attention to more remote sounds with increasing noise interference (e.g., a copy machine, passing traffic). Next, participants practice alternating their attention between two sounds. To improve their divided attention, participants are later instructed to focus on several sounds simultaneously.

Clinical ATT training may lead individuals to demonstrate an attentional vigilance for particular auditory sounds within the alerting network. In terms of the orienting network, participants trained in ATT enact the regulatory strategy of selectively attending to particular auditory sounds. Using the regulatory strategy of alternating their attention between auditory sounds, individuals trained in ATT engage the executive control network. Within this network, ATT individuals disengage attention from internal thoughts and reengage attention with external sounds to help manage their emotions. Therefore the varying task instructions in ATT training may modify each of the three attentional networks in unique ways. ATT methods require a moderate amount of cognitive effort and require the engagement of attentional processes that are based in both distractive as well as concentrative regulatory strategies (Gross, 1998).

This auditory ATT paradigm has been successful in reducing clinical symptoms of several DSM-diagnosed disorders, including panic disorder (Wells, 1990), social phobia (Wells, White, & Carter, 1997), major depression (Papageorgiou & Wells, 2000; Siegle, Ghinassi, & Thase, 2007), and hypochondriasis (Papageorgiou & Wells, 1998). These reductions in symptoms emerged after 2–10 weeks of practice and in several studies the non-clinical levels were maintained at 3, 6, and 12 months follow-up. Training included one weekly half-hour session with a licensed clinician and two 15–20 minute practice sessions at home per day. Participation in these studies was limited to clinical samples and the sample sizes for these studies were small (only up to – 4 per group; with the exception of 31 in the Siegle et al. study). These important limitations notwithstanding, clinical training methodologies appear successful in facilitating emotion regulation with clinical populations by improving regulation outcomes.

Meditative Attention Training Methods

Secular meditative training can be categorized into two common types of practices: focused attention (FA) and open monitoring (OM; Lutz et al., 2008). Focused attention meditation involves voluntarily directing sustained attention on a specific object (i.e. most often the breath). Open monitoring meditation involves cultivating awareness in the absence of any attentional focus. In open monitoring, participants may become aware of external stimuli

(e.g. noises, movement); however upon noticing their mind wandering, they must disengage their attention from the distracting stimuli and redirect their attention back to the process of awareness.

According to our model, concentration meditation (e.g., a type of focused attention training such as Shamatha) and insight meditation (e.g., a type of open monitoring training such as Vipassana) both initially require more cognitive effort to enlist as compared to other attentional regulatory processes (although these techniques may require less effort with substantial practice, Tang & Posner, 2009). However, the studies outlined below suggest that both of these practices may improve individuals' emotion regulation outcomes, such as increasing their actual levels of well-being. Within the alerting network, concentration meditative training involves sustaining attention on an object (e.g. the breath) while insight meditation instead involves a more general sustained awareness without focus. Concentration meditation is likely to influence the orienting network to a greater degree in that it requires selectively attending to the object of meditation. In contrast, in requiring that one has an open focus of attention, insight meditation does not involve selective attention to an object. Both meditative practices require continual disengagement with distracters, enlisting the executive control network. While concentration meditation involves a reengagement with the selected object of attention, insight meditation involves a non-reactive labeling of any distracters that may arise, followed by an immediate reorientation back towards sustaining awareness without focus.

Several other types of meditative practices are centered on mindfulness techniques: mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), and integrative body-mind training (IBMT). Mindfulness combines two primary components: the online self-regulation of attention and an open and accepting orientation towards one's experiences in the present moment (Bishop et al., 2004). Bishop and colleagues (2004, p. 233) speculate that mindfulness involves components of sustained attention, attentional switching, and a cognitive monitoring process that involves "inhibit[ing] secondary elaborative processing of the thoughts, feelings, and sensations that arise in the stream of consciousness." MSBR involves a variety of meditative and yogic practices that dissect the actual direct experience of stress into its individual components by noticing the mind's reaction to the perceived stress, and then learning how to let go of that reactivity (Kabat-Zinn, 2003). MBSR allows the physiological effects of stress to pass naturally while an individual reassesses their relation to that stressful event. Because MBSR techniques incorporate a variety of methods, and not a single training technique, they were not included in Table 2. MBSR likely modifies a number of mechanisms influencing emotion regulation.

MBCT has been developed within the field of clinical psychology as an intervention to reduce relapses specifically in recurrent major depression, although current research is extending MBCT techniques to other clinical disorders (Coelho, Canter, & Ernst, 2007; Segal, Williams, & Teasdale, 2002; Teasdale et al., 2000). MBCT combines techniques acquired from mindfulness practices with those of cognitive therapy. Individuals are taught to view negative events or emotions as products of the mind and not inherent unchangeable traits of the self. IBMT is derived from Chinese medicine and incorporates mindfulness training, body relaxation and posture adjustment, breath adjustments, and guided mental imagery techniques (Tang, Ma, Wang, Fan, Lu, Yu, et al., 2007).

In their review of the theoretical foundations of mindfulness, Brown and colleagues (2007) call for the need to elucidate how mindfulness might converge with other attention processes (e.g. attentional stability or concentration, attentional flexibility, and the three attentional networks) in order to inform research on how mindfulness may impact other cognitive,

affective, physiological, and neurobiological variables. A recent study has suggested that a reduction of negative rumination may partially mediate a causal link between higher levels of mindfulness and the reduction of individuals' levels of anger, verbal aggression and hostility (Borders, Earleywine, & Jajodia, 2010). Evidence also has demonstrated that participation in a Vipassana meditation retreat (i.e. insight meditation) show a reduction in the reflective dimension of the ruminative responses scale, although reduction in the brooding dimension was not significant (Chambers, Chuen Yee Lo, & Allen, 2008).

A final notable type of meditation is loving-kindness meditation (LKM). LKM is a meditative practice, derived from South Asian Buddhist practices, where individuals learn to actively generate a state of positive emotional experience (i.e. loving-kindness, compassion, and empathy), for example -- wishing for positive experiences for other individuals (Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008). With practice the target of compassion can change from being specific individuals to strangers and ultimately to being non-referential -- not related to any specific object, person, or situation -- though this last stage is only obtained with extensive practice. Although with LKM the explicit focus is not on training attention but rather training oneself to generate this positive emotional state, we feel it is important to include this type of training in the current model as LKM does incorporate some components of maintaining and training attentional focus. Furthermore, many types of meditative traditions view LKM as crucial to augment other practices (Lutz, Brefczynski-Lewis, et al., 2008). LKM requires the use of the alerting network to create sustained attention to positive emotion and the orienting network to selectively attend towards this positivity. Practicing LKM individuals must direct their attention towards evoking the emotion as well as maintain this state with concentration. In this sense, LKM can be viewed as an attentional process that requires both concentrative techniques as well as rumination on the positive (Gross, 1998). The executive control network is required to facilitate the individual's disengagement with distracters and reengagement with attending to and generating a positive emotional state.

While there are many different forms of meditative practices, only MBSR and LKM training and their variants are reviewed because they have the most empirical backing. Below we will consider evidence concerning how both MBSR and LKM practices improve emotional regulatory processes.

MBSR interventions promote emotion regulation—Evidence that MBSR meditative training helps individuals regulate their emotional state comes from studies of many different populations: healthy adults, individuals experiencing high levels of stress, physically ill patients, and college students (Anderson, Lau, Segal, & Bishop, 2007; Carlson, Speca, Faris, & Patel, 2007; Carlson, Speca, Patel, & Goodey, 2004; Carmody & Baer, 2008; Chang et al., 2004; Davidson et al., 2003; Ramel, Goldin, Carmona, & McQuaid, 2004; Rosenzweig, Reibel, Greeson, Brainard & Hojat, 2003; Shapiro, Oman, Thoresen, Plante, & Flinders, 2008; Shapiro, Schwartz, & Bonner, 1998). In one study, healthy adults were randomly assigned to either an eight-week MBSR course or a wait-list control group (Anderson et al., 2007). Immediately after the training, participants in the MBSR course showed significant reductions in emotion regulation outcome measures such as depression and anxiety symptoms, anger, and anger-related rumination, as well as increases in positive affect, compared to pre-training levels. In addition, improvements in the level of experienced mindfulness predicted improvements in general emotional well-being.

In another study, the experimental group consisted of volunteers participating in an eight-week MBSR workplace intervention (Davidson et al., 2003). During work hours, volunteers attended two sessions per week taught by a facilitator trained in mindfulness meditation (Davidson et al., 2003). The control group consisted of wait-listed employees who would

receive the intervention at a later date. All participants completed a pre-and post-battery of laboratory testing involving electroencephalography (EEG) readings and psychosocial measures. Participants who had received MBSR training showed significant increases in left-sided activation in the anterior cortical area when compared with the activation levels in these same regions of the control participants. This left anterior cortical activation increase in MBSR participants may indicate emotion regulatory processes are taking place as activation in this area is correlated with positive emotional expression and higher levels of dispositional positive affect (Davidson et al., 2000; Urry et al., 2004). The authors conclude that MBSR training can lead to brain changes that promote better handling of the negative emotion when experiencing stress and that these changes are durable, lasting even after the intervention has taken place (Davidson et al., 2003).

Another group to whom a MBSR intervention may be particularly beneficial is medical and graduate students, who must deal with a high degree of stress. In one study a group of medical students electively participated in a ten-week MBSR seminar and were paired with matched controls, who took another optional seminar on alternative medicine (Rosenzweig et al., 2003). The seminar started and ended during finals period where students completed the Profile of Mood States questionnaire to assess their total mood disturbance (TMD) (McNair, Lorr, & Droppleman, 1992). Upon completion of the seminar, the experimental group's TMD scores were significantly lower than those of the control group. The experimental group scored eighteen-percent *lower* than their baseline score, while the control group scored thirty-eight percent *higher* than their baseline. Specifically, the experimental group scored significantly lower than the control group on the tension-anxiety, fatigue-inertia, and confusion-bewilderment domains and higher on the vigor-activity domain (Rosenzweig et al., 2003). These results indicate students receiving the MBSR training were better able to regulate their emotions during a stressful time as indicated with the significant difference in the TMD, an emotion regulatory outcome measure. Another similar study found that medical students who took an MBSR and loving-kindness training course demonstrated lower self-reports of emotional outcomes of depression, state-and-trait anxiety, and increased scores of empathy and spiritual experience compared to wait-listed controls (Shapiro et al., 1998).

Meditative training has also been found to help individuals experiencing illnesses regulate their emotions and reduce their stress levels. Carlson and colleagues (2004) studied the effect of MBSR on patients with breast and prostate cancer. Patients enrolled in an eight-week MBSR program that incorporated relaxation techniques, sitting meditation, hatha yoga, and didactic courses as well as daily home practice. At the end of the study, there was a difference between pre-and-post intervention scores such that individuals exhibited a reduction in stress level and improved overall quality of life as assessed by the outcome of a total mood disturbance score.

A recent study illustrates that a modified MBSR training program, Mindfulness-based Mind Fitness Training, may help military reservists preparing for deployment to regulate their emotions (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010). Soldiers enrolled in the 8-week training program that had high levels of practice over time demonstrated increases in working memory capacity (WMC) relative to those that had low levels or practice over time; the latter showed decreases over time in WMC. Soldiers that had high levels of practice over time also reported higher levels of positive affect and lower levels of negative affect than soldiers with low levels of practice. In addition, the relationship between practice time and negative affect was mediated by WMC.

Loving-kindness meditation promotes emotion regulation—While MBSR meditative programs may be more effective in training individuals to manage negative

emotions, interventions focused on loving-kindness practices may be more likely to facilitate the generation of positive affect (Fredrickson et al., 2008). Loving-kindness meditation may improve emotion regulation by bringing attention to and generating feelings of positivity. For example, one study found that social connection towards strangers could be created in a laboratory setting through a brief loving-kindness meditation exercise (Hutcherson, Seppala, & Gross, 2008). Individuals assigned to this meditative practice showed increased feelings of positivity (positive social emotions) and social connectedness just after a few minutes of practice, compared with a closely matched control group.

In another study, working adults participated in a six-week loving-kindness meditation training (Fredrickson, et al., 2008). The training consisted of weekly hour-long workshops and instructions to meditate daily if possible. Adults who received the training, compared to a matched control group, showed increases over time in daily experiences of positive emotions (Fredrickson et al., 2008). These positive emotions in turn facilitated increases in personal resources such as social support, decreased illnesses, increased mindfulness, and increased purpose in life.

Aside from generating more frequent positive emotions, meditative practices may also increase levels of attentional control as demonstrated in the alerting, orienting, and conflict monitoring networks (Jha, Krompinger, & Baime, 2007). Jha and colleagues recruited novice meditators, who participated in an eight-week MBSR course, and more experienced meditators, who participated in a month-long mindfulness retreat. Both these groups, and an additional matched control group, performed the Attention Network Test prior to and immediately following their training. The experienced meditators in the retreat group demonstrated greater efficiency in conflict monitoring before the retreat than the novice group, and the novice meditators showed significant improvement, relative to the control group, in attentional orienting after their MBSR training. These findings may reflect improved abilities to voluntarily focus attention in the novice meditators and an existing ability in the experienced meditators. The authors also found that after the retreat the experienced meditators showed improved alerting abilities as opposed to the control and MBSR groups and that this ability was directly correlated with their prior level of meditative experience (Jha et al., 2007). Future work is needed to distinguish what additional mechanisms may be responsible for the changes demonstrated by different types of meditative practices.

Fixing our Focus

Now that we have reviewed the structure and contents of the model, we turn to a consideration of what the model can tell us. First, just as antecedent-based regulatory strategies may be more effective in modifying emotional experience than response-focused strategies that modify the emotion after it has fully transpired (Gross & John, 2003; Mauss et al., 2007a; Schutte et al., 2009), the current model would lead to the prediction that if attention can be modified or trained in the alerting or orienting networks, relative to the executive control network, these types of training methodologies may be more efficient and may require less effort to acquire. While all types of AT methods initially require some degree of effort to acquire, it is likely that with repeated practice these attentional processes can become more automated over time, requiring substantially less effort to execute (Davidson & Lutz, 2008; Lutz et al., 2008; Lutz, Brefczynski-Lewis, et al., 2008; Wegner & Bargh, 1998).

Individual differences will exist in what type of training procedure is most useful for certain populations. Training gaze patterns may have the largest effect on modifying emotion regulation *processes.* Gaze training may only modestly enhance downstream emotion regulation *outcomes* and this relationship may only change as a result of the process itself

being modified. More research is needed to show whether these changes in regulatory processes also create changes in regulatory *outcomes*. Meditative attention training methods have been shown to directly lead to positive emotion regulation outcomes such as increases in positive affect (Anderson et al., 2007), daily positive emotions (Fredrickson et al., 2008), and positive social emotions (Hutcherson et al., 2008). Yet research that examines how meditative techniques influence attentional *processes* is limited (Brefczynski-Lewis et al., 2007; Jha et al., 2007; Lutz et al., 2008; Lutz et al., 2004). Meditative methods may yield more pronounced improvements in emotion regulation through modifying individuals' regulation processes concurrently with their emotional outcomes. Furthermore, directly modifying emotion regulation outcomes might facilitate greater positive resource acquisition helping individuals better cope with future challenges. While meditation seems to have the potential for versatile effects, to what degree each network is modified is contingent upon the amount of time an individual has practiced (Jha et al., 2007). Although meditative practices take the most cognitive effort to initially enact, they may create the most lasting regulatory outcomes of all the training techniques. Meditative practice also improves individuals' levels of mindfulness (Shapiro et al., 2008). Mindfulness is a trait which impedes hedonic adaptation, a major barrier that minimizes the effectiveness of many interventions (Lyubomirsky, Sheldon, & Schkade, 2005; Shapiro, Carlson, Astin, & Freedman, 2006).

Another possibility raised by the model is that, because each of the different training techniques influences distinct attention networks in *unique* ways, combining strategies may magnify their effect on improving emotion regulation. Practicing multiple training techniques may uniquely influence more widespread neuroanatomical structures (Raz & Buhle, 2006) and keep training practice novel. Learned automaticity from training would free cognitive resources that could then be used to resolve other sources of neural conflict. Future research is needed to clarify this prediction and more rigorously examine how each attentional network is modified by the unique types of training methods.

The current model may also help determine what attention-based regulatory strategies are used as components of other emotion regulatory strategies. For example, this model may be useful in further determining how attentional deployment does and does not work within the context of cognitive reappraisal, a regulatory strategy where attentional deployment is a key component (e.g. van Reekum et al., 2007). In order to cognitively reappraise an extremely negative visual scene (such as a car accident), an individual may selectively attend to aspects of the scene (e.g. an ambulance in the background) in order to construct a successful reappraisal story (e.g. the accident victim is ultimately rescued and survives the trauma). This implicates the orienting attentional network. In addition, because the individual has to reconcile competing interpretations of the scene (inhibit the initial negative interpretation and generate a more positive one), the executive network is also likely recruited. Therefore since selective attention is being used, reappraisal may especially activate areas of the brain involving orienting and executive control networks. However, these two regulatory processes can also be dissociated and may recruit unique neural regions (i.e. "distancing" instructions may require recruitment of medial systems and right PFC systems; Ochsner & Gross, 2008).

To summarize, our model linking types of attention training to specific aspects of attention, as well as to emotion regulation strategies and cognitive effort, suggests several main conclusions. First, it is indeed possible to map forms of training onto specific attentional processes, at least conceptually. Second, training can simultaneously modify all of the attentional networks (i.e. the current model is not a process model). Third, attention training directly modifies the use of attentional processes as regulatory strategies, which in turn, can modify affective experience and other emotion regulation outcomes. Fourth, training

techniques are likely to influence components of attentional processes or outcomes differentially and the quantity of time spent training may moderate these effects. And finally, meditation seems to have the most potential for impact across a wide variety of attentional networks as well as modifying a broad range of emotion regulation outcomes. All training techniques that involve attentional concentration might require more cognitive effort, but may ultimately be more effective than strategies based in distraction.

Limitations and Challenges to AT Methodologies

In addition to investigating what distinct mechanisms may underlie different attention training methodologies, more research is needed to further augment existent training procedures to make them more effective. It is important to emphasize that across all the attention training interventions reviewed, only small effects have been observed in small sample sizes over brief time intervals. In light of this limitation, several other challenges hinder the development of effective AT methodologies: quantifying effective training durations, developing positive AT stimuli, and keeping interventions salient and interesting.

The first challenge in developing AT methods involves discriminating how much training is sufficient to show stable patterns of attention that are healthy and adaptive, as compared to previously maladaptive or suboptimal attentional patterns. AT paradigms can range from one session (Hutcherson et al., 2008; MacLeod et al., 2002; Wadlinger & Isaacowitz, 2008) to several sessions across weeks of training (Dandeneau et al., 2007; Davidson et al., 2003; Fredrickson et al., 2008; Wells, 1990; Wells et al., 1997). The duration of the training effects is most likely related to the length of the training. It has been suggested that an ideal amount of training time for individuals with clinical disorders is five weeks; however, nonclinical populations may see results in as little as one session of training (Dandeneau et al., 2007; Papageorgiou & Wells, 1998, 2000). Future research needs to determine to what extent the efficacy and impact of attention training methodologies is contingent on the duration of the training and the frequency of practice during that training (e.g., daily, bi-weekly, weekly).

One challenge specific to cognitive training methodologies is how positive training stimuli are developed. Overall, positive images are inherently of lower average arousal than negative images (Grühn & Scheibe, 2008). Because low-to-moderate-arousal positive stimuli do not elicit the same sense of increased urgency of attention as negative stimuli, individuals experiencing depressive or anxiety disorders may have difficulty in orienting their attention towards this type of positive information. AT methods aimed at inducing changes in attention toward positive stimuli may need to employ positive stimuli of a high emotional valence or use large numbers of stimuli over many training sessions. Tamir and Robinson (2007) have suggested that positive stimuli depicting rewarding information, specifically, may be most effective in attracting attention.

A final challenge is to refine and create new AT paradigms that are interesting to participants rather than repetitive, “mindless” behaviors. One avenue for future exploration may be to intertwine training paradigms into virtual reality (VR) worlds. Participants in VR experiments have been shown to have the same physiological responses as those experienced in reality (Wilhelm, Pfaltz, Gross, Mauss, Kim, & Wiederhold, 2005). Another direction may be to develop video games that modify specific attentional processes. Research has shown that after just ten days of playing action video game training, individuals demonstrated enhanced visual skills in the domains of spatial distribution, temporal resolution, the capacity of visual attention (Green & Bavelier, 2003). Combining training methodologies in different ways may help to capture and maintain the interest and motivation of participants.

Future Directions

While this review has demonstrated that different attentional training methodologies can enhance individuals' emotion regulation abilities, this work is merely a beginning. The evidence presented in this paper suggests that attentional deployment may be a critical tool for regulating emotion; however it is important to note that this evidence remains preliminary. Specifically, longitudinal training interventions are needed to elicit higher-impact effects that may help elucidate the longevity and mechanisms of the training. In addition, combining training methodologies may maximize training effectiveness. It is possible that interventions promoting strategic regulatory goals may be more effective than those that rely on automatically trained attentional biases (Johnson, 2009). An interdisciplinary effort among cognitive, clinical, and social-developmental psychologists may prove most fruitful in both designing effective interventions and investigating the responsible mechanisms.

Additional research is particularly needed to investigate which training methodologies are most successful for specific populations (geriatric, pediatric, clinical, non-clinical). Several demographic and personality factors may influence the efficacy of AT methods. Because older adults generally display positivity effects in their visual processing (Carstensen & Mikels, 2005: Isaacowitz et al., 2006), training methods aimed at training internal attentional states might generate more pronounced results. However, younger adults, and those older adults who do not demonstrate positivity in their visual processing, may initially benefit more from gaze training methodologies that aim to increase attention to positive information. Another individual difference variable that may affect training is emotional intelligence (EI). Individuals higher in emotional intelligence have been found to use more antecedent-focused regulatory strategies (Schutte et al., 2009). In fact, individuals high in EI, who are more sensitive to emotional cues, may also have a greater ability to automatically attend to and identify subliminally presented emotional stimuli (Fiore, 2009). These patterns of attention may facilitate emotion regulation, especially within social contexts. Fiore (2009) notes that in individuals high in EI the mere presence of emotional cues may activate habitual tendencies towards adaptive emotion regulatory behaviors; these individuals might also use more automatic strategies to regulate their emotions. In regards to attention training, these individuals are likely to excel at the "find-a-smile" or other types of gaze training tasks. However, if individuals high in EI also have superior emotion regulation abilities, another type of concentration-based attention training strategy may be more effective in engaging their interest as well as helping them further refine their attentional skills. To what extent the types of training we describe may actually *increase* EI in those naturally low in it remains to be investigated.

Finally, the individuals who may benefit the most from AT paradigms may be those with clinical emotional processing disorders (Mohlman, 2004). Because these individuals often experience attentional dysfunction in their inability to disengage from negative information, using training techniques to teach new patterns of selectively orienting towards more positive and neutral information may help these groups improve their affect regulation. It is possible that some types of attentional training might even serve to promote regulation of the sources of emotion disruption, or problem-focused coping, rather than impacting just the regulation of the emotional response, or emotion-focused coping. Such problem-focused coping could be particularly adaptive in certain circumstances (e.g., Lazarus & Folkman, 1984). Different types of attention training procedures can modify emotion regulation processes, regulation outcomes, or both. While training attention will most influence the emotion regulation processes that encompass attentional deployment, it may also influence other regulation strategies to the extent that they enlist attentional processes. Once research determines which attention regulation strategies different clinical populations employ successfully most frequently, interventions can be selected and tailored to maximize their

effectiveness and impact. Interventions designed to target both regulatory processes and outcomes will most likely be the most effective.

Conclusion

Individuals can effectively regulate their emotion through their attentional deployment, and this process can be successfully trained. Individuals who are able to better regulate their emotions from attentional training may experience more positive emotions. Experiencing increased positive emotions may in turn enhance attentional resources, such as increasing attentional broadening, flexibility, and control. Therefore, training attention might commence a series of codependent attentional and emotional processes that result in an upward spiral of positivity (Fredrickson & Joiner, 2002). Specifically, the frequency of positive relative to negative emotional experience predicts overall happiness (Diener et al., 1991; Fredrickson & Losada, 2005) and individuals trained to seek out the positive may build natural tendencies to approach environmental rewards. Training attention may serve as one key to enhancing emotion regulation, which in turn influences not only affect but also downstream behavior.

As discussed in the model above, one of the most promising strategies of regulating attention to improve emotional functioning comes from different focused attention and open monitoring meditative interventions that teach individuals to refocus and refine many concurrent attentional processes. These attentional interventions may most effectively target all three types of attentional networks, thus yielding potentially large downstream effects.

To train ourselves to become most effective at regulating our own emotional states, we may first have to adjust the source of our focus. Social and personality psychologists interested in improving general emotional functioning and eliciting more positive emotional states may benefit from considering this contemplative process of attending to attention itself. Although traditionally outside the realm of social-psychological research, the optimal attention-based training method available to improve emotion regulation may turn out to be meditative interventions.

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Figure 1.
Relationship between attention training interventions, attentional processes as emotion regulation strategies, and emotion regulation outcomes.

Table 1

Empirical Studies Linking Attention Training Interventions to Improved Emotion Regulation

Study	N	Participant Type	Mean Age	% Male	Control Group	Affective Dependent Variables
Dot-probe Training Methods						
MacLeod et al. (2002) Study 1	64	Undergraduate students	19	38	Matched neutral task	Self-reported anxiety and depression[a]
MacLeod et al. (2002) Study 2	64	Undergraduate students	19	50	Matched neutral task	Self-reported anxiety and depression[a]
Amir et al. (2008)	94	Undergraduate students	19	51	Matched neutral task	STAI[b]
Goetz et al. (2008)	39	Undergraduates	--	38	Matched neutral task	[c] Self-reported mood markers
Wadlinger & Isaacowitz (2008)	47	Undergraduate students	19	36	Matched neutral task	[d] Gaze to negative images
Amir et al. (2009)	29	Individuals with GAD[e]	26	50	Matched neutral task	STAI, BDI-II[f], WDQ[g], PSWQ[h], HRSA[i], HAMD[j]
Johnson (2009)	109	Undergraduate Students	19	39	Matched neutral task	STAI, Self-reported state frustration and anxiety scores
Schmidt et al. (2009)	36	SAD[k] patients	22	67	Matched neutral task	LSAS[l], BSPS[m], SPAI[n], STAI-T, BDI-II
Visual Search Training Methods						
Dandeneau et al. (2008) Study 2b	147	Undergraduate students	--	33	Matched neutral task	VPT[o], POMS[p], RSES[q]
Dandeneau et al. (2008) Study 3a	25	Undergraduate students	--	12	Matched neutral task	PSS[r], RSES, STAI-S, Self-reported stress, FIOS[s]
Dandeneau et al. (2008) Study 3b	23	Telemarketers	--	61	Matched neutral task	PSS, Salivary cortisol
Clinical Auditory Training Tasks						
Wells (1990)	1	Panic disorder patients	40	0	None	Self-reported anxiety[t], STAI-S
Wells et al. (1997)	3	Anxiety patients	--	--	None	Self-reported anxiety, STAI-S
Papageorgiou & Wells (1998)	3	Hypochondriac patients	70	0	None	BAI[u], GDS[v]
Papageorgiou & Wells (2000)	4	Major depressive disorder patients	36	25	None	BDI[w], BAI, MCQ[x]
Siegle, Ghinassi, & Thase (2007)*	31	Adults with unipolar depression	--	--	Treatment as usual	BDI, NHRSQ[y]
Watson & Purdon (2008)	108	Undergraduates	18.99	37	Several conditions	DASS-21[z]
Meditative Practices						
Mindfulness-Based Stress Reduction						
Shapiro et al. (1998)	73	Premed and med students	--	44	Waitlist	ECRS[aa], SCL-90[bb], STAI
Davidson et al. (2003)	41	Corporate employees	36	29	Waitlist	STAI, PANAS[cc]

Study	N	Participant Type	Mean Age	% Male	Control Group	Affective Dependent Variables
Rosenzweig et al. (2003)	302	Med Students	--	--	Didactic seminar	POMS
Carlson et al. (2004)	59	Cancer patients	42	26	None	POMS, EORTC-QLQ-C30[dd], SOSI[ee]
Chang et al. (2004)	43	Continuing education students	47	43	None	PSOM[ff], PSS
Ramel et al. (2004)	23	Veterans	51	65	Waitlist	BDI, STAI
Anderson et al. (2007)	72	Community adults	--	--	Waitlist	PANAS, BDI, BAI, ASI[gg], NAI[hh], ARS[ii], PSWQ
Carmody & Baer (2008)	174	Adults in stressful circumstances	47	37	None	BSI[jj], PSS, PWB[kk]
Shapiro et al. (2008)**	44	Undergraduate students	18	20	Waitlist	PSS, RRQ[ll]
Farb et al. (2010)	20	Adults	45.55	33	Waitlist	BDI-II, BAI, SCL-90-R[mm], Self- rated level of sadness
Loving-Kindness Meditation						
Fredrickson et al. (2008)	139	Working adults	41	35	Waitlist	LOT[nn], Ego- Resilience[oo], PWB, SWLS[pp], CES-D[qq], mDES[rr]
Hutcherson et al. (2008)	93	Young adults	24	43	Neutral imagery task	Positive and negative mood composites
Integrative Mind Body Training						
Tang et al. (2007)	80	Undergraduates	21.8	55	Relaxation training	POMS
Vipassana Meditation (Insight Meditation)						
Chambers et al. (2008)	40	Non-clincial adults	33.70	55	Waitlist	RRS[ss], BDI, BAI, PANAS
Mindfulness Intervention***						
Erisman & Roemer (2010)	30	Adults w/emotion regulation difficulty	24.10	50	Neutral Information	PANAS, DERS-S[tt]
Mindfulness-based Mind Fitness Training****						
Jha et al. (2010)	29	Marine Corps Reservists	30	100	Military & civilian control	PANAS

Note. All studies appear in chronological order by training type. Participant number, age, and sex were reported for the experimental or intervention condition when possible; if these values were not reported by condition, these columns indicate the overall numbers across all conditions.

*Also used Paced Auditory Serial Addition Task (PASAT) training method.

**Also used the Eight Point Program (Easwaran, 1991).

***10-minute in laboratory intervention drawn from work by Segal, Williams, & Teasdale, 2002.

****8-week course modified from the MBSR protocol for military populations.

[a]Data was analyzed from analogue mood scales presented electronically during stress task.

[b]STAI = State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970). STAI-S = State anxiety scale; STAI-T = Trait anxiety scale.

[c] See Tamir, Robinson, & Clore, 2002.

[d] Assessed by eye tracking.

[e] Generalized anxiety disorder.

[f] BDI-II = Beck Depression Inventory-II (Beck, Steer, & Brown, 1996).

[g] WDQ = Worry Domains Questionnaire (Tallis, Eysenck, & Mathews,1992).

[h] PSWQ = Penn State Worry Questionnaire (Meyer, Miller, Metzger, & Borkovec, 1990).

[i] HRSA = Hamilton Rating Scale for Anxiety (Hamilton, 1959).

[j] HAMD = Hamilton Rating Scale for Depression (Hamilton, 1960).

[k] SAD = Seasonal affective disorder.

[l] LSAS = Liebowitz Social Anxiety Scale (Liebowitz, 1987).

[m] BSPS = Brief Social Phobia Scale (Davidson, Potts, Richichi, Ford, Krishnan, Smith, et al., 1991).

[n] SPAI = Social Phobia and Anxiety Inventory (Turner, Johnson, Beidel, Heiser, & Lydiard, 2003).

[o] VPT = Visual Probe Task which measured attention bias towards threatening social information.

[p] POMS = Profile of Mood States (McNair et al., 1971).

[q] RSES = Rosenberg Self-Esteem Scale (Rosenberg, 1965).

[r] PSS = Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983).

[s] FIOS = Feelings of Inadequacy Scale, a subscale of School Abilities Scale (Fleming & Courtney, 1984).

[t] Self-reported anxiety was rated immediately following each treatment session.

[u] BAI = Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988).

[v] GDS = Geriatric Depression Scale (Yesavage et al., 1983).

[w] BDI = Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961).

[x] MCQ = Meta-Cognitions Questionnaire (Cartwright-Hatton & Wells, 1997).

[y] NHRSQ = Nolen-Hoeksema's Response Style's Questionnaire (Nolen-Hoeksema, Morrow, & Fredrickson, 1993).

[z] DASS-21 = Depression, Anxiety, Stress Scales-21 (Lovibond & Lovibond, 1995).

[aa] ECRS = Empathy Construct Rating Scale (La Monica, 1981).

[bb] SCL-90 = Hopkins Symptom Checklist 90 – Revised, Subscale 4 Depression (Derogatis, 1977).

[cc] PANAS = Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988).

[dd] EORTC-QLQ-C30 = European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (Aaronson et al., 1993).

[ee] SOSI = Symptoms of Stress Inventory (Leckie & Thompson, 1979).

[ff] 4PSOM = Positive States of Mind questionnaire (Horowitz, Adler, & Kegeles, 1988).

[gg] ASI = Anxiety Sensitivity Index (Reiss, Peterson, Gursky, & McNally, 1986).

[hh] NAI = Novaco Anger Inventory (Novaco, 1975).

[ii] ARS = Anger Rumination Scale (Sukhodolsky, Golub, & Cromwell, 2001).

[jj] BSI = Brief Symptom Inventory for psychological symptoms and somatic complaints (Derogatis, 1992).

[kk] PWB = Psychological Well-Being Scales (Ryff & Keyes, 1995).

[ll] RRQ = Rumination and Reflection Questionnaire (Trapnell & Campbell, 1999).

[mm] SCL-90-R = The Symptom Checklist 90 Revised (Derogatis, 1994).

[nn] LOT = Life Orientation Test - Revised (Scheier, Carver, & Bridges, 1994).

[oo] Ego-Resilience Measure (Block & Kremen, 1996).

[pp] SWLS = Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985).

[qq] CES-D = Center for Epidemiological Studies – Depression Measure (Radloff, 1977).

[rr] mDES = Modified Differential Emotions Scale (Fredrickson, Tugade, Waugh, & Larkin, 2003).

[ss] RRS = Ruminative Responses Scale [subscale of Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991)].

[tt] DERS-S = State Difficulties in Emotion Regulation Scale (McLaughlin, Mennin, & Farach, 2007).

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Table 2

A Model of Attention Training Methods: Integrating Emotion Regulation Strategies and Attentional Networks

Attentional Training Methodologies[1]		**Emotion Regulation Strategies**		
Higher	Concentration Meditation[a] (C)	Sustained attention on object	Selective attention to object	Disengage distracters; reengage object
	Insight Meditation[b] (C)	Sustained awareness w/out focus	---	Disengage distracters; non-reactive labeling of distracters
Moderate	Loving-Kindness Meditation[c] (R/C)	Sustained attention to positive emotion	Selective attention to positive emotion	Disengage distracters; reengage object
	ATT[d] (D/C)	Vigilance for neutral sound	Selective attention to neutral sound	Alternate attention b/w sounds; Attend to multiple sounds
Lower	Dot-Probe Training (D)	Vigilance for positive information	Selective visual attention to positive information	Disengage negative and neutral information
	Visual Search Training (D)	Vigilance for positive information	Selective visual attention to positive information	Avoidance of negative information
Effort (to execute)	Attentional[2] Network	Alerting	Orienting	Executive
	Similar Constructs[3]	Awareness, alertness, vigilance, sustained attention	Scanning, selective attention	Selective, focused, alternating, and divided attention
Cognitive Effort (to acquire)[4]		*Lower*	*Moderate*	*Higher*

Note.

[1] Within the model training types can be categorized as reflecting Gross's (1998) attentional deployment emotion regulation strategies of concentration (C), distraction (D), and rumination (R).

[2] This model focuses on the primary attentional network/s recruited, although components of all networks may be recruited during training tasks (see Posner & Petersen, 1990).

[3] Delineates additional nomenclature corresponding to the alerting, orienting, and executive networks (see Raz & Buhle, 2006).

[4] Cognitive effort to acquire refers to effort required to learn a new strategy while effort to execute refers to effort required to employ a learned strategy.

[a] Also known as Shamatha or Focused Attention Meditation. The object of meditation is most commonly one's breath.

[b] Also known as Vipassana or Open Monitoring Meditation.

[c] Also known as Metta Meditation.

[d] Auditory attention training derived from clinical psychology