The Mediating Role of Cognitive Flexibility in the Link between Broadened Attentional Scope and Positive Changes in Mood

Shawn Martin

In Collaboration with Amanda Dennis and Victoria Fleischmann

Advisor: Professor Rebecca Compton

Haverford College

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Abstract

The present study sought to investigate the link between broadened attentional scope and positive changes in mood reported in recent studies (e.g., Gu et al., 2017) and stemming more generally from Broaden and Build Theory (Fredrickson, 1998; 2001). It was hypothesized that the cognitive construct that mediates this relationship is cognitive flexibility. Participants (n =66) from Haverford and Bryn Mawr Colleges viewed a sad film clip aimed at temporarily depressing mood, then completed the abbreviated profile of mood states ("A-POMS") (Grove & Prapavessis, 1992) to assess mood. Participants were then split into two groups to undergo a priming exercise aimed at temporarily influencing either a broadened or narrowed scope of attention by viewing zooming out or zooming in images of neutral content selected from IAPS (CSEA-NIMH, 1999). Cognitive flexibility was then measured using the Water Jar Task ("WJT") (Greenberg, Reiner, & Meiran (2012) and mood was reassessed a second time using the A-POMS. Eye-tracking equipment was used during the attentional manipulation to confirm its effectiveness and to more closely link gaze-patterns with the dependent variables. It was predicted that the participants in the broadened attention group would display greater cognitive flexibility and a greater decrease in mood disturbance during the experiment. The results were primarily unsupportive of the hypotheses and cast doubt on the certainty of earlier findings and on the validity of the tests used in the present study.

Keywords: cognitive flexibility, A-POMS, eye-tracking, scope of attention, WJT

Introduction:

Within the field of cognitive sciences, the relationship between attention and emotion has been the subject of considerable study. The present research aims to add to this knowledge by demonstrating the existence of a link between two concepts already established to be related: broadened attention and positive mood. In doing so, it is necessary to review the history of the research which led to our hypotheses, explain their importance, and offer suggestions as to how this knowledge can be used to address actual human issues. Though a more in-depth explanation of all hypotheses will be addressed later, our primary prediction, stated in common language, is that the reason broadening attention results in improved mood is because prompting people to have a broader attentional focus improves their ability to switch between different modes of thinking; a construct referred to as cognitive flexibility. We intend to show that when individuals sharpen their skills to switch between modes of thinking, they will contemplate their problems in more realistic, goal-oriented ways, as opposed to accepting their problems as insurmountable or unchangeable (Fredrickson & Joiner, 2002). The fundamental point of this research is to uncover a simple, inexpensive, and reliable method to alleviate negative moods. The value of such a tool hardly needs to be stated; while the extent to which people are obstructed by feelings of sadness and depression vary greatly, everyone deals with such feelings from time to time.

To truly appreciate how these ideas emerged, we must refer to the preliminary psychological investigations into the relationship between attention and emotion. Naturally, these studies have approached the attention-emotion link from either end, and so it is possible to group these studies, broadly, into those which link changes in attention to changes in emotion and those which focus on the other direction. But studies which directly seek to link attention and emotion are, in fact, more recent. They developed out of a larger body of research which sought to link positive and negative affect with a plethora of measures of cognitive processes, such as creativity and flexibility. Before a review of the explicit findings about emotion and attention, it is necessary to delve even further into the past to understand the justification for those studies.

The Link between Affect and Cognitive Flexibility/Creativity

Beginning in the early 80's, Alice Isen and colleagues conducted a series of experiments with the initial intention of establishing a link between affect and decision making (Isen & Means, 1983; Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987; Isen, Rosenzweig, & Young, 1991). Such studies repeatedly demonstrated an idea which evoked considerable interest: positive emotions were linked to more creative, more effective, and more efficient problem-solving. Their findings combined, an initial framework of the relationship between positive affect and broadened cognition was laid.

Isen (2002) reviews the development of many of the studies linking positive affect with more flexible and adaptive thinking. In perfect agreement with Broaden and Build Theory (to be discussed in later sections), it seems that inducing people to feel positive affect leads to their thinking in more creative ways as measured in a truly varied set of scenarios (Isen, 2001). One simple way to measure this effect is through words association. People induced to feel positive affect are routinely capable of producing more varied and creative word associations, such as is measured through the Remote Associates Task (RAT) (Isen, Johnson, Mertz, & Robinson, 1985; Isen, Daubman, & Nowicki, 1987). Induction of positive affect has also been shown to lead to more creative categorization tendencies (Isen & Daubman, 1984; Isen, Neidenthal, & Cantor, 1992). It is important to note that studies of this nature are not only limited to open-ended measures. People induced to feel positive affect and mood also tend to outperform others in a variety of strategy tasks/games, such as Duncker's (1945) candle task (Green & Noice, 1988, Isen et al., 1987).

These findings have been replicated, by various experiments, in a truly diverse sample; the link between positive affect and creativity/cognitive flexibility is highly robust (Isen, 2002). Building on the influx of research of this nature in the 80's and 90's, a new framework for its application was being construed. Coinciding quite closely with the emergence of Positive Psychology as a new domain of study in 1998, (Seligman & Csikszentmihalyi, 2014) Broaden and Build theory was introduced by Barbara Fredrickson (Fredrickson, 1998; Fredrickson, 2001) as a new way of understanding positive emotions.

Fredrickson and Broaden and Build Theory

Broaden and Build theory (BAB), as a model, states principles such as that positive emotions lead to growth of one's thought-action repertoires, and that increased thought-action repertoires leads to development of resilience against negative emotions (Fredrickson, 2004). While the segment of BAB most relevant to the present study is its proposal that positive emotional states produce measurable and testable effects on attention, its tenets are not limited to that concept. The primary focus of BAB is best described as the link between attention and emotion, but one must appreciate that these findings are what prompted investigation into the emotion-end of the link. Such studies are reviewed later, but the fundamental findings about the benefits of positive emotions from BAB are worth understanding for their own sake because the entire end-goal of manipulating attention, as stated in the introduction, is to uncover an easy and inexpensive way to attain positive mood. Since the ultimate purpose of the present study is to add knowledge to the attention emotion link *because* of the value of positive emotions, BAB research on the value of positive emotions is itself the justification for studies such as ours. So while BAB's contributions to the framing of the attention-emotion relationship is our primary focus, BAB as a whole is worth understanding as a model generally.

Fredrickson relies on multiple sources of evidence to back her claims about the function of positive emotions and the detriments of negative ones, and a particular study from 2001 is a good example that can be used to understand the main ideas behind BAB as a whole. In the wake of 9/11, Fredrickson saw an opportunity to test her theories that positive emotions pave a path for ongoing resilience from negative ones beyond their ephemeral value in a given moment. In the introduction of her and colleague's 2003 study (Fredrickson, Tugade, Waugh, & Larkin, 2003), the benefits of positive emotions are discussed in four contexts: physiological undoing of autonomic responses caused by negative emotions, cognitive broadening (the most relevant to the present study), resource building, and resilience. A brief discussion of each, with a special focus on cognitive broadening, will shed light on the building blocks of BAB.

The physiologically measurable effects of positive emotions are well-established. Fredrickson cites several studies in which negative emotions, especially fear and anger, are shown to lead to increased heart rate and blood pressure (Fredrickson et al., 2000; Ohman, 2000). Fredrickson goes on to explain, perhaps unsurprisingly, that positive emotions have been found to aid people in returning to baseline levels of those physiological measures more effectively than just neutral distractions or time (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000). The value of such studies, though perhaps not *particularly* profound or groundbreaking in adding to our knowledge of the bridge between mental state and physiology, is in their confirmation of the BAB theory. Because many studies in the attention-emotion link rely on self-reports of mood, it is reassuring that such self-reports have been shown to correlate with what can be considered more objective measures in other scenarios.

The other three contexts discussed, resource building, cognitive broadening, and resilience, cannot be adequately explained as independent from each other because in fact they are related. While Fredrickson shows that positive emotions lead to both broadened cognition and resilience, a more accurate categorization might be that positive emotions lead to broadened cognition which itself leads to resilience and resource-building. Indeed, Fredrickson is cognizant of this relationship and incorporates it into her review of each of the contexts separately.

Beginning her discussion of broadened cognition, Fredrickson refers to the various late 20th century experiments run by Isen already mentioned in this review which serve to show basic links between emotion and cognitive flexibility/creativity. Going further, then, she reviews preliminary studies on how that relationship can be applied to resilience and resource-building and on how induced positive emotions aid in processing of important self-relevant information. Reed & Aspinwall (1998), asking participants to recall a moment of past kindness in order to generate positive emotions, found that such participants demonstrated less bias and more adaptive handling of information about personally relevant health-risks. Other research along these lines sought to establish how naturally acquired positive emotions, in contrast to experimentally induced ones, were often predictive of more adaptive handling of personal tragedies. Bonnano & Keltner (1997) showed that widowed adults who discussed their grief with facial expressions of fear and anger exhibited more feelings of grief and lower perceived levels of health at 14 and 25 month follow-ups than participants who displayed facial expressions indicative of positive emotions. The same authors found similarly that use of certain types of laughter and smiling in grieving adults resulted in comparable outcomes (lower levels of self-reported anger and increased enjoyment) (Keltner & Bonanno, 1997). Other studies served to strengthen and generalize those findings by demonstrating the same relationship between positive emotions and coping in a younger sample and for more day-to-day maladies as opposed to death of loved ones (Martin, 2001).

To wrap up this review of BAB, one must analyze what Fredrickson refers to as resource building, and what I believe could properly be called learning. Essentially, the point is that the reason positive emotions appear to be capable of instilling such long-term benefits is because once one develops a coping strategy that proves effective, that strategy is remembered and used again when necessary in the future. Evidence for this approach can be seen in a variety of longitudinal studies comparing early-life attitudes with health. Danner, Snowdon, Wallace, and Friesen (2001) report that nuns' use of more positive emotional content while writing autobiographies in their early 20's was strongly correlated with longevity about 60 years later. Conversely, Peterson, Seligman, & Vaillant (1988) found that pessimistic explanatory style was associated with worse health in mid-late life when measured in participant's mid-20's. Both article's authors discuss how traits such as resilience and coping-strategy build on themselves to contribute to long-term outcomes, giving evidence towards Fredrickson's theory of resource building. Fredrickson and Joiner (2002) refer to this phenomenon as the "upward spiral" of positive emotions. In a self-report study of a strong sample size (n=138), college students' responses indicated that "positive affect and broad-minded coping reciprocally and prospectively predict one another" (Fredrickson & Joiner, 2002, p. 172). Specifically, self-reports of positive affect predicted broad-minded coping five weeks later and vice versa.

BAB, then, contributes to the present study by establishing the link between positive emotions and broadened cognition. Specifically, one's repertoire of coping strategies can be built upon to serve as long-lasting psychological resources throughout life. In the next two sections, how BAB inspired future researchers to investigate the link between emotion and *visual* attention will be examined.

Mood and ***Visual*** *Attention*

BAB studies and earlier contributions from Isen established certain connections between emotion and cognition, but it has mostly been more recent that a focus on visual attention has been adopted. Such studies can most efficiently be divided based on the type of tests they run in order to acquire information. Whereas most tests of this nature rely on behavioral data, many others utilize brain imaging techniques to explain the neurophysiological effects mood and affect can cause on attention. The following two sections provide an overview of studies related specifically to how components of emotion are related to visual attention in that order (i.e., as opposed to studies related to how components of attention affect emotion.)

Behavioral Data

Though most studies on the visual attention-emotion link are the product of BAB thinking, some prevenient efforts actually started earlier in the 90's. Basso, Schefft, Ris, & Dember (1996) analyzed the relationship not by inducing positive mood, as many studies on the subject tend to do, but by comparing self-report measures of general emotional dispositions. They found that depression was associated with a tendency towards local visual processing whereas optimism was associated with global visual processing. Derryberry & Tucker (1994) found similar results but framed them within the context of motivation. Being in a motivated state, they assert, has implications for attention, an idea entertained in greater detail by Harmon-Jones and Gable (see *Affect and Approach Motivation* for reviews of their work).

To better understand these findings, it is helpful to mention a repeatedly found tendency of anxious individuals to be more attentive to threats. Eysenck (1992) claims that because anxious individuals are hyper vigilant to threats, their general baseline level of attention to the environment should be very broad to reflect a constant scanning for threats. Keogh & French (1999) designed an experiment to test this theory by seeing how highly anxious individuals would attend to stimuli presented centrally and peripherally compared to non-anxious individuals. Especially when an anxious mood was induced, anxious participants were quicker to identify threatening words in the periphery, indicating a broadened scope of attention. The reason this study is of particular interest, however, is that the same effect was found for non-anxious individuals. When induced to be in a momentary state of anxiety, control participants also displayed a broadened scope of attention. Though this finding may seem contrary to the general principle of negative moods narrowing attention, anxiety, because of its specific relationship to threat detection, should be considered separately from other “negative” emotions. Research has confirmed the value of such a distinction; MacLeod, Matthews, & Tata (1986) demonstrated that clinically anxious individuals were affected by the aforementioned attentional biases and that clinically depressed patients were not. Indeed, our present study is focused specifically on sadness.

One theory of emotion and attention is that positive mood states broaden attention specifically by reducing inhibitory control mechanisms. Rowe, Hirsh, & Anderson (2006) demonstrated this by showing that participants induced to be in positive moods were less able, when trying, to focus on a central target, and were more distracted by peripheral stimuli. Certainly influenced by BAB thinking, the authors hypothesized that positive moods likely cause a shift in attention in order to facilitate exploration and openness, which, admittedly, may be an undesirable result when one is attempting to focus attention.

One finding regarding this idea is interesting because of how it appears to simultaneously agree and disagree with fundamental BAB thinking. Grol, Koster, Bruyneel, & Raedt, (2014) found that induction of positive mood broadened attentional scope, when a distinction was made, specifically to self-relevant information and not to information about others. On the one hand, this seems to support the idea of resource building; by seeking to gain more knowledge about the self, one could more effectively handle adversity in the future. On the other hand, this seems in contrast to the idea that positive moods facilitate open exploration. This study is one of several to claim that the attentional outcomes of mood manipulation may not apply universally to all stimuli and information. Others are discussed in future sections, specifically *Affect and Approach Motivation.*

Other studies addressed how differences in memory can affect the attention-emotion link. The first of Gasper & Clore's (2002) experiments in their study showed that participants induced to be in a good mood redrew an image from memory in ways that replicated global rather than local aspects of the image to a much greater extent than participants in a negative mood. Other researchers, rather than predicting the specific broadening of attention following positive moods, have addressed the attention selectivity induced by stress. Consistent with the idea that attention is a limited resource (discussed in the following section), stress, which for our purposes may be compared to a negative mood state, hogs attentional resources, leaving less to be used in other processes. Chajut & Algom (2003), though with the motive of demonstrating how stress could reduce distractibility rather than narrow attention more generally, experimentally confirmed this theory.

Other experiments have focused on how facial expressions in others can serve to broaden or narrow attention. Fox, Russo, Bowles, & Dutton (2001) showed that threatening faces slowed or prevented participants from noticing other information presented peripherally whereas faces exhibiting positive emotions did not have that effect. Fenske & Eastwood (2003) found that effect to hold even when participants were not asked to reallocate attention, which was not the case in Fox et al., (2001). Such data serve to extend considerably stronger-established generalities in psychology that threats serve to narrow attention (e.g., Baddeley, 1972; Easterbrook, 1959). While this basic and consistent idea certainly contributes to BABesque claims about emotion and attention, the difference is that the majority of studies reviewed focus not on the effect of threats on attention but on depressed moods. Sadness is not equal to feeling threatened, though it is true that both seem to affect attention.

Other facial-expression studies have focused specifically on the broadening capacities of happy faces rather than the narrowing effects of threatening ones. Johnson, Waugh, & Fredrickson, (2010) found that the extent to which participants displayed Duchenne (genuine) as opposed to non-Duchenne (non-genuine) smiles during mood inductions predicted results of attention. Two experiments demonstrated that genuine smiles were correlated with increased attentional breadth on a global-local visual processing task and increased attentional flexibility on an attentional orientation task.

More recently, affect has been linked to perceptual tuning. Uddenberg & Shim (2015) conducted a study to test emotion on perceptual tuning curves for motion direction. When participants were asked to identify the direction of motion of various dot displays, those in a positive mood compared to neutral or negative moods were far less selective in determining the direction of motion, which the authors assert is indicative of a global-processing perspective.

Physiological Data

Some fMRI and MRI studies have been designed to answer questions about attention which evolutionary psychology could theorize about, but which are in need of confirmation. A good example of this comes from a 2004 study by Pessoa & Ungeleider. In concert with intuition, they review the concept that attention is a limited resource which cannot be extended to every stimulus within (and especially outside of) our visual field. In a sense, they argue, visual attention could even be considered a “filter” designed to instigate neural processing of relevant information in the visual field and neglecting less relevant information. The information that is attended to, however, can be subject to biases; an idea derived from Desimone & Duncan’s (1995) *biased competition* model. This model suggests that these biases can be both top-down or bottom-up, indicating that both experience and biology can affect how attention functions in a given individual. The intriguing question they ponder, however, is whether emotionally salient stimuli can become the subject of neural processing even if it is not the subject of conscious attention. To summarize their review of their own research, they ultimately conclude that emotional stimuli must reach some threshold level of activity in the visual cortex in order for that stimuli to become subject to visual awareness, but that emotional stimuli can “bias the competition for neural resources” (Pessoa & Ungeleider, 2004, p. 176.) In other words, while emotional stimuli can have only limited effects outside of visual awareness, they are more likely to become the focus of visual awareness compared to non-emotional stimuli.

While this information is helpful to our basic understanding of how human attention functions, what’s more directly relevant to the present study is research about how a person’s emotional state, rather than the emotional content of stimuli in their environment, alters their perception/attention. Schmitz, De Rosa, & Anderson (2009) tackled that question directly. Using an fMRI study to measure place processing in the parahippocampal place area (PPA), they examined how field of view would be affected by positive, neutral, and negative affective states. In support of their hypotheses, they found that field of view was largest for participants when in a positive affective state. Specifically, they used object-sensitive extrastriate cortical responses in the PPA to show that positive affect increased recognition of peripheral information whereas negative affect decreased it. These findings coincide well with other fMRI studies measuring the attention-emotion link. Soto et al., (2009) utilized a special sample to investigate this relationship: patients with visual neglect. Patients with lesions to their parietal cortices are typically unable to respond to stimuli presented to the space contralateral to the lesion and are furthermore heavily biased to attend to information presented to their ipsilesional space. When such patients were induced to feel positive affect, their ability to identify and respond to information presented to their contralesional side was greatly improved compared to neutral and negative affective states. Thus, in both healthy and clinical populations, positive affect has been demonstrated to literally and physically broaden visual attention.

Eye-tracking data has also been applied to this concept. Wadlinger and Isaacowitz (2006) found that participants induced to be in positive mood spent more time gazing at peripheral information and made more frequent saccades than participants in neutral moods. Such findings establish that physiological data, whether from eye-tracking or neuroimaging studies, consistently produce the same results.

While the preceding studies of behavior and neuroimaging have satisfactorily established that positive mood broadens visual attention, the opposite direction of that relationship has similarly been examined. In the next section, a review of studies focusing on manipulating attention with the goal of achieving changes in mood will be reviewed.

Visual Attention and Mood

Manipulating attention to uncover changes in emotion has taken many forms in the literature, including EEG, fMRI, behavioral, and self-report studies. Though many experiments have contemplated that manipulating attention could affect emotion, very few have specifically addressed whether priming a broadened or narrowed attentional scope would directly impact participants' mood; indeed, Gu et al., (2017) (described in the section *Most Recent Contributions)* may be the first and the present study the second. Nonetheless, a review of studies which controlled attention in some sense in order to achieve some type of emotion-related outcome is worthwhile, as they all contributed to the formulation of hypotheses regarding the attention-emotion link.

Srinivasan & Hanif (2010) undertook such an effort in a study involving emotional facial expressions. Participants were presented with either happy or sad faces preceded by stimuli aimed at priming either a global or local perceptual processing disposition. It was found that participants primed to be in a global-processing state of mind more easily identified happy faces and participants in a local-processing state more readily identified sad faces. Raymond, Fenske, & Tavassoli (2003) cite neuroimaging studies indicating the neural overlap of systems of emotion and attention in justifying their study on attention and emotional decision making. Neutral images were rated for emotional tone by participants who had in earlier trials been forced to ignore or attend to those same images. It was found that equally neutral images were rated as carrying much less of an emotional tone when participants had been forced to ignore them rather than attend to them and were also rated less emotionally than novel images. Similar results were reported by MacNamara, Ochsner, & Hajcak, (2011). These findings show that a consistently-held psychological idea, that emotional stimuli attract attention more than non-emotional stimuli, is applicable in reverse. That is, it seems that what is attended to more is deemed more emotionally salient after the fact.

Furthermore, it seems that attentional training can, in some circumstances, affect emotional vulnerability to threatening stimuli. Macleod, Rutherford, Campbell, Ebsworthy, & Holker (2002) show that emotional responses to threats could be minimized by training participants to look away from areas on a screen which presented negative words. Though it is unclear how this could be applied to everyday life, it at least serves as more evidence of the ability to change emotional reactions by choosing what to attend to and what not to attend to. Furthermore, the principle itself is promising: given the review of evidence presented later in this section as to the tendency of optimistic people to attend to the world differently than pessimistic people (e.g., Isaacowitz, 2005), that attention could potentially be trained to model those differences is worthy of study. Though there is some data that attentional training exercises can have beneficial outcomes (Gu et al., 2017), they tend to focus on specific, typically clinical issues and not on whether mood can be improved generally (e.g., Wells, 1990; Shalev, Tsal, & Mevorach, 2007; Attwood, O'Sullivan, Leonards, Mackintosh, & Munafo, 2008). As such, our study is especially justified by this apparent gap.

Several EEG studies have used the Late Positive Potential (LPP) to show that different attentional tendencies would be associated with neural representations of increased emotional evaluation. Dunning & Hajcak (2009) utilized two experiments to demonstrate how directing attention could influence emotional reaction as measured by the LPP. Unsurprisingly considering the very nature of LPP, it was found that the LPP was larger when participants passively viewed unpleasant images compared to neutral images. An interesting finding, however, was that when attention was specifically drawn to non-arousing sections of emotional images, LPP was similar in magnitude to passive viewing of neutral images. At first it may sound that such results contradict the established tendency of emotional stimuli to grasp attention, but the authors address this point by stating that "*motivated attention* can be overcome by *directed attention*" (p.31). In other words, while it is true that emotional stimuli more easily grasp attention when viewing is passive, said finding can be nullified by deliberately focusing attention elsewhere. Schupp et al., (2007) similarly found a larger P3 responses when participants actively rather than passively looked at emotionally disturbing images.

Other studies have added to the field not by directly manipulating attention *per se,* but by demonstrating differential attentional tendencies by people who differed by some factor of emotional measure. For example, Isaacowitz (2005), using eye tracking, found that optimistic participants attended differently to images than pessimists. Controlling for a myriad of other potentially relevant factors, Isaacowitz found that optimistic participants spent less time looking at unpleasant images than pessimistic participants. This finding is fairly robust; Raila, Scholl, & Gruber (2015), without using the word "optimistic," found that participants high in trait happiness and life satisfaction showed a tendency to spend more time looking at positive images compared to participants lower on those measures.

Related to this idea, the elderly positivity bias is worth examining. It is firmly established that age is related to subjective emotional experiences, such that older individuals tend to experience less negative and more positive emotions (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). From a personality perspective, this is manifested through a steady decline in trait neuroticism across the lifespan (McCrae et al., 1999; Donnellan & Lucas, 2008). Citing his own earlier work, Isaacowitz reasoned that this development could likely be measured by differences in attention through eye tracking. Allard, Wadlinger, & Isaacowitz (2010) not only found a positive gaze preference in older adults, but also founds, using pupil dilation, that less cognitive effort was extended to do so compared to younger people. While the preceding studies do not have the quality of establishing causality, as attention was not directly manipulated, they nonetheless establish that individuals with chronically more positive average moods seem to attend to stimuli differently. More information about differential attending strategies and emotional outcomes are mentioned in the next section.

Though the previous sections' contents suggest a strong, replicable, and uniform relationship between mood and attention, not all research has fallen cleanly along these lines. In the following sections, incongruities will be discussed under the broader context of how tangential perspectives to the attention-emotion link can add to our understanding. Specifically, the connection between cognitive flexibility and emotion regulation and the concepts of approach-motivation and emotional intensity will be deliberated.

Cognitive Flexibility and Emotion Regulation

There is ample precedent in justifying the proposal that cognitive flexibility is related to the ability to combat negative mood. Southwick, Vythilingam, & Charney (2005) directly identified cognitive flexibility as a psychosocial factor related to depression and/or stress resilience, for example. But at least in part, this relationship can be thought of in the context of the link between cognitive flexibility and emotion regulation strategies. Emotion regulation refers to the approach individuals take in reacting to threatening or upsetting stimuli (Gross & Thompson, 2007). One of the most widely discussed strategies in the emotion regulation literature, cognitive reappraisal, has an intuitive relationship with cognitive flexibility. Cognitive reappraisal refers to "the ability to re-frame and reevaluate experiences in a more positive light," and it has been shown to correlate with cognitive flexibility. (Haglund, Nestadt, Cooper, Southwick, & Charney, 2007). I use the term “intuitive” to refer to their correlation because, though they are separate constructs, one’s ability to engage in cognitive reappraisal, by definition, involves use of cognitive flexibility, because cognitive reappraisal involves changing the way one thinks. Given their close tie, it is very interesting to note the conflicting results of studies attempting to establish the relationship between cognitive reappraisal and attention.

A series of early to mid-2000’s neuroimaging studies demonstrated that the parieto-temporal regions and lateral/medial regions of the prefrontal cortex were important for cognitive reappraisal and emotion regulation more generally (Eipert et al., 2007; Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner et al., 2004; Schaefer et al., 2002). Noting that those regions overlap with areas controlling visuospatial attention and oculomotor control, van Reekum et al., (2007) hypothesized that cognitive reappraisal might be related to attention. Using eye-tracking software, they found that participants asked to use cognitive reappraisal when faced with disturbing images displayed consistently different eye-track patterns than participants asked merely to attend to them. This implies that cognitive reappraisal indeed has some kind of relationship with attention. But future studies found conflicting results.

H.L. Urry (2010), with the intention of testing the idea that cognitive reappraisal was merely a result of specific patterns of attentional deployment, conducted an experiment which actually held attention constant across a variety of conditions. Participants were instructed to hold their attention to just the part of an emotional image that was covered by a transparent circle (the effectiveness of which was confirmed through eye-tracking,) and to either up-regulate or downregulate their emotional response using cognitive reappraisal. The results were that participants were successful in regulating their emotions despite their gaze-pattern being controlled to be different from that which was found by van Reekum et al., (2007). In addition to self-report, corrugator activity confirmed the results on most trials. This casts doubt on the idea that emotional response is governed by attentional deployment, since regulation was clearly possible even in the absence of preferred or ideal gaze-patterns. Further studies yet (Bebko, Franconeri, Ochsner, & Chiao, 2011; Bebko, Franconeri, Ochsner, & Chiao, 2014; Troy, Wilhelm, Shallcross, & Mauss, 2012) continued to find conflicting results either stating that cognitive reappraisal was or was not controlled by specific patterns of attentional deployment. Given such an unstable connection between attentional deployment and emotional regulation itself, findings regarding attentional scope and mood might best be understood outside of the *content* of attention as much as the *method* of attention. In other words, whereas most of the aforementioned studies made a distinction between the emotional and non-emotional areas of images, the present study is concerned with the breadth of attentional deployment independent of the content. That being considered, it has been shown that the content of one's attention does indeed affect the general finding that broadened attention is associated with positive mood. In the next section, other factors which have been demonstrated to affect this relationship will be discussed.

Affect and Approach Motivation

Consider the evolution of attention. On one hand, the ability to sustain focus on complex tasks and not be distracted is one of the factors which has allowed for so much human innovation and planning, and on the other, it is advantageous for our attention to be quickly drawn to sudden threats in our environment. Given this fact, another idea relevant to how attention is used, not necessarily only by humans but by other animals as well, is approach motivation. Approach motivation refers to "an urge or action tendency to go toward an object" (Gable & Harmon-Jones, 2008, p. 476). Objects or situations said to be high in approach motivation are ones which promote approach, whereas ones in low in approach motivation do not. This is different, however, from withdrawal motivation, which specifically promotes withdrawal; which is more than simply not promoting approach. These terms now defined, the compelling point that Gable & Harmon-Jones (2008) make is that nearly all studies linking attentional scope and emotion use stimuli low in approach motivation. This is highly relevant to the meaningfulness of their findings, because the authors hypothesize that objects/situations high in approach motivation, because of the potential reward associated with approach (food, sexual partners, etc.), most likely narrow attention to facilitate achieving a goal. Though studies on the attention-emotion relationship generally make an effort to use neutral-stimuli because of the inherent confounding variable, Gable & Harmon-Jones maintain that most studies have ignored approach motivation, which may well be just as relevant. As such, they designed their own experiments to test this idea.

In one study, participants were shown a series of positive affect pictures/videos but which differed in levels of approach motivation (cats being low-approach and delicious desserts being high-approach.) The intention was that though both stimuli should instill positive emotions in participants, only one should promote a desire to approach. The results were that high-approach group participants displayed a less global attentional focus (as measured by Kimchi & Palmer’s (1982) local-global visual processing task) than low-approach motivation group participants; their hypothesis was confirmed. Further studies published in the same article confirmed these results and also demonstrated that it was specifically approach motivation that was responsible for these differences. Along these lines, other research has found that training attention either towards or away from rewards effects approach behavior to rewarding stimuli, but does not alter mood itself (Goetz, Robinson, & Meier, 2008).

A comparable idea, entertained by mostly the same authors some years later, is that of *intensity* of emotions. Harmon-Jones, Gable, & Price (2013) hypothesized that not only approach motivation, but also the intensity of emotions, has been largely overlooked by the research on the attention-emotion link. A study consistent with intuitive thinking on human attention found that regardless of whether a stimuli were positive or negative in nature, intensely emotional stimuli tended to narrow attention while only slightly emotional stimuli tended to broaden it. In a separate study, Gable & Harmon-Jones (2010) made it their explicit goal to contradict earlier studies by showing that negative-affect stimuli very low in intensity and approach motivation had similar broadening effects to positive-affect stimuli of low intensity and approach motivation. It is not affect but intensity, they claim, which is responsible for changes in attention. Other researchers have claimed that the effect of mood on attention is not actually based on the valence of mood but rather on which orientation of attention is momentarily dominant preceding experiments (Huntsinger, 2012; Huntsinger, 2013).

These findings are relatively inconsistent with the generally accepted principle of positive emotions broadening attention and negative emotions narrowing it. Nevertheless, the value of the present study and similar studies of the past are not necessarily undermined by these data. The pressing concern that ours and future studies should glean from these findings combined is to keep the relevant factors constant. In other words, so long as a study’s stimuli do not vary greatly in approach motivation or intensity of emotions, findings regarding direction of emotion and effects on attention are still entirely valid. The best way to make use of this information would be to find stimuli inflexible on these measures, which could be confirmed using pilot tests with raters or participants blind to the purpose of the ultimate study. Indeed, finding stimuli that adhere to these standards is of importance to us, and we have taken full advantage of the ratings of affect and arousal provided for all IAPS images.

Most Recent Contributions

Many studies, some with different goals than others, have jumped at the opportunity to contribute to the attention-emotion relationship. One of (perhaps *the*) most recent to do so, and the one whose unanswered questions we seek to resolve with the present study, is that of Gu et al., (2017). Given the extent to which our experiment is modelled after theirs (with several noteworthy changes), it is warranted to examine their study in somewhat greater detail. The authors claim that while contemporary studies have sufficiently proven that mood can be influenced by manipulating attention, the ability to relieve preexisting negative moods via attentional manipulation is lacking. More importantly, Gu et al. (2017)'s study is different from all previous work in that it sought to directly induce a broadened and narrowed scope of visual attention, rather than influencing thinking towards global or local processing. Two experiments were conducted to test whether this direct intervention on visual attention could help alleviate negative moods. The first study featured participants being shown a series of neutral photos either zooming in or out, and it was found that participants in the zooming-out condition's moods were less negative after all participants began with a negative mood induction. In the second study, mildly depressed participants were instructed to spend some time each day looking at either a proximate or distant scene for 8 weeks, and it was found that participants viewing the distant scene had notable improvements in mood. In the present study, we intend to mostly replicate experiment 1 from Gu et al., (2017).

The Present Study

We have established that manipulating attention to be broad rather than narrow both increases positive mood and decreases negative mood, and further, through the work of Fredrickson, that positive emotions stimulate broader, more open-ended thinking. But what is it about “seeing the big picture,” specifically, that accounts for this relationship? Based on the suggestion of Gu et al., (2017), we hypothesize that the relationship between broadened attention and changes in mood is mediated by cognitive flexibility. Specifically, we have formulated three hypotheses.

H1: Replicating the main finding from Gu et al.’s, (2017) first experiment: Participants in a broadened attention group will have a more significant reduction in negative mood than participants in a narrowed attention group.

H2: The average group score on cognitive flexibility will be greater for a broadened attention group than for a narrowed attention group (i.e., the positive change in mood in a broadened attention group is mediated by cognitive flexibility.

H3a: Within a broadened attention group, participants who spend more time looking at newly presented visual information compared to already available information will have the largest improvements in mood as well as highest cognitive flexibility scores.

H3b: Regardless of group, participants who spend a greater amount of time looking at peripheral rather than central information will have the largest improvements in mood as well as highest cognitive flexibility scores.

It is important to reiterate that these hypotheses are securely based in the research leading up to this study.

H1 is a near direct replication of experiment 1 of Gu et al., 2017. **H2** is based on the fact that cognitive flexibility is one of the constructs strengthened by positive emotions: our theory is that when positive emotions are elicited by manipulating attention, cognitive flexibility is the construct responsible, serving a mediating role. Indeed, links between attention and constructs related to cognitive flexibility have already been demonstrated. Hanif et al., (2012) found that manipulating participants into having a broadened scope of attention increased their ability to self-regulate; that is, to stay focused on present tasks by eliminating the effects of distracting competing impulses. Other studies yet have linked cognitive flexibility and alleviation of negative emotions (Southwick et al., 2005). Some studies have even directly linked positive affect with increased cognitive flexibility (Compton, Wirtz, Pajoumand, Claus, & Heller, 2004). Given these studies' findings about how cognitive flexibility connects emotion and attention in some circumstances, we seek to establish that it does so when attention is manipulated.

Our hypotheses related to eye tracking have the quality of being backed not explicitly by prior research but through the extension of several ideas. Wadlinger and Isaacowitz (2006) demonstrated, using eye tracking, that participants induced into a positive mood spent more time gazing at peripheral information, and Gu et al. (2017) were successful in improving mood by utilizing a method we seek to model very closely. As such, our eye tracking hypothesis is formulated by the application of logic: since we intend to improve participants' mood through attentional manipulation, it is sensible that prior findings about eye-patterns related to positive moods will be replicated.

Furthermore, following in the path of many studies earlier described to have reproduced a finding that was initially made regarding mood and redone by manipulating attention, ours is the first to do so with the link between mood and tendency to gaze at peripheral information.

Methods

Sample and Design

Participants were undergraduates from Haverford and Bryn Mawr Colleges (n=66) who participated in exchange for introductory psychology course credit or $15. Though 66 people initially participated, data for 5 participants were excluded from all analyses due to technological malfunctions during the experiment, distractions from outside the room during the experiment, or inability/failure of the participants to follow instructions. Furthermore, some participants' data were partially excluded. Of participants whose entire data set was not excluded, 7 participants' eye-tracking data were excluded due to an unusually low percentage of data recorded, which could have been caused by looking away from the screen or technological malfunction. A value of 75% of the time during which recording took place that data was successfully collected was the cutoff rate for this limit because it was at that point that noticeable gaps in eye-tracking data were apparent. Of participants whose data was not fully excluded, 2 participants' water-jar task data were excluded due not completing the task because of time constraints or inadvertent deletion of their data. Of the participants (n=61) whose data were included in at least some analyses, 43 were female and 18 were male. The average age of participants was 19.8 years (SD = 1.45). 31 were in the zoom-in condition, 30 were in the zoom-out condition.

Participants were placed evenly into either a broadened or narrowed attention group. Placement in these groups constituted the primary independent variable of the study. Other independent variables were patterns of visual attention as measured by the eye-tracking device. The dependent variables of all tests were performance on the cognitive flexibility test and changes in mood.

Overview of Procedure

The procedure followed the outline of Gu. et al, (2017) fairly closely, but with several key changes. All participants, after providing informed consent, were placed in front of a standard laptop. They were first induced to have a negative mood using a sad 3-minute film clip. After completion, all participants filled out the mood measure (Abbreviated Profile of Mood States (A-POMS)) for the first time to acquire a measure of their mood to compare to the end of the experiment. Given that the experiment called for the use of programs (E-prime, Tobii Studio) that function best when running on their own computer, two computers were linked to a single monitor in order to reduce distraction and unnecessary movement for the participants. Those computers, in order to ensure optimal functioning of the E-Prime and Tobii Studio programs, were not connected to the internet, which was required for the participants to take the assessment of mood. So, the mood induction and assessment took place on the laptop and the attentional manipulation and cognitive flexibility exercise took place on the desktop computer, which were next to each other on a table. After a brief calibration exercise with the eye-tracking apparatus, participants engaged in the attentional manipulation task. For the attentional manipulation, four different sequences of the same images were created and applied in a fashion so as to occur equally frequently to participants in each condition in order to prevent any inadvertent effects sequence order of the images may have had. After completion of the attentional manipulation task, participants were issued the A-POMS a second time or given the cognitive flexibility measure, the Water-Jar task, in counterbalanced order to control for the effects that one may have on the other. Given that both serve as dependent variables ideally measured immediately after the experimental manipulation, the reasoning behind counter-balancing is that should either test itself affect results of the other, which is expressly not our intention, that information would be statistically determinable. The following section provides a detailed account of the implementation of the different measures.

Mood Induction

A three-minute video from the film “The Champ” was used to induce participants to feel sadness. The film clip depicts a young boy finding his father, a boxer, dead as a result of injuries sustained while boxing. The scene is well established to induce sadness and has been used for that purpose by numerous past studies (Gross & Levenson, 1995; Haase, Seider, Shiota & Levenson, 2012; Seider, Shiota, Whalen & Levenson, 2011).

Mood Measurement

Following the methods of Gu et al., (2017) mood was assessed twice during the experiment, once before and after the attentional manipulation, using the Abbreviated Profile of Mood States (A-POMS) (Grove & Prapavessis, 1992). Participants rated the extent to which they felt 40 mood-related adjectives described their current state on a likert scale from 0-4, 0 being not at all and 4 being extremely. The scale can be divided into two subsections, positive and negative affect, which are broken down further in positive affect by measures of high-esteem and vigor and in negative affect by tension, fatigue, depression, confusion, and anger. Though differences between positive and negative affect are included in final analyses, our primary interest was in comparing changes in Total Mood Disturbance (TMD). Following other studies (Shen, Liu, Li, Zhang, & Zhou, 2012; Zhu, 1995; Gu et al., 2017) TMD is calculated by subtracting measures of positive affect from negative affect and adding a constant of 100.

Eye Tracking

Eye tracking was measured during the attentional task using a *Tobii TX300* model using *Tobii Studio* software. Participants completed a 9-point calibration exercise to acquaint the system with each participant's gaze pattern. Participants sat approximately 60 cm in front of the screen and a sampling rate of 120 Hz. was used. 7 specific variables were compiled from the eye-tracking device by creating two areas of interest. The first, which applied to all participants, was the distinction between the inner and outer 50% of the screen. The second, which applied only to participants in the zoom-out group, distinguished between the information which was already presented to the participant and information which was "new" by virtue of appearing on the screen only as the image began to zoom out, revealing additional content. The variables were: Proportion of the total duration of viewing directed towards the outer 50% of the screen (Duration in the Periphery-DP), proportion of fixations (brief period of visual focus on a given area on the screen) which occurred in the outer 50% of the screen (Fixation Count in the Periphery- FCP), amount of times a participant switched focuses between the outer and inner 50% of the screen (Visit Count- VC), and total fixations across the entire screen (Total Fixation Count-TFC). Separate analogous variables were created to apply only to participants in the zoom-out condition. We have chosen the term "Dynamic" to refer to these variables. They were: Proportion of the total duration of viewing directed towards new visual information (Dynamic Duration- DD), proportion of fixations directed towards new visual information (Dynamic Fixation Count- DFC), and the amount of times a participant switched focus between new and old visual information (Dynamic Visit Count- DVC).

Attentional Manipulation

Again following the procedure of Gu et al., (2017), participants in the narrowing condition viewed 45 6-second videos of still images, presented in one of four possible sequences, which opened with the full scope of the image presented and zoomed in at a constant rate over the 6 seconds towards the center of the image. In the broaden group, the same images were presented but the video was in reverse order; starting with focus on a central point and zooming out until the entirety of the image was visible. Images were presented in *Tobii Studio* in order to accommodate use of eye-tracking. Images were selected from the International Affective Picture Systems (IAPS: CSEA-NIMH, 1999). The criteria for selecting images, based on explicitly stated limitations from Gu et al., (2017) (Though it is worth noting that they did *not* use IAPS images for their study) and available research, were images that were as neutral in affect and as low in arousal as possible; exhibiting little or no emotional content and being entirely neutral in approach-motivation. Furthermore, images were presented such that at no point were participants completely unable to make-out the content of the picture, as to do otherwise might have inadvertently caused feelings of confusion or disorientation. A strength of the present study as in Gu et al., (2017) is that by presenting real-life images for the sake of attentional manipulation, ecological validity was maximized, compared to many other studies which made use of abstract, artificial measures of local-global processing.

Cognitive Flexibility Measure

As our measure of cognitive flexibility, we used the Water-Jar task (WJT) initially designed by Luchins (1942) to measure the *Einstellung effect,* which refers to the tendency to overlook simple solutions to problems if one is already in the mindset of using a more difficult solution. In the present study, we borrowed a computerized version created by Greenberg, Reiner, & Meiran (2012) using E-prime software. Though initially used to measure the construct of "Cognitive Rigidity," we feel that the nature of the test measures precisely what cognitively flexibility represents (i.e., the ability to switch modes of thinking.) Participants were presented with three jugs of water, each holding a specified amount of units, and told to use addition and subtraction of the three jars to match some target amount. Participants were given a pencil and scrap paper to aid with any calculations. The first phase involved *set trials*, in which the formula for the solution was constant and complex. While the capacities of the various jars and the target amount changed, the formula for solving remained constant (e.g., -1A + 1B - 2C). Participants were given as many as 10 set trails until they solved 6 correctly. Following set trials were 3 *critical trials* in which the established complex pattern *and* a simpler formula (e.g., A + C) both reached the target amount. The key measure of cognitive flexibility was whether participants noticed the easier solution (the use of which saved them time and effort due to requiring less key-board presses). Following the critical trials were 3 *extinction trials* in which only the simpler formula was able to be used to reach the target. On extinction trials, exceeding 60 seconds to find the solution was operationalized to mean displaying decreased cognitive flexibility. To reiterate, using the more complex solution on critical trials was understood as displaying decreased cognitive flexibility. Thus, cognitive flexibility scores ranged from a possible low of zero to a possible high of 6. A point was awarded every time a participant used the simpler formula on critical trials or solved an extinction trial correctly and under the time limit.

Statistical Analyses and Expected Results

As previously mentioned, it was expected that participants in the broadened attention group would have a greater improvement in mood as defined by the difference in total mood disturbance between the first and second A-POMS. This was investigated using a 2 (Time; first vs. second A-POMS result) x 2 (Group; broadened vs. narrowed attention) mixed ANOVA. Specifically, an interaction effect of group and time on difference in TMD was expected such that participants in the broadened group would show lower measures of TMD at time 2 than participants in the narrowed condition. As for the second hypothesis, it was expected that the broadened attention group would outperform the narrowed attention group on our measure of cognitive flexibility: the WJT. An independent-samples t-test was used to compare the groups, with a main effect of group expected. Finally, eye tracking information was analyzed using correlation analyses. We anticipated that, regardless of group, participants who spent more time gazing at peripheral information would have the greatest improvements in mood and highest scores on cognitive flexibility. Within the broadened attention group only, we predicted that participants who spent more time looking at newly presented areas of the image would display the same results; higher cognitive flexibility and greater alleviation of negative mood. To reiterate, the reason the hypothesis of new vs. old information was not extended to the narrowed attention group is because their field of view began with the full scope of the image already; they were never presented with “new” information.

Results

Effectiveness of Attentional Manipulation

The goal of the attentional manipulation exercise was two-fold. The first was to temporarily cause participants in the zoom-out group (ZOG) to assume a broadened visual perspective while causing participants in the zoom-in group (ZIG) to assume a narrowed visual perspective. The second was to use eye-tracking information collected during the manipulation to compare gaze patterns with outcomes of cognitive flexibility and mood independent of group placement. In order to confirm that participants in the two groups actually did employ different gaze patterns, the extent to which the two groups gazed at peripheral information was compared. After all participants whose eye-tracking and overall data were excluded, 54 remained, 27 per group. The expectation was that, as measured by DP and FCP, participants in the ZOG would exhibit a much greater focus on the periphery of images compared to those in the ZIG. An independent samples t-test confirmed this expectation: **DP:** t (52) = -3.329, p = .002 (ZIG: M: 19.27%, SD: 10.33%. ZOG: M: 27.81%, SD: 8.42%). **FCP:** t (52) = -4.008, p < .001 (ZIG: M: 22.40%, SD: 9.92%. ZOG: M: 32.34%, SD: 8.24%).

In addition to confirming that the two groups differed on average in gaze patterns, correlations between the various eye-tracking variables were conducted to confirm that they measured unique but related gaze patterns. Though levels of significance and the strength of correlations differed slightly across analyses run with different subdivisions of the full group of participants, those which emerged from the full group were fairly representative of the correlations overall: (**DP and FCP:** r(53) = .941, p < .001; **DP and VC:** r(53) = .604, p <.001; **DP and TFC:** r(53) = .469, p <.001; **FCP and VC:** r(53) = .537, p <.001; **FCP and TFC:** r(53) = .318, p = .020.) These tests indicate that each eye tracking variable overlapped very strongly with- but was not identical to- the other eye-tracking variables.

Group Comparisons

WJT

Our central hypothesis in regards to cognitive flexibility was tested by comparing the ZIG and the ZOG’s performance on the WJT. It was hypothesized that the ZOG (n=28) would outperform the ZIG (n=31) because the visual manipulation in that group was aimed at priming a global visual perspective. An independent samples t-test was conducted to compare the groups’ scores. Counter to predictions, there was no statistically significant difference between the group, *t* (57) =0.802, p > .10; (ZIG: M= 3.32, SD = 1.78, ZOG: M = 2.93, SD = 2.00). Though statistically there was no difference between the groups, the small difference in scores was in the opposite direction from predictions; the ZIG demonstrated greater cognitive flexibility than the ZOG. Follow-up analyses were conducted to determine whether procedure order (i.e., whether participants completed the WJT or the second A-POMS first) had an effect on the outcome, but it was not found to. Even when accounting for procedure order, the two groups did not vary as predicted on this measure.

A-POMS

An analogously structured hypothesis was formulated for mood. The ZOG was predicted to have a more substantial improvement in mood than the ZIG tested by measuring changes in mood between the first and second A-POMS. A 2 (Time; first vs. second A-POMS) x 2 (Condition; ZIG/ZOG) mixed factorial ANOVA was run to determine whether there was a difference in total mood disturbance between the two groups. A main effect of time indicated that participants in both conditions had a significant improvement in mood at time 2 (M= 99.03, SE =1.81) compared to time 1 (M=113.35, SE = 1.97) (TMD M = 99.03, SE =1.81), F (1,59) = 60.85, p < .001. However, contrary to predictions, this change in mood was not different across groups. Though all participants experienced mood improvement, this improvement was not statistically greater or less as a factor of group placement, F(2,59) = .004, p > .10. Follow up analyses were conducted to determine whether procedure order had an effect and also whether there were notable differences between changes in positive and negative moods as opposed to mood disturbance in aggregate. Such analyses did not uncover any significant findings; regardless of procedure order, there was no difference between the groups in the extent to which participants' moods improved. Additionally, analyses dividing TMD into positive and negative moods did not reveal any further effects.

Within Subject Comparisons

Though group differences were hypothesized to emerge due to the effectiveness of the attentional manipulation, it was further hypothesized that one's attentional state as measured by eye tracking would have consequences for mood and cognitive flexibility even outside the context of group placement. In other words, it was hypothesized that even if placement into a group did not succeed in manipulating certain attentional states, whatever attentional patterns a participant *did* employ could still be used to predict mood and cognitive flexibility outcomes. Thus, all analyses detailed in this section are correlations between eye tracking patterns by either all participants or participants just in the ZOG and outcomes of cognitive flexibility and mood.

WJT

Eye-tracking-derived variables from all eligible participants were compared to WJT scores using Pearson's correlations. Excluding all participants with incomplete WJT or eye-tracking data lead to their being 53 participants' data. It was hypothesized, because it would imply the assumption of a global visual perspective, that higher DP, FCP, VC, and TFC measures would all positively correlate with WJT scores (measuring cognitive flexibility). Despite these predictions, no statistically significant correlations were found. (**DP**: $r(53) = -.009$, $p > 0.10$; **FCP**: $r(53) = -.031$, $p > 0.10$; **VC**: $r(53) = .101$, $p > 0.10$; **TFC**: $r(53) = .051$, $p > 0.10$.) As for the variables which applied exclusively to the ZOG, the hypothesis was the same: DD, DFC, and DVC were all expected to correlate positively with WJT scores according to the same justification that was applied to the universal eye-tracking variables. Analyses were run for participants in the ZOG with no eye-tracking or WJT exclusions ($n = 26$). However, no significant correlations were found. (**DD**: $r(26) = .234$, $p > 0.10$, **DFC**: $r(26) = .116$, $p > 0.10$, **DVC**: $r(26) = .076$, $p > 0.10$.)

Follow-up analyses sought to test the effect of procedure order on these correlations, but no significant effects were found. Whether participants took the second A-POMS or WJT first did not change the relationship between gaze patterns and cognitive flexibility and mood.

A-POMS

The same hypotheses made regarding correlations between eye-tracking variables and WJT performance were also made regarding improvement in mood. After eliminating data from all participants with incomplete eye-tracking or A-POMS information, 54 remained. A single variable that quantified total improvement in mood (TMD at time 1 minus TMD at time 2) was calculated for this test to simplify correlations that would otherwise require reference to both issuances of the A-POMS. Thus, positive correlations were again predicted between DP, FCP, VC, TFC, and total mood improvement. However, no significant correlations were found (**DP**: $r(54) = .035$, $p > 0.10$; **FCP**: $r(54) = .046$, $p > 0.10$; **VC**: $r(54) = -.116$, $p > 0.10$; **TFC**: $r(54) = -.129$, $p > 0.10$.)

Follow-up analyses tested whether procedure order affected the results of these correlations, and a single significant correlation was unveiled. Among participants who took the A-POMS before taking the WJT, and whose data were not excluded, ($n = 25$), there was a significant negative correlation between TFC and total mood improvement ($r(25) = -.447$, $p < .05$). Though specific hypotheses were never explicitly produced regarding procedure order, it is still counter to predictions that any group of participants would exhibit a *negative* correlation between total-screen fixation counts and mood improvement. Such a correlation was expected to be significantly positive among all participants.

Dynamic variables that applied only to the ZOG were also analyzed with the expectation of positive correlations between DD, DFC, DVC, and total mood improvement. Analyses were run on members of the ZOG with no A-POMS or eye-tracking exclusions (n = 27). No significant positive correlations were found, but one marginally significant negative correlation emerged between DVC and total mood improvement. (**DD**: $r(27) = .082$, $p > 0.10$, **DFC**: $r(27) = 0.008$, $p > 0.10$, **DVC**: $r(27) = -.342$, $p = 0.081$.)

Thus, contrary to predictions, it seems the extent to which participants in the ZOG switched attention between new and old information (quantified by DVC) was marginally correlated with a smaller, not greater, improvement in mood. When follow-up analyses were conducted to control for procedure order, this marginally significant correlation persisted for those who took the A-POMS first but not for those who took the WJT first. (A-POMS First (n = 14): $r(14) = -.464$, $p = 0.095$. WJT First (n = 13): $r(13) = .296$, $p > 0.10$.) So while more switching between new and old visual information was correlated with a less substantial improvement in mood among all participants in the ZOG, this correlation only held, when tested, among those whose mood was measured immediately after the attentional manipulation.

To test whether any patterns of attention were correlated with a subset of mood, the positive and negative subscales of the A-POMS were separated and additional analyses were conducted comparing them separately. Just as “Total Mood Disturbance” at times 1 and 2 were subtracted to create “Total Mood Disturbance Difference” to simplify correlations, so too were the variables “Total Negative Mood” at times 1 and 2 and “Total Positive Mood” at times 1 and 2 subtracted to create the variables “Total Negative Mood Difference (TNMD)” and “Total Positive Mood Difference (TPMD)” respectively. It was predicted that all eye tracking variables (DP, FCP, VC, TFC, DD, DFC, and DVC) would be positively correlated with TNMD and negatively with TPMD. When tests were run with all participants who were not excluded (n = 54), no significant correlations emerged ($p > 0.10$). When follow up analyses tested the effect of procedure order, a single marginally significant correlation was uncovered. Among participants who took the A-POMS first and whose data were not excluded (n = 25), FCP was found to be negatively correlated with TPMD ($r(25) = -.354$, $p = .083$)). So, in line with predictions, of participants whose mood was measured before the cognitive flexibility test, the greater extent to which they demonstrated fixations in the periphery of images was marginally related to a larger increase in positive mood over the course of the experiment.

Analyses with the variables unique to the ZOG (dynamic variables) were then compared to the two divisions of mood. Just as was the case with variables applying to all participants, positive correlations were expected with TNMD and negative correlations were expected with TPMD. After exclusions were considered, 27 participants' data from the ZOG remained. Among all correlations, only one proved significant: a negative correlation between DVC and TNMD ($r(27) = -.388$, $p = .046$.) Thus, contrary to predictions, the extent to which participants in the ZOG switched attention between new and old information was correlated with a smaller, as opposed to greater, decrease in negative mood.

Discussion

Summary

The present study took an established relationship between attention and emotion and tested a construct -cognitive flexibility- that appeared to be a likely force in mediating that relationship. The past research utilized to arrive at this hypothesis was highly consistent. Gu et al., (2017) particularly served as an inspiration to the present study by taking a theoretical link and showing that visual attention can be manipulated to directly impact emotion. Other studies (e.g., Compton et al., 2004; Isen, 2002) have linked positive affect with cognitive flexibility. Research from emotion regulation strategies suggest the sensibility that enhanced cognitive flexibility could contribute to positive emotions by serving as a secure source from which to produce meaning and adaptive conclusions following sad or traumatic events. As indicated in the introduction, Haglund et al.'s, (2007) definition of one particular emotion regulation strategy, cognitive reappraisal, is remarkably similar to the definition of cognitive flexibility itself. The greater ease with which one can switch modes of thought intuitively should relate to the ease with which one can produce adaptive explanations for the inevitable maladies every human experiences at some point in life.

With regards to eye-tracking, our study took several experiments showing how mood can effect gaze patterns (Allard et al., 2010; Isaacowitz, 2005, Wadlinger & Isaacowitz, 2006) and attempted to demonstrate the bi-directionality of that relationship by showing how gaze patterns would vary with mood.

Despite the support of the literature, our two central hypotheses both fell short of confirming expectations. Specifically, the ZOG and ZIG were not statistically different from each other on WJT performance or on changes in mood. Conclusions from eye-tracking variables were, if anything, in the opposite direction of proposed hypotheses. While a variety of reasons for the emergence of these unexpected results will be considered later, it is first important to analyze the results themselves and discuss their actual meanings in non-technical language.

Examination of Significant and Marginally Significant Tests

Though the primary hypotheses were not supported, a number of significant and marginally significant statistical tests indicated certain relationships between gaze-patterns and mood-related outcomes. Most of the results proved to be in the opposite direction of what was expected.

Because both the second assessment of mood and cognitive flexibility were ideally measured directly after the attentional manipulation, a counter-balanced sequence was applied to participants evenly across groups to minimize the unintended effects of procedure order. Not a single significant correlation emerged when all eligible participants were considered, but a few effects did come from the group of participants whose mood was measured directly after the manipulation and from participants in the ZOG only. Total fixation count was marginally negatively correlated with mood improvement for participants whose mood was measured first. This variable measures a general tendency to shift attention around on the entire screen. The existing eye-tracking literature (e.g., Wadlinger & Isaacowitz, 2006), has found essentially the opposite effect. In that study, saccades, which measures the same pattern of attentional deployment, were found to correlate positively with positive mood.

Interestingly, Wadlinger & Isaacowitz's (2006) findings match the single correlation of this study that was in the hypothesized direction: the tendency of participants whose mood was measured immediately after the manipulation to show improvement in positive mood as the amount of their fixations in the periphery increased. Wadlinger & Isaacowitz (2006) found that participants induced to be in positive moods, in addition to exhibiting more saccades, also focused more on peripheral information. Why this held true only to participants in the present study whose mood was measured right after the manipulation may be due to an unintended influence of the WJT on mood.

Combining the concept of saccades and focus on the periphery, we also found that DVC, which measures instances of switching between newly and already presented information, was negatively correlated with mood improvement both for all participants in the ZOG and also those specifically whose mood was measured just after the manipulation. Again, this finding is in direct disagreement with the literature.

In reconciling the results of the present study with those of the existing literature, there are a few possible explanations. In some cases, assumptions were made about the similarity between previous studies and the current one that were not warranted. For example, while statistical tests confirmed that the two groups in the present study did not differ in mood, even had there been differences there is no guarantee that participants of either group would achieve the level of positive mood necessary to witness the effects of mood on attention indicated by Issacowitz and others' studies. There are many methods by which to influence and measure mood, and few other studies have specifically chosen the APOMS as a measure, making comparisons difficult.

Relatedly, it may be possible, given that the experiment for all participants began with a negative mood induction, that participants' moods at the time that eye-tracking data were recorded were all fairly negative. It was our intention that the attentional manipulation itself would differentially affect the speed of recovery to baseline mood after the negative mood induction, but when eye-tracking variables were recorded, participants, regardless of group, were still in the process of returning to baseline mood.

Other explanations for these apparent discrepancies may arise from having relied on the incorrect assumption that all effects of emotion and attention can be caused by approaching either end of the link. The literature has shown several such instances of inconsistencies relating to eye-tracking data. For example, recall that van Reekum et al., (2007) found that participants asked to engage in cognitive reappraisal while viewing unpleasant images demonstrated different gaze patterns than participants asked merely to attend to them. But when Urry (2010) controlled gaze patterns to be different than those associated with cognitive reappraisal, participants were still able to use cognitive reappraisal to reduce the impacts of negative images. This same type of inconsistency is modelled by the relationship between our experiment and those of Allard et al., (2010), Isaacowitz, (2005), and Wadlinger & Isaacowitz, (2006). Those studies demonstrated how, whether through experimental induction of positive mood or through self-reported mood-related dispositions (e.g., self-assessed optimism/pessimism), mood affected gaze patterns. Specifically, Wadlinger & Isaacowittz (2006) showed that participants induced to be in a positive mood focused attention more on the periphery of images and demonstrated more saccades. But in our study, for the most part, either no relationship or a negative relationship was found between attention to the periphery and movements to and from the periphery (which is essentially the meaning of 'saccade') and positive mood. To summarize, our study is not the first to fail to produce behavioral/emotional changes by manipulating attention even when certain patterns of attention were shown to be practiced by people with those same behaviors/emotions. It is simply a fact that not every effect involving attention and emotion is bi-directional, and our study contributes to this understanding.

As for the hypotheses regarding cognitive flexibility, prior research has produced very compelling evidence as to why it should play a role in the attention-emotion link. Given that the theories used in forming these hypotheses are sound, it is likely that at least part of the reason our hypotheses were not confirmed was due to problems with the validity of tests and manipulations used in the present study. Though the A-POMS and film clip from the "The Champ" seem reliable, valid manipulations/measurements that have been used by many researchers previously, our attentional manipulation technique, though based on previous studies, was ultimately a new creation. Furthermore, the WJT has been used only sparingly in the past, and, in fact, was initially created to measure “cognitive rigidity,” which we inferred to be the opposite of cognitive flexibility. In the next section, limitations pertaining to the validity of the tests/measures used in the present study will be discussed.

Limitations

Attentional Manipulation

Gu et al., (2017) indicated that the images used in their study may have inadvertently been positive or pleasant in nature. The confounding variable which lead to their participants' increase in positive mood, then, may have been the pleasantness of the images viewed rather than the effect of the manipulation. Our study addressed this issue by using images confirmed to be neutral according to IAPS ratings (Valence ranged from 4.39-6.78 on a scale from 1-9 on which 9 indicated very strong positive emotions and 1 very strong negative emotions). However, since the images used in Gu et al.'s, (2017) zoom-in and zoom-out conditions were rated in a pilot study to be very similar to each other in valence, this could not explain why the groups differed in change in mood, only why they both improved over time. But since the manipulation technique in the present study did not produce *any* statistically significant differences in changes in mood between the two groups, despite replicating the actual zoom-in/zoom out techniques mentioned in their paper as closely as possible, perhaps the positive valence (rated on average at 5.15/7) of the images used in Gu et al.'s (2017) study actually did contribute to their participants' mood improvements.

Another consideration regards the validity of the manipulation itself. Does viewing images of random objects neutral in valence on a computer screen which either zoom in or out actually impact one's scope of visual attention? The reasoning for employing such a method was based on the high degree of statistical significance in tests achieved by Gu et al., (2017) (p values for many central hypotheses were <.001.) But finding significant differences between two groups by using a particular method by no means ensures that that method accomplished what it was intended to. It is worth considering the other experiment conducted in the same paper by Gu et al., (2017) which was not the focus of our experiment. Participants with cases of mild depression were asked to spend a short amount of time each day for 8 weeks viewing an actual scene from a real environment that was either distant or proximal. Participants in the proximal group reported alleviation of symptoms to a much greater degree than those in the distant condition. Though both experiments produced highly significant differences in the two groups, it is at least thought-provoking that the differences between the groups was greater in the real-scene experiment than in the computer-screen experiment.

WJT

The WJT, undoubtedly, required a certain degree of arithmetical competency to complete. The construct of cognitive flexibility refers to the ability to switch modes of thinking, but it is quite difficult to assess such a broad idea, and ultimately, researchers must select a particular type of thinking to test. In our case, that type of thinking was arithmetical reasoning. Participants were asked to solve math problems without the help of calculators that often involved somewhat difficult arithmetic operations. It seems likely that one’s underlying mathematical competency was a greater prediction of success on the WJT than one’s true cognitive flexibility. Some other tests of cognitive flexibility involve choices on mazes/trails (Kortte, Horner, & Windham, 2010), self-reported questionnaires (Martin & Rubin, 1995), and card-sorting tasks (Grant & Berg, 1985). That our study chose the WJT reflects a practically arbitrary decision about which domain of thought to use to measure a construct which applies to, really, every domain of thought. Given that the effects of cognitive flexibility we sought to measure had to do with mood regulation via emotional regulation strategies, perhaps it would have been more effective to use a different or several different tests of cognitive flexibility.

Furthermore, the version of the WJT used in the present study, borrowed from Greenberg et al.'s (2012) study on cognitive rigidity, was translated to English from Hebrew. As such, the instructions on how to complete the task were occasionally awkwardly worded. For participants for whom English was not a first language, instructions may occasionally have been difficult to interpret even with experimenters staying in the room to provide assistance during practice trials.

A further issue yet was participants who adhered neither to the intended 'complex' nor 'simple' formula of solving problems (i.e., -1A +1B -2C versus 1A +/- 1C), but instead found another formula that worked on a single or several trials. This option was not anticipated prior to initiating the experiment, and decisions about scoring of such trials were only made after the fact. Ultimately, we determined that any use of a formula other than the simplest possible should be scored the same as if a participant continued to use the established complex formula. But given the very definition of cognitive flexibility- the ability to switch modes of thinking- perhaps this scoring decision was not ideal. After all, if a participant found an entirely new formula to use that did indeed correctly solve the problem, should not such a choice be considered as displaying cognitive flexibility?

All of these issues having to do with our test of cognitive flexibility, in combination with the strength of the earlier literature linking cognitive flexibility with mood, indicate a problem with validity. Though only follow-up studies can say for certain, it seems likely that the WJT, as used in this experiment, may not have accurately measured cognitive flexibility in quite the way that was intended.

Ideas for Future Research

The limitations indicated in the previous sections lead to many ways to approach future studies of the attention-emotion link. First and foremost, a reproduction of the present study that fixes the indicated problems is an important next step. Such a study should employ a more ecologically valid method of attentional manipulation. Given that the zoom-in/zoom-out images technique was created by Gu et al., (2017) and replicated only once in the present study, there is simply not enough data to confirm its effectiveness. Secondly, a different, and perhaps several different, measures of cognitive flexibility should be utilized. Though it may be more time consuming and require more resources, using multiple tests that measure flexibility in different types of thinking could be used to converge on a signal cognitive flexibility score. Any study that employs only a single method does not truly measure general cognitive flexibility, only flexibility in whatever specific type of thought has been selected.

Regarding attention as measured by eye-tracking, future studies should test the effect of gaze patterns on emotion more directly. Our hypotheses connecting mood changes and gaze patterns were contingent on the attentional manipulation being effective, but that may not have been the case. A study which forces participants to attend to images in a specific way, such as in the methodology employed in Urry’s 2010 study, would more firmly test the ability to affect emotion via attention. Specifically, participants could view neutral images and be asked to follow a transparent sphere that stays either primarily in the periphery or the center, followed by a mood assessment. Such a study would confirm whether the gaze patterns associated with positive moods could cause those moods if forced as opposed to merely influenced. While the present study attempted to affect attention, and indeed the two groups' average patterns of attention were different, it fell short of producing the level certainty the proposed study would offer.

Studies that demonstrate the bi-directionality of the attention-emotion link notwithstanding, it seems likely that single interventions of attentional training can only have impacts that reach so far. Two promising aspects of the second study about viewing a scene from the environment conducted by Gu et al., (2017) are its repeated exposure over eight weeks and in its ability to influence not just fleeting moods but lingering feelings of depression. The researchers attributed the success of that study to the broadening effects of viewing a distant scene, but it seems likely that the act of deliberately taking time out of the day to completely focus on something other than one's own problems could also contribute to alleviation of negative moods/feelings of depression. Given the impressive volume of research linking meditation with positive physical and mental health outcomes (Pargament, 2013), perhaps incorporation of a broadened attention exercise into established meditation techniques could serve to increase effectiveness even more.

Conclusion

The literature from Broaden and Build Theory, especially that pertains to resilience and resource building, is too consistent for cognitive flexibility not to be related to the attention-emotion link. While the goal of the present study was to show that cognitive flexibility is responsible for the effects of broadened attention on mood, literature has already firmly established the relationship between cognitive flexibility and positive mood. For that reason, it is perhaps more accurate to describe the present study as contributing to theoretical research on attention rather than producing a method by which to alleviate negative moods. Though there is clearly a cognitive, behavioral, and neurological overlap between the constructs of attention and emotion, researchers interested exclusively in improving mood need only focus on methods to improve cognitive flexibility. The study of the attention-emotion link seems more likely to produce general information about the human mind rather than realistic and attainable methods to alleviate mood disturbances.

References

Allard, E. S., Wadlinger, H. A., & Isaacowitz, D. M. (2010). Positive Gaze Preferences in Older Adults: Assessing the Role of Cognitive Effort with Pupil Dilation. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*, 17(3), 296–311.

Attwood, A.S., O'Sullivan, H., Leonards, U., Mackintosh, B., & Munafo, M.R. (2008). Attentional bias training and cue reactivity in cigarette smokers. *Addiction*, 103(11). 1875-1882.

Baddeley, A. (1972). Selective attention and performance in dangerous environments. *British Journal of Psychology*, 63, 537–546.

Bebko, G.M., Franconeri, S.L., Ochsner,K.N., & Chiao, J.Y. (2011). Look before you regulate: Differential perceptual strategies underlying expressive suppression and cognitive reappraisal. *Emotion*, 11(4), 732-742.

Bebko, G. M., Franconeri, S. L., Ochsner, K. N., & Chiao, J. Y. (2014). Attentional deployment is not necessary for successful emotion regulation via cognitive reappraisal or expressive suppression. *Emotion*, 14(3), 504.

Bonanno, G.A., & Keltner, D. (1997). Facial expression of emotion and the course of conjugal bereavement. *Journal of Abnormal Psychology*, 106(1), 126-137.

Carstensen L.L, Pasupathi M., Mayr U., Nesselroade J.R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology*, 79, 644–655

Chajut, E., & Algom, D. (2003). Selective attention improves under stress: Implications for theories of social cognition. *Journal of Personality and Social Psychology, 85*(2), 231-248.

Compton, R.J., Wirtz, D., Pajoumand, G., Claus, E., & Heller, W. (2004). Association Between Positive Affect and Attentional Shifting. *Cognitive Therapy and Research*, 28(6), 733-744.

Danner, D.D., Snowdon, D.A., & Friesen, W.V. (2001). Positive Emotions in Early Life and Longevity: Findings from the Nun Study. *Journal of Personality and Social Psychology*, 80(5), 804-813.

Desimone, R., & Duncan, J. (1995). Neural mechanisms of selective attention. *Annual Review of Neuroscience*, 18, 193-222.

Donnellan, M. B., & Lucas, R. E. (2008). Age differences in the big five across the life span: Evidence from two national samples. *Psychology and Aging, 23*(3), 558-566.

Dunning, J. P. & Hajcak, G. (2009). See no evil: Directed visual attention modulates the electrocortical response to unpleasant images. *Psychophysiology*, 46, 28–33.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review*, 66, 183–201.

Eipert, F., Veit, R., Weiskopf, N., Erb, M., Birbaumer, N., & Anders, S. (2007). Regulation of emotional responses elicited by threat-related stimuli. *Human Brain Mapping*, 28(5), 409-423.

Eysenck, M. W. (1992). Anxiety: the Cognitive Perspective, Erlbaum, Hove.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold attention in subclinical anxiety? Journal of Experimental Psychology: General, 130, 681–700.

Fredrickson, B.L. (2001). The Role of Positive Emotions in Positive Psychology: The Broaden-and-Build Theory of Positive Psychology. *American Psychologist,* 56(3), 218-226.

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 359(1449), 1367.

Fredrickson, B.L., & Joiner, T. (2002). Positive Emotions Trigger Upward Spirals toward Emotional Well-Being. *Psychological Science,* 13(2), 172-175.

Fredrickson B.L, & Levenson, R.W. (1998). Positive Emotions Speed Recovery from the Cardiovascular Sequelae of Negative Emotions. *Cognition & Emotion,* 12(2):191-220.

Fredrickson, B.L., Mancuso, R.A., Branigan, C., & Tugade, M.M. (2000). The Undoing Effect of Positive Emotions. *Motivation and Emotion*, 24(4), 237-258.

Fredrickson, B.L., Maynard K.E., Helms M.J., Haney T.L., Siegler I.C., & Barefoot J.C. (2000). Hostility predicts magnitude and duration of blood pressure response to anger. *Journal of Behavioral Medicine,* 23(3), 229-43.

Fredrickson, B.L., Tugade, M.M., Waugh, C.E., & Larkin, G.R. (2003). What Good Are Positive Emotions in Crises? A Prospective Study of Resilience and Emotions Following the T Terrorist Attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology*, 84(2), 365-376.

Gable, P.A., & Harmon-Jones, E. (2008). Approach-Motivated Positive Affect Reduces Breadth of Attention. *Psychological Science,* 19(5), 476-482.

Gable, P.A., & Harmon-Jones, E. (2010). The blues broaden, but the nasty narrows: attentional consequences of negative affects low and high in motivational intensity. *Psychological Science*, 21(2), 211-215.

Gasper, K. & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science*, 13, 34–40.

Goetz, P.W., Robinson, M.D., & Meier, P.D. (2008). Attentional training of the appetitive motivation system: Effects on sensation seeking preferences and reward-based behavior. *Motivation and Emotion*, 32(2), 120126.

Grant, D.A, & Berg, E.A. (1985). Wisconsin Card Sorting Task. *Test Critiques*, 4, 677-682.

Greene, T. R., & Noice, H. (1988). Influence of positive affect upon creative thinking and problem solving in children. *Psychological Reports*, 63, 895–898.

Greenberg, J., Reiner, K., & Meiran, N. (2012). "Mind the Trap": Mindfulness Practice Reduces Cognitive Rigidity. *PLoS ONE*, 7(5), e36206.

Grol, M., Koster, E.H.W., Bruyneel, L., & Raedt, R.D. (2014). Effects of positive mood on attention broadening for self-related information. *Psychological Research*, 78(4), 566-573.

Gross, J. J. & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition and Emotion*, 9, 87–108.

Gross, J. J., & Thompson, R. A. (2007). Emotion Regulation: Conceptual Foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3-24). New York: Guilford Press.

Grove, J. R. & Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an abbreviated profile of mood states. *International Journal of Sport Psychology*, 23, 93–109.

Gu, L., Yang, X., Li, L. M. W., Zhou, X., & Gao, D. G. (2017). Seeing the big picture:

Broadening attention relieves sadness and depressed mood. *Scandinavian Journal of Psychology*, 58(4), 324-332.

Haase, C. M., Seider, B. H., Shiota, M. N. & Levenson, R. W. (2012). Anger and sadness in response to an emotionally neutral film: evidence for age-specific associations with well-being. *Psychology and Aging*, 27, 305–317.

Haglund, M.E.M., Nestadt, P.S., Cooper, N.S., Southwick, S.M., & Charney, D.S. (2007). Psychobiological mechanisms of resilience:Relevance to prevention and treatment of stress-related psychopathology. *Development and Psychopathology,* 19, 889-920.

Hanif, A., Ferrey, A. E., Frischen, A., Pozzobon, K., Eastwood, J. D., Smilek, D., & Fenske, M. J. (2012). Manipulations of attention enhance self-regulation. *Acta Psychologica,* 139(1), 104-110.

Huntsinger, J.R. (2012). Does Positive Affect Broaden and Negative Affect Narrow Attentional Scope? A New Answer to an Old Question. *Journal of Experimental Psychology*, 141(4), 595-600.

Huntsinger, J.R. (2013). Does Emotion Directly Tune the Scope of Attention? *Current Directions in Psychological Science,* 22(4), 265-270.

Isaacowitz, D.M. (2005). The Gaze of the Optimist. *Personality and Social Psychology Bulletin*, 31(3), 407-415.

Isen, A.M. (2001) An Influence of Positive Affect on Decision Making in Complex Situations: Theoretical Issues with Practical Implications. *Journal of Consumer Psychology,* 11(2), 75-85.

Isen, A.M. (2002). Missing in action in the AIM: Positive Affect's facilitation of cognitive flexibility, innovation, and problem solving. *Psychological Inquiry*, 13, 57–65.

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology*, 47, 1206– 1217.

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987) Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*. 52, 1122–1131.

Isen A.M., Johnson, M. M. S., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of Personality and Social Psychology*, 48, 1413–1426.

Isen, A. M., & Means, B. (1983). The influence of positive affect on decision-making strategy. *Social Cognition*, 2, 18–31.

Isen, A. M., Niedenthal, P., & Cantor, N. (1992). The influence of positive affect on social categorization. *Motivation and Emotion*, 16, 65–78.

Isen, A. M., Rosenzweig, A. S. & Young, M. J. (1991) The influence of positive affect on clinical problem solving. *Medical Decision Making*, 11, 221–227.

Johnson, K.J., Waugh, C.E., & Fredrickson, B.L. (2010). Smile to see forest: Facially expressed positive emotions broaden cognition. *Cognition & Emotion*, 24(2), 299-321.

Keltner, D., & Bonanno, G.A. (1997). A study of laughter and dissociation: distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology*, 73(4), 687-702

Keogh, E., & French, C.C. (1999). The Effect of Trait Anxiety and Mood Manipulation on the Breadth of Attention. *European Journal of Personality*, 13, 209-223.

Kimchi, R., & Palmer, S.E. (1982). Form and texture in hierarchically constructed patterns. *Journal of Experimental Psychology: Human Perception and Performance*, 8, 521–535.

Kortte, K.B., Horner, M.D., & Windham, W.K. (2010). The Trail Making Test, Part B: Cognitive Flexibility or Ability to Maintain Set? *Applied Neuropsychology*, 9(2), 106-109.

Luchins, A.S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological Monographs,* 54 (6, Whole. No. 248).

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*(1), 15-20.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology*, 111(1), 107-123.

MacNamara, A., Ochsner, K. N. & Hajcak, G. (2011). Previously reappraised: The lasting effect of description type on picture-elicited electrocortical activity. *Social, Cognitive, and Affective Neuroscience*, 6, 348–358.

Martin, M.M., & Rubin, R.B. (1995). A New Measure of Cognitive Flexibility. *Psychological Reports*, 76(2), 355-365.

Martin, R. A. (2001). Humor, laughter, and physical health: Methodological issues and research findings. *Psychological Bulletin, 127*(4), 504-519.

McCrae, R. R., Costa, P. T., de Lima, M. P., Simões, A., Ostendorf, F., Angleitner, A., . . . Piedmont, R. L. (1999). Age differences in personality across the adult life span: Parallels in five cultures. *Developmental Psychology, 35*(2), 466-477.

Ochsner, K.N., Bunge, S.A., Gross, J.J., & Gabrieli, J.D. (2002). Rethinking feelings; an fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, 14(8), 1215-1229.

Ochsner, K.N., Ray, R.D., Cooper, J.C., Robertson, E.R., Chopra, S., Gabrieli, J.D., et al. (2004). For better or for worse: neural systems supporting the cognitive down- and up-regulation of negative emotion. *NueroImage*, 23(2), 483-499.

Ohman A. Fear and anxiety: Evolutionary, cognitive, and clinical perspectives. In: Lewis M, Haviland-Jones JM, editors. *Handbook of emotions*. 2nd ed. Guilford Press; New York: 2000. pp. 573–593.

Pargament, K. I. (2013). APA Handbook of Psychology, Religion, and Spirituality: Context, Theory, and Research. *American Psychological Association*, 1, 311-327.

Peterson, C., Seligman, M.E., & Vaillant, G.E. (1988). Pessimistic explanatory style is a risk factor for physical illness: a thirty-five-year longitudinal study. *Journal of Personality and Social Psychology*, 55(1), 23-27.

Pessoa L., & Ungerleider, L.G. (2004) Neuroimaging studies of attention and the processing of emotion-laden stimuli. *Progress in Brain Research*, 144, 171–182.

Raila, H., Scholl, B. J., & Gruber, J. (2015). Seeing the world through rose-colored glasses: People who are happy and satisfied with life preferentially attend to positive stimuli. *Emotion*, *15*(4), 449-462.

Raymond, J. E., Fenske, M. J. & Tavassoli, N. T. (2003). Selective attention determines emotional responses to novel visual stimuli. *Psychological Science*, 14, 537–542.

Reed, M.B., & Aspinwall, L.G. (1998). Self-Affirmation Reduces Biased Processing of Health-Risk Information. *Motivation and Emotion*, 22(2), 99-132.

Rowe, G., Hirsh, J.B., & Anderson, A.K. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences*, 104(1), 383-388.

Schaefer, S.M., Jackson, D.C., Davidson, R.J., Aguirre, G.K., Kimberg, D.Y., & Thompson-Schill, S.L. (2002). Modulation of amygdalar activity by the conscious regulation of negative emotion. *Journal of Cognitive Neuroscience,* 14(6), 913-921.

Schmitz, T. W., De Rosa, E. & Anderson, A. K. (2009). Opposing influences of affective state valence on visual cortical encoding. *Journal of Neuroscience*, 29, 7199–7207.

Schupp, H. T., Stockburger, J., Codispoti, M., Junghöfer, M., Weike, A. I. & Hamm, A. O. (2007). Selective visual attention to emotion. *Journal of Neuroscience*, 27, 1082–1089.

Seider, B. H., Shiota, M. N., Whalen, P. & Levenson, R. W. (2011). Greater sadness reactivity in late life. *Social Cognitive and Affective Neuroscience*, 6, 186–194.

Seligman M.E.P., & Csikszentmihalyi M. (2014) Positive Psychology: An Introduction. In: *Flow and the Foundations of Positive Psychology*. Springer, Dordrecht

Shalev, L., Tsal, Y., & Mevorach, C. (2007). Computerized Progressive Attentional Training (CPAT) Program: Effective Direct Intervention for Children with ADHD. *Child Neuropsychology*, 4, 382-388.

Soto, D., Funes, M. J., Guzman-Garcia, A., Warbrick, T., Rotshtein, P. & Humphreys, G. W. (2009). Pleasant music overcomes the loss of awareness in patients with visual neglect. *Proceedings of the National Academy Science*, 106, 6011–6016.

Southwick, S. M., Vythilingam, M., & Charney, D. S. (2005). The psychobiology of depression and resilience to stress: Implications for prevention and treatment. *Annual Review of Clinical Psychology*, 1, 255–291

Srinivasan, N. & Hanif, A. (2010). Global-happy and local-sad: Perceptual processing affects emotion identification. *Cognition and Emotion*, 24, 1062–1069.

Troy, A. S., Wilhelm, F. H., Shallcross, A. J., & Mauss, I. B. (2010). Seeing the Silver Lining: Cognitive Reappraisal Ability Moderates the Relationship Between Stress and Depressive Symptoms. *Emotion (Washington, D.C.)*, 10(6), 783–795.

Urry, H. L. (2010). Seeing, thinking, and feeling: emotion-regulating effects of gaze-directed cognitive reappraisal. *Emotion*, 10(1), 125.

van Reekum, C. M., Johnstone, T., Urry, H. L., Thurow, M. E., Schaefer, H. S., Alexander, A.L., & Davidson, R. J. (2007). Gaze fixations predict brain activation during the voluntary regulation of picture-induced negative affect. *Neuroimage*, 36(3), 1041-1055.

Wadlinger, H. A. & Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. *Motivation and Emotion*, 30, 87–99.

Wells, A. (1990). Panic disorder in association with relaxation induced anxiety: An attentional training approach to treatment. *Behavior Therapy*, 21(3), 273-280.