# Cognitive Flexibility as a Potential Mediator of Attentional Scope and Mood

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## Abstract

It has been well established that positive emotions can broaden awareness and help people to "see the big picture" (Frederickson, 2004). Recent findings (Gu et al., 2017) suggest that this is a bi-directional relationship, in that manipulating scope of attention can improve mood. This study aimed to confirm those findings, corroborate them with eye-tracking technology, and explore a potential mechanism for this relationship: cognitive flexibility. Participants were induced into a negative mood and randomly assigned to an attentional scope manipulation (either broadening or narrowing). After the manipulation, levels of cognitive flexibility and mood recovery were assessed. Contrary to expectations, the results of this study did not find a relationship between visual attentional scope and mood. Additionally, neither attentional scope nor mood was found to be related to levels of cognitive flexibility. Cognitive flexibility therefore cannot be considered to be a mediator of attentional scope and mood without further research into this subject.

*Keywords*: attentional scope, emotion, mood, eye-tracking, broaden and build

Cognitive Flexibility as a Mediator of Attentional Scope and Mood

When consoling a friend or family member, it is not uncommon to advise them to "look at the bigger picture," in hopes that the upset person will break out of their negative pattern of thinking and feel better. This phrase may be used colloquially, however there is a considerable amount of empirical research that supports the validity of this advice. Commonly discussed within the broaden-and-build theory of positive emotion by Barbara Fredrickson, positive emotions broaden awareness and help people to "see the big picture." According to this theory, broadened awareness then sets off a chain of events which ultimately leads to further increases in positive emotion and creates an upward spiral of emotion (Frederickson, 2004). When experiencing positive emotion, people not only think more broadly and have exploratory novel thoughts more readily, but they also expand their visual attentional scope (Wadlinger & Isaacowitz, 2006). This means that they will attend to, and hold in their working memory, a greater range of visual content.

Recently, a study by Gu et al. (2017) suggested that this is a bi-directional relationship, in that manipulating scope of attention can actually improve mood. The findings of their study have considerable implications for new methods of regulating emotion. If these findings can be confirmed, new interventions could be developed using the broaden-and-build theory's premise that mood and attentional scope are inherently linked; however, rather than waiting for mood to influence attention, attention can be directly manipulated to alter mood and spark this upward spiral of positive emotion.

This study aimed to confirm the findings of Gu et al. (2017) and extend them in two ways. First, cognitive flexibility was assessed as a potential mediating factor of attentional scope and mood. Secondly, eye tracking was added to provide an additional level of analysis to attention. Following the Gu et al. (2017) study, the present study manipulated attentional scope and assessed how it influenced existing negative mood. To expand on this confirmation, a measure of cognitive flexibility was added to evaluate its role as a potential mediator. Furthermore, eye movements were recorded and analyzed to find both group and individual differences in looking patterns. Overall, this study aimed to both confirm that the attentional scope-emotion relationship is bidirectional and to test a potential mechanism for this dynamic. This was done to deepen the understanding of how attentional scope manipulations can be applied to emotion regulation strategies or other types of interventions.

## Attentional Scope

Though often addressed in literature, attentional scope is not typically defined by the authors discussing it. In order to define this term, the meaning of the word "attention" must first be understood.

**Understanding attention.** In the words of the American psychologist William James,

> "Every one [sic] knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others..." (James, 1890, p. 404).

In this quote, James highlights some key aspects of attention that researchers have been questioning and confirming for centuries now. In calling attention "the taking possession by the mind" he indicates that attention is a voluntary action. Furthermore, he asserts that attention is selective and limited in its capacity. While the empirical data supporting these claims would not be available for decades, James' explanation of attention was, and still is, a useful point of departure for discussing the concept.

Attention can be defined as the ability to focus awareness on a thought, action, or stimulus while ignoring other irrelevant information (Gazzaniga, Irvy & Mangun, 2009). Voluntary and reflexive attention are considered to be the two broadest types of attention. Voluntary attention is the ability to consciously and intentionally attend to something. It is a top-down process that is typically associated with the pursuit of a goal. Examples of this type of attention include reading or trying to hear someone clearly. Reflexive attention, on the contrary, is a bottom-up process which describes the involuntary capture of attention by an external stimulus. Examples of this include attending to a loud, sudden noise or being drawn to a distracting item in the visual field, such as noticing a highlighted word in a long paragraph. These two types of attention are characterized primarily by whether the person intends on paying attention to the stimulus (Gazzaniga, Irvy & Mangun, 2009).

Selective attention allows people to process relevant stimuli, thoughts, or behaviors and ignore irrelevant or distracting information. This is not to be confused with whether the attention is intentional or not. Selective attention is characterized by the mechanisms in which it allows a person to process some stimuli, while bypassing others. The classic example of selective attention is the "cocktail party effect" (Cherry, 1953). This is the ability to attend to a conversation with another person and tune out competing information in the loud and highly stimulating environment of a cocktail party. The "cocktail party effect" is also used to denote the phenomenon of hearing one's name called in that busy and distracting environment. This provides an example of reflexive and selective attention, while the first example of attending to a conversation in the loud room would be voluntary selective attention. The selectivity of attention is directly related to the limited capacity of attention. This limited capacity requires that information be filtered, or selectively attended to, so that the most task-relevant information is prioritized and processed. While there are types of attention that are non-selective, they are not central to the discussion of attentional scope and therefore will not be discussed in this study.

**Attentional scope: attention in working memory.** When using the term “attention,” one may think of the content that is in visual or cognitive focus at one given moment in time. It is also important to think of attention *across* time, especially when discussing attentional scope. Considering attention in this way allows for a greater understanding of how attention works in a dynamic and complex environment. Attentional scope has been described as “the array of thoughts, percepts, and actions that will be activated in WM [working memory] or available for selection for selection from LTM [long term memory]” (Whitmer & Gotlib, 2013, p.19). This description is useful because it is one of the few that explicitly states working memory as a factor in attentional scope. It discusses the content of attention across several seconds (within the scope of working memory) rather than at one moment in time.

Attentional scope has been shown to influence cognitive processing at the level of working memory as well. Having a narrower attentional scope means that a person will keep a more limited selection of information in their working memory, compared to those experiencing a broader attentional scope. Those experiencing a broader attentional scope will maintain a larger and more diverse array of information in their working memory (Friedman & Förster, 2010). These states lead to differences in cognition because of the varying amount of resources held in working memory. According to the attentional scope model of rumination, narrowed attentional scope leads to a slower rate of conceptual change in working memory because cognitive resources are devoted to the limited selection of information in the working memory and are unable to attend to novel information and make remote connections with long term memory (Whitmer & Gotlib, 2013). The opposite is true for broadened attentional scope. In this state, cognitive resources are spread thinner and can therefore make more diverse connections, leading to more varied thought and connections with long term memory.

This is not to say that narrowed attentional scope is an entirely limiting state. More narrowed attentional scope is more adept to deeply encode the information at the center of attention and disregard extraneous stimuli. This is useful for maintaining focus and minimizing distractions (Whitmer & Gotlib, 2013). However, in the wrong context, these traits can be maladaptive. For example, high focus and low distractibility provides the perfect mindset for rumination, or perseverative and negative thinking about oneself or their situation (Nolen-Hoeksema, 1991). So, in a ruminating state, it could be useful for a person to attempt to broaden their attention in order to incur a conceptual change in working memory.

Considering that in some contexts broad attentional scope is more appropriate than narrow and vice versa, it is logical to consider whether attentional scope can be manipulated, and if so, by what factors? There is substantial evidence that mood can tune the scope of attention such that positive mood broadens attention and negative mood narrows attention. This dynamic will be discussed in more detail in the following section.

**Mood's Effect on Attentional Scope**

Before discussing how mood impacts attentional scope, it is important to clarify the way that this paper uses the term "mood." The literature being reviewed in this section has used the terms "affect," "mood," and "emotion" to describe variables of interest. Each of these terms refers to a unique construct. Emotions are generally considered to be phenomena including multiple correlated components such as pleasure or displeasure, action readiness, physiological changes and cognitive appraisals (Lang, 1995; Gable & Harmon-Jones, 2008). Affect has been defined as a psychophysiological construct which is composed of the valence (positive or negative evaluation), the motivational intensity (the intensity of the desire to go towards or away from) and the arousal (physiological activation) of the state (Harmon-Jones, Gable & Price, 2013). Mood is similar to these two constructs, but is said to lack an object (Frijda, 1994). Despite the slight differences in their definitions, past studies have demonstrated that positive affect, mood, and emotion, lead to identical results of broadening attention. This paper therefore uses all three terms loosely to discuss the valence of the state, as indicated by these studies.

**Broaden-and-build theory of positive emotions.** Positive emotion increases the breadth of attention both visually and cognitively, according to extensive research. These findings are often explained in the broaden-and-build theory of positive emotions. Conceptualized by Barbara Frederickson, the broaden-and-build theory of positive emotions describes the process by which positive emotions lead to an upward spiral in emotion and well-being. She argues that positive emotions lead to a broadened momentary thought-action repertoire which allow for a person to gain new perspectives, engage in new activities, and form new relationships. Though the positive emotions may be fleeting, these novel experiences help to build lasting personal resources such as social support, resilience, and knowledge, all of which in turn improve health, well-being, and overall chances of survival. These beneficial effects cause the person to feel more positive emotion and restart the chain of events, creating an upward spiral of positivity (Fredrickson, 2004).

Fredrickson frames the broaden-and-build theory in terms of evolutionary adaptive significance. Negative emotions such as fear, anger, or disgust, have been theorized to be evolutionarily advantageous because they prompt people to flee, fight, or spit out potentially poisonous food (Nesse, 1990). Furthermore, narrowing of attention would be advantageous when experiencing negative emotions. When experiencing fear, those who became highly focused on the fear-inducing danger would be more likely to survive than those who broadened their attention and focused on another thought or item in their visual field. These negative emotions are well researched, and rather well understood. However, the significance and utility of positive emotions has only emerged in the last several decades. According to the broaden-and-build theory, positive emotions were evolutionarily advantageous because they allowed for the broadening of attention which led to new discoveries, social relationships, and skills. The new knowledge, relationships and skillset enhanced survival and thus became more selected for through natural selection (Fredrickson, 2004).

***The broaden hypothesis.*** For the present study, the initial step in this cycle is the most central: the broadening effect of positive emotions. The broaden hypothesis states that "Positive emotions, relative to negative emotions and neutral states, widen the array of thoughts, action urges, and percepts that spontaneously come to mind" (Fredrickson, 2013, p. 17). Widening the array of thoughts, actions, and perception is in essence, widening the attentional scope of the individual. This hypothesis stems from the research of Fredrickson's collaborator, Alice Isen, and her colleagues. Her work revealed that when people experience positive emotions, they display unusual patterns of thought. Through her extensive research on the topic, she revealed that those who are experiencing positive emotions tend to think more flexibly, inclusively (Isen & Daubman, 1984), creatively (Isen, Daubman, & Nowicki, 1987), and are more open to information (Estrada, Isen, Young, 1997). Fredrickson (2013) reasoned that these vast effects of positive emotions were all the downstream effect of a single mechanism affected by positive emotion: broadened momentary awareness. This hypothesis initiated a cascade of research to test and expand on the theory by both Fredrickson and outside researchers.

*Evidence supporting the broaden hypothesis.* To assess scope of visual attention, many studies have used local-global visual processing paradigms. These tasks ask participants to judge which comparison figure an image is closest to. One of the comparison images represents a local aspect of the image, and the other represents a global aspect. Individuals who exhibit more negative personality traits, such as depression and anxiety, are more likely to judge these images as more similar to the local comparison, indicating a more narrowed attentional scope. Conversely, individuals with prominently positive personality traits, such as optimism and subjective well-being, show the opposite effect and are more likely to compare the initial figure to the image representing the global comparison (Basso, Schefft, Ris & Dember, 1996).

Fredrickson and Branigan (2005) also used a local-global visual processing task to assess attentional scope. They used a task adapted from Kimchi and Palmer (1982) which required participants to match a figure based on either its overall shape, or the smaller shapes which make up its components. Fredrikson and Branigan manipulated mood directly in their study, rather than assessing trait emotions. The results of their study also followed the pattern previously mentioned of positive emotions increasing global processing, and negative emotions increasing local processing.

One study implemented functional magnetic resonance imaging (fMRI) to assess the effects of emotional state on expansion or constriction of visual field (Schmitz, De Rose, & Anderson, 2009). In this study design, participants were induced into a positive, negative, or neutral mood and were then presented images of faces surrounded by images of houses. They were told to maintain a central fixation throughout the trials and to determine the gender of the faces presented. The researchers then used fMRI to evaluate the activity in the fusiform face area, activated by the processing of human faces, and the parahippocampal place area, activated by visual stimuli depicting places, such as a house or park. Participants induced to experience positive emotions demonstrated comparatively higher activity in the parahippocampal place area than did the participants induced to feel negative or neutral emotions, indicating greater attention to the peripheral house images. This supports the broaden hypothesis in that positive emotion led to an increase of attention to the content in the periphery of the visual field. Furthermore, participants induced to feel negative emotions actually demonstrated a reduction in activity in the parahippocampal place area compared to the neutral condition, indicating that negative emotion decreased attentional scope.

*Eye-tracking and attention.* While the aforementioned studies provide substantive evidence for the broaden hypothesis, it is eye-tracking technology that has allowed researchers to directly assess looking behaviors to conclude that positive emotions genuinely alter breadth of visual attentional scope. Eye-tracking has been used extensively to study overt attention, that is selective attention to an area by orienting the eyes to look in that direction.

Eye-trackers work by projecting near-infrared light on the eyes and using a camera to detect and record reflections from the cornea and pupil (Tobiipro.com, 2017). The technology allows for direct and continuous measurement of visual attention, which is preferred in many cases to less direct methods such as the measurement of manual reaction times. Although eye movements can only indicate overt visual attention and do not directly provide data on covert visual attention (attention that does not require eye movements), the relationship between eye movements and covert attention is still closer than the relationship between reaction times and covert attention (Armstrong & Olatunji, 2012).

Eye-tracking is also less susceptible to confounds than reaction times are. For example, when shown threatening stimuli, participants tend to momentarily “freeze” their manual responses. However, eye-tracking is able to detect saccades, or rapid eye movements between two fixation points, which indicate their foci of attention (McNaughton & Corr, 2004). Additionally, the continuous recording of eye-tracking, with sampling rates ranging from 60 Hz to approximately 2000 Hz, allows for visual attention to be analyzed in multiple ways. So, pupil size, gaze latency and location of gaze fixation can be recorded and areas of interest can be laid over stimuli to assess attention to a specific region (Tobiipro.com, 2017).

A study by Wadlinger and Isaacowitz (2006) took advantage of this technology to essentially “look at looking.” They induced a positive mood in their experimental group and then showed them and the control group slides containing several images, varying in layout. Attentional scope was assessed by measuring the amount of time participants spent looking at content in the periphery of the slide and how many saccades they made per slide. The results of this study found that participants in a positive mood looked more to the periphery and made more frequent saccades compared to the control group. This is in alignment with the broaden-and-build theory in that positive emotions led to an increase in scope of visual attention.

*A caveat to the broaden hypothesis: motivational intensity.* While an overwhelming percentage of studies investigating the relationship between positive emotions and attentional scope have found that positive emotion leads to broadened attention, there have been several studies that found contradictory findings. However, these findings can be explained by motivational intensity. Motivational intensity is dimension of emotion that addresses whether the action associated with said emotion leads the person to take action. Positive emotions are associated with approach motivation, or the desire to go towards the causal stimulus. Approach motivation can be separated into different levels of motivational intensity. Positive emotions that create high approach motivation, such as desire, cause people to go towards an object or goal. Positive emotions with low approach motivation such as contentment do not prompt this goal-driven behavior (Gable & Harmon-Jones, 2008).

Studies have shown that people experiencing positive emotions with low approach motivation experience the broadening of attentional scope commonly reported in the literature. However, those experiencing positive emotion with high approach motivation experience the opposite effect, a narrowing of attentional scope (Gable & Harmon-Jones, 2008; Harmon-Jones, Gable & Price, 2013; Huntsinger, 2012). The low approach motivation finding can be explained in the same way that broaden-and-build theory explains this finding: that relaxed, comfortable environments were spaces in which it was evolutionarily advantageous to expand attention to seek new relationships and experiences (Fredrickson, 2004). However, the contradictory findings of high approach motivation require a different explanation. Gable and Harmon-Jones (2008) have suggested that since positive emotions requiring action, such as desire or inspiration, are facilitated by a more focused approach, this may have been more evolutionarily favorable.

**Attentional Scope's Effect on Mood**

While there is considerable evidence supporting the ways in which mood can influence attentional scope, there is also growing evidence that this is a bidirectional relationship. The broaden-and-build theory frames mood and attentional scope as having a cyclical relationship. However, while they view mood as having a direct influence on attentional scope, they posit that attentional scope only influences mood after several other intermediary steps (Fredrickson, 2004). Other studies have found that attentional scope can have a much more direct influence on mood. For example, Gable and Harmon-Jones (2012) found that compared to local processing, global processing was more effective at reducing the processing of negative images, suggesting that broadened attention may have a protective effect against negative emotions. Another study by van Reekum and colleagues (2007) used eye-tracking technology and functional magnetic resonance imaging to find that differences in brain activation during emotion regulation tasks were correlated with different types of gaze behaviors, or focuses of visual attention. The majority of studies thus far examining the ways in which attentional scope influences mood have investigated how attentional scope manipulations affect subsequent emotion processing (Urry, 2010; Manera, Samson, Pehrs, Lee & Gross, 2014; Bebko, Franconeri, Ochsner & Chiao, 2011).

Only one study to date has assessed how manipulating attentional scope can affect existing mood, rather than the processing of future emotions. In this study, the researchers, Gu, Yang, Li, Zhou, and Gao (2017), first induced all participants to feel sad by showing them an emotional video. Then, participants were randomly assigned to either the broadened or narrowed attentional scope group. To manipulate attentional scope, Gu et al. took commonly viewed scenes (buildings, landscapes, animals, and events) from HDTV documentaries and either zoomed in or out, altering the scope of attention. Participants in the broadening condition watched the videos that zoomed out and those in the narrowing condition viewed the videos that zoomed in. Their results showed that broadening visual perspective can lead to the alleviation of negative mood and an increase in positive mood. The implications of this finding are significant for the treatment of depressive symptoms or for people who wish to improve mood overall.

**Limitations of previous research.** While the findings of Gu et al. (2017) could have significant implications for emotion regulation interventions, there are several aspects of their methodology that require additional testing to confirm the validity of their study. Most glaringly, the images that the study used to manipulate attentional scope may have been unclear and abstract when fully magnified. Participants in the broadening condition may have felt initial discomfort by this disorientation and experienced relief upon finally understanding the content of the image when it was zoomed out. If present, this confounding effect would have been exacerbated by the researchers' method of keeping the participants engaged in the video stimuli. Participants were told that they would have to answer one question at the end of the visual task. Though they were told not to worry about it during the task, participants still may have felt an undue pressure to understand the images they were looking at and experience positive emotions when initially confusing images were broadened.

Additionally, the Gu et al. (2017) study had an unusual choice of procedure order. The researchers tested mood at two time points to evaluate the effectiveness of attentional scope in alleviating negative mood. However, the pre-test was done before the emotion induction. So, the final mood state was being compared to scores which reflect mood prior to negative emotion induction. While the group differences they found are still meaningful because the procedure order was consistent across groups, there is no way to compare an individual's mood before and after the attentional scope manipulation to assess individual differences.

Furthermore, the study took place in China with an entirely Chinese sample. This setting and population is relevant because studies in cross-cultural psychology have shown that East Asian populations have stronger global processing tendencies than Western populations. This difference is thought to be a result of the prominence of interdependence in Asian cultures and the emphasis of independence on Western cultures (Fu, Dienes, Shang & Fu, 2013). Further research is needed to demonstrate the generalizability of the findings by Gu et al. (2017) to Western cultures.

The current study aimed to improve and expand upon the Gu et al.'s 2017 study. The present study planned to confirm the findings that broadened attentional scope can alleviate negative emotions and increase positive emotions. However, when crafting the procedure of this study, Gu et al.'s unusual procedure order, image choice and presentation was considered and improved upon. Given that the present study took place in a Western setting, if the findings of the current study confirmed those of Gu et al. (2017), it would provide support for the generalizability of their findings. In addition to improving the methodology of the Gu et al. (2017) study, the current study aimed to expand on their findings by integrating eye-tracking technology into the procedure to add additional validity and the ability to assess individual differences in real looking patterns. Furthermore, cognitive flexibility was investigated as a potential mediating factor between broadened attentional scope and improved mood.

**Cognitive Flexibility**

Cognitive flexibility is a major factor in a person's psychological health. This construct is difficult to define since it has been studied by a diverse range of disciplines without considerable consistency or synthesis. For present purposes, cognitive flexibility refers to what other papers may define as attentional or psychological flexibility, and is the opposite of cognitive rigidity. These various terms all reflect one construct from different vantage points. In a paper synthesizing these terms, Kashdan and Rottenberg (2010) argue that the terms refer to the following processes: adapting to fluctuating situational demands, reconfiguring mental resources, shifting perspective, and balancing competing desires, needs, and life domains.

The present study conceptualizes cognitive flexibility as the ability to switch cognitive processing strategies in order to adapt to changing environmental stimuli (Dennis & Vander Wal, 2009; Cañas, Quesada, Antolí & Fajardo, 2003) and investigates whether it could be the underlying mechanism linking positive emotions to broadened attention and vice versa. Though the study by Gu et al. (2017) links attentional scope and mood, it does not provide an explanation of any possible mechanism for this relationship. While it is a significant finding that broadened attention can lead to improved mood, this finding is limited in the ways that it can be practically implemented until it is more thoroughly understood. Considerable research supports the findings that positive emotions are associated with increased cognitive flexibility (e.g. Dreisbach & Goschke, 2004; Baumann & Kuhl, 2005), and that cognitive flexibility is associated with a broader cognitive scope (Olivers & Nieuwenhuis, 2005; Hanif et al., 2011). Given these associations, it is reasonable to predict that cognitive flexibility could act a mediator of broadened attention and improved mood.

**Cognitive flexibility and positive emotion.** As stated earlier, a large amount of research indicates that positive affect leads to improved cognitive flexibility. This dynamic has been studied in a variety of ways. Many studies, such as one by Nadler, Rabim and Minda (2010) have used positive or negative videos to induce happy or sad mood and evaluated cognitive processing using task-switching paradigms. Task-switching paradigms require participants to shift their attention or actions between externally assigned tasks. Nadler et al. (2010) used a category learning task to find that participants induced to feel happy outperformed negative and neutral groups in classifying stimuli by different rule-described categories. Another study induced positive emotion by showing participants comedic film clips or giving them small gifts, and found that these positive states led to an increased range of word associations when compared to a control group (Isen, Johnson, Mertz & Robinson, 1985).

More recently, a study has examined the influence of positive mood on cognitive flexibility using fMRI data. In this study, researchers assessed this relationship and how the dorsal anterior cingulate cortex (dACC) plays a role in it. They used images of positive, negative, or neutral valance to induce emotion in participants, and then tasked participants with identifying whether a target digit (in a colored font) was odd or even. After a set of trials, the color of the target digit changed, requiring participants to switch their pattern of thinking. Behavioral data showed that those in the positive emotion condition demonstrated better adaptation to the change, whereas those in the negative condition demonstrated increased response latencies and more errors (Wang, Chen & Yue, 2017).

Data from fMRI revealed that in the switch trials (change in color), participants demonstrated an increase in activity of the dACC not evident in the initial trials (before the change in color). However, this activation was significantly lower in the positive condition compared to the neutral condition. Furthermore, the negative condition demonstrated an increase in dACC activation. These findings were interpreted to mean that positive emotions can increase cognitive flexibility by decreasing activation of the dACC (Wang, Chen & Yue, 2017). This is not the only study to find this pattern of dACC activation when assessing cognitive flexibility using fMRI data (Maier & Di Pellegrino, 2012; Swainson et al., 2003). This region has been shown to be involved in monitoring conflict, changing current behavior according to the environment, and detecting error, all of which are factors that play a role in cognitive flexibility (Clayson & Larson, 2012).

There is however, a caveat to this trend of positive emotion leading to increases in cognitive flexibility. As with the dynamic between positive emotion and attentional scope, this relationship is dependent on the motivational intensity of the stimulus. Experimental data has demonstrated that when participants were induced to experience low approach motivated positive mood, this enhanced their cognitive flexibility, reaffirming other studies. However, those induced to experience high approach motivated positive affect experienced more perseveration, indicating lower levels of cognitive flexibility (Liu & Wang, 2014).

The finding that low approach motivation leads to enhanced cognitive flexibility is in line with common explanations of how low approach motivation leads to greater breadth of attention: that in a relaxed and positive environment, it was evolutionarily advantageous to seek out new relationships, knowledge, and skills (Fredrickson, 2004). The finding that high approach motivation leads to reductions in cognitive flexibility also makes sense in an evolutionary context, especially when considering that the study also found that high approach motivation decreased distractibility (Liu & Wang, 2014). When in pursuit of a goal with significant biological outcomes such as sustenance or reproduction, it would not have been beneficial to be distracted and sidetracked by more exploratory pursuits (Gable & Harmon-Jones, 2010). This finding is significant in the context of the current study. Since different levels of approach motivation in mood influence attentional scope and cognitive flexibility in the same way, there is even more reason to believe that cognitive flexibility is an intermediate step in this relationship.

**Cognitive flexibility and mental illness.** Within the plethora of studies addressing mood and cognitive flexibility, much of the research has been dedicated to examining the role of cognitive flexibility in psychopathology. The majority of this research is focused on how cognitive rigidity, or inflexibility, is linked to mental illnesses such as depression or anxiety disorders. Theories posit that increased levels of cognitive flexibility can improve mood by making people more psychologically resilient. In this direction, cognitive flexibility acts as a form of cognitive reappraisal, allowing individuals to consider alternate explanations and positively reframe challenges. When individuals demonstrate low levels of cognitive flexibility, or high levels of rigidity, their ability to cognitively reappraise or cope with their dilemmas may be hindered (Haglund, Nestadt, Cooper, Southwick & Charney, 2007).

Cognitive rigidity can manifest in individuals with depression in a number of ways. One of the most signifying markers of severe depression is rumination (Nolen-Hoeksema, 1991). Rumination is an example of an inflexible behavior because it involves cycling through the same pattern of negative thoughts, which rarely leads to new perspectives or action (Kashdan & Rottenberg, 2010). Additionally, people with major depression often follow an inflexible attributional style in which they identify internal, global, and stable factors as the causes of negative events they experience (Abramson, Metalsky, & Alloy, 1989). With literature suggesting that cognitive inflexibility plays a significant role in the course of depression, researchers and therapists have been pressured to bring the process of thinking to the forefront of depression research, rather than simply the content of thought (Moore & Fresco, 2007).

Anxiety disorders are also characterized by many behaviors that can be seen as a manifestation of cognitive inflexibility. Similar to depression, individuals with anxiety may have cyclical thoughts that do not lead to productive action or novel ideas. Additionally, the avoidance aspect of anxiety can be a behavior that is highly rigid and can be very difficult for affected individuals to change, despite its maladaptive nature (Hayes, Strosahl & Wilson, 1999). When considering the definition of cognitive flexibility, the ability to switch cognitive processing strategies in order to adapt to changing environmental stimuli, it becomes clear that very anxious individuals must have very low levels of cognitive flexibility given their persistent, maladaptive, and worried state.

Despite the evident connection between cognitive inflexibility and prevalence of mental illness, it is not well understood which is the causal and which is the resulting trait. This is largely due to the fact that most research on individuals with mental illness is done with participants who are already diagnosed with the disorder of interest, making it impossible to determine temporal precedence. Though it is well understood that mood can influence cognitive flexibility, there is little research that investigates whether the reverse is true as well. Kashdan and Rottenberg (2010) have called for studies that directly manipulate cognitive flexibility to assess how this influences mood and mental illness.

**Cognitive flexibility and attentional scope.** Cognitive flexibility is associated with attentional scope in several ways. To assess the relationship between these two variables, researchers have focused on the “attentional blink”. This term refers to the phenomenon in which people experience a moment of attentional “blindness” after shifting their focus (Raymond, Shapiro & Arnell, 1992). The general explanation of the attentional blink is that the processing of the initial stimulus takes up substantial cognitive resources, so when attention is shifted, access to these resources is either unavailable or so weak that processing of the second stimulus cannot occur (Olivers & Nieuwenhuis, 2005).

Olivers and Nieuwenhuis (2005) have used this phenomenon to demonstrate that performance on attentionally demanding tasks may improve when the task is accompanied by an irrelevant mental activity. The study assessed attentional blink with a rapid serial visual presentation (RSVP) in which participants must identify two target digits after they are presented in close succession. Before the task, some participants were instructed to focus on identifying these two digits, while others were asked to think about a recent holiday or hosting an imaginary dinner party. Contrary to expectation, the latter group was actually more successful at identifying the second target digit. By attending to an irrelevant task, their performance on the central RSVP task was enhanced. This contradicts common expectations because as discussed earlier, attention is limited and performance tends to decline as focus is spread across more tasks. Olivers and Nieuwenhuis explained these results in terms of breadth of attention and cognitive flexibility. They argue that attending to the irrelevant task diffuses and broadens attention, which in turn removes some cognitive resources from the first stimulus in the RSVP task, resulting in reduced interference with the second stimulus. By removing some resources from the first stimulus, there was more flexibility in their allocation, allowing for this enhancement of performance (Olivers & Nieuwenhuis, 2006).

This finding has been replicated and corroborated by several other researchers who also connected their findings to attentional scope and cognitive flexibility. Hanif and colleagues (2011) found that broadened attention improved participants' self-regulation, which they attributed to an increase in cognitive flexibility. Their explanation is similar to Oliver and Nieuwenhuis' in that they believe that broadening attention allowed for an enhanced processing of external cues, increasing cognitive flexibility and aiding in self-regulation.

In addition to these findings, cognitive flexibility and attentional scope are linked by the ways in which they are affected by mood. As discussed in earlier sections of this paper, positive mood has been shown to increase breadth of attention and cognitive flexibility, with the same interaction of approach motivation, while negative mood has been shown to narrow attentional scope and reduce flexibility. Since these variables have been shown to respond in the same ways to emotion and often have similar outcomes for behavior and cognition, some researchers have collapsed them into one construct, such as in much of the literature surrounding broaden-and-build theory.

It is important to clarify that cognitive flexibility and attentional scope are in fact distinct constructs. Though often discussed in terms of its behavioral and cognitive outcomes, attentional scope is limited to the perception of stimuli. In contrast, cognitive flexibility is a type of cognitive processing. Cognitive flexibility is heavily reliant on attentional processes, such as attentional scope, to assess situational needs and available resources, however, it is not intrinsically an attentional mechanism. The considerable overlap in their roles however, does require further research to understand more clearly.

**The Present Study**

The present study served to elucidate whether cognitive flexibility mediates the relationship between broadened visual attention and the alleviation of negative mood. To do this, it was necessary to first confirm the preliminary findings that attentional scope can be visually manipulated to effectively influence mood. This was done by inducing a negative mood in participants, showing them videos that manipulate visual scope, and then assessing changes in their mood. To extend these findings in a novel way, an additional measure of cognitive flexibility was added following the visual attentional scope manipulation to assess its potential role as a mediator. This measure assessed the participants' abilities to change their patterns of thinking, demonstrating their levels of cognitive flexibility. Furthermore, this study was designed to advance the current understanding of the dynamic between breadth of attention and mood by including a direct measurement of overt visual attention. This was done by using eye-tracking technology to confirm that the manipulation of attentional scope worked as intended and to collect data on individual differences in attentional patterns.

Collecting data on individual differences in visual attention will add an additional dimension to the current study that was not present in the Gu et al. (2017) study. These fixation patterns will demonstrate how naturally occurring differences in breadth of attention can interact with cognitive flexibility and influence individual changes in mood. Visual attentional scope can be assessed as either spatial attention (attention to the screen periphery versus the center) or content attention (attention to novel versus original screen content). Furthermore, with these additional metrics of visual attention, the hypotheses posited in this study can be tested to determine whether they still hold when visual attention is operationalized differently. If individual differences are found and they correlate with the hypotheses in the same trends as expected, based on the literature reviewed in this study, this will provide additional support for the reliability and validity of the present study.

It is important to study methods of regulating and manipulating emotion because they are relevant to treatment for depression and other psychological disorders. Altering attentional deployment has been shown to be a more automatic regulatory strategy, which requires less cognitive effort to implement than other types of emotion regulation strategies (Mauss, Bunge, & Gross, 2007). In a follow-up study to their initial results, Gu et al. (2017) found that training individuals to broaden their attention over a course of eight weeks led to a reduction in depressive symptoms. Given the fatigue and diminished ability to think or concentrate associated with depression (American Psychiatric Association, 2013), a strategy that uses little cognitive effort could be a strategic and effective intervention for those who are living with the disorder. Integrating attentional scope manipulations into cognitive behavioral therapy could help people with depression avoid rumination and "see the bigger picture," allowing them to actively begin the upward spiral of positive emotions discussed in the broaden-and-build theory (Fredrickson, 2004).

Confirming the results of Gu et al. (2017) would also have significant implications for positive psychology. According to their study, manipulating attentional scope may be able to both decrease negative mood and increase positive mood. This means that broadening attention can not only help to improve the quality of life of those living with psychological disorders, but it can also benefit individuals without clinical diagnoses by improving their psychological well-being. Positive psychology emphasizes the need for interventions which can not only alleviate negative emotions, but also increase positive ones. Attentional broadening tasks can be a simple practice that people can add to their daily routines to improve their mental health and wellbeing, similar to gratitude journals or mindful meditations.

Identifying a possible mediator for the relationship between attentional scope and mood is vital to fully understanding this relationship. It would clarify why and how broadened attention leads to improvements in mood, which would allow interventions using broadened attention to be more effective and consistent. If the underlying mechanisms are understood, then the critical aspects of broadening attention can be identified and emphasized. This study will help to clarify the first step in the broaden-and-build theory of positive emotions, which would influence the development of interventions using broaden-and-build to alleviate negative mood and create an upwards spiral of positivity and well-being. While cognitive flexibility, given its relationship with both variables, is a logical candidate for a mediator in this relationship, it is necessary to conduct an experimental study to examine all three of these variable in conjunction.

Based on the literature reviewed, the following results are expected:

**H1:** Broadened attentional scope will lead to an improved mood.

**H2:** Broadened attentional scope will lead to an increase in cognitive flexibility.

**H3:** Cognitive flexibility will be positively correlated with improved mood.

**H4:** Cognitive flexibility will mediate the relationship between attentional scope and mood.

**H5**: Across both experimental groups, participants with greater focus on peripheral information will have the greatest improvement in mood.

**H6**: Across both experimental groups, participants with greater focus on peripheral information will have the highest cognitive flexibility scores.

**H7:** Within the broadening attentional scope group, participants who demonstrate more attention to new video stimuli will have greater improvements in mood.

**H8:** Within the broadening attentional scope group, participants who demonstrate more attention to new video stimuli will have higher cognitive flexibility scores.

# Methods

## Participants and Study Design

The participants in this study were students (*n* = 66) from Haverford College and Bryn Mawr College who met initial screening criteria requiring that they did not have any type of visual impairment that would impede eye-tracking (e.g. glaucoma or Amblyopia). Of the participants run, 61 were included in data analysis. The average age of the participants was 19.8 years (range 18-23). Of the sample, 43 participants self-identified as women or female and 18 identified as men or male. The five participants who were run and retroactively excluded were removed due to technological difficulties, suspected substance use, and excessive distractions from an adjacent lab. Subjects were recruited through a Haverford College research study recruitment website, advertisements on social media, and the personal networks of the researchers. Participants received either $15 or credit toward an introductory psychology course as compensation.

Direction of change in attentional scope served as the central independent variable of this study. The 66 participants were assigned to either the attentional broadening or narrowing condition using a pre-determined systematic counterbalancing order. Measures of cognitive flexibility and mood were administered following the attentional scope manipulation to assess the effect of broadening or narrowing attentional scope on the dependent variables: cognitive flexibility and alleviation of negative mood.

**Overview of Procedure**

The procedure for both the broadened attention group and the narrowed attention group was the same, except for the visual stimuli in the attention manipulation. Participants read an informed consent document upon entering the lab and signed it to indicate their voluntary participation in the study. Participants were first induced into a negative mood by viewing an emotional film clip. Immediately following the negative mood induction, participants completed the Abbreviated Profile of Mood States to evaluate their mood before the attentional scope manipulation. Participants were then seated with their eyes about 25 inches from the eye-tracker where they performed the eye-tracking portion of the study. Participants underwent a brief calibration procedure to ensure that their eye gaze behavior was properly tracked later in the study. Next, participants viewed scenes on the eye-tracking monitor which zoomed either in or out, depending on their designated attentional scope condition. During this task, the participants' eye gaze behavior was recorded for subsequent analysis. Following this task, participants completed the Abbreviated Profile of Mood States a second time to measure their mood as well as the "water jar task" to assess their cognitive flexibility post-attentional scope manipulation. These final two tasks were administered in counterbalanced order across subjects to control for any effects one task may have had on the other. Upon completion of the study, participants were debriefed and received either course credit or financial compensation for their participation.

## Materials

**Mood induction.** Modeled after the study by Gu et al. (2017), negative mood was induced by showing participants a 3-minute clip from *The Champ*. In this clip, a young boy reacts to his father's death following a boxing match. This clip has been shown to reliably elicit sadness (Gross & Levenson, 1995; Gu et al., 2017). Gu et al. (2017) conducted a test prior to their experiment to verify the validity of this stimulus. In their sample of university students (*n*=20), they found that the clip significantly elicited negative emotions. Furthermore, this clip has been used extensively across a broad range of other studies with the same intention of inducing negative emotions (Haase, Seider, Shiota & Levenson, 2012; Timpano, Shaw, Cougle & Fitch, 2015; Nasoz, Alvarez, Lisetti & Finkelstein, 2004).

**Abbreviated Profile of Mood States (A-POMS).** To assess mood both before and after the attentional scope manipulation, participants completed the A-POMS (Grove & Prapavessis, 1992). This measure is a 40-item questionnaire in which participants rate various adjectives based on how well they describe their current mood. Each adjective is rated on a Likert scale from 0 (not at all) to 4 (extremely). The measure can be broken down into several subscales: tension, fatigue, depression, vigor, confusion, anger, and esteem-related moods. Scores on these subscales are then used to calculate the "total mood disturbance" by subtracting the scores of vigor and esteem (positive affect) from tension, depression, anger, fatigue, and confusion (negative affect) plus a constant of 100 (to eliminate negative scores). Higher scores of total mood disturbance indicate more severe negative mood. The subscales could also be summed across positive (vigor and esteem-related moods) and negative (tension, fatigue, depression, confusion and anger) subscales to calculate total positive or negative mood disturbance. The A-POMS used in this study had only 39 items due to errors transferring the measure to an online survey platform. This error was accounted for in subsequent scoring and analyses.

This measure was selected because it has been shown to be reliable (Cronbach's alphas for subscales ranged from .664 to .954 with a mean of .798; Grove & Prapavessis, 1992) and has been extensively used in a broad range of other studies including the study by Gu et al. (2017). Using this measure has allowed for the results of the present study to be compared to their findings which is necessary to confirm their results.

**Water jar task.** To assess cognitive flexibility, participants completed a computerized version of the water jar task on E-Prime, developed by Greenberg, Reiner, and Meiran (2012). In this task, participants were instructed to measure out a certain amount of water into a target cup using three onscreen jars labeled A, B, and C, using the simplest and shortest solution. Each jar has the capacity to hold a fixed volume of water which is clearly indicated next to the label. These jars could be used to either add their indicated volume or subtract that amount from the target cup. Participants were provided with a pen and paper to assist in calculations, and inserted their solution by typing the quantity of each jar desired and toggling between the "add" and "subtract" options. Before starting this task, participants were given two practice problems and the experimenter ensured that they understood the task and onscreen navigation completely.

The problems in the water jar task can be separated into three types: set trials, critical trials, and extinction trials. The set trials are problems which must be solved by using the formula B-A-2C, meaning that participants had to first add one B jar, then subtract one A jar and two C jars. After correctly solving six set trials with this method, participants were then given four critical trials which could be solved by either B-A-2C or by the simpler formula: A±C.

Finally, participants were given two extinction problems, which could only be solved with the simple formula. This task was scored by giving participants one point for each critical and extinction trial they solved in under four minutes using the simple formula (A±C). Thus, scores could range from one to six, with higher scores reflecting more cognitive flexibility.

This task is designed to measure the *Einstellung effect*, or the way that thought patterns formed through experience can become rigid and prevent the identification of more appropriate approaches or solutions (Greenberg, Reiner & Meiran, 2012). The set trials established a pattern of thought through the participant's experience solving the problems with the B-A-2C formula. The critical trials then tested the rigidity of this thought pattern by allowing for it to either persist or be replaced by a simpler, more adaptive solution. Participants with greater cognitive flexibility should have then been more adept to break away from this rigid mindset and solve the problem with the simple solution (A±C). Participants who were particularly influenced by the Einstellung effect and displayed poor cognitive flexibility not only had trouble solving the critical tasks, but may have also failed to solve the extinction trials in under four minutes. In essence, the critical trials determined whether the participant developed a rigid way of thinking, and the extinction trial determined whether they had recovered from that pattern of thinking (Luchins, 1950).

This task was selected because other measures of cognitive flexibility such as the Wisconsin Card Sorting Task and the Trail-Making Task (Heaton, 1981; Reitan, 1986) are often used to assess people with cognitive deficiencies or frontal lobe damage and may not have been sensitive enough to reveal differences in a young, healthy, college-educated sample. Furthermore, although several self-report questionnaires are available and widely used, an external assessment was selected to minimize social desirability bias.

## Apparatus

The participant's eye gaze patterns were sampled at a rate of 120 Hz using a Tobii TX300 eye-tracking monitor. The eye-tracker was situated below a computer screen (11.5 x 20 in) and projected an infrared light source which a built-in camera used to record the corneal reflection data. This type of eye-tracker does not require any materials (e.g. wires, glasses, etc.) to be fixed onto the participant, so they viewed the screen without restraint. Participants viewed the stimuli with their eyes about 25 inches from the screen and underwent a brief 5-point calibration procedure prior to data collection.

**Video stimuli.** A series of videos was presented to each participant using E-Prime (Psychology Software Inc.) with the intention of manipulating attentional scope. Forty-five images were selected from the International Affective Picture System (Lang, Bradley & Cuthbert, 1997). These pictures were of neutral or low positive valence to mitigate the effect of the pictures' content on mood following the attentional scope manipulation. Valence ratings for the images selected ranged from 4.39 to 6.78, according to the IAPS norms. The scale ranged from 1-10, with 1 being most negative and 10 being most positive. Images were also low in approach motivation, or arousal, since studies have indicated that approach avoidance motivation can influence attentional scope (Adams & Kleck, 2005). IAPS arousal ratings ranged from 1.72-3.26 on a scale from 1-10, with 1 being the least arousing to 10 being the most arousing. Modeled after Gu et al. (2017), attentional scope was manipulated by converting each image into a six second video by gradually zooming in. This video was used to narrow attentional scope. These videos were played in reverse for the broadening attentional scope group (zooming out to the original image from the most magnified still). The content of the videos was clear at all levels of magnification to prevent any unintended effects of a transition from an abstract to a recognizable image. Each participant was assigned to one of four different video orders, since the software did not allow for them to be truly randomized. Both the broadening and narrowing attentional scope conditions had the same four orders. Participants were instructed to view each video as if they were watching television at home, following methods of similar studies of attentional scope (Gu et al., 2017; Isaacowitz, 2005; Raila, Scholl & Gruber, 2015).

## Processing of Eye-Tracking Data

**Defining areas of interest.** Three types of areas of interest (AOIs) were created over the video stimuli. These AOIs began at the start of the video and lasted for its full duration. The first AOI was the “Full Screen AOI,” which was a large rectangular area covering the entire screen. This was created as a comparison for the other AOIs, so that the attention to those could be compared to the attention to the screen as a whole. The second AOI was the “Middle 50% AOI,” which was created as a rectangle over the middle 50% of the screen on each video across both groups. This was a static AOI that was present for the entire duration and was created to assess attention to the center of the screen regardless of the content displayed. Finally, the “Dynamic Center AOI” was created around the initial frame of the zooming out videos and shrank with the content of the initial frame as the video zoomed out. This was created to evaluate attention to new versus old content in the broadened attention group. Only the broadened attentional scope group could be included in this evaluation of new versus old visual content as a measure of attentional scope, as the narrowing attentional scope group did not have any new content appearing as the videos zoomed in.

The purpose of creating AOIs around the center of the images was twofold. It was used to assess whether participants in the broadening attentional scope condition actually broadened with the content of the video, or if they remained fixed on the initial image that was presented. For the broadened group, this provides information about the degree to which participants are attending to new versus old information. This was later assessed as both a confirmation that the attentional scope manipulation worked as intended and as a potential measure of cognitive scope. Additionally, the AOIs were used to assess naturally occurring patterns of broad or narrow visual attention across both groups. Some participants may have looked more to the periphery of the screen than others (broader attention) regardless of the direction of scope manipulation. These individual differences were later analyzed to evaluate whether they had an effect on the alleviation of negative mood.

**Extracting gaze variables.** Eye-tracking data on the total duration of gaze fixations, the total number of fixations, and the total number of visits to the AOIs were extracted for the static middle 50% AOI and full screen AOI for all participants. For the participants in the broadening attentional scope group, those gaze metrics were also extracted using the dynamic center AOI. The extracted data was then used to calculate a total of seven gaze metrics used in subsequent analyses.

***Attention to the entire screen.*** The first variable from the eye tracking data is the *Fixation Count- Full Screen* metric. The *Fixation Count- Full Screen* metric reflects the total number of visual fixations made on the screen, regardless of the locations of the fixations. This variable was extracted from the Full Screen AOI for all participants, regardless of experimental group, and indicates how varied or their eye gazing behavior was across the entire screen.

***Attention to the screen center versus periphery.*** The next three variables were calculated to compare attention on the periphery versus the center of the screen. Comparing these two areas allowed for attentional scope to be measured in terms of spatial relations. The *Fixation Duration-Periphery* metric was created to reflect the time spent looking at the periphery of the screen. This variable was calculated by taking the difference between the total fixation duration (in seconds) on the Middle 50% AOI and the Full Screen AOI. This number was then divided by the total fixation duration on the entire screen to create a proportion of the amount of time spent looking at the periphery versus the center of the screen.

The next variable created to compare center versus peripheral attention was *Fixation Count-Periphery*. The fixation count indicates the total number of fixations made within an AOI, a reflection of how erratic or dynamic a participant's looking behavior was within an AOI. The *Fixation Count- Periphery* metric therefore reflects how much participants looked around in the periphery of the screen versus the center. This variable was created by taking the difference between the fixation count on the Middle 50% AOI and the Full Screen AOI to reflect the time spent looking at the periphery of the screen. This number was then divided by the fixation count on the full screen to create a proportion of the number of fixations made on the periphery versus the center of the screen.

The third variable to reflect differences in attention to the center versus the periphery was the *Visit Count- Periphery.* The visit count variable indicates the number of visual visits made to a certain AOI. A "visit" is considered to be any saccade from outside of the AOI to the inside. This metric therefore reflects the number of saccades made between the periphery and the center of the screen. This variable was calculated by simply extracting the visit count data from the Middle 50% AOI.

***Attention to novel versus old visual content.*** While the prior three variables assess attentional scope as relative spatial locations, attentional scope can also be conceptualized at the relative amount of attention paid to novel versus old visual content. Given that only the broadening attentional scope group had novel visual content to evaluate, the next three variables were only calculated using data from participants in that group. The variables are *Fixation Duration- New Content, Fixation Count- New Content*, and the *Visit Count- New Content*. They are calculated in the same ways the respective screen center versus periphery variables were, however instead of using the Middle 50% AOI to extract the data, the Dynamic Center AOI was used. These variables are meant to evaluate individual differences in attentional scope, as measured by attention to novel versus old visual content.

**Exclusions**

Participants were only included in the eye tracking analyses if the eye tracker was able to identify the position of at least one of their eyes for a minimum of 75% of the sampling points. This led to seven additional exclusions, or a total of 54 participants with full eye-tracking data. These exclusions only affected analyses which used the eye-tracking metrics described above. The participants were still included in the rest of the analyses since they viewed the video stimuli like any other participant.

For analyses including the water jar task, an additional two partial exclusions were made for participants who did not complete the task due to an inability to understand the instructions. Again, these exclusions only affected analyses that included the water jar task scores. Statistical tests using the A-POMS and eye-tracking data were still run on these participants since they both were given the second A-POMS immediately following the attentional scope manipulation. No additional partial exclusions were made for the A-POMS.

# Results

## Attentional Scope and Mood

**Attentional scope group comparisons.** To first confirm that the broadened attentional scope group actually looked more to the periphery than the narrowed attention group, an independent samples t-test was performed comparing the *Fixation Duration- Periphery* variable between the broadened and narrowed groups. A significantly higher proportion of looking time to the periphery was found in the broadening attentional scope group ($M = .278$, $SD = .084$) compared to the narrowed attentional scope group ($M = .193$, SD = .103; $t(52) = -3.329$, $p < .01$). This analysis was also run using the *Fixation Count- Periphery*. This t-test also demonstrated the same significant effect (broadened attentional scope: $M = .323$, $SD = .082$; narrowed attentional scope: $M = .224$, $SD = .099$; $t(52) = -4.008$, $p < .01$). These results confirmed that attentional scope manipulation was successful in cuing participants to attend to different regions of the screen.

As stated earlier, we predicted that the broadened attentional scope manipulation would lead to an improved mood (H1). In order to test this prediction, a 2 x 2 mixed factorial ANOVA was conducted, where the dependent variable was “total mood disturbance” from the A-POMS and the independent variables were experimental group (broadening or narrowing of attentional scope) and A-POMS time (pre- or post-attentional scope manipulation). We expected that there would be a significant interaction effect of group and time, such that both groups would have similar scores of total mood disturbance pre-attentional scope manipulation, and that post-attentional scope manipulation the broadening group would demonstrate a lower total mood disturbance than the narrowing group. Contrary to this expectation, the interaction between time and condition was not found to be significant ($p > .90$). This means that the broadening attentional scope condition did not lead to a greater improvement in mood than the narrowing condition. However, a main effect of time was found ($F(1,59) = 60.85$, $p < .001$), such that total mood disturbance declined over time (pre-attentional scope manipulation: $M = 113.35$, $SE = 1.97$; post-attentional scope manipulation: $M = 99.03$, $SE = 1.81$). Thus, over time, participants' moods improved, regardless of their group.

To determine if broadened attention led to a reduction in negative symptoms or an increase in positive symptoms, regardless of total mood disturbance, this ANOVA was repeated using the pre- and post- positive and negative subscales of the A-POMS instead of the full measure as the within-subjects variable. These results were not significant ($p > .67$), indicating that the attentional scope manipulation also had no effect on positive or negative mood when they were considered separately. Further correlational analyses demonstrated that reductions in negative symptoms were correlated with increases in positive symptoms ($r = -.491$, $p < .01$, $n = 54$. This supports the previous finding by demonstrating that as negative mood was alleviated, positive mood increased proportionately.

Since the A-POMS and the water jar task were counterbalanced in the procedure, additional analyses were conducted to evaluate any effects that procedure order may have had on the results. Given that mood was found to improve for all participants from time one to time two, for those who were given the water jar task first, it is possible that simply waiting longer to test mood could have caused improvements in mood for those participants. To account for this possibility, an additional 2 x 2 x 2 between-subjects ANOVA was run, where the dependent variable was total mood disturbance from the A-POMS and the independent variables were experimental condition (broadening or narrowing of attentional scope), A-POMS time (pre- or post-attentional scope manipulation) and procedure order (A-POMS or water jar task first).

In addition to the main effect of time, as discussed in the previous paragraph, there was also a main effect of procedure order ($F(1,57) = 6.24$, $p < .02$). On average, participants who filled out the A-POMS first in the counterbalancing had a higher total mood disturbance ($M$ = 109.75, $SE$ = 2.20) than those who completed the water jar task first ($M$ = 101.89, $SE$ = 2.23). A higher total mood disturbance indicates a more negative mood. Thus, participants who completed the water jar task first reported better moods after the attentional scope manipulation than those who completed the A-POMS first. No other interactions or main effects in this analysis were found to be significant ($ps > .10$).

**Individual differences correlations.** Though we successfully manipulated attentional scope such that the broadened attentional scope group looked more to the periphery of the screen than the narrowed attentional scope, we also expected to find individual differences in attentional scope across both groups. If our predictions regarding attentional scope were correct, we would expect that these hypotheses would hold true when evaluated at the level of individual differences.

To determine whether, regardless of group, participants with a greater focus on the peripheral information had the greatest improvements in mood (H5), a correlational analysis was performed with total mood disturbance difference scores (the difference between individual A-POMS scores before and after the attentional scope manipulation) and the four metrics used to assess the spatial breadth of attention across the screen: *Fixation Duration- Periphery*, *Fixation Count- Periphery*, *Visit Count- Periphery*, and the *Fixation Count- Full Screen*. Contrary to our expectations, none of these correlations were significant ($ps > .40$).

To see if procedure order affected these results, the correlations were re-run including only participants who were administered the A-POMS first. In this sample, the *Fixation Count-*

*Full Screen* was significantly negatively correlated with the total mood disturbance difference ($r$ = -.447, $p$ = .025, $n$ = 25). In other words, among participants who received the A-POMS first, those who had a greater number of fixations on the screen demonstrated less overall mood improvement. This is in the opposite direction to our hypothesis (H5). No other significant correlations were found between total mood disturbance difference and the eye tracking metrics in the A-POMS first participants ($p$ > .13) nor were any of these correlations found to be significant when only those who had the water jar task were included ($p$ >.68). However, differentiating between positive and negative subscales on the total mood disturbance revealed a marginally significant correlation between *Fixation Count- Periphery* and positive mood disturbance ($r$ = -.354, $p$ = .083, $n$ = 25) in participants who completed the A-POMS before the water jar task. This means that participants who made more fixations on the periphery of the screen had a greater improvement in positive symptoms compared to those who made more fixations on the center of the screen, even though their moods did not improve more overall.

Additionally, we hypothesized that within the broadening attentional scope group, participants who demonstrated more attention to novel video stimuli would have greater improvements in mood, compared to those who attended more to the center of the screen (H7). To test this, correlational analyses were run with the total mood disturbance difference variable and the dynamic eye tracking metrics: *Fixation Duration- New Content*, *Fixation Count- New Content*, and *Visit Count- New Content.* These reflect the eye tracking metrics that are based on the conceptualization of attentional scope as the relative amount of attention paid to new versus old visual content. Though we expected to find positive correlations between these variables and total mood disturbance, there was a marginal trend towards significance in the opposite direction for the *Visit Count- New Content* variable ($r$ = -.34, $p$ = .08, $n$ = 27). This trend was not different when broken down across procedure order (A-POMS first: r = -.46, $p$ = .09, $n$ = 14; water jar task first: $r$ = -.32, $p$ = .28, $n$ = 13). This correlation indicated that as the number of saccades between the old and new visual content increased, mood improved less. When total mood disturbance was broken down into positive and negative subscales, it became evident that the marginally significant association between mood and saccades was driven by a change in negative symptoms ($r$ = -.39, $p$ < .05, $n$ = 27), rather than a change in positive ones ($r$ = .12, $p$ = .55, $n$ = 27). The other correlations between mood and the dynamic eye tracking metrics were not significant (*ps* > .68).

**Attentional Scope and Cognitive Flexibility**

**Attentional scope group comparisons.** To ultimately assess whether cognitive flexibility mediated the relationship between attentional scope and mood, statistical analyses first had to be performed to demonstrate that broadened attentional scope leads to an increase in cognitive flexibility (H2). To assess this hypothesis, an independent samples t-test was performed comparing levels of cognitive flexibility, as measured by the water jar task, in the narrowing and broadening attentional scope conditions. We expected that the broadening group would have higher cognitive flexibility scores. However, the group difference was not significant ($p$ > .40) as the groups scored essentially the same on the water jar test (broadening group: $M$ = 2.93, $SD$ = 2.00; narrowing group: $M$ = 3.32, $SD$ = 1.78). Including procedure order (A-POMS or water jar task first) as an additional factor did not make a difference in these results. Thus, it cannot be concluded from this test that broadened attentional scope leads to an increase in cognitive flexibility.

**Individual differences correlations.** Though the experimental manipulation of attentional scope was not found to lead to an increase in cognitive flexibility, individual differences in attentional scope, as measured by the eye-tracker, were also evaluated. To determine whether, regardless of group, participants with a greater focus on the peripheral information had the highest levels of cognitive flexibility (H6), a correlational analysis was performed with water jar scores and the eye-tracking metrics comparing the spatial attention across the screen (*Fixation Duration- Periphery*, *Fixation Count- Periphery, Visit Count- Periphery,* and the *Fixation Count- Full Screen)*. Contrary to our predictions, none of these correlations were significant ($p$ > .47). To see if procedure order affected these results, the correlational analyses were re-run isolating those who completed the A-POMS first and those who completed the water jar task first. Neither procedure order had significant correlations between the water jar task and the eye-tracking metrics ($p$ > .31).

We also hypothesized that within the broadening attentional scope group, participants who demonstrated more attention to new video stimuli as the videos zoomed out would have higher cognitive flexibility scores, compared to those who attended more to the original content at the center of the screen (H8). To test this, correlational analyses were run with the water jar scores and the dynamic eye tracking metrics which reflected attention to novel versus old visual content (*Fixation Duration- New Content*, *Fixation Count- New Content,* and *Visit Count- New Content)*. Though we expected to find positive correlations, none of the correlations were significant ($p$ > .25). This indicates that increased attention to new video stimuli was not associated with improved cognitive flexibility in the broadened attentional scope group.

**Cognitive Flexibility as a Mediator of Attentional Scope and Mood**

Considering that varying breadths of attentional scope were not found to have differing effects on mood and cognitive flexibility either at the level of the individual or group differences, it is not surprising that we also did not validate our initial expectation that cognitive flexibility should positively correlate with improved mood (H3). A correlational analysis between participants' scores on the water jar task and total mood disturbance did not find a significant relationship between the two variables ($p > .89$). Our hypothesis that cognitive flexibility should mediate the relationship between attentional scope and mood (H4) was not tested because the preconditions for mediation were not present. We did not find a causal effect of attentional scope on mood, nor did we find a relationship between cognitive flexibility and either variable. Therefore, it is not logically possible that cognitive flexibility could mediate a relationship between attentional scope and mood.

## Discussion

The current study sought to evaluate cognitive flexibility as a potential mediator of the relationship between attentional scope and mood. We aimed to first confirm that broadening attentional scope leads to improvements in mood and then to expand this finding to determine whether cognitive flexibility was responsible for this change in mood. Finally, we used eye tracking to support these hypotheses and add a more direct measurement of visual attention to the study. Though we closely followed the methods of prior studies that investigated the relationship between visual attentional scope and mood, we did not find the two to be related. Additionally, neither attentional scope nor mood was found to be related to levels of cognitive flexibility. Cognitive flexibility therefore cannot be considered to be a mediator of attentional scope and mood, according to the results of this study.

The current study was designed to confirm prior findings that manipulating visual attentional scope could lead to greater recovery in mood after a negative mood induction (Gu et al., 2017). If breadth of visual attention truly leads to changes in mood, broadened attentional scope should be associated with a subsequent improvement in mood in this study. Additionally, upon the addition of eye tracking technology we expected to find the same trends, such that participants with broader visual attentional scope, regardless of experimental group, would demonstrate greater improvements in mood. We also anticipated that among participants in the broadened attentional scope group, those who attended more to novel video content would demonstrate greater improvements in mood, due to this increased variability in the content of visual attention.

In addition to replicating the findings of Gu et al. (2017), we also wanted to expand on their findings by determining whether cognitive flexibility was responsible for the relationship between attentional scope and mood. If it was responsible for this relationship, cognitive flexibility should increase with broadened attentional scope and with improved mood. Furthermore, if cognitive flexibility mediated the relationship between attentional scope and mood, participants in either group with broader attentional scope, according to the eye tracking data, should demonstrate higher levels of cognitive flexibility. Finally, those in the broadening attentional scope condition who attended more to the novel video content should demonstrate higher levels of cognitive flexibility, since they are taking in a larger amount of new information than those who only attend to the initial video content.

## Attentional Scope and Mood

Contrary to expectations, we did not replicate the results of Gu et al. (2017), such that we did not find that broadened visual attentional scope led to improvements in mood (H1). Though all participants demonstrated some degree of mood recovery from immediately after the negative mood induction until after the attentional scope manipulation, there was no difference in mood recovery between the broadened and narrowed attentional scope groups.

There are several alternative explanations for the differences in these results. The current study generally followed the methods of Gu et al. (2017), but we made several modifications. Different images were used for the video stimuli in this study: our content was specifically chosen so that it would never be ambiguous during the duration of the video. In other words, the content of the videos was never so magnified that it became abstract. This was done to prevent an artificial improvement in mood upon realizing what the image was depicting. Because Gu et al. (2017) did not specifically try to avoid this issue and they told participants that they would have to answer a question about the images following the viewing, it is likely that this confounded their results. If the zooming out group demonstrated mood improvements due to this unexpected factor in Gu et al. (2017), and we prevented this from occurring, it would explain why we did not find the same results they did.

The content of the images used in the present study to create the videos for the attentional scope manipulation differed from those used in Gu et al.’s 2017 study. The present study used images from the International Affective Picture System that were rated low for arousal and neural for valence. Gu et al. used scenes from high-definition television documentaries. They had an additional sample of participants rate these pictures on pleasantness from one (not at all) to seven (extremely). The images used scored about a five on average, which is more pleasant than neutral. It is possible that the present study did not replicate the findings of Gu et al. (2017) because in order for broadened attentional scope to improve mood, attention must be broadened to include additional pleasant stimuli. Although this explanation is plausible, there is still a considerable amount of research that indicates that attentional scope alone may be able to alter mood.

Additionally, the present study's procedure assessed mood immediately after the negative mood induction and again following the attentional scope manipulation. Gu et al. evaluated mood *before* the negative mood induction and then again after the attentional scope manipulation. By measuring mood before the negative mood induction, Gu at al. may have actually been assessing resistance to the negative mood induction, rather than overall recovery from it. It is possible that the broadened attention group had worse moods to begin with, resulting in an artificially low mood recovery. Though this is not likely, without an initial measure of mood, this possibility cannot be ruled out.

When procedure order was taken into account, it also became clear that participants who completed the water jar task first had overall better moods compared to those who completed the A-POMS first. This finding was unexpected, as participants were systematically assigned to either procedure order, which should have prevented an any differences in mood between the procedure orders at time one. Given the initial difference in mood before the attentional scope manipulation and the procedure counterbalancing, this finding is more indicative of a group confound, rather than a true effect of order on the results.

Eye tracking was added to this study in order to add a measure of attentional scope. A prior eye-tracking study demonstrated that when in a positive mood, participants made more saccades and looked more to the periphery of the screen (Wadlinger & Isaacowitz, 2006). Considering the potential bi-directional nature of this relationship, as evidenced by Gu et al. (2017), we expected to see mood improve as breadth of attention increased, as measured by the eye-tracker in the present study. Specifically, we expected that regardless of the video content participants saw, those who attended more to the periphery of the screen would have better recoveries in mood (H5). Contrary to this expectation, a relationship between attentional scope, as measured by the eye-tracker, and mood was not found.

When the results were divided by procedure order, several unexpected effects emerged from the data. Among the participants who completed the A-POMS immediately following the attentional scope manipulation, those who had a greater number of fixations to the periphery of the screen had overall less mood improvement than those who made more fixations on the center. This finding is in the opposite direction of our hypothesis, indicating that those who look more to the center of the screen have greater mood recoveries. When this relationship was broken down between positive and negative A-POMS subscales, it became evident that although there was less mood improvement in this sub-group overall, they demonstrated a marginally significant improvement in *positive* mood traits compared to participants who focused on the center of the screen. Given that these two unexpected results somewhat contradict one another, they will be explained in terms of the first result, which is not broken down by A-POMS subscales, since it is a statistically stronger effect.

Based on prior literature associating global processing, or wider breadth of visual attention, with positive mood (e.g. Basso, Schefft, Ris & Dember, 1996; Fredrickson and Branigan, 2005; Schmitz, De Rose, & Anderson, 2009), we expected that those who look more to the periphery of the screen would have greater recoveries in their mood. However, we found the opposite to be true, such that the greatest mood recoveries were in those who looked more to the *center* of the screen. This result can be explained by literature which has identified the conditions under which positive mood is associated with narrowed attentional scope. In most research studies, motivational intensity, or the intensity of the desire to go towards something, is low. Under low motivational intensity, both positive and negative emotions can broaden attention (Gable & Harmon-Jones, 2010). However, when motivational intensity is high, both positive and negative emotions can lead to narrowing of attentional scope (Gable & Harmon-Jones, 2008). Because the current study was designed to be of low motivational intensity, it is possible that the induced low motivational intensity sadness led to a broadening of attention in the eye-tracking portion of the study for some participants. This negative mood that lacked an object of desire or the pursuit of a goal could have potentially lead to rumination on the negative mood, resulting in less overall mood improvement for those participants.

Because breadth of visual attention can be conceptualized as either the breadth of visual spatial attention, like in the above analyses, or the breadth of visual content, we also included a measurement of attention to novel versus original information in the broadened attention group. This measurement reflects the amount of attention focused on the initial frame of the video stimuli, compared to the newly appearing content as the video stimuli zoomed out. We expected the same trends for both definitions of attentional scope. When considering breadth of content attended to, we anticipated that the participants who attended more to the novel video content, rather than the original content, would have greatest improvements in mood (H7). As with our other hypotheses regarding attentional scope and mood, this expectation was not supported by the results of the study.

One marginally significant finding contradicted the hypothesis that participants who looked more to the novel video content would have largest improvements in mood (H7). As participants made more saccades between the old and new content, their mood improved less, specifically, their negative symptoms did not improve as much as those who made fewer saccades between new and old content. This could be explained by the same mechanisms outlined in the last hypothesis: that the low motivational-intensity negative mood resulted in a greater breadth of attention, but also an increase in ruminative behaviors, resulting in broader attention and less improvement in mood.

Overall, we did not replicate the associations between attentional scope and mood that Gu et al. (2017) found in their study. Neither the broadened attentional scope group or broader looking patterns, as measured by the eye-tracker, led to an improvement in mood, as expected. This disparity and the additional unexpected findings can likely be accounted for by the changes we made in the video stimuli and procedure order from Gu et al.'s methodology. Further research needs to be conducted in order to provide sufficient evidence that broadened visual attentional scope leads to improvements in mood.

**Attentional Scope and Cognitive Flexibility**

In addition to expecting a relationship between attentional scope and mood, we also anticipated that there would be a relationship between attentional scope and cognitive flexibility. We predicted that broadened attentional scope would lead to an increase in cognitive flexibility (H2). Contrary to this expectation, the broadened and narrowed attentional scope groups had nearly identical scores on the water jar task.

As discussed in the introduction, researchers have theorized that attentional scope should influence cognitive flexibility by altering the cognitive resources available for use and there are studies to reliably support this theory (Olivers & Nieuwenhuis, 2006). Thus, it is surprising that this finding was not replicated. Given that the attentional scope manipulation influenced neither mood nor cognitive flexibility in the expected ways, it is possible that the stimuli we used were insufficient. Though eye tracking data confirmed that those in the broadened condition actually looked more to the periphery of the screen, compared to the narrowed group, the computer screen may not have been large enough to allow for enough variability in attentional scope.

Alternatively, this unexpected finding could be attributed to a lack of validity of the water jar task. Observations of the participants revealed that the goals of the task are difficult to conceptualize and that the process of learning them and figuring out the task took a considerable amount of cognitive effort and focus. This may have detracted from any effects of attentional scope on the levels of cognitive flexibility. Limitations of the water jar task will be further discussed in the *Methodological Limitations* section of this paper.

Since the theory for the relationship between attentional scope and cognitive flexibility is logically sound and sufficiently supported by other studies, we expected this relationship to hold when assessed using eye-tracking technology. We anticipated that regardless of group, participants with greater focus on peripheral information would have the highest cognitive flexibility scores (H6). Additionally, since attentional scope is thought to increase cognitive flexibility by spreading cognitive resources more thinly and allowing for new connections to be made more easily, we predicted that regardless of group, participants who demonstrated increased attention to novel video stimuli would have the highest cognitive flexibility scores (H7). Neither of these hypotheses were supported by the results. This is likely also due to a lack of validity in the water jar task. If the water jar scores were not truly indicative of levels of cognitive flexibility, any effects of the attentional scope manipulation on cognitive flexibility would be obscured.

Though neither cognitive flexibility nor mood was associated with attentional scope, considerable research links the two together, suggesting that regardless of the success of the attentional scope manipulation, higher levels of cognitive flexibility should be correlated with improved mood (H3). This hypothesis was not supported by the results of the present study. However, considering that the link between higher levels of cognitive flexibility and positive mood are very well established (e.g. Isen et al., 1985; Nadler et al., 2010; Wang, Chen & Yue, 2017) and that no other hypothesis regarding cognitive flexibility were supported, it is likely that this lack of support can also be attributed to an insufficient measure of cognitive flexibility rather than a genuine lack of a relationship between the two constructs. Finally, given that cognitive flexibility, mood, and attentional scope were not found to be related to one another overall, it is logically impossible that cognitive flexibility could mediate the relationship between attentional (H4); thus, this analysis was not run.

Overall, it cannot be concluded from the results of this study that cognitive flexibility mediates the relationship between attentional scope and mood. Neither increased cognitive flexibility nor improved mood were significantly associated with broadened attentional scope. This contradicts our hypotheses for the current study. Given the extensive literature connecting these three variables however, it is likely that our hypotheses were not confirmed due to limitations of the current methodology, rather than a true lack of an interaction between these constructs.

## Methodological Limitations

The limitations of the current study's methodology primarily included the lack of construct validity for the water jar task, insufficient demographic information collected, and the type of attentional scope manipulation we employed.

**Water jar task.** Although the water jar task appeared to be a better measure of cognitive flexibility than tasks such as the Wisconsin Card Sorting Task or the Trail Making Task (Heaton, 1981; Reitan, 1986), the measure is not without criticism. Not long after the water jar task (or Einstellung Task as it has been called in the past) was developed, a flood of researchers rushed to assess the validity of the measure. Though some deemed it to be a successful measure of cognitive rigidity (Luchins & Luchins, 1950; 1959), others found issues with its validity and ability to correlate with other measures of cognitive rigidity (Wrightsman & Baumeister, 1961).

Several studies have examined the correlations between scores on the water jar task when performed on paper versus with the same task with physical jars (Wrightsman & Baumeister, 1961; Vallée-Tourangeau, Euden, & Hearn, 2011). Their results demonstrated that the scores differed between the two modes of administering the task such that more rigid behaviors were elicited by the pen and paper task than the physical task. This indicates that the method of administering the task matters. There are no studies to date that directly compare the results of a computerized version of this task to a paper or physical version, making our measure of cognitive flexibility incomparable to others. Furthermore, in one of the studies, neither mode of administering the task was associated with other methods of assessing cognitive flexibility, demonstrating low construct validity (Wrightsman & Baumeister, 1961). This means that even if the computerized version of this task was comparable to the paper and physical versions, none of these measure may actually assess cognitive flexibility or rigidity as intended.

In addition to lacking construct validity, the water jar task also seemed to elicit emotional responses from the participants. Since the emotions elicited seemed to depend mostly on individual ability to understand the instructions of the task, this measure of cognitive flexibility added an unreliable emotional condition that likely influenced the mood scores for those who took the A-POMS after the water jar task. This theory is strengthened by the fact that some significant, if unexpected, results were found in mood recovery when the A-POMS was administered before the water jar task, but not in the reversed order.

**Demographic information.** Problems with the water jar task were evident in the present study since one's ability to perform the task successfully seemed to be driven mostly by mathematical reasoning skills, rather than cognitive flexibility. Given that mathematical reasoning skills vary so widely across the population, it would have been beneficial to record information on the students' declared or intended major and class year while collecting demographic data. Given that first and second year students' decisions to study science, technology, engineering, and mathematics majors are directly influenced by high school math achievement (Wang, 2013), and that upperclassmen have improved mathematical reasoning skills as a result of their education, collecting demographic data on their majors and class years would be a good indicator of their mathematical reasoning skills. If water jar task scores varied more with major than they did with attentional scope group, it could then be concluded that the water jar task was actually measuring cognitive flexibility in this study.

Additionally, the current study did not ask participants to report their ethnicity or nationality. The study by Gu et al. (2017) was done with an entirely Chinese sample, and there is considerable evidence from cross-cultural psychology that East Asian cultures have enhanced global processing tendencies compared to Western populations. This difference in global versus local processing could have influenced the results, however there is no way to assess this difference without data on the ethnicities or nationalities of the present sample. Though our study was carried out in a Western context, and therefore it is highly likely that most participants came from Western backgrounds, the college from which participants were recruited enrolls a large number of international students. Without the demographic data that would clarify the ethnicities and nationalities of the study participants, or a comparative study between East Asian and Western groups, it cannot be concluded whether it was the ethnicity of the sample that accounted for our failure to replicate the results of Gu et al.

**Attentional scope manipulation.** Though the inaccuracy of the water jar task contributed quite heavily to the limitations of the present study, the video stimuli we used for the attentional scope manipulation also likely contributed to the limitations as well.

The ability to find a genuine relationship between attentional scope and mood in the results of either the present study or the Gu et al. study may be limited by the method of manipulating attentional scope: zooming in or out videos on a computer screen. Using a computer screen to display the video stimuli reduces the maximum breadth of attentional scope to the dimensions of the computer screen, which is far smaller than one's typical visual range. A computer screen may not allow for enough variability in attentional scope to induce any measurable effect on mood. While the present study was unable to find any effects of attentional scope on mood or cognitive flexibility, the attentional scope manipulation was successful in that it prompted participants in the attentional scope group to look more to the periphery of the screen and the narrowed group to look more to the center. This supports the notion that attentional scope can be successfully manipulated, but perhaps a larger display of visual stimuli is necessary to produce detectable variability in the results. This theory is supported by the findings of the second experiment in Gu and colleagues' 2017 paper: that training depressed individuals to regularly broaden their attention over an eight-week time span led to an improvement in mood and fewer depressive symptoms. Though additional research is needed to validate these results, they provide preliminary evidence that broadening attentional scope in naturalistic settings can positively influence mood.

**Future Directions**

Considering these limitations, future research should be focused on two main areas of improvement: establishing that broadened attentional scope causes improvements in mood, and developing better methods of assessing cognitive flexibility. It is only after these main areas of research are addressed that cognitive flexibility can be reassessed as a potential mediator for the relationship between attentional scope and mood.

In order to establish that broadened attentional scope causes improvements in mood, better methods of manipulating attentional scope need to first be developed. If, as discussed in the limitations section, the dilemma with the current attentional scope manipulations is that there is not a large enough visual range, new manipulations could take the form of zooming in or out videos on a larger screen, such as a projection screen for presentations. Alternatively, people could be taught to broaden their attentional scope on their own in naturalistic settings, as they did in Experiment 2 of Gu et al.'s 2017 study. This method could be supplemented by the addition of mobile eye trackers such as the Tobii Pro Glasses 2. Finally, the application of virtual reality would allow for an incredibly nuanced manipulation of attentional scope. Programmers could black out visual content past a certain visual range, allowing for naturalistic looking patterns without the human error associated with training people to manipulate their own attentional scopes. With these alternative methods of manipulating attentional scope, future research studies will be much better equipped to establish a causal relationship between broadened attentional scope and improvements in mood.

Before cognitive flexibility can be assessed as a potential mediator between attentional scope and mood, there needs to be a reliable and valid way to assess the construct. Of the current available methods, there do not appear to be any tests or tasks that reliably assess cognitive flexibility rather than mathematical reasoning or problem-solving ability, allow for variability in a non-disabled population, and avoid adding unintended emotional effects. Self-report assessments are subject to test-retest biases and social desirability biases, however tests such as the Cognitive Flexibility Scale appear to be stronger in their construct validity than current externally-evaluated tests or tasks (Martin & Rubin, 1995; Martin & Anderson, 1998). In the future, either new tests or the self-report measures should be used to measure cognitive flexibility and rigidity, as the current tests are not sufficient.

To create a new measures of cognitive flexibility, it may be necessary to rethink what is meant by cognitive flexibility. In the past, cognitive flexibility has been used to refer to one's ability to adapt to fluctuating situational demands, reconfigure mental resources, shift perspective, and balance competing desires, needs, and life domains (Kashdan & Rottenberg, 2010). There are some measures currently available that assess these constructs, though they are not explicitly designed to measure cognitive flexibility. For example, the *Alternative Uses Test* instructs participants to conceive of as many possible uses as they can for a simple object, such as a brick (Guilford, 1967). This task, designed to measure creativity, requires that the participant think flexibly about the item and to not remain rigidly attached to its traditional use. Additionally, there are many types of task-switching paradigms, where participants are required to quickly switch the set of instructions they are using. These, though not designed for this purpose, hint at levels of cognitive flexibility as well. In future studies, those wishing to assess cognitive flexibility should consider the definition of cognitive flexibility they are using and search for alternative measures which may assess the same underlying constructs. Given the variety of possible definitions, it may be beneficial to evaluate cognitive flexibility in multiple ways to gain a more robust assessment of the construct.

With better methods of manipulating attentional scope and measuring cognitive flexibility, a mediational role of cognitive flexibility may be elucidated by further research into this topic. In addition to a mediational role, cognitive flexibility should also be considered as a potential moderator. Since there is so much literature connecting cognitive flexibility to attentional scope and mood, it is possible that if it does not account for the relationship between them, it may influence the relationship in a different way: by influencing the strength of the effect.

## Conclusion

The current study has revealed that further research is needed before broadened attentional scope can be causally linked to improvements in mood and before cognitive flexibility can be credited for this dynamic. Prior research has made strong connections between attentional scope, mood, and cognitive flexibly, however upon combining all three of these variables, no such relationships were found. This indicates that the methodology of the present study needs to be built upon in the future to reassess this research question with superior attentional scope manipulations and improved measurements of cognitive flexibility. Research in this area should continue despite the current dearth of empirical evidence, as confirming and understanding this dynamic could allow for attentional scope manipulations to be integrated into cognitive behavioral therapy or positive psychology practices, allowing individuals both with and without depressive symptoms to improve their mood with a simple and low effort technique.

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