Bachelor Degree Project

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DISPOSITIONAL OPTIMISM AND ATTENTIONAL BIAS TO HAPPY FACIAL EXPRESSIONS

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Abstract

Research suggests that the human attentional system is biased towards emotional events in the environment. This attentional bias is believed to be an adaptive function that can provide survival benefits for the organisms that possess it. Dispositional optimism is a trait defined as a general expectation that good things will happen in the future. This trait has received interest as an adaptive trait that has a multitude of psychological and physical benefits for the individuals who exhibit it. The aim of this study is to examine whether there is a difference in the attentional bias towards happy and angry facial expressions based on level of dispositional optimism using the dot-probe paradigm. Thirty-two psychologically and neurologically healthy females (mean age = 26.5, *SD* = 5.8) participated in the study. They completed a questionnaire measuring dispositional optimism and performed the dot-probe task in a laboratory setting in the University of Skövde. In the dot-probe task a short exposure (100 ms) of photographs depicting happy, angry and neutral facial expressions was used as emotional cues. A general bias towards happy faces across all participants was detected. Also, a clear trend towards an interaction between DO and AB to emotional faces was found in the group high in DO displaying and AB towards happy facial expressions. This study implies that for the psychologically and neurologically healthy population, a fast operating and automatic AB for positive stimuli exists, moreover, this AB may be modulated by individual differences in DO.

Keywords: selective attention, attentional bias, emotion, bottom-up, dispositional optimism, facial expression.

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Introduction

> Everyone 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, and is a condition which has a real opposite in the confused, dazed, scatterbrain state which in French is called *distraction*, and *Zerstreutheit* in German. (James, 1890 p. 403)

What the great psychologist William James so eloquently managed to capture in this insightful quote is phenomenon that psychologists are still working on understanding today. How does this selection and prioritization work? Why are some thoughts or external events allowed to take possession of the mind, while others are chosen to be ignored? To what extent is the selection mediated through the conscious mind and how large is the automatic component of the process?

Emotions guide behavior (e.g., approach and avoidance), modulate cognitive processes (e.g., memory and decision making), and are signal to the individual that important events are present in the environment (Sander, Grandjean, & Scherer, 2005). One of the cognitive processes that emotions are suggested to modulate is the process of selective attention (Vuilleumier, 2005), where selective attention is the cognitive act of prioritizing and selecting some information over other information, thereby directing the attentional and sensory processing resources towards that information (Petersen & Posner, 2012). It has for example been observed that when the attentional system has to choose from stimuli that are non-emotional and emotional, the emotional stimuli will receive attentional prioritization, i.e., there is an attentional bias towards emotional stimuli (Pool, Brosch, Delplanque, & Sander, 2016).

An interesting question that arises is: what factors are involved in determining how salient an individual's attentional system will deem emotional stimuli. One option is that individual differences in well- and ill-being modulate what the nervous system deems as salient. There are now quite a lot of data that suggest that individual differences in ill-being and psychopathology (e.g., anxiety disorders) play a role in the determination of salience of threatening stimuli (Goodwin, Yiend, & Hirsch, 2017). Much less evidence exists in favor of an equally plausible relation, that is, how individual differences in well-being relate to the determination of salience of positive and rewarding stimuli (Grafton, Ang, & MacLeod, 2012). Dispositional optimism is a trait related to well-being concerned with general outcome expectancies where individuals who are high in this trait generally expect good things to happen in the future (Scheier & Carver, 1985). In recent years researchers have begun investigating how dispositional optimism relates to attentional biases. Research on the topic is however still very scarce and more research is much needed.

Therefore this study investigates how dispositional optimism relates to an attentional bias towards emotional stimuli. Understanding the dynamics between attentional bias and dispositional optimism can help us understand how some of the benefits that are present for individuals with high levels of dispositional optimism are mediated. This understanding can in turn help us to potentially develop novel interventions designed to manipulate implicit attentional biases, and in that sense, guide the individual towards a direction of a positive spiral of increased well-being and flourishing, as is suggested by the broaden and build theory (Garland et al., 2010).

Selective Attention

As human beings we are constantly bombarded with various stimuli in multiple modalities. Some of these, if detected, can be capitalized on to be beneficial to our survival; others if ignored or missed, can be detrimental to our survival; while others still are neutral and have no effect on our chances of survival. Thus, to maximize survival and fitness, our nervous system is organized to prioritize and choose some stimuli over others for further, deeper processing. This is done through the means of attention, more specifically, through selective or orienting attention (Petersen & Posner, 2012). Selective attention can be defined as any cognitive process that results in the selection of some information over some other information (Weierich, Treat, & Hollingworth, 2008). Posner (1980) argues that there are three processes involved in selective attention. The first process is engagement, the initial capture of attention. The second is shifting, the process of switching from one stimuli to another. The third process is disengagement, an individual must first disengage from a stimulus for shifting to be able to occur.

The selection process can occur based on the low-level perceptual characteristics of a stimulus, e.g., due to the salience or distinctiveness of its features. This bottom-up type of selective attention is mediated sub-cortically, is rapid, unconscious and referred to as exogenous attention. Selective attention can also be intentional, top-down driven by our desires and goals for the task at hand. When selective attention is top-down driven, it is mediated through the cortex; the selection is conscious and a much slower process. This type of selective attention is called endogenous attention (Corbetta & Shulman, 2002). These two types of selective attention rely on partially segregated neural networks, however, they perform the same function, that is, they orient attention to the area where the significant event took place and increase the brain activity devoted to the processing of that sensory information (Corbetta & Shulman, 2002). This is done to prioritize the processing of the significant stimuli over other competing stimuli (Corbetta & Shulman, 2002). Theeuwes (2010) proposes that early attentional processes occurring before 120 ms after stimulus onset can be considered as an automatic orientation of exogenous attention towards the stimuli; it is thus believed to be independent of the observers' intentions and top-down processes. At later stages, around 200-250 ms after stimulus onset, top-down, voluntary endogenous attentional mechanisms are engaged, selection is then based on expectancy and goal sets, resulting in actively and voluntarily avoiding or attending to the stimuli (Theeuwes, 2010).

When considering exogenous attention for non-emotional stimuli (stimuli that do not induce emotions in the observer), Carretié (2014) suggests that there are three different processes at work: preattention, orienting and sensory amplification. Preattention is the constant monitoring and evaluation of the environment to scan for potential important events that need attending. Preattention necessarily has to be effective in the periphery of our visual system, as salient stimuli that are not currently in foveal and attentional focus also need to be detected, oriented towards and responded to adaptively. This preattentive monitoring of the non-attended areas of the visual field must therefore be effective even without the visual acuity derived from events within the foveal area (Jonas, Schneider, & Naumann, 1992). When the preattentive system deems an event salient enough to reach a certain threshold, a reorientation of attentional resources is initiated: the orienting response. The orienting can occur via head or eye movements if the salient event occurred in a location spatially separated from the location of current endogenous attention allocation (Carretié, 2014). It is also possible to covertly, without any head or eye movements, reallocate attention towards the salient stimuli (Posner, 1980). Finally, amplification of sensory processing through the modulation of sensory-relevant cortical areas takes place so that the processing of the salient event is prioritized and potentiated over other stimuli (Asplund, Todd, Snyder, & Marois, 2010). According to Petersen and Posner (2012) there are two neural systems involved in orienting attention: a ventral attentional system and a dorsal attentional system. The ventral attentional system includes structures such as the temporoparietal junction (TPJ), including superior temporal sulcus and gyrus (STS-G), the inferior frontal gyrus (IFG) and the anterior part of the insula. This system interrupts internally driven attention towards environmentally salient events. The dorsal attentional system is involved in planning and executing the orienting response via limb and eye movement. Areas linked to this system are consequently areas involved in these tasks, including the superior parietal lobule, and several dorsal caudal frontal regions like the frontal eye fields and premotor areas.

Emotional Attention

Attentional selection also works based on the emotional salience of stimuli. Emotional stimuli have been demonstrated to receive attentional priority over non-emotional stimuli, that is, there is a bias towards emotional stimuli (Pool et al., 2016). Some authors (e.g., MacLeod, Mathews, & Tata, 1986) have argued that this bias is specific for threatening stimuli and is an evolutionarily adaptive mechanism. This means that organisms that have a biased attentional system towards threatening stimuli can react and respond quicker to a threat than organisms without this bias. Therefore, organisms with the bias have increased chances of survival. In individuals with anxiety disorders, this natural tendency to attend to threatening information in the environment is much more pronounced than in the normal population, and it is argued that this may be involved in the maintenance of the symptoms of the disorder (Yiend, 2010). Others (e.g., Chovil, 1997) propose that emotion is a communicative expression and that emotion in general can signal important information between interacting individuals. van Rooijen, Ploeger, and Kret (2017) argue that an angry face can indicate an imminent threat, and similarly, a fearful facial expression can indicate a lurking danger close-by. A friendly facial expression, on the other hand, could indicate a potentially positive social interaction, a bonding opportunity, and promote group cohesion. These are important events that could and should be capitalized on to promote individual and group survival in social animals, such as humans. This is why Pourtois, Schettino, and Vuilleumier (2013) suggest that when a multitude of stimuli compete for our limited attentional resources, emotional stimuli is a special category and are therefore prioritized so that one can organize a rapid and adequate response. This is what Vuilleumier (2005) calls emotional attention. This emotional attention is similar to exogenous attention in that it functions rapidly and automatically, however, it is also similar to endogenous attention in that it depends strongly on an individual's affective state, that is, levels of worry, anxiety, depression, and other individual differences (Goodwin et al., 2017; Peckham, Mchugh, & Otto, 2010). These three types of attention - endogenous, exogenous and emotional attention - have been suggested to interact with one another and have additive effects on selective attention (Pourtois et al., 2013).

Neural Mechanism of Emotional Attention

According to Vuilleumier (2005) there is a lot of evidence that emotional stimuli capture attention, however, there is a debate as to whether this emotional attention is automatic or voluntary. Some authors have argued that emotional attention requires voluntary attentional resources. This is argued due to the observation that high voluntary attentional load reduces emotional attention (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002). Other authors (e.g., Brosch, Pourtois, Sander, & Vuilleumier, 2011) have argued that emotional attention operates automatically, separately from voluntary attention. This view is supported by observations of attentional prioritization of emotional stimuli, even when voluntary resources are allocated elsewhere (Brosch et al., 2011). It has also been argued for the automaticity of emotional attention in that the earliest observations of increased event related potentials (ERPs) at posterior sites (P1a) in response to emotional stimuli that peak at around 100 ms after stimuli onset (Carretié et al., 2009; Carretié, Hinojosa, Mercado, & Tapia, 2005). There also appears to be a difference in how valence and arousal affect ERP responses, as valence seems to influence ERP at an earlier (100-250 ms) stage whereas arousal seem to influence at a relatively later (200-1000 ms) stage (Olofsson, Nordin, Sequeira, & Polich, 2008).

The neural pathway from the retina to the visual cortex consists of two streams. The parvocellular stream is sensitive for light, color, higher spatial frequencies, lower temporal frequencies and has lower contrast sensitivity. The magnocellular stream is sensitive to lower spatial frequencies, contrast, higher temporal frequencies and is insensitive to color (Derrington & Lennie, 1984; Schiller & Malpeli, 1978). Carretié (2014) found that emotional stimuli capture attention even when it is presented eccentric to current attention allocation. Based on this, it is suggested that exogenous emotional attention relies mostly on the magnocellular route. Thus, when the preattentive/evaluation network (PEN) scan, monitor and evaluate the environment, this system need to be fast working and include the eccentric areas outside of current attentional allocation in the monitoring for emotional stimuli. There are a few candidate components for PEN, and out of these, the amygdala is the most studied.

The amygdala is a brain structure that is centrally included in most theories of emotion (Pool et al., 2016). This almond shaped structure has many of the properties that one would expect to see in a structure involved in preattentive processing. In animal studies, a direct low, thalamo-amygdalar, fast road to the amygdala have been found in addition to the slower thalamo-cortical-amygdalar road, thus supporting the notion that the amygdala has an important role in the urgency of evaluating incoming stimuli (LeDoux, 2000). There are also studies that support the notion, albeit without any direct anatomical evidence, that this type of route exist in humans too (de Gelder, Vroomen, Pourtois, & Weiskrantz, 1999; Vuilleumier, 2005). While the faster coarse route to the amygdala has been questioned due to lacking evidence of fast-latencies responses in the amygdala, Méndez-Bértolo et al. (2016) recently recorded intracranial activity of the lateral amygdala using stimuli in low, high and normal spatial frequency. Here they found further evidence for a fast pathway to the amygdala with responses in the lateral amygdala evident at 74 ms after stimuli onset for low and normal spatial frequency, supporting the notion of a faster, coarse, magnocellular route to the amygdala. Méndez-Bértolo et al. (2016) argue that the lack of previous findings of fast-latencies responses may be due to previous studies using an electrode placement more laterally in the amygdala than Méndez-Bértolo et al. (2016) did. They also found a second later effect (120 ms) of emotion that was selective for the high and normal spatial frequency, consistent with the notion that the first reaction is an urgent response to low level coarse information, while more detailed information is projected to the amygdala from the visual cortex. The amygdala also has connections that would be considered important for a structure involved in preattention such as connections to hypothalamus and the periaqueductal gray (PAG) for preparation of adaptive motor and autonomic activation (LeDoux, 2000; Rizvi, Ennis, Behbehani, & Shipley, 1991), as well as connections that can powerfully modulate activity in sensory regions in the auditory and visual cortices (LeDoux, 2000; Vuilleumier, 2005). The basolateral amygdala (BLA) receives sensory information from both sensory thalamus and sensory cortices. The BLA can then project to the striatum and the orbitofrontal cortex to guide approach and avoidance behavior. This nucleus also projects to the central nucleus of the amygdala (CeA) to produce adequate autonomic, endocrine and further attentional responses (Davis & Whalen, 2000), as well as projections to reward areas, such as the nucleus accumbens and the bed nucleus of the stria terminals (Janak & Tye, 2015).

Another structure that has been suggested as a part of the PEN is the ventral prefrontal cortex (vPFC) (Carretié, 2014). This structure receives direct visual input from early in the visual pathway, and is able to modulate visual processing through backward projections to visual areas (Bar, 2003; Bar et al., 2006; Sarter, Givens, & Bruno, 2001). Jarbo and Verstynen (2015) claim that the connection between the vPFC and posterior parietal regions (involved in spatial attention) is most likely mediated through cortico-striatal connections. Thus both the vPFC and the amygdala could be considered as hub regions in the brain for connecting vital structures (Pessoa, 2008). In the macaque, the vPFC also has projections to motor control areas such as PAG, motor cortices, and ventral striatum as well as projections to areas involved with generating autonomic responses e.g., the hypothalamus (Cavada, 2000; Ongür & Price, 2000) and reacts early to stimuli presented in the periphery (Carretié et al., 2013; Carretié et al., 2005).

Finally the insula is suggested to be a part in the PEN (Carretié, 2014). This structure receives input directly from the pulvinar, mediodorsal nuclei, and the ventromedial nuclei of the thalamus (Shi & Cassell, 1998). The insular cortex receives input from olfactory and gustatory cortices, but it also receives input from the superior temporal sulcus, an area sensitive for facial expressions (Gallese, Keysers, & Rizzolatti, 2004). It is also known that the insula responds to complex visual information, such as features of facial expression of disgust (Phillips et al., 1997) and has been shown to respond to such information at a rather early, 140 ms after stimuli onset, stage in processing (Willenbockel, Lepore, Nguyen, Bouthillier, & Gosselin, 2012).

Regarding amygdala activation in response to faces, there seems to be almost a universal activation of the amygdala in response to being exposed to fearful facial expressions (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002). While activation in response to happy faces has also been detected, this finding seems less robust (Morris et al., 1996). Canli et al., (2002) found that the amygdala increases in activation in response to happy facial expressions as a direct function of trait extraversion, one of the big five personality traits (DeYoung, Quilty, & Peterson, 2007). Trait extraversion correlates positively with dispositional optimism however (Williams, 1992) and it could be argued that they may both contribute to the increased amygdala activation in response to happy facial expressions.

Appraisal theories of emotion (e.g., the component process model) argue that the amygdala gets activated through the mechanism of detecting relevance (Sander et al., 2005). This view of amygdala activation suggests that in the case of negative stimuli, for all organisms, there is an evolutionary relevance to detect negative and potentially threatening stimuli, this is why activation of the amygdala in response to negative stimuli seems universal. In response to positive stimuli, e.g., happy facial expressions, amygdala activation would depend upon the appraised relevance of the stimuli to the organism. The relevance detection of a stimuli is suggested to occur through three checks (Sander et al., 2005). The first check is to gage the abruptness, familiarity and predictability of a stimuli, i.e., to check whether it is a novel stimulus which needs attending. The second gage is of the stimulus intrinsic pleasantness. This is checked through both a biologically prepared, i.e., genetically fixed, schemata but also through learned associations (Sander et al., 2005). In support of this, it is also already well established that the amygdala is involved in both negative and positive conditioning and associative memories (Janak & Tye, 2015; Murray, 2007). The last part of the relevance detection is a goal/needs check. A person that scores high on dispositional optimism might be conceptualized as someone with a conditioned behavior of thinking where they expect good things to happen and is thus more likely to expect positive adaptive encounters with smiling faces more frequently than individuals low in dispositional optimism, and thus appraise a smiling face as more relevant than individuals low in dispositional optimism do.

Attentional Bias Towards Emotional Stimuli

The tendency for individuals to attend to certain categories of stimuli, while ignoring, overlooking or disregarding other kind of stimuli is the phenomenon of attentional bias (AB; Fadardi, Cox, & Rahmani, 2016). Researchers have developed several methods to measure AB towards emotional stimuli. Yiend (2010) divides the tasks designed to measure AB and emotion into four broad types of tasks. These are filtering, search, multiple task paradigms and cuing/double cuing tasks. In filtering, emotional distractors are presented together with targets (e.g., emotional Stroop task; Richards & Blanchette, 2004). Search tasks involve participants searching through an array of distractors to find and report on a target (Eastwood, Smilek, & Merikle, 2001; Yiend, 2010). In multiple task paradigms, participants must allocate their limited attention to more than one demand. An example of this is the attentional blink paradigm, where participants are supposed to attend to two targets in short succession. When the first target is attended, this occupies attentional resources and if the second arrives too soon afterwards this will be missed (Yiend, 2010). Cuing and double cuing tasks (e.g., dot-probe task) involve a stimulus attracting attention to a location or locations, this is then followed by a target that should be detected. The bias is usually calculated in speed and accuracy of responses (Yiend, 2010).

Using such tasks, research has shown that in a crowd of distractors, emotional targets are easier to detect than non-emotional targets (Eastwood et al., 2001). This effect is similar to a pop-out effect, however it is also different, because unlike the regular pop-out effect, response times scale with number of distractors. This scaling is less sensitive to distractors as it occurs on a more shallow slope than can be observed in non-emotional conjunction search (Eastwood et al., 2001). The facilitation of search reflects a bias for emotional stimuli over neutral ones. Richards and Blanchette (2004) found that in a version of the Stroop task, participants were slower to name the color of a word if the word had emotional valence attached to it through classical conditioning. This suggest an automatic capture of attention elicited by the emotional word as attending to the word is irrelevant to the task, and even counterproductive. In attentional blink paradigms, participants often miss a second target, if it is presented shortly after another target in a stream of multiple stimuli is shown in fast succession. However, this failure of detection is reduced when the second target is an emotional one (Anderson, 2005) and is increased if the first stimuli is an emotional one (Schwabe et al., 2011).

A function of the mechanism underlying fear is to facilitate detection of danger in the environment to help the organism rapidly and adaptively respond to maximize survival chances (Bar-haim, Lamy, Pergamin, Bakermans-kranenburg, & van Ijzendoorn, 2007). It is thus adaptive to have an attentional system that prioritizes negative emotional stimuli (MacLeod et al., 1986). It has been suggested that the attentional systems of anxious individuals may be extra sensitive and biased to negative emotional stimuli (Beck, Laude, & Bohnert, 1974; Mathews & MacLeod, 1985). This notion has motivated researchers to extensively examine the relation between individual ill-being and AB towards negative stimuli. When differences in psychological ill-being are considered, individuals who are diagnosed with mental disorders show specific biases in the relevant domain (Goodwin et al., 2017; Yiend, 2010). For example, individuals with speech phobia tend to show AB towards words related to speech phobia (Becker, Rinck, Margraf, & Roth, 2001), patients with panic disorder show an AB towards stimuli related to panic disorder (Chen et al., 2013). In both of these studies, patients with general anxiety disorders showed non-specific AB towards negative stimuli, congruent with the nature of general anxiety disorder. While AB towards threatening stimuli is common within the anxious population, this bias does not seem to be evident within the non-anxious population (Bar-haim et al., 2007). Also, the affective context can influence the direction and degree of AB so that stimuli that are emotionally congruent with the affective context will be more salient (Cox, Christensen, & Goodhew, 2017). For example, a negative context could indicate that danger is more probable and hence increase the saliency of negative emotional stimuli. It is also known that what captures attention is not any event, but it is related to individual-level variables, (e.g. mood, motivation and personality traits) (Isaacowitz, 2006). After observations of mood- and motivation-congruent gaze, Isaacowitz (2006) suggested that humans seek out mood-and goal-congruent stimuli and avoid incongruent stimuli. However, the reverse is also true: what individuals attend to will benefit from deeper processing, and will therefore possess a larger portion of their mind and most likely direct their future thoughts, choices and behavior, thus affecting their goals and mood (Wadlinger & Isaacowitz, 2010).

Pool et al. (2016) suggest that while early AB research focused on the biases of negative emotional stimuli, researchers have recently begun expanding the study of AB towards positive emotional stimuli. In their meta-analysis, the authors conclude that within the healthy population a bias towards positive emotional stimuli exists. While individual differences in psychopathology and ill-being have been studied quite extensively with regard to AB, individual differences in well-being and how these could play a role in the AB to positive as well as negative stimuli have not been studied nearly as much. There is, however, some evidence that individual differences in measures of well-being may play a role in the AB to positive and negative stimuli. Vittersø, Oelmann, and Wang (2007) hypothesized that individuals that rate themselves as satisfied with life would favor pleasant information in the attentional processing. This is exactly what they found: with higher scores of life satisfaction, reaction times to detect happy emotional facial expressions were shorter. Sanchez and Vazquez (2014) used eye-tracking to measure the AB for happy, angry, sad and neutral facial expressions and related this to scores of life satisfaction and positive emotions. They found that it was the positive emotions that were responsible for the bias towards positive stimuli. Mauer and Borkenau (2007) used the emotional Stroop task to measure AB to positive and negative words. They found that emotionally positive words captured attention in individuals high in approach temperament. Tamir and Robinson (2007) found that daily positive mood was associated with AB towards positive words in the dot-probe task. Furthermore, they demonstrated that manipulating the mood to be more positive also increased the AB towards positive stimuli. Theeuwes and Belopolsky (2012) found that stimuli, conditioned to be associated with high monetary gain, capture attention in a bottom-up, automatic way. Similarly, Gupta, Hur, and Lavie (2016) found that faces, that had previously been associated with monetary gain, captured attention the same way that intrinsically valanced stimuli did. Interestingly, when negative stimuli were presented as distractors, interference could be reduced by perceptual load. When positive stimuli were presented as distractors however, interference could not be reduced by perceptual load but were unaffected. Gupta et al. (2016) therefore suggests that bias towards positive stimuli can sometimes be more robust than negative AB. Consistent with Gupta et al. (2016), Pool et al. (2016) report in their meta-analysis that there is no overall difference in the bias towards intrinsic and learned valanced stimuli

Dot-Probe Task as a Measure for Attentional Bias Towards Emotional Stimuli

The dot-probe task is one of the most frequently used tasks to measure AB (Yiend, 2010) and it is now considered the gold standard for measuring AB (Pfabigan, & Tran, 2015). Although Yiend (2010) talks about an earlier, auditory version of the task, it was first introduced by MacLeod et al. (1986) in its visual form. In this paradigm, two cues, typically one valanced and one neutral, (e.g., photographs of faces) are presented briefly, either to the left and right of a fixation point, or at the bottom and top of a fixation point. These cues are then followed by a target (e.g., a dot) that is presented at the location of one of the locations previously occupied by a cue. The task for participants is to as quickly and as accurately as possible determine the location, orientation, or the identity of the target. Typically, when the target appears in the location previously occupied by an emotional cue (congruent condition), participants are faster at responding to it, than when the target appears in the location where the neutral cue was (incongruent condition): this is the AB. Weierich et al. (2008) suggest that when one measures attentional processes, if the target appears not more than 150 ms after the emotional cue, one measures the initial orienting shift, which takes around 100-150 ms to occur. If the cue-target onset asynchrony (CTOA) is more than 250 ms, this allows the participants to make several shifts in attention, and an AB with this CTOA is more likely to reflect difficulty in disengaging attention.

The dot-probe task has been extensively used to measure the AB of populations with psychopathology using negative stimuli (Yiend, 2010). Goodwin et al. (2017) suggested that compared to healthy controls, patients with general anxiety disorder (GAD) display an AB towards threat when it is presented in a word form rather than using scenic images or facial expressions. When comparing the AB of GAD patients with the AB of patients with other mental disorders, the AB of GAD patients seems to be more prominent than the AB of depressed and speech phobic patients. There is evidence for AB in depression, however, this evidence has been less consistent than the evidence for AB in GAD (Mathews & MacLeod, 1994). Mathews and MacLeod, (1994) refer to Williams, Watts, MacLeod, & Mathews (1988) who suggested that anxiety and depression are associated with biases in different cognitive operations. Anxiety, they claim, is associated with a bias in attention whereas in depression there is a bias in recall. Later meta-analyses contradict this in showing that there is a detectable AB for depressed patients (Peckham et al., 2010) as well as other cognitive biases (e.g., memory bias; Belzung, Willner, & Philippot, 2015). Angry or sad facial expressions have typically been used as threat stimuli, with neutral or happy facial expressions being used as controls (Bar-haim et al., 2007). Happy facial expressions have therefore not been analyzed much in its relation AB. In Goodwin et al. (2017) review they found that in most studies with GAD patients which measured AB for positive stimuli no AB for these could be detected.

There is much less literature relating individual differences in well-being to biases displayed in the dot-probe task. Like discussed previously, Vittersø et al. (2007) found evidence of AB towards positive stimuli for participants rating themselves as satisfied with life. Tamir and Robinson (2007) found a similar association between a bias towards positive stimuli and positive daily mood. There is one example of that a manipulation to increase AB towards positive stimuli, also increased the sensitivity of these participants to a positive mood induction (Grafton et al., 2012). Thus, whereas AB using the dot-probe task has been studied quite extensively in regards to its relation to psychopathology, especially anxiety and negative emotional stimuli (Yiend, 2010), very little work on AB towards positive stimuli in relation to individual differences in psychological well-being has been done.

Dispositional Optimism and Attentional Bias

Dispositional Optimism (DO) is a concept put forward by Scheier and Carver (1985) and is defined as a general expectation that good things will happen in the future. DO is measured with the Life Orientation Test Revised (LOT-R; Scheier & Carver, 1985). LOT-R is a 10-item scale with four filler items, three items are coding for optimism and three items coding for pessimism (which are reverse coded to create a unipolar score of optimism) (Scheier, Carver, & Bridges, 1994). DO is considered as a relatively stable trait which is comprised of positive attitude, thoughts and opinions about future events (Hirsch, Conner, & Duberstein, 2007; Scheier, & Carver, 1992). This style of positive thinking has been associated with many psychological and physical benefits for the optimist, e.g., higher rates of college retention (Solberg Nes, Evans, & Segerstrom, 2009), and more effort exerted towards high, but not low priority goals (Geers, Wellman, & Lassiter, 2009). Individuals high in DO are less likely to smoke, more likely to exercise, and have more healthy diets than individuals low in DO (Boehm, Williams, Rimm, Ryff, & Kubzansky, 2013). People with high levels of DO also manage stressful life events better, and these stressful life events have less negative impact on their physical health (Scheier, & Carver, 1992). Scheier and Carver (1992) go on to say that these benefits seems to manifest due to different coping mechanisms utilized by people who score high on DO and people who score low on DO. High DO people put a positive spin on problems that they face, while tackling the problem head on and not avoiding it. This is as opposed to individuals who score low on DO who are more inclined to avoid problems and see them as unsurmountable and hence give up on problems more easily. Because of this, DO has received interest in the AB literature and the bias has been suggested as a possible mechanism which mediates some of the benefits afforded to individuals high in DO (Segerstrom, 2001).

There is evidence that DO, at least in western cultures, increases with age (You, Fung, & Isaacowitz, 2009). There is also evidence that AB towards positive stimuli seems to increase with age, something known as a positivity effect (Isaacowitz, Wadlinger, Goren, & Wilson, 2006b). One could argue that increased DO might be a plausible mechanism in which this positivity effect is mediated. This might explain why the positivity effect on attention for the aging population has been equivocal in the literature (Reed & Carstensen, 2012), the positivity effect might actually arise from increased DO (Isaacowitz, 2005). This is something that is very seldom considered.

In recent years there has been an increase in the interest in DO in relation to AB and although still scarce, an increasing number of publications investigate the relationship. Most studies to date have used eye-tracking to measure AB in relation to DO. When Kelberer, Kraines, and Wells (2018) used eye-tracking to investigate DO and its related construct, hope, they found that people with high levels of both DO and hope, display less gaze fixation on dysphoric (e.g., a picture of a crying human) and threatening (e.g., a picture of a human pointing a gun towards the camera) stimuli. Only DO was found to be associated with increased eye-fixation on positive (e.g., a group of fiends laughing and smiling) stimuli. In a eye tracking study, Isaacowitz (2005) compared participants high in DO and low in DO in gaze fixation on either negative images of melanoma, drawings that matched the contours of the melanoma pictures or with neutral faces. In this study, participants high in DO tended to show selective inattention to stimuli depicting melanoma, while showing no bias for any of the other stimuli. Peters, Vieler, and Lautenbacher (2015) used eye-tracking to test the effects of DO and state optimism on AB for joyful, angry and faces depicting painful expressions. They found that after removing one extreme outlier, there was a positive correlation between DO and eye-gaze towards joyful facial expressions. No correlation between DO and eye-gaze towards or away from neither angry or painful facial expressions was found.

Segerstrom (2001) found that participants high in DO displayed an AB towards positive words in the emotional Stroop task. This effect was accompanied with slower skin conductance response in response to negative stimuli for high DO individuals. Segerstrom (2001) concludes that these unconscious attentional processes may be one factor that contribute to the many positive effects associated with DO. This is interesting in parallel to what Yiend (2010) claimed about the AB working as a neurological mechanism involved in the maintenance of psychopathology. Similarly, it could be argued that a similar mechanism is involved in the development and maintenance of psychological well-being. In fact, an interesting avenue for increasing the understanding of the mechanisms of what drives psychopathology and psychological well-being comes from evidence that in modulating the biases towards positive and away from negative stimuli, one can increase the well-being and decrease the risk for depression in individuals (Browning, Holmes, Charles, Cowen, & Harmer, 2012; Wadlinger & Isaacowitz, 2010).

To the best knowledge of the author of the present study, there is only one published study on the relationship between AB and DO using the dot-probe task. This was conducted by Shafiee and Agha-Yousefi, (2012) who tested the AB for schematic happy and angry facial expressions in relation to DO. This study found that the high DO group showed an attentional avoidance from angry facial expressions whereas the low DO group displayed an attentional vigilance for angry facial expressions. No bias was found for the happy facial expressions. However, there are a number of limitations with this study. The authors used schematic facial expressions and participants were chosen based on high and low scores of DO, rather than dividing already collected participants based on the scores of DO. There is a problem with the ecological validity of this methodology. Using schematic facial expressions is likely to generate unambiguous perceptions of the depicted emotions (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a), but it is not certain that this will translate well to viewing a real smiling or angry face. Thus, while very interesting and informative, it is not certain that this result can be generalized to everyday life. Moreover, choosing participants based on the scores of DO is not likely to reflect the scores of the general population and the results may thus only apply to the extremes of the distribution of DO. Moreover, as the study was published in Persian only, any further investigation of methodological issues (more than presented in the Abstract), such as exposure time of stimuli, is difficult.

Aim and Hypotheses of the Present Study

This study investigates whether DO is related to a biased attention towards positive stimuli. Specifically the aim of this study is to examine whether there is a difference in the AB towards happy and angry facial expressions, based on level of DO using the dot-probe paradigm. Furthermore, the study seeks to examine whether the relationship between AB and DO exists when measuring early bottom-up attentional processes for happy and angry facial expressions.

Based on the literature on AB and DO, it is hypothesized that the group with high scores of DO, as compared to the group with low scores of DO, will show an increased AB towards happy facial expressions (hypothesis 1). The group with high scores of DO, as compared to the group with low scores of DO, will also show less AB towards angry facial expressions (hypothesis 2).

Whittle, Yücel, Yap, and Allen's (2011) reviewed evidence regarding sex differences in the neural mechanisms underlying emotional processes between males and females. Existing evidence suggests that males and females use different strategies during emotional processing. The authors suggests that to avoid confounds when researching emotion, one should not ignore sex differences. Hampson, van Anders, and Mullin (2006) discussed the evolutionary primary caregiver hypothesis. This hypothesis comes in two variants and suggests that females are better at recognizing either all facial expressions (the attachment promoting hypothesis) or only the negatively valanced emotions (the fitness threat hypothesis). In their study Hampson et al. (2006) found that females show an overall advantage in recognizing emotional expressions. Kret and De Gelder (2012) have further reviewed this topic, showing that females have a general advantage in the perception and expression of all emotions. Men, however, show greater response to threatening cues, especially from other males, than do women. This they argue must be considered when doing psychological and neuroscientific research on emotion. Hampson et al. (2006) suggest that female superiority in perceptual speed of emotional stimuli has been recognized since the 1940s and Vassallo, Cooper, and Douglas (2009) found the first evidence of faster reaction times in the recognition of emotional facial expressions. There is also evidence of a female superiority in AB tasks. For example, Isaacowitz (2005) measured eye fixations with eye-tracking and found two predictors of AB away from negative stimuli; DO and sex. Because of these findings of sex differences in emotion perception and due to the limited time frame of this study, the present study will focus exclusively on females.

There is a large corpus of evidence suggesting that the perception of emotions is largely lateralized to the right hemisphere (Bornhofen & Mcdonald, 2008). Moreover, this lateralization seems to occur across several different modalities, but it has been studied most extensively in the visual modality using facial expressions (Schirmer & Adolphs, 2017). Borod et al. (1998) found that patients with brain damage due to stroke were significantly impaired in recognizing facial, prosodic, and lexical emotions when the damage was in the right hemisphere, relative to when the stroke occurred in the left hemisphere and relative to healthy controls. Similarly, Innes, Burt, Birch, and Hausmann (2015) found that emotional processing seems largely lateralized to the right hemisphere, even when the general bias for processing of information within the left visual field is controlled for. This lateralization can be found across both genders, however, it seems to be more pronounced in males rather than females (Bourne, 2005). Bourne (2005) suggests that this ability to utilize both hemispheres when processing emotional facial expressions could be argued to be a possible cause for the female superiority in emotion processing. It is thus plausible that when utilizing a task such as the dot probe, with very short exposure times and no saccadic movement of the eyes, one would observe a greater effect in the left visual field than the right visual field. This has not always been considered in dot probe studies. However, when this variable has been considered, the observed bias has been stronger in the left hemifield (e.g., Fox, 2002; Mogg & Bradley, 1999; Brosch, Sander, & Scherer, 2007). Thus, in this study, it is hypothesized that the AB will be more pronounced within the left visual field/right hemisphere (hypothesis 3).

As the emotional cues will be presented in the visual periphery, one concern is the degradation of perception outside of the fovea (Gupta et al., 2016). However, much of face detection is mediated by subcortical, magnocellular routs, through the amygdala, pulvinar and superior colliculus, and this route modulates processing in cortical structures involved in identification and recognition of expression (Johnson, 2005). Furthermore, Carretié (2014) suggests that eccentricity of the emotional stimuli does not modulate the attentional capture, much in line with evidence suggesting that the magnocellular route seems to be of much importance for emotional attention. The short exposure time of cues is used as Pool et al. (2016), in their meta-analysis, concluded that AB towards positive stimuli is stronger when measuring the reflexive, automatic, engaging component of attention as opposed to the later intentional, attentional strategies.

Method

Emotional faces, visual field, and level of DO were all independent variables. Response time was the dependent measure. The study was a 2 (emotional faces) x2 (visual field) x2 (DO) between-within-subjects study. It was conducted according to the Declaration of Helsinki in a laboratory setting at the University of Skövde.

Participants

A total of 32 female, right-handed, native Swedish speaking, psychologically and neurologically healthy participants were included using an opportunity sampling by mailing out ad-posters, recruitment of people on campus and advertisement on social media. The ages ranged from 21 to 45 years old, with a mean of 26.5 years (*SD* = 5.8).

Stimuli and Apparatus

The dot-probe task was designed using the open access software OpenSesame v3.1 (Mathôt, Schreij, & Theeuwes, 2012) and ran on a HP notebook computer model HP ZBook 15 G3 using a HP ZR22w monitor with a refresh rate of 60 Hz.

The set of photographs displaying emotional facial expressions that were used as cues was derived from the Karolinska Directed Emotional Faces database ("Karolinska Directed Emotional Faces (KDEF) documents — Department of Experimental Clinical and Health Psychology — Ghent University", 2018). Faces depicting 13 female and 13 male identities were selected (for full list of photographs used, see the Appendix 1). The identities were chosen based one the validity study of Goeleven, De Raedt, Leyman, and Verschuere (2008) according to the following criteria:

faces with the highest un-bias hit rate, highly rated intensity, and arousal. The accompanying neutral facial expression of the same identities was also used. All emotional facial expression cues were cropped to display only faces and no other features, e.g., hairline, clothing etc. All the cue faces were converted into grayscale and the luminance and contrast were adjusted with SHINE toolbox (Willenbockel et al., 2010) of MATLAB (The MathWorks, Natick, MA). The background was set to gray.

Measures

For a measure of DO, the Swedish version of the Life Orientation Test Revised (LOT-R) was administered (Muhonen & Torlekson, 2005). LOT-R (Scheier & Carver, 1985; Scheier et al., 1994) is a 10 item scale with four filler items. The LOT-R measures generalized outcome expectancies with three items coding for optimism (e.g., "In uncertain times, I usually expect the best.") and three items coding for pessimism (e.g., "If something can go wrong for me, it will."). The latter are reverse coded to create a unipolar score of optimism. The overall score is calculated by summing up the six optimism and reverse-coded pessimism items and it ranges from 0-24 where higher scores indicate a higher degree of DO. In this sample, the Cronbach's alpha was 0.847. The results from the LOT-R ranged from 5-24. Using the total LOT-R score, participants were divided into two groups using the median split: participants scoring above 17.5 were categorized as high in DO and participants scoring below 17.5 were categorized as low in DO, resulting in 16 participants in each group.

Participants also responded to a number of other self reported scales as a part of another study and therefore, these results are not reported here.

Procedure

Participants were first asked to read through a study description and sign an informed consent. Following this, they were asked to fill in the measurements, including the LOT-R. Next, the participants were informed about the experimental procedure. They were then seated on a fixed back and head rest chair 55 cm from the computer screen. Participants wore noise reduction earmuffs, and the windows were blacked out, to limit possible distractors.

The participants first underwent 20 practice trials to get familiarized with the procedure of the trials before beginning the experimental trials. The following experimental loop consisted of two blocks, each with 104 trials. Each experimental trial began with a fixation cross (1x1 cm) that was presented in the middle of the screen for 750 ms. Following this, a pair (same identity) of one emotional (happy or angry) and one neutral facial expression was presented for 100 ms, to the right and to the left of the fixation cross. These cues were 11.3 cm^2 and the distance between the centre of each image was 14.6 cm apart. Immediately when the faces disappeared, the target dot (a white 0.1 x 0.1 cm^2 dot) replaced one of the pictures. The participant then responded as fast and as accurately as possible to indicate whether the dot appeared to the left or to the right, using marked keys on the keyboard. After participant responses, an empty frame, designating inter-trial interval, was shown for 1000 ms. In total there were 208 experimental trials. Thus, each happy and angry face was displayed 4 times and the neutral faces was displayed 8 times for each participant (as the neutral faces was displayed both during the happy-neutral and the angry-neutral trials). The emotional and neutral faces appeared equally many times randomly to the left and right of the fixation cross, likewise with the target dot (104 exposures for each visual field). The outline of the dot-probe task is depicted in Figure 1.

To examine whether the participants perceived the cues (i.e., emotional faces) as the emotions they were actually depicting, an analysis of percentage of correctly identified emotional expressions was conducted as well as an analysis of the mean reported intensity and arousal of the facial expressions. After the participants had finished the dot-probe task, they were asked to make judgements regarding the cues that had been displayed. They were shown all the 26 faces, displaying the three emotions, in a sequence and asked to judge what emotion was being displayed: choosing from Ekman and Friesen's (1971) five basic emotions (happy, angry, sad, disgusted, and surprised) with the option to choose indistinct and neutral. They were then asked to rate the displayed intensity of the expressed emotion using a 9-point Likert scale where 1 indicated ”not at all” and 9 indicated ”very much”. Lastly, the participants were asked how arousing the stimuli were to them, using the same 9-point Likert scale, accompanied by the Self-Assessment Manikin as an aid for clarity (Lang, 1980). The rating procedure was modelled in accordance with the validity study of Goeleven, et al., (2008).

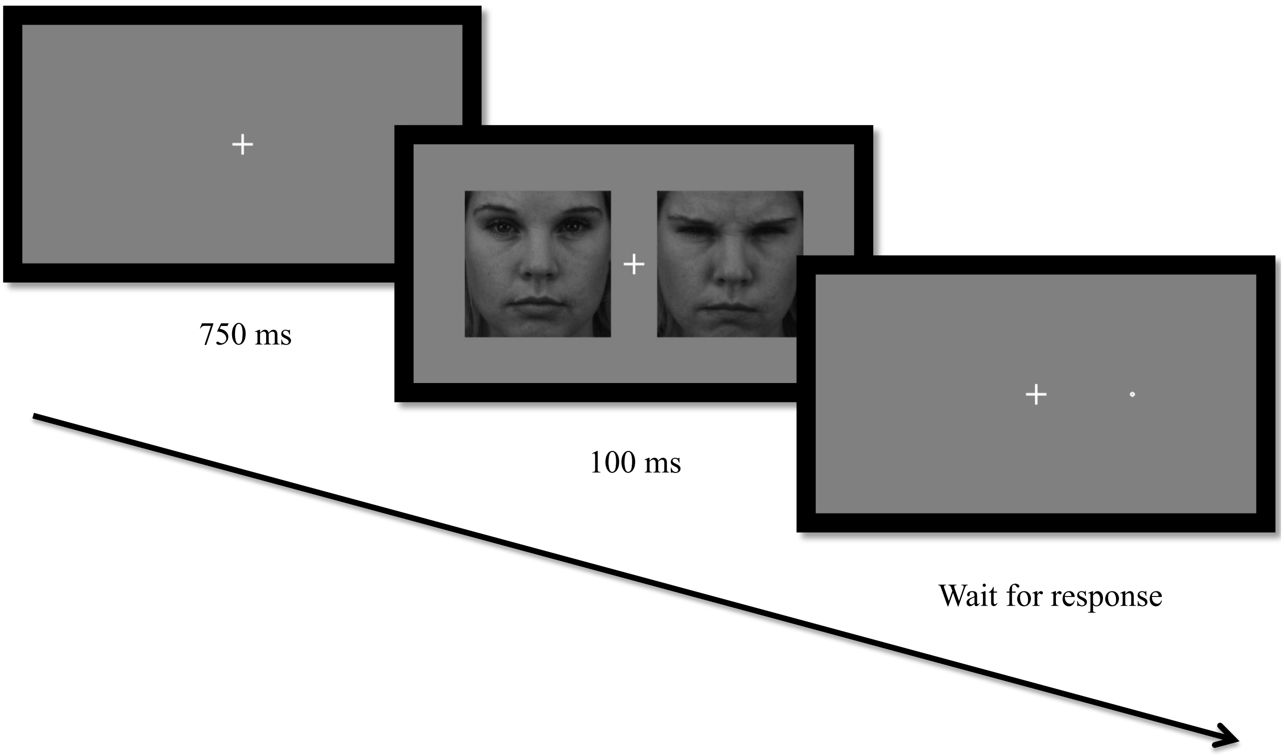

Figure 1. The sequence of the experimental procedure.

Results

Descriptive Statistics of Dispositional Optimism

The LOT-R total mean for this sample was 16.97 with a standard deviation of 4.99. This seems to be a representative score for individuals from this region of the world, as Fischer and Chalmers (2008) performed a meta-analysis of DO around the world and their result indicated that the Swedish mean was 64.95% of maximum score on the LOT-R. As the scale used in the present paper had a maximum score of 24, the Swedish mean according to Fischer and Chalmers (2008) should be 15.59. More recent results from the Nordic region show similar results. When Schou-Bredal et al. (2017) measured the mean population scores of DO in Norway, they found that the mean was 17.2 with a standard deviation of 3.

Cue Evaluation

The results regarding the perception of the different facial expressions as well as the evaluation of their intensity and arousal can be seen in Table 1. These results are in alignment with the rates obtained by Goeleven et al. (2008) who found a hit rate of 63%, 93% and 79% for neutral, happy and angry facial expressions respectively. The ratings for intensity and arousal were also in line with those obtained in Goeleven's et al. (2008) validation study. This indicates that the sample of the present study perceived the correct emotional expression to the same extent as the validation study by Goeleven et al. (2008) suggests can be expected. Since the hit rate for neutral facial

Table 1
Hit Rate, Intensity and Arousal Ratings of Emotional Facial Expressions

Measure	Neutral	Happy	Angry
Hit rate (%)	65.76	91.19	72.33
Intensity rating - mean (SD)	4.26 (2.205)	5.95 (1.989)	6.07 (2.198)
Arousal rating - mean (SD)	2.21 (1.429)	3.88 (1.964)	3.55 (1.873)

Note. Numbers within parenthesis denotes standard deviations. Intensity and arousal ratings range from 1, low to 9, high.

expressions were quite low, an analysis of the incorrect identification of the neutral facial expressions was made. The two most common incorrect identification of neutral facial expressions were sadness and anger. In 65% of incorrect identification of neutral facial expressions, the expression was perceived to be depicting sadness. An additional 15% of the incorrect identification of neutral facial expressions was perceived as angry. For incorrect identification of angry facial expressions, the most common responses were surprise (25%) and indistinct (25%).

Attentional Bias Scores in the Dot Probe Task

According to published studies, the first step in the analysis of reaction times (RT) is to discard error trials (i.e., responding incorrectly to the target location). Out of the total number of 6656 trials, 103 trials (1.5%) were incorrect and hence removed. Next, outliers (i.e., trials with extreme RT) were removed using three different methods: two different standard deviation approaches (±2SD and ±3SD) and one interquartile range approach(±1.5IQR). In the standard deviation approaches used, the first step was to remove extreme RT (i.e., under 200 ms and above 2500 ms), which removed an additional 41 trials. Next, the mean and standard deviation was calculated for each individual and, for the ±2 SD approach, RT above and below two standard deviations from individual means were removed (192 removed trials). For the ±3 SD approach, the same procedure was executed removing three standard deviations above and below individual means (82 removed trials). Altogether, after removing extreme RT and outliers using the ±2 SD method, 5.06% of trials were removed. Remaining 6553 trials were included in the analysis of AB in the ±2 SD approach. For the ±3SD method, after extreme RT and outlier removal, 3.38% of trials were removed and the remaining 6320 trials were included in the analysis of AB in the ±3 SD approach. These methods were used as it is commonplace to exclude outliers using this type of method (Price et al., 2015). In fact, removal of observations above and below the mean plus and minus a number of standard deviations, usually 2, 2.5 or 3, from the dataset is the most common method of RT outlier removal used in the literature (Leys, Ley, Klein, Bernard, & Licata, 2013). There are, however, a number of issues with using these methods as they are based on the mean. Firstly, these methods are dependent on the assumption of a normal distribution, outliers included. Secondly, the mean and standard deviation are heavily dependent upon outliers and big outliers can thus skew these measures (Miller, 1991). A method for detecting outliers which is heavily dependent on outliers can both leave outliers that should be removed and there is also a risk of removing legitimate observations. The standard deviation approach is therefore somewhat suspect and has been advised against (Leys, et al., 2013). On the other hand, the interquartile range (IQR), which is a robust dispersion estimation over the middle 50% of the observations, can be used to calculate outliers. This method is less sensitive to outliers as it is based upon the median, which does not vary much with outliers (Acuna & Rodriguez, 2004). The procedure of removing trials that are less than 1.5 x IQR below the 25th percentile and 1.5 x IQR above the 75th percentile as outliers has thus been recommended (Frigge, Hoaglin, & Iglewicz, 1989). Therefore, this procedure was also adopted for detecting outliers in this study. Each participant's IQR was calculated and 1.5 x each individuals IQR was added on top of the 75th percentile and subtracted from the 25th percentile. All trials outside this range were removed from further analysis. With this approach (±1.5IQR) 215 trials (3.28%) were removed, which along with error trials sums up to a total of 318 removed trials (4.78%). The number of removed trials was acceptable using all three methods (±2 SD: 5.06%; ±2 SD: 3.38%, ±1.5IQR: 4.78%)

As is common in the literature, the bias was then separately calculated for each emotional expression and visual field with the formula *Bias Score = mean RT to incongruent trials - mean RT to congruent trials.* This means that a positive bias value indicates a faster latency for that condition (i.e., attentional vigilance), whereas a negative score indicates an attentional avoidance for that condition. Congruent means that the probe appeared at the location of the emotional cue, whereas incongruent means that the probe appeared at the location opposite from the emotional cue.

A 2(emotional faces) x 2(visual field) x 2(DO) repeated measures mixed design analysis of variance (ANOVA) was conducted on the attentional bias score data. Since age has been associated with a positivity bias (Isaacowitz et al., 2006a), this variable was included as a covariate to eliminate error variance on account of this. DO group was the between-subject variable and visual field and emotional expression of the cue were within-subject variables.

As the statistical procedure used in dot-probe experiments have varied to quite a large extent regarding handling of outliers (Leys, et al., 2013), three different ANOVAs were conducted after

Table 2

ANOVA results. The main effect of Dispositional Optimism, Visual Field, and Emotional Face are displayed, followed by the four interaction effects.

Factors	Method	*df*	*F*	*p*	η_p^2
DO	±1.5IQR	1,27	2.066	.162	.071
	±2SD	1,27	2.539	.123	.086
	±3SD	1,27	1.370	.252	.048
Visual Field	±1.5IQR	1,27	1.297	.265	.046
	±2SD	1,27	1.712	.202	.06
	±3SD	1,27	1.814	.189	.063
Emotional Face	±1.5IQR	1,27	6.966	**.014**	.205
	±2SD	1,27	9.599	**.005**	.262
	±3SD	1,27	4.836	**.036**	.153
Emotional Face x DO	±1.5IQR	1,27	4.100	.053	.132
	±2SD	1,27	4.487	**.043**	.143
	±3SD	1,27	1.326	.260	.047
Visual Field x DO	±1.5IQR	1,27	1.630	.213	.057
	±2SD	1,27	1.682	.206	.059
	±3SD	1,27	1.809	.190	.063
Visual Field x Emotional Face	±1.5IQR	1,27	0.123	.728	.005
	±2SD	1,27	0.054	.818	.002
	±3SD	1,27	0.086	.771	.003
Visual Field x DO x Emotional Face	±1.5IQR	1,27	0.231	.635	.008
	±2SD	1,27	0.108	.744	.004
	±3SD	1,27	0.063	.803	.002

Note. *p*-values displayed in bold = $p < .05$. DO = Dispositional Optimism. η_p^2 = partial eta squared (ES).

removing outliers using the ±2SD, ±3SD, and ±1.5IQR methods. As can be seen in Table 2, in all statistical analyses, results showed a significant main effect of emotional face with a large effect size (Cohen, 1988). That is, participants responded significantly faster when the target occupied the space where a happy facial expression had been displayed as compared to when the dot occupied the space where an angry facial expression had been displayed (see Table 3 for descriptive statistics). No significant main effect was found for visual field. This means that there was no significant difference in RT for probes occurring in the left and right visual. For the ±3SD and ±1.5IQR methods, the analysis found no significant interaction between the level of DO and emotional face. For ±1.5IQR, the effect size for the interaction between DO and emotional face is still within Cohen's (1988) description of medium effect size and a clear trend towards a significant interaction can be seen. When the ±2SD method was used, the interaction between DO and emotional face was significant with a medium effect size, meaning that participants high in DO, displayed stronger AB towards happy facial expressions than participants low in DO do (see Table 3 and Figure 2).

Table 3

Descriptive Statistics for Attentional Bias Scores towards Emotional Faces in Individuals with Low vs High Levels of Dispositional Optimism

Emotional face	Method	All Mean (*SE*)	High DO Mean (*SE*)	Low DO Mean (*SE*)
Happy	±1.5IQR	4.33 (1.59)	8.12 (2.32)	0.54 (2.17)
	±2SD	4.95 (1.57)	8.72 (2.30)	1.18 (2.16)
	±3SD	4.1 (1.86)	6.9 (2.72)	1.31 (2.54)
Angry	±1.5IQR	-0.92 (1.54)	-1.32 (2.25)	-0.52 (2.11)
	±2SD	-0.86 (1.37)	-0.86 (2.00)	-0.85 (1.87)
	±3SD	-1.07 (1.51)	-1.01 (2.21)	-1.12 (2.07)

Note. Method denotes the method of outlier removal. All = All participants, regardless of DO group. *SE* = Standard error. DO = Dispositional optimism

As can be seen in Table 2, all analyses gave similar results with significant effects for emotional face. For the analysis using ±1.5IQR as outlier removal, a clear trend towards significance can be seen for the interaction between DO and emotional face. This interaction was significant when using the ±2SD method to remove outliers.

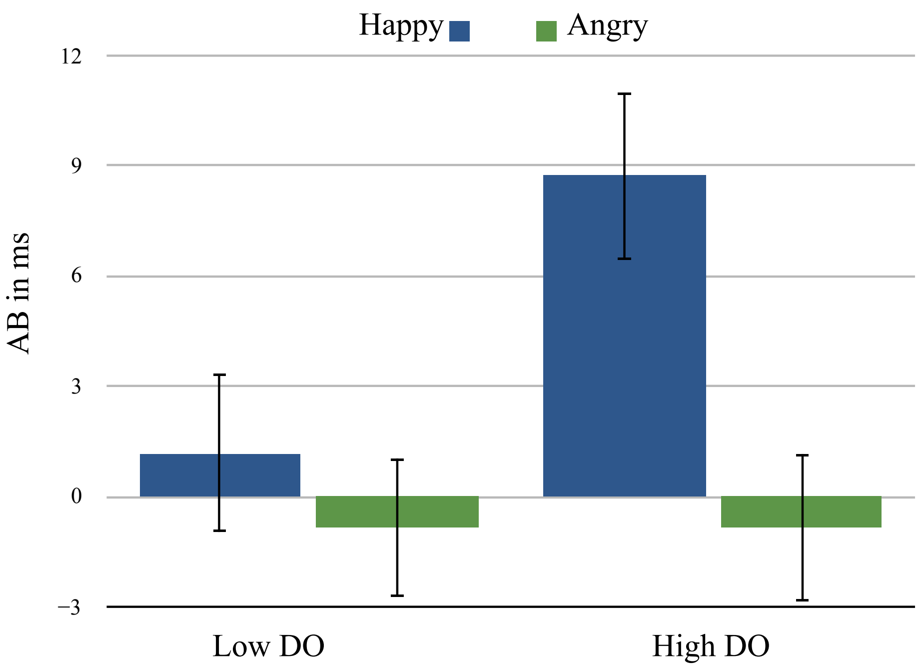

Figure 2. An illustration of the mean bias of participants high and low in DO towards happy and angry cues when using ±2SD to remove outliers. Whiskers represent the standard error. Numbers on the Y-axis represent attentional bias in ms.

Discussion

The aim of this study was to examine whether there is a difference in the AB towards happy and angry facial expressions, based on level of DO. This study is novel in that it is one of the first that examine the relationship between DO and AB towards emotional facial expressions using the dot probe paradigm with RT as dependent measure. It is also novel in that it is the first to use this methodology while not pre-selecting participants based on levels of DO, but instead divided participants based on obtained ratings of DO in the sample.

In this study, across all the different methods used for outlier removal, a bias towards happy facial expressions was detected independent of level of DO, using the dot-probe detection task. While a statistically significant main effect of emotional face could be observed across all methods of outlier removal, the results of the interaction between DO and emotional face was dependent on the method of outlier removal. In two out of three methods (±3SD and ±1.5IQR), no statistically significant interaction was found between DO and emotional face. In one of the methods (±2SD), an interaction between DO and emotional face was found. This interaction showed that the group with high levels of DO, as compared to the group with low levels of DO, displayed an AB towards happy facial expressions. For the ±1.5IQR method, while not significant, the effect size for the interaction between DO and emotional face was within Cohen's (1988) range for medium effect size. In fact, when the mean AB towards happy facial expressions for the group with high and low levels of DO are compared, one can clearly see that most of the bias reported from the emotional face variable stems from the group high in DO. Hypothesis 1 of this study was that the group with high scores of DO as compared with the group with low scores of DO would show an increased AB towards happy facial expressions. This hypothesis was partially confirmed in that one of the methods of outlier removal resulted in a confirmation of the hypothesis. Hypothesis 2 of this study was that the group with high scores of DO as compared with the group with low scores of DO would show less AB towards angry facial expressions. Hypothesis 3 of this study was that the AB would be more pronounced in the left visual field/right hemisphere. Neither the second nor the third hypotheses of this study could be confirmed.

The fact that all three statistical methods found similar results regarding the main effect of emotional face grant confidence in that this finding is robust and reliable. The interaction between DO and emotional face was found in only one of the approaches used. Therefore this finding is less robust and remains questionable. Unfortunately, the calculated probability of a type II error in detecting an interaction between DO and emotional face was as high as 50.3% when using the ±1.5IQR method. Considering this along with the medium effect sizes for the interaction between DO and emotional face observed in the ±1.5IQR and ±2SD methods as well as the trend towards significance in the ±1.5IQR method and the significance found when using the ±2SD method, does however suggest that it could be a real effect. However, this should be further investigated in future studies.

These results suggest that the healthy population does not have an AB towards threatening faces, but rather more so towards happy faces. These findings are contradictory to the suggestion that all humans have an innate bias towards negative stimuli as an evolutionary adaptive mechanism (MacLeod et al., 1986). However, the findings are in line with researchers who claim that the bias towards positive stimuli is more robust than the bias towards negative stimuli (Gupta et al., 2016). They are also in line with evidence showing that non-anxious people do not display a bias towards threatening stimuli (Bar-haim et al., 2007). They can also be interpreted as being consistent with the notion that the bias is determined through individual relevance (Pool et al., 2016), mediated through e.g., levels of psychopathology, goals and affective state, as the healthy population may in fact be more accustomed to derive important information from friendly than threatening encounters. This is supported by the results of the current study which clearly shows that participants high in DO, who may be conceptualized as finding relevance in future positive events, are the driving force in the main effect for emotional face.

In contrast to hypothesis 3, no significant evidence for a superiority of the left visual field was found. One possibility could be that the failure to reach significance was due to low statistical power. Unfortunately, there was not enough time to gather more participants for this study. A replication of this study with a larger sample size and increased statistical power is needed.

However, there may be several explanations for the lack of an effect for the visual field. One plausible explanation might be the differences observed between the sexes in the lateralization of emotion perception and processing (Bourne, 2005). It is well known that the brains of males are more lateralized in emotional processing than the brains of females are, and like previously discussed, this may explain why females have an advantage in the perception of emotions (Bourne, 2005). While females have an advantage in perceiving and processing emotions, the fact that they display less lateralization in these processes may explain why this sample did not show a left hemifield advantage. Moreover, in previous attentional bias studies that have examined the lateralization effect, the samples have consisted of both male and female participants. This may, in fact, be why there is a discrepancy in the findings of this study and previous literature. One interesting avenue for future research would be to conduct a similar study where both male and female participants are included. This way, differences in lateralization as well as differences in AB with respect to participant sex may be assessed. Another possibility for this discrepancy might be that the dot-probe detection task is not sensitive enough to detect the lateralization effect. However, this is unlikely to stand as an explanation on its own as this task has been used to detect such differences in previous studies (Fox, 2002; Mogg & Bradley, 1999; Brosch et al., 2007). Using a female only sample in combination with the dot-probe task, however, might be too crude a method to detect differences in visual field dominance.

The reason for using only female participants was, along with limited timeframe of the study and avoiding one more variable to control for, data suggesting that females are faster and better in emotion perception (Bourne, 2005). Since this study employed very short presentation time of emotional facial expressions, the sex which displays faster and better emotion perception seems like logical decision. While that may be the case, unfortunately this still leaves us unable to generalize this finding to the male population. It could be that there is no similar effect for the male population. This is highly unlikely however, as previous findings have not been conducted exclusively on female participants. An interesting research question in relation to gender differences is whether the emotional facial expression communicates, and affects the bias, differently to males and females if the person expressing it is male or female. That is, do males and females react differently to a facial expression based on whether the person expressing it is male or female.

One more issue worth discussing is the recognition rates of different emotional facial expressions. For happy facial expressions recognition rates were over 90%, there is therefore no need to be worried that participants interpreted the expression as some other emotion. Recognition for angry facial expressions was 72%, worse than for happy expressions, but acceptable. The recognition rates for neutral faces, however, were as low as 66%. After analyzing the mistakes, it was found that the most common incorrect identification of neutral facial expressions were to mistake them as depicting sadness. This was the case in close to 65% of the incorrect identifications of the neutral facial expressions. The second most common incorrect identification of neutral facial expressions were that the faces depicting anger (15%). Altogether, out of the incorrect identifications, 80% were emotional expressions that are commonly used as threat stimuli (Bar-haim et al., 2007). This could have confounded the results in a few ways. One problem arises when displaying an angry-neutral face pair. If both facial expressions are identified by the participant as threatening, the effect for each cue could cancel each other out. Another problem arises in the happy-neutral face pair. If the neutral facial expression was interpreted as threatening, it could be that part of the effect found for happy facial expressions is due to the fact that participants tended to avoid threatening stimuli. Another possibility is that participants attended towards threatening facial expressions and that this was cancelled out in the angry-neutral condition, and attenuated the effects found for happy facial expressions. However, the majority of participants did correctly recognize the facial expression as neutral and it is plausible that some of these assessments were judgements that participants felt less sure about and therefore guessed (some participants expressed difficulty in understanding the depicted emotions).

Future research should investigate whether a replication of this study with higher statistical power will find an interaction between DO and emotional faces. Furthermore, an interesting avenue is to add sex of the participant and of the person in the photograph, expressing the emotional facial expressions as independent variables. This way, any differences in the degree of lateralization in processing and perceiving of emotional faces could be detected. Furthermore, this grants the possibility of examining whether the sex of the person expressing the emotional facial expression interacts with the perceiver sex, in the fast acting autonomic way that the dot-probe task enforces. There is, for example, evidence that males respond more than females to threat cues from other males (Kret & De Gelder, 2012). Furthermore, as it is generally difficult to find differences in indirect measures of AB (i.e., RT differences) of unselected participants (Bar-Haim et al., 2007), future research should combine the method used in the present study with direct measures of attention, such as eye-tracking and ERP measurements. This provides benefits, such as providing data where one can relate and validate direct measures of attention (e.g., ERP results) with behavioral measures and this way, reveal the functional significance of ERP results to find the neural basis of AB.

The findings of the present study add to and support previous research in implying that there seems to be a fast operating mechanism of attention that favors positive rather than threatening facial stimuli. This can be inferred because of the short exposure time of the emotional facial expressions, as an exposure of 100 ms does not allow for top down processing (Theeuwes, 2010). Therefore, any effects within this timeframe reflect automatic, bottom-up effects. This seems to especially apply in people high in DO. Moreover, these findings alongside previous findings suggest that the tendency to allocate attention towards positive stimuli is much due to subcortical, preattentive processes that operate in a bottom-up manner and not just top-down mediated attentional strategies deployed. It is probable that, like Wadlinger and Isaacowitz (2010) suggest, these attentional effects will have an effect on behavior as well. That is, what is attended by an individual will possess a larger portion of that individuals mind and therefore it is likely to affect and direct future thought, choices and behavior. Because of this link, interesting avenues of research can emerge, e.g., possible therapy and coaching designed to develop attentional processes that are adaptive and appropriate for increasing psychological well-being. In fact, as discussed earlier, some efforts to manipulate the AB of individuals as a means to decrease ill-being have already been made in relation to the psychopathological population (Browning et al., 2012; Wadlinger & Isaacowitz, 2010) and to increase well being in the healthy population (Grafton et al., 2012). It is also plausible, although not certain, that interventions designed to increase DO will increase bias towards positive stimuli as well. Whether attentional bias modification towards positive stimuli can in turn also lead to the upward spiral that the broaden and build theory suggest is an interesting issue for future research (Garland et al., 2010). While threat detection indeed is important and adaptive for an organism (MacLeod et al., 1986), being able to learn, recode what is relevant to oneself and respond according to the demands of the current environment is also adaptive. For the healthy population, and perhaps it is interpreted as more so for the healthy population high in DO, attending towards positive stimuli, such as a happy facial expression can be of immense value, indicating possible positive interactions, bonding, and mating opportunities.

Conclusion

This study examined the differences between individuals high vs low in DO in their AB towards happy and angry facial expressions. It is the first study to investigate this association using the dot-probe detection task with short exposure of photographs of facial expressions. A general bias towards happy faces across all participants was detected. Also, a clear trend towards an interaction between DO and AB to emotional faces was found in the group high in DO displaying and AB towards happy facial expressions. This study implies that for the psychologically and neurologically healthy population, a fast operating and automatic AB for positive stimuli exists, moreover, this AB may be modulated by individual differences in DO.

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Appendix 1

List of Photographs Used (original filenames from Karolinska Directed Emotional Faces database)

Block	Emotional expression	Male	Female
Practice	Happy	M07HA	F04HA
		M08HA	F25HA
		M21HA	F26HA
	Angry	M07AN	F04AN
		M08AN	F25AN
		M21AN	F26AN
	Neutral	M08NE	F25NE
		M21NE	F26NE
		M07NE	F04NE
Experimental	Happy	F01HA	M06HA
		F02HA	M10HA
		F06HA	M11HA
		F07HA	M12HA
		F09HA	M13HA
		F13HA	M14HA
		F16HA	M16HA
		F19HA	M17HA
		F22HA	M18HA
		F23HA	M22HA
		F27HA	M24HA
		F29HA	M28HA
		F35HA	M30HA

Block	Emotional expression	Male	Female
Experimental	Angry	F01AN	M06AN
		F02AN	M10AN
		F06AN	M11AN
		F07AN	M12AN
		F09AN	M13AN
		F13AN	M14AN
		F16AN	M16AN
		F19AN	M17AN
		F22AN	M18AN
		F23AN	M22AN
		F27AN	M24AN
		F29AN	M28AN
		F35AN	M30AN
	Neutral	F01NE	M06NE
		F02NE	M10NE
		F06NE	M11NE
		F07NE	M12NE
		F09NE	M13NE
		F13NE	M14NE
		F16NE	M16NE
		F19NE	M17NE
		F22NE	M18NE
		F23NE	M22NE
		F27NE	M24NE
		F29NE	M28NE
		F35NE	M30NE