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# Impact of Expressive Intensity and Stimulus Location on Emotion Detection

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IMPACT OF EXPRESSIVE INTENSITY AND STIMULUS LOCATION ON  
EMOTION DETECTION

A Thesis  
Presented to  
The Faculty of the Department of Psychological Sciences  
Western Kentucky University  
Bowling Green, KY

In Partial Fulfillment  
Of the Requirements for the Degree  
Master of Science

By  
Brittany Nicole Groh

August 2017

IMPACT OF EXPRESSIVE INTENSITY AND STIMULUS LOCATION ON  
EMOTION DETECTION

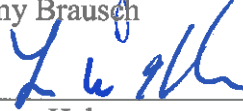
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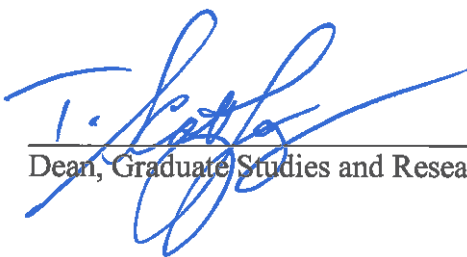
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6/30/17

Date

I dedicate this thesis to my parents, Mike and Wendy Groh, who always push me to do my best and to not give up on my aspirations.

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# IMPACT OF EXPRESSIVE INTENSITY AND STIMULUS LOCATION ON EMOTION DETECTION

Brittany Groh

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65 Pages

Directed by: Andrew Mienaltowski, Amy Brausch, and Lance Hahn

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Previous research demonstrates that the age of an observer, the peripheral location of a face stimulus on a display, and the intensity of the emotion expressed by the face all play a role in emotion perception. Older individuals have more difficulty identifying emotion in faces, especially at lower expressive intensities. The purpose of the current study was to understand how younger and older adults' abilities to detect emotion in facial stimuli presented in the periphery would be affected by the intensity of the emotional expressions and the distance that the expressions are presented away from the center of the display. The current study presented facial stimuli for a short duration to bypass reactionary attentional influences. More intense fearful and angry expressions were expected to be easier to classify for both younger and older adults than lower intensity expressions, but all expressions were expected to become more difficult to classify when presented further in the periphery. Older adults and younger adults displayed similar emotion detection for typical and extreme intensity angry expressions and for high intensity fearful expressions. However, older adults struggled to detect typical intensity fear, and this deficit grew with the angle of eccentricity from which the stimuli were presented from the center of the display. Possible explanations for these age differences are discussed.

*Keywords:* intensity, eccentricity, aging, facial expressions

## **Introduction**

Darwin (1998) considered fear to be an emotion that unites the community against danger by signaling when a threat is present in one's environment. Fear-evoking stimuli capture our attention, regardless of their location relative to our position, provided that they fall in our visual field. In addition to easily detecting threats that are directly in our central line of sight, our attention is also directed toward threats that emerge in our peripheral vision. Although we deploy our attention toward peripheral threatening stimuli, given the limitations of our visual system, we often have difficulty in instantly knowing what exactly the threat is. Another factor that must be examined is how this attention-capturing ability changes across the lifespan. Older adults tend to perform worse than younger adults at recognizing emotions, which may inhibit their ability to detect threatening situations as well as when these individuals were younger (Isaacowitz, et al., 2007; Orgeta & Phillips, 2008). That said, we still experience fear and react to protect ourselves from threat, but this may function differently across age.

When a threat takes the form of another human, that person is likely to be expressing an emotion. Sometimes attackers approach us within our central line of sight, but often they do not. When detecting emotions expressed by other humans in our periphery, we have more difficulty detecting the exact emotional state being expressed relative to when emoting others are centrally located in our visual field (Anderson, Mullen, & Hess, 1991; Rossion, Dricot, Goebel, & Busigny, 2011). When the location of a fearful face is manipulated within our peripheral vision, the further into the periphery a face is presented, the lower the accuracy of correctly detecting fear (Rigoulot, D'Hondt, Honorém, & Sequeire, 2012). Relative to emotion detection of facial stimuli presented

foveally, the accurate detection of emotion in the periphery is limited by a much smaller concentration of cone photoreceptors situated in the retina five degrees beyond the center of the foveal system (Schira, Tyler, Breakspear, & Spehar, 2009). In order to understand what is being seen, the brain, specifically the amygdala, plays a vital role in the ability of individuals to process various emotions within the visual field. The attention to salient emotional stimuli is guided by the amygdala when the stimuli are being unconsciously observed, which may occur when stimuli are presented in the periphery (Troiani, Price, & Schultz, 2014). Although an individual may not be oriented towards the stimulus, the fearful stimulus breaks through to conscious perception to be analyzed (Troiani et al., 2014).

### **Signals of Fear**

Fear-evoking stimuli usually emerge unexpectedly and under two conditions. First, fear can be perceived as we read fear in another being's face, which can in turn cause us to experience trepidation. Second, fear is experienced through the direct observation of stimuli that naturally evoke a fear-response, like a snake, spider, or angry human. The emotional information that is perceived when exposed to a fearful stimulus enhances our sensory experience of the stimulus to make it easier to stay focused on the threat (e.g., Phelps, Ling, & Carrasco, 2006). With respect to threatening humans or to humans who are themselves experiencing fear in our environment, their facial features (e.g., eye gaze direction, eye brow displacement, size of mouth opening, etc.) are analyzed for signs of threat (Calvo, Fernández-Martín, & Nummenmaa, 2014).

**Fearful Stimuli.** Stimuli evoke fear when they signal threat or the potential for pain and/or bodily harm to ourselves or those around us. Our reactions to such signals are

valuable to our survival; fear-evoking stimuli automatically capture our attention.

Öhman, Flykt, and Esteves (2001) found that individuals automatically identify a fearful stimulus in a background filled with neutral stimuli because the fearful stimulus draws our attention to it. Fear-evoking stimuli have a lower threshold for our perception because our sensory systems are biased toward investing more energy into their interpretation. Such perceptual biases are especially evident in people with phobias, as these individuals will automatically scan their surroundings for a feared stimulus. A fear of bugs, mice, snakes, and/or bats are also common and elicit fear responses (Davey et al., 1998).

**Fear in Faces.** Individuals respond to highly arousing negative facial expressions more readily compared to expressions that are not arousing (Compton, 2003). If an observer sees a fearful expression on an actor's face, the observer will wonder what made that actor fearful and may even be more attuned to aspects of his or her own environment where a fear-evoking stimulus may lurk (e.g., Adams et al., 2003). Detecting fear in an actor depends on the saliency of the emotional cues that signal the internal state of the actor. The ability of an observer to notice fearful cues varies as a function of the intensity of expression and the context in which the expression appears (Chiao et al., 2008; Righart & de Gelder, 2008). Context includes the social circumstances underlying the emergence of the facial expression as well as the location in which a fearful expression is made. Intensity of the emotion drives the saliency of cues because greater intensity yields more distinctive or exaggerated cues and removes any subtlety when judging the actor's emotional state. Of course, emotional saliency is impacted if an actor's expression is presented only quickly, is obstructed from view, or falls outside of the observer's line of sight.

Generally speaking, the regions of an actor's face that are used to communicate emotion vary given the emotion that the actor wishes to communicate. Researchers have examined location specificity of cues and often divide the face into two main regions. Emotions are reliably detected from the mouth and eye regions of static faces (Katsikitis, 1997; Nummenmaa & Calvo, 2015). In fact, cues used to detect emotions are often characterized as either having upper-face or lower-face dominance when describing where on the face observers look to judge emotion. The lower-facial region – which includes the lips, gums, and teeth of the mouth as well as the cheeks – is used to identify anger, disgust, and happiness, whereas the upper-facial region - which includes the eyes, the eye brows, the bridge of the nose, and the forehead - is used to identify surprise, fear, and sadness (Adolphs et al., 2005; Calvo, Beltrán, & Fernández-Martín, 2014; Katsikitis, 1997). In general, the distinctiveness of a specific facial feature, in either the upper- or lower-facial region, allows individuals to identify facial expressions from a single cue (Calvo et al., 2014b). This distinctiveness allows one to bypass a configural analysis of the face as a whole and as a result reduces processing time because fixation is solely on one feature (Calvo et al., 2014a). The uniqueness of certain facial features allows quick identification and processing of facial expressions.

Fear identification is sometimes regarded as an innate ability given that fearful expressions capture attention relatively automatically (Palermo & Rhodes, 2007) and that infants can detect fear from examining the sclera, or eye whites, of adults (Jessen & Grossmann, 2016). In the study, seven-month-old infants displayed greater sensitivity than did five-month old infants to fearful eyes compared to happy eyes. The authors propose that unconscious processing (e.g., visual enhancement of stimuli) emerges

between five and seven months of age. Although researchers cannot say that infants see fear, the results indicate that infants can tell the difference between happy and fearful emotion cues in the eye region of facial stimuli (Jessen & Grossmann, 2016; Vaish, Grossmann, & Woodward, 2008). In addition to the eyes in the upper-facial region, the eyebrows were also a key feature used to identify both fear and surprise. Raised and arched eyebrows tend to be more prominent to the viewer compared to the mouth in both fearful and surprised faces (Adolphs et al., 2005; Katsikitis, 1997).

**Fear and the Brain.** Various regions of the brain are activated when a fear-evoking stimulus is present (LeDoux, 2003). Activation in the brain to emotional stimuli often depends upon the exact stimulus presented and the context under which the stimulus is presented (e.g., emotion recognition, memory task, oddball task, etc.). There are two parallel pathways that process emotional stimuli. The first is the more traditional, but debated, cortical “high road” pathway that starts in the thalamic lateral geniculate nucleus continues through the striate cortex, and ends in the amygdala. This pathway is slow and is used for fine-grained stimuli evaluations (LeDoux, 1998). The intercommunication amongst the cortex, amygdala, and hippocampal and parahippocampal regions of the brain is considered to be the conventional pathway by which emotion influences stimulus processing (Pessoa & Adolphs, 2010). High spatial frequency information is used for fine visual shape and evokes more activity in this pathway compared to broad and low spatial frequency (Vuilleumier, Armony, Driver, & Dolan, 2003). This higher spatial frequency input has more detailed features that help with discrimination of stimuli. The second pathway is the subcortical “low road” pathway that goes from the superior colliculus to the thalamic pulvinar and to the amygdala, using

neural tracts that are capable of communicating at a speed that is faster than the conventional track (Cecere et al., 2013; Pessoa, 2013; Pessoa & Adolphs, 2010). This is used for fast, automatic, and nonconscious analysis of potentially threatening stimuli (Cecere et al., 2013; Pessoa, 2013). In Mendéz-Bértolo and colleagues (2016), human intracranial electrophysiological data were collected and amygdala reactivity to fearful faces was registered at ~70 ms. This suggests that the amygdala shifts attention to the fearful face more rapidly than other emotional faces, happy and neutral. When examining differences between broad, low-, and high-spatial frequency images, fast responses to fearful faces was evident in low-spatial frequency stimuli (Méndez-Bértolo et al., 2016). It is more broadly understood that the subcortical emotional processing pathway has greater evidence supporting the rapid speed of processing of information compared to the cortical high road. Clearly, though, both pathways are important for interpreting the nature of a threatening individual in one's environment, including that person's social intentions.

Fear links stimuli to patterns of behavior through hastened neuronal responses. For instance, behavioral patterns have been linked to the amygdala. The basolateral amygdala receives the majority of the sensory inputs that are linked to fear, with the exception of the olfactory system (Adolphs, 2013). Following the detection, breakdown, and processing of features of the stimuli, the central nucleus of the amygdala regulates fear responses. The context-dependency of fear is examined through certain circumstances, the type of threat, the distance to the threat, and the time elapsed since a threat was encountered (Adolphs, 2013). Fearful faces evoke stronger neural activity than neutral ones (Pessoa, 2013). The central amygdala plays an important role in mediating

the projections to the brainstem and hypothalamus, which is used to coordinate behavioral, autonomic, and neuroendocrine responses.

The amygdala becomes activated and serves to enhance our perception of emotional stimuli, especially faces (Adolphs, 2008; Pichon, de Gelder, & Grezes, 2009; Rahko et al., 2010; Vuilleumier et al., 2003). This structure shifts attention to salient emotional stimuli, even when unconsciously aware of the stimuli (Troiani et al., 2014). The amygdala and interconnected areas, including the orbital frontal cortex, assess the value of sensory events and boost processing, thus allowing individuals to respond quickly to potential threats (Pourtois, Schettino, & Vuilleumier, 2013). This is most apparent when viewing faces in foveal regions compared to centrally presented non-face threatening stimuli (Almeida, Soares, & Castelo-Branco, 2015). In addition to activations in the amygdala, the fusiform gyrus focuses on the broad category of faces in both centrally and peripherally displayed faces (Almeida, van Asselen, & Castelo-Branco, 2013).

In addition to the amygdala, the hippocampus and parahippocampal gyrus are activated more strongly by fearful and happy faces compared to other emotional stimuli when presented centrally (Rahko et al., 2010). These two structures are associated with memory encoding and retrieval, so greater activation for the hippocampus and parahippocampal gyrus may be linked with the facilitation of the memory for the features of the emotional stimuli, including their location and their importance to our own existence. The pulvinar is increasingly viewed as an attentional guidance system and high level visual processing system that may regulate information transfer for automatic and pre-attentive processes (Almeida et al., 2015). More research is needed to confirm the existence of this track, but, if it does exist, it will provide additional support for the



premise that emotional features of stimuli, especially those that may be threatening, receive processing priority to enhance stimulus perception and to amplify our reaction to emotionally evocative stimuli. The pulvinar tends to guide the attention and processing to the displayed emotional stimuli (Almeida et al., 2013).

In general, stronger activation in the brain can be viewed as a signal that something important and possibly life-threatening is happening in the observer's environment. If the stimulus is fear-evoking, sub-cortical and cortical pathways converge to facilitate the rapid detection of the stimulus, even in peripheral views. The amygdala is arguably one of the most important structures as it is an integral structure in threat assessment and emotional processing.

### **Capturing Attention: Peripheral Vision**

As mentioned, emotional stimuli capture our attention, including stimuli that fall in our peripheral field of view. The ability to detect emotion cues outside the foveal region of our visual field is considered to be a defense mechanism meant to protect us from threat. Arousing emotional faces can be more easily detected in our periphery than non-arousing faces (Bayle, Schoendorff, Hénaff, & Krolak-Salmon, 2011; Rigoulot et al., 2011). For example, when participants were asked to determine whether or not a peripherally presented face stimulus expressed emotion, the ability to detect fear was less affected by the distance into the periphery than other negative emotions (Bayle et al., 2011).

Of course, the perception of emotional information in our periphery does have some limits given the perceptual limits that we all experience due to the structure of the eye and how images are projected onto the retina. Cone photoreceptors are used for

decoding the finer details of images, like facial cues that reveal the emotional states of others. The center of the fovea has the highest cone density of any region of the retina (Lindsay & Norman, 1977); however, the parafoveal and peripheral regions of the retina have substantially fewer cone cells. As a result, as a stimulus moves further out into the periphery, there is a reduction in discriminability of facial features and visual acuity (Anderson et al. 1991; Rossion et al., 2011). To counteract this reduction and to make it more likely that an observer will correctly identify a stimulus, for images presented further out into the periphery, the features need to have a higher contrast conveying the emotional content of the image (Rossion et al., 2011). The reduced cone density of peripheral regions of the retina affects chromatic and achromatic acuity by reducing the clarity of individual features. This decline in acuity suggests that emotion detection might be less difficult when the features of the image that communicate emotion are more distinctive (e.g., wide eyes or open mouth), which is usually the case when emotional expressions are more intense.

**Crowding.** The effect that clutter has on the discriminability of features of an object in the periphery is described as crowding (Whitney & Levi, 2011). To counteract the effects of crowding, the visual system filters the stimuli to better define the contours of facial features to aid in the identification of the stimulus being presented (Hess & Dakin, 1997). The high contrast between the eyes and skin around the eyes results from more defined contours allowing the individual to see the boundaries within the facial features and to see those features with more accuracy as the eccentricity increases. Crowding is normally studied by presenting a stimulus in a scene where it is either closely surrounded by other objects or not closely surrounded. The detection of an object

may not be hindered by crowding if the stimulus can be seen due to its high contrast, but the identification of the object is impaired because it is being surrounded, or crowded, by distractors and the individual objects are indistinct or jumbled (Whitney & Levi, 2011). With respect to facial stimuli, observers have a reduced ability to accurately identify the object or face being presented in the periphery. The use of higher contrast stimuli with more salient facial features, such as the eyes and mouth, may reduce the problem in object identification and feature integration introduced by crowding around the stimulus (Mermillod et al., 2008; Nummenmaa & Calvo, 2015). Facial expressions are identified with varying accuracies based on contrast, crowding, and the angle of eccentricity, or the distance the stimulus is presented from the focal point.

**Distinctiveness.** Emotion recognition is dependent upon how salient the facial cues are when an actor is expressing emotion. The more salient the facial cues are to the observer, the less difficulty the observer will have in determining what the actor is feeling. Saliency is defined as the visual prominence of stimuli compared to their surroundings (Calvo et al., 2014a). With respect to emotional salience, greater salience stems from more visible cues and greater certainty in the interpretation of those cues (Calvo et al., 2014b). Recognizing discrete emotions usually requires one to focus on a number of regions of an actor's face. When we express discrete emotions, like fear or anger, our facial muscles reposition our eyes, eyebrows, nose, mouth, chin, forehead, and ears to communicate what we are feeling. For happiness, a broad smile is the distinctive feature that allows an observer to quickly identify the actor's emotional state (Calvo et al., 2014a). Although the mouth is the most salient with happy faces, the eyes also communicate the actor's feelings. The eyes become more squinted and close slightly

more with happy faces compared to neutral and fearful faces (Jessen & Grossmann, 2016). To communicate fear, our eyes widen and our eyebrows rise above their normal position, wrinkling the forehead. In addition to the speed of identifying happy expressions, the accuracy of this identification is greater when the stimulus appears in both central and peripheral locations of our visual field compared to other emotions (Calvo et al., 2014a). As a result, highly distinctive stimuli, such as smiles of happy faces, are less affected by being presented further into the periphery (i.e., at larger angles of eccentricity from the center of the display). Fear on a face can be identified through enlarged eye-whites that capture the attention of observers, thus increasing the distinctiveness of the stimulus. Also, more salient eye-whites increase the visual angle over which fear cues can be observed (Carson & Reinke, 2014; Susskind, Lee, Cusi, Feiman, Grabski, & Anderson, 2008). Distinctiveness of stimuli, specifically the eye-whites for fearful expressions, are important in identifying fearful expressions.

### **Age and Emotion Detection**

One of the main objectives of the current study is to compare younger and older adults on their ability to detect peripheral emotional expressions. Prior research on age differences in emotion recognition notes that older adults perform worse than younger adults at recognizing emotions (Isaacowitz et al., 2007; Orgeta & Phillips, 2008). Older adults usually have more difficulty discriminating between negative emotional expressions than do younger adults when the expressions convey emotions at low intensity (Mienaltowski et al., 2013; Orgeta & Phillips, 2008). At lower intensities, facial cues are less salient, and this lack of salience contributes to older adults' difficulty in detecting differences between fear and other negative emotions (e.g., anger and sadness)

(Mienaltowski et al., 2013). It is also inferred that older adults may be impaired in everyday social interactions due to the reduced ability to differentiate low-intensity emotions from higher intensity emotions (Orgeta & Phillips, 2008).

For the current study, the aforementioned age differences in emotion recognition were expected to be exacerbated by the presentation of emotional face stimuli in the periphery because aging is associated with impairments in peripheral vision. The useful field of view (UFOV), or the region of visual space from which an individual can extract information at any given time, deteriorates as individuals age, beginning around 20 years of age (Sekuler, Bennett, & Mamelak, 1999). This deterioration can be better described as a decrease in the efficiency of extracting information rather than shrinkage of one's visual field (Sekuler et al., 1999). However, this deterioration can be temporarily reversed with practice (Ball, Beard, Roenker, Miller, & Griggs, 1988). As a result of changes in the UFOV, older adults are outperformed by younger adults while identifying targets in peripheral vision. Older adults also tend to have more difficulty identifying targets in situations with clutter (Ball et al., 1988). Cluttered scenes contain more information that individuals must sort through in order to identify what is being asked.

In addition to changes in the UFOV, motivationally speaking, older and younger adults have different preferences when examining emotional stimuli. It has been suggested that older adults attend to positive stimuli more than to negative stimuli, whereas younger adults show no preference or possibly show a bias toward negative stimuli (Carstensen, 2006). Socioemotional selectivity theory has been used to account for this age-related difference and claims that, with advancing age, individuals shift away from future-oriented goals to the present-oriented goal of regulating emotional states and

feeling good (Murphy & Isaacowitz, 2008). Support for socioemotional selectivity theory lies in a number of studies that examine partner preferences across the adult life span (Carstensen, 2006); however, at a more micro-processing level, the theory has also been supported by studies examining age differences in emotion recognition and attentional preferences for emotional stimuli. For instance, older adults have difficulty attending to negative emotional cues and show weaker negativity preferences than do younger adults during emotion recognition paradigms (Murphy & Isaacowitz, 2008). This means that older adults seek more positive stimuli and reject more negative stimuli (Nashiro, Sakaki, & Mather, 2011). Because attentional preferences such as these are driven by controlled processing, observed age differences are characterized as an intentional product of where younger and older adults invest their cognitive resources.

More recently, a cognitive control hypothesis has been advanced to argue that older adults focus greater effort on regulating emotion than do younger adults (Nashiro et al., 2011). Given the natural tendency to ignore or avoid negativity, age differences in emotion detection might also emerge because older adults have added difficulty in labeling negative facial expressions of emotion relative to younger adults (Orgeta & Phillips, 2008). Likewise, the attentional bias away from negativity that accompanies age may contribute to older adults' tendency to report that emotional faces portray less intensity than is reported by younger adults. Older adults would rather examine positive emotions compared to negative emotions, and they tend to prioritize emotion regulatory goals over other goals. In studies like the current one, it is unclear if such goals can impact emotion detection, as participants are specifically asked to interpret facial emotion

in order to classify the stimuli and the stimuli are presented at a rate that is too fast to support a controlled suppression of negativity.

As opposed to the positivity effect, younger adults tend to have a negativity bias. Negative events tend to be more salient, dominant in combinations of positive and negative stimuli, and are more striking than positive events (Rozin & Royzman, 2001). In other words, the features of stimuli in negative events are greater and more salient than that of positive events. On average, positive events occur more frequently than negative events which may allow individuals to be more watchful for dangerous negative events due to the increased rarity of their occurrence compared to frequent positive events (Rozin & Royzman, 2001). When asked to search a crowd for an angry face, reaction times were much faster compared to when searching for a happy face. This can be described as a “pop-out” effect for angry faces, as this is a search for potential threats (Öhman, Lundqvist, & Esteves, 2001). Although older adults do show this same “pop out” effect, the magnitude of the effect is much less than that of younger adults (Mather & Knight, 2006). For younger adults, physiological arousal is also greater for negative events compared to their positive counterparts suggesting that these events may result in greater attention due to this arousal that is not as evident in positive events (Compton, 2003; Rozin & Royzman, 2001). As a result, younger adults tend to be more sensitive to negative stimuli, therefore focusing more on negative emotional stimuli, such as fearful and angry expressions (Vaish et al. 2008). This bias may be due to an evolutionary adaptation in which individuals are able to avoid potentially harmful situations because of the sensitivity to negative stimuli. This bias allows us to respond more strongly to negative stimuli, in hopes of responding to the situation as accurately as possible. As we

age, the negativity bias gets smaller and may even reverse to become a bias toward positivity (Kisley, Wood, & Burrows, 2007).

### **Current Study**

Fear-evoking stimuli capture our attention, as our brain, specifically the amygdala, is designed to detect fear quickly and unconsciously. Although fear detection is affected by the location in our visual field that a fearful face is presented, it is impacted less so than are other emotions, such as disgust (Bayle et al., 2011). Also, the speed and accuracy of emotion identification is impacted by the expressive intensity of the emotion portrayed on facial stimuli. Moreover, if facial cues for emotion are salient, such as the eyes for fearful expressions, emotion identification is faster and more accurate. The current study examined younger and older adults' ability to detect fearful and angry facial expressions of varying intensities at multiple locations in the visual field. Although studies (i.e. Isaacowitz et al., 2007) examining age differences in emotion recognition have been performed in the past, there is no existing research on age differences in peripheral emotion detection. Older adults were expected to have more difficulty than younger adults with peripheral emotion detection. The current study focused on emotion detection using fearful and angry expressions. Anger in others can commonly elicit fear in an observer and thus serves as a more indirect assessment of the impact of aging on fear detection. Emotional faces were presented one at a time at a range of distances from the center of the display (5°, 10°, or 15° to the left or right of a central fixation point), and participants were asked to indicate if the facial stimuli were emotional or neutral. Emotion detection performance and response time were assessed for participants at each angle of eccentricity that stimuli were presented on the left and right sides of the display.



## **Hypotheses**

There were several hypotheses proposed for this study. First, younger adults were expected to, on average, display greater emotion detection ability than older adults for both the fearful/neutral emotion detection task and the angry/neutral emotion detection task. Second, this age difference was expected to vary as a function of the intensity of the expression, such that younger and older adults' emotion detection performances would be more similar at high intensities than at low intensities. Third, as the degree of eccentricity at which the facial stimuli were presented away from the center of the display increased, emotion detection was expected to decline for both younger and older adults. Fourth, this decline associated with increasing eccentricity was expected to be larger for lower intensity emotional faces than for higher intensity emotional faces. Finally, decline in emotion detection ability due to eccentricity is expected to be larger for lower intensity for older adults than for younger adults. Although additional dependent measures were gathered during the participants' behavioral responses to the facial stimuli (e.g., response time and response bias), no specific predictions were made with respect to the impact of the independent variables on these additional measures.

## **Method**

### **Participants**

A total of 43 younger adults participated in the study, but four of these participants were dropped due to non-compliance (2), due to strategically focusing on the left side of the screen instead of on the fixation point (1), or due to a group assignment error (1). There were a total of 42 older adults that participated in the study, but two were dropped due to non-compliance (1) or due to a change in the protocol of the experiment

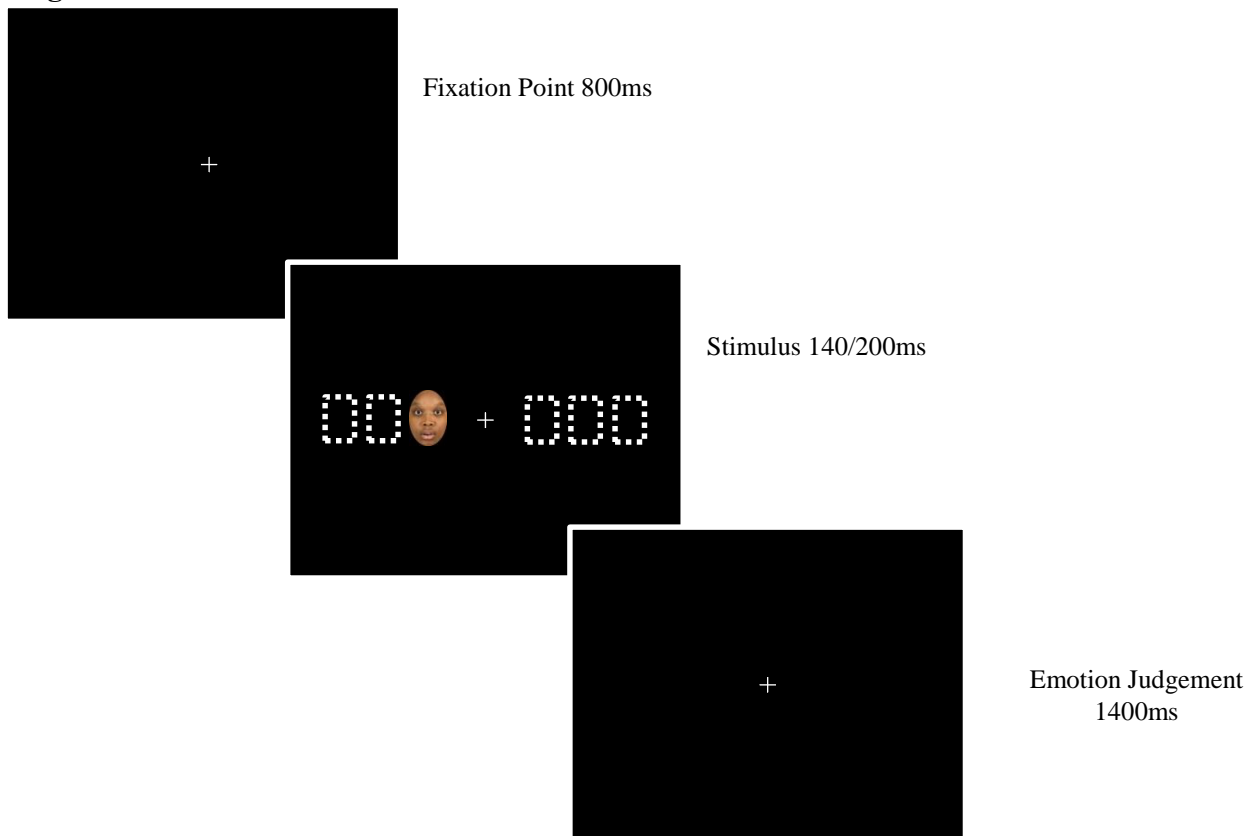
(1). The remaining sample included 39 younger adults, age 18 to 26 ( $M = 19.6$ ,  $SD = 1.9$ ), and 40 older adults, age 62 to 79 ( $M = 70.7$ ,  $SD = 4.7$ ). Younger adults were recruited from Western Kentucky University's Study Board participant pool, and older adults were recruited from the Bowling Green community via a recruitment mailing sent using random selection from voter registration data and cold calling previous participants of the Department of Psychological Sciences. Members of the community were screened for mild cognitive impairment using the Mini-Mental Status Exam (Folstein, Folstein, & McHugh, 1975) prior to participation. A passing score of 17 out of 21 points was required for participation ( $M = 20.4$ ,  $SD = 0.8$ ). No participants were dropped due to a failing score.

## **Materials**

**Peripheral Emotion Detection Task.** Participants were presented with emotional and neutral facial stimuli at six different locations along the horizontal axis of a computer monitor  $-15^\circ$ ,  $-10^\circ$ ,  $-5^\circ$ ,  $+5^\circ$ ,  $+10^\circ$ , and  $+15^\circ$  from a central fixation cross. Negative eccentricities indicate the location of the stimulus was on the left side of the focal point and the positive eccentricities indicate the stimulus was on the right side. Participants completed either a task utilizing neutral and fearful expressions (fearful/neutral task) or a task utilizing neutral and angry expressions (angry/neutral task). In total, there were 768 trials per task: 128 trials for each location, with 64 neutral trials and 64 emotional trials. The 64 emotional trials were further broken down into 32 extreme expressions and 32 typical expressions. The stimuli used in this task are described below.

Within each trial, a fixation point appeared on the screen for 800 ms and then the facial stimulus appeared for 140 ms for younger adults and 200 ms for older adults (Figure 1). The stimulus duration was selected to minimize the possibility that participants would move their eyes from the fixation cross to the stimulus image. Adults age 20 to 40 require approximately 250 ms ( $SD \approx 40$  ms) to fixate on a new location, whereas adults age 60 to 69 require approximately 342 ms ( $SD \approx 64$  ms) to refixate (Carter, Obler, Woodward, & Albert, 1983). Different stimulus durations (i.e., just below 2SDs from mean of age group) were used for the younger and older adult samples to reduce any benefit of eye movements towards the target facial stimuli. After the face stimulus disappeared from the display, participants were given as long as 1400 ms to

**Figure 1**



respond before the computer registered no response. Participants indicated whether the presented face was emotional or neutral. Response keys (1 = emotional, 3 = neutral) were assigned on the keyboard for the entirety of the session to minimize errors. On any given trial, emotional and neutral trials were equally likely to appear. Trials were presented on an ASUS VG248QE 24 inch full HD 1920x1080 monitor from which participants were seated 57.3 cm (1 cm = 1° visual angle) using E-Prime stimulus presentation software. The refresh rate of the monitor was set to 100 Hz to allow for stimulus control at 10 ms increments.

Each task was designed so that trials were blocked by expressive intensity, and the order of the expressive intensity was counterbalanced by participant (i.e., typical/extreme or extreme/typical). Participants completed 128 trials per block with stimulus location randomly assigned across the three consecutive blocks of each expressive intensity. Participant accuracy data were converted into hit rates and false alarm rates for each condition (task by location by intensity) so that emotion detection could be assessed using d-prime values and that response bias (c) could be calculated. More information on the calculations for d-prime and c are provided in the results section.

***Emotional Facial Stimuli.*** Fearful, angry, and neutral facial stimuli were selected from the Chicago Face Database (<http://www.chicagofaces.org/>) to use in this study. Two pilot studies were performed to reduce the overall sample of possible stimuli to 4 male and 4 female targets expressing extreme emotion and typical emotion. In the pilot study, participants viewed extreme (100% expressivity) and morphed (70% expressivity/30% neutral) facial stimuli in Qualtrics and were asked to what extent each

face expressed anger, disgust, fear, happiness, sadness, and surprise on a five-point Likert scale (5 = a great deal, 4 = a lot, 3 = a moderate amount, 2 = a little, and 1 = none at all. Data from the first pilot study showed that participants were unable to discriminate between the extreme and morphed emotional expressions. The face stimuli were morphed a second time for another pilot study. Typical expressivity was operationalized as an equal mix (50%) of the neutral and emotional images of a given target for both angry and fearful expressions. Again, participants rated each stimulus on the same five-point Likert scale. Stimuli were selected based on the participant-rated intensity of the angry and fearful stimuli. The four male and female targets selected for the angry/neutral task possessed typical and extreme angry expressions that differed from one another in participant-rated intensity. Unfortunately, participants provided similar ratings for the typical and extreme fearful expressions used in the fearful/neutral task. Consequently, for this study, after completing the emotion detection task, participants completed a central emotion task in which they compared the typical and extreme version of each target's emotional expression and also rated the intensity of each emotional facial expression included in the version of the emotion detection task that they completed.

***Centrally-Presented Emotion Recognition Task.*** Participants were asked to provide two judgments relative to each target expression used in the current study. First, the two images of each target expressing the same emotion at different intensities were displayed side-by-side on the monitor and participants were asked to determine which face, the left or the right, expressed the most intense emotion. Participants made one judgment for each target, for eight total judgments. Second, participants were asked to rate each emotional face stimulus using this question, "To what extent does this image

display fear (anger)?" using a five-point scale. (1 (none at all), 2 (a little), 3 (a moderate amount), 4 (a lot), and 5 (a great deal). Participants rated each stimulus twice, for a total of 32 trials. Stimuli were presented in random order and participants were given as much time as needed to respond on each trial. Averages of intensity opinion were calculated for each of the two stimulus types (i.e., extreme and typical angry and extreme and typical fear) viewed by each participant, depending on condition.

**Individual Difference Measures.** In addition to the primary experimental task of interest, participants completed a number of individual difference measures that were not directly relevant to the study's hypotheses but which are important for investigating some of the demographic characteristics of the younger and older adult samples. Each of these tests is described below. Internal consistencies for these measures are reported later in the results section. Participant performance on these tests is useful for comparing the samples from the current study to those of other studies that examine emotion processing in the aging literature.

***Colenbrander Visual Acuity Test- Central and Peripheral.*** Participants stood 1 meter from a chart of letters in which the size of the letters varied in each row. Their job was to read the letters in each row when prompted by the experimenter. Participants completed both a peripheral acuity assessment and a central acuity assessment. For the peripheral assessment, a piece of manila folder with several strategically placed and differently sized boxes cut out was positioned over a letter in a row reflecting the worst acuity. Following the response, if correct, it was repositioned to a more challenging acuity level. If incorrectly identified, the test would move to the next closest position to 0°, or the center of the display. This test started on the left -15° and then proceeded to -

10° and on to -5°. Participants were then asked to complete a central vision task in which they read the letters from as many rows as possible while viewing the chart in the center of their visual field. The final part of the visual acuity task was to repeat the peripheral test on the right side of the visual field, starting at +15°. Acuity was recorded in terms of the logarithm of the minimum angle of resolution. The test-retest reliability ranges from 0.72-0.84 (Colenbrander, 1988; Siderov & Tiu, 1999).

***Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) Scale.***

The BIS/BAS is a 24-item measure (see Appendix A) of motivation (Carver & White, 1994) that can be subdivided into four factors (test-retest reliability): BIS (0.66), BAS Drive (0.66), BAS Reward Responsiveness (0.59), and BAS Fun Seeking (0.69). The BIS measures sensitivity to punishment-related cues in one's environment and the anticipation of such an event occurring. The BAS subfactors measure sensitivity to various aspects of cues of positive affect. Items relating to BAS drive indicate an individual's desire to and directed pursuit to attain their goals. BAS fun seeking indicates an individual's willingness to try novel activities and events, some of which are impulsive, in hopes of attaining new rewards. The final subfactor, BAS reward responsiveness, focuses on the individual's attention to the reward for action or any potential for a positive outcome following the action (Carver & White, 1994). For each item, participants indicated how true each item was of them using a four-point Likert scale ranging from 1 = very true for me to 4 = very false for me. For example, one statement reads, "I go out of my way to get things I want." Scores were calculated for each of the subscales by adding up a total number for the ratings provided.

***Center for Epidemiological Studies Depression Scale (CES-D).*** The CES-D (see Appendix B) is a 20-item depression screen used to identify depressive symptomatology in both adults and adolescents (Radloff, 1977). Participants used a 4-point rating scale to indicate the degree to which they have displayed depression symptoms over the past week (e.g., 1 = rarely or none of the time versus 4 = all of the time, 5-7 days). For example, one item is described as follows. “During the past week, I did not feel like eating. My appetite was poor.” Scores for this depression screen range from 20 to 80 (CESD-R, n.d.). When developed, the CES-D demonstrated an internal consistency of 0.88-0.91 and a test-retest reliability of 0.87 (Radloff, 1977).

***Finding A’s Test.*** Participants locate words that contain the letter “a” in five columns on each of five pages. Each column has 5 words containing the letter “a,” and participants are given two minutes to find these words on as many of the pages as possible. The test measures perceptual speed, and has a test-retest reliability of .82 (Ekstrom et al., 1976).

***Advanced Vocabulary Test.*** This test of verbal ability requires participants to identify which of five possible foil words is most similar in meaning to a target word (Ekstrom et al., 1976). The test consists of 36 items and has a test-retest reliability of 0.93. The test has two pages with 18 items on each page. Participants are given four minutes to complete each page.

***Demographics questionnaire.*** The demographics questionnaire was used to understand our participant pool and the extent to which the study’s findings might generalize to other universities and communities in the United States. Items in the questionnaire requested responses in regards to the participants’ age, ethnic background,



religious beliefs, level of education, subjective physical health, uncorrected perceptual deficits, and psychopathologies, and is meant to be for descriptive purposes only (See Appendix C).

***Telephone Mini Mental Status Exam.*** This dementia screen is a telephone version of the Mini Mental Status Exam (Folstein, Folstein, & McHugh, 1975) and has a test-retest reliability of 0.80 to 0.95 (Tombaugh & McIntyre, 1992). It includes a number of items that examine the participants' orientation to time and place, memory, attention, and language comprehension. Scores for a healthy older adult are at least 17 out of a possible 21. A score below 17 indicates an increased risk for mild cognitive impairment, so individuals who score below 17 are excluded from participation in the study. Prior to being scheduled for an experimental session, older participants consented to completing this screen over the telephone. Individual scores were recorded for each participant but were not linked to the data collected during the experimental session. Dementia screens are commonly used to ensure that participants are healthy and should be able to complete experimental task without much frustration or difficulty.

## **Procedure**

Upon arrival to the lab, the study was described to the participants, and the participants were asked to provide their informed consent (see Appendix D). Next, participants completed the expanded Colenbrander Visual Acuity test which included a test of peripheral vision and then participants were prepared for the computer-based emotion detection task. For this task, the stimuli were presented through E-Prime (pstnet.com) and the participants completed each block of trials. Participants were instructed to respond as quickly and accurately as possible to each stimulus when

prompted. The experimenter answered any questions and then the task began. Between each block, participants took a break if desired. At the conclusion of the emotion detection task, participants were presented with the emotional faces of each target used in the study and asked to indicate which image was more intense and how intense each individual image appeared. Following these tasks, participants completed the BIS/BAS scale, the CES-D (Feelings Scale), Finding A's Speed of Processing Test, the Advanced Vocabulary Test, and the demographics questionnaire. Once all of the tasks were completed, participants were thanked for their participation, debriefed, and compensated. Younger adults were compensated with 8 credits for their psychology course, and older adults were given a \$20 gift card.

## **Results**

### **Comparisons on Individual Difference Measures**

Demographic data were collected from the 39 younger adult (22 females and 17 males) and the 40 older adult (20 females and 20 males) participants. Younger and older adults' mean individual difference data are reported in Table 1. In terms of assignment to experimental conditions, there were a total of 40 participants in the fear condition (fearful/neutral task) with 20 in each age group, and there were a total of 39 participants in the anger condition (angry/neutral task) with 19 younger adults and 20 older adults.

Independent samples t-tests were conducted to compare younger and older adults on each of the individual difference measures; t-test outcomes with effect size and the internal consistency of the measures are reported in Table 1. Younger adults reported a greater drive to seek desired outcomes (BAS Drive) and to seek fun (BAS Fun Seeking) than did older adults, but younger and older adults did not differ in their reward

responsiveness (BAS Reward) or in their tendency to inhibit reactions to situations with unpleasant outcomes (BIS). Past studies using the BIS/BAS have been limited to younger adult samples, but the findings are consistent with the literature reviewed earlier on age differences in socioemotional goals. Older adults outperformed younger adults on the vocabulary test, but younger and older adults did not differ from one another on the Finding A's assessment of processing speed. Younger adults reported more symptoms on the CES-D depression scale than did older adults. The correlation matrix for these measures are reported in Table 2 separately for younger and older adults.

Table 1

*Individual Differences*

Measure	Mean (SD)		t(df) =	p	Cohen's	
	YA	OA			d	$\alpha$
BAS Drive	11.77 (2.15)	9.65 (2.92)	3.66 (77)	< .001*	.83	0.85
BAS Fun Seeking	12.31 (2.12)	10.28 (1.99)	4.40 (77)	< .001*	.99	0.60
BAS Reward	17.72 (1.86)	16.95 (1.99)	1.77 (77)	.08	.40	0.65
BIS	20.85 (3.56)	19.83 (3.17)	1.35 (77)	.18	0.30	0.69
Finding A	26.21 (10.90)	24.75 (8.06)	.68 (77)	.50	0.15	0.74
Vocab Test	14.45 (4.27)	21.93 (6.19)	-6.25 (77)	< .001*	-1.41	0.87
CES-D	16.59 (10.08)	8.03 (6.44)	4.51 (77)	< .001*	1.02	0.90
Central Visual Acuity	.02 (.25)	.15 (.23)	-2.50 (77)	.02*	.57	N/A

\*indicates significant at  $p < .05$

Table 2

*Individual Differences Correlation Matrix*

	BAS Drive	BAS Fun Seeking	BAS Reward	BIS	Finding A	Vocab	CES-D	Vision
BAS Drive	1	.512*	.337*	-.079	-.097	-.068	-.058	.039
BAS Fun Seeking	.433*	1	.322*	-.175	.054	-.215	-.003	.051
BAS Reward	.418*	.136	1	.194	-.090	-.272	.082	.022

BIS	-.263	-.126	.144	1	-.206	-.134	.513*	.127
Finding A	-.121	-.184	.009	.270	1	.329*	-.057	.260
Vocab	-.175	-.132	-.063	.017	.203	1	.111	.181
CES-D	-.065	.052	-.086	.343*	-.031	-.038	1	.249
Central Visual Acuity	.079	-.019	.071	.090	.298	.069	.044	1

Note: \*  $p < .05$ ; Younger adults' correlations are reported below the diagonal and older adults' correlations are reported above the diagonal.

Visual acuity was assessed using both a standard central presentation and a peripheral presentation of a Colenbrander acuity chart. Older adults performed worse than younger adults. Differences across eccentricity are provided in Table 3. A mixed-model ANOVA was conducted to examine the impact of location and age on log MAR values. Main effects of age,  $F(1, 77) = 6.369, p = .014, \eta_p^2 = .076$ , and location,  $F(1, 462) = 183.447, p < .001, \eta_p^2 = .704$ , were qualified by a location  $\times$  age interaction,  $F(6, 462) = 8.351, p < .001, \eta_p^2 = .098$ . Participants had greater visual acuity at the central location ( $0^\circ$ ) with younger adults declining faster than older adults because they started at a higher level of acuity (Table 3). Younger adults had higher acuity than older adults at every peripheral location in the visual field.

Table 3

*Vision Acuity Descriptives*

Eccentricity	Younger		Older	
	Mean	SE	Mean	SE
-15°	.96	.02	.89	.02
-10°	.89	.03	.81	.03
-5°	.71	.05	.48	.05
Center ( $0^\circ$ )	.02	.04	.15	.04
+5°	.66	.05	.47	.05
+10°	.81	.04	.64	.04
+15°	.90	.04	.79	.04

## Stimulus Validation

Participants were asked to indicate which of two faces were most intense for each target expressing emotion in the emotion detection task to which they were assigned. In the fearful condition, participants correctly identified the high intensity image 96.2% of the time on average. This is 3.50 standard deviations greater than chance (50%),  $t(39) = 22.251, p < .001$ . In the angry condition, participants correctly identified the high intensity image 95.6% of the time on average. This is 3.26 standard deviations greater than chance,  $t(38) = 20.393, p < .001$ . Participants perceived the difference in intensity in each condition.

In addition to the above, participants were asked to rate the extent to which each image expressed the condition specific discrete emotion (fear, anger) on a scale of 1-5. In the fearful condition, participants reported the intensity of the low intensity images ( $M = 2.36, SD = .56$ ) to be significantly less than that of high intensity images ( $M = 3.69, SD = .54$ ),  $t(39) = 18.866, p < .001, d = 2.98$ . Likewise in the anger condition, participants reported the intensity of the low intensity images ( $M = 2.05, SD = .36$ ) to be significantly less than that of the high intensity images ( $M = 3.38, SD = .53$ ),  $t(38) = 16.951, p < .001, d = 2.71$ .

## Emotion Detection Task

All data collected using *E-Prime* were processed and analyzed using SPSS.  $D'$ ,  $c$ , and response time values were submitted to mixed-model, multi-factorial ANOVAs (described below). Omnibus ANOVAs were conducted first and then followed up with additional ANOVAs to decompose interactions. All analyses were conducted at an  $\alpha =$

.05 level, post-hoc tests were performed where necessary using least-significant difference tests.

**Discrimination Sensitivity ( $d'$ ).** When examining the ability for participants to detect emotion on face stimuli, participants are limited to two choices. Responses to emotional faces and neutral faces are converted into a single sensitivity value ( $d'$ ) that indicates if participants are able to discriminate between these two options (Macmillan & Creelman, 2004, pp. 3-25). The formula for  $d'$  is  $d' = Z(\text{hit rate}) - Z(\text{false alarm rate})$ . The hit rate and false alarm rate for each condition is calculated and then normalized to that they can be compared using the sensitivity  $d'$  formula. A high sensitivity value indicates the participant is able to discriminate between emotional and neutral expressions well, but a low sensitivity value indicates that a participant is less able to discriminate between emotional and neutral facial stimuli. A perfectly sensitive individual would have a hit rate of 100% and a false alarm rate of 0%. However, a completely insensitive individual would have equivalent hit and false alarm rates, resulting in a  $d'$  value of 0. As indicated by the formula for calculating  $d'$ , emotion detection sensitivity increases when the hit rate increases or when the false alarm decreases. Note that a  $d'$  value equal to zero reflects chance performance, as one is equally likely to respond that they detect emotion whether or not emotion is actually present on the stimulus.

A 2 (Age Group: younger and older adults) by 2 (Intensity: typical and extreme) by 6 (Angle of Eccentricity: -15, -10, -5, +5, +10, and +15 degrees) mixed-model, multi-factorial ANOVA was conducted to examine the impact of each independent variable on  $d'$ -prime values for the fearful/neutral condition and for the angry/neutral condition. Expressive intensity and angle of eccentricity were within-subjects factors, and age group

was the between-subjects factor. Separate ANOVAs were conducted on data for each condition.

For the fearful/neutral condition, the ANOVA revealed main effects of intensity,  $F(1, 38) = 60.649, p < .001, \eta_p^2 = .615$  and location,  $F(5, 190) = 47.089, p < .001, \eta_p^2 = .553$ , which were qualified by an intensity  $\times$  location  $\times$  age interaction,  $F(5, 190) = 3.270, p = .007, \eta_p^2 = .079$  (see Figure 2 for means and standard errors). To decompose this interaction, the impact of location and age was examined in ANOVAs separately by intensity. For low intensity expressions, the ANOVA revealed that main effects of age,  $F(1, 38) = 18.235, p = .042, \eta_p^2 = .104$ , and location,  $F(5, 190) = 23.168, p < .001, \eta_p^2 = .379$ , were qualified by an age  $\times$  location interaction,  $F(5, 190) = 3.573, p = .004, \eta_p^2 = .086$ . As depicted by the dotted lines capturing  $d'$  values for the low intensity fear expressions in Figure 2, younger adults show a steeper decline in  $d'$  values than do older adults as the face targets are presented further into the periphery. The closer the performance line gets to a  $d'$  of zero, the closer participants perform at chance levels. Chance performance occurs when participants are equally likely to respond that the stimulus is emotional compared to neutral. If participants are unable to correctly discriminate between the neutral and emotional stimuli, the performance would be near zero, or a chance performance. Comparing the mean  $d'$  value for each intensity level and location is useful for characterizing younger and older adult performance for this task. It appears that older adults' performance overall is closer to chance performance in the periphery, based on the gradual decline of the inverted "V", than younger adults hence the interaction. Younger adults performed above chance from -10 to +10 degrees,  $t_s(19) = 4.19-5.75, ps < .001$ , but older adults performed above chance only at -5 and +5

degrees,  $ts(19) = 2.22-2.46$ ,  $ps < .02$ . For high intensity expressions, the ANOVA revealed a main effect of location,  $F(5, 195) = 34.343$ ,  $p < .001$ ,  $\eta_p^2 = .468$ . Least significant difference post-hoc tests revealed that  $d'$  values were greatest at -5 degrees and +5 degrees and declined significantly with each additional  $5^\circ$  increment in each direction. In the high intensity condition, both age groups performed significantly above chance from -15 degrees to +15 degrees (young:  $ts(18) = 5.23-9.38$ ,  $ps < .001$ ; old:  $ts(19) = 5.81-10.01$ ,  $ps < .001$ ). The effects of age observed in the ANOVA for low intensity expressions was not observed in the ANOVA for high intensity expressions.

### Intensity x Location x Age for Fear Detection

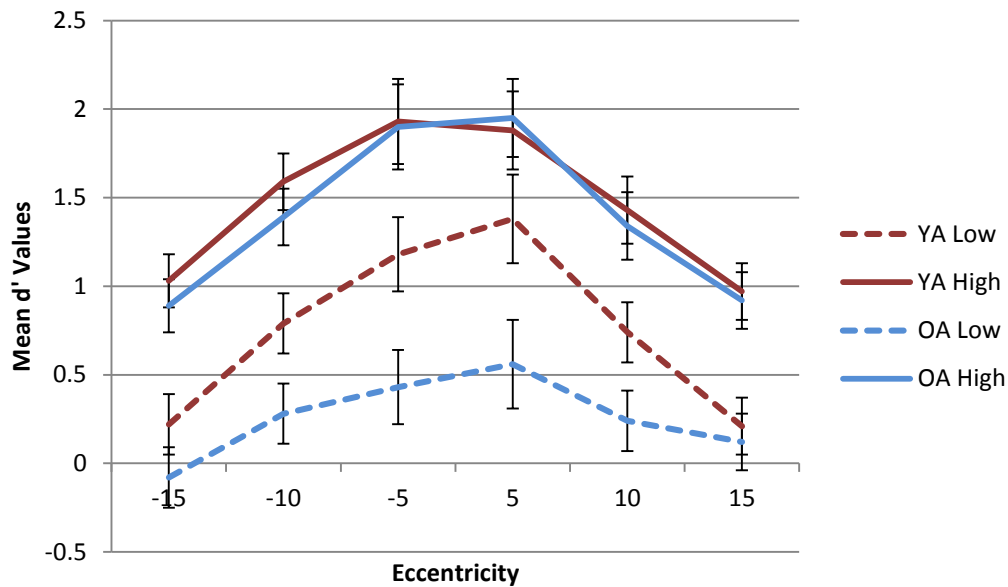


Figure 2. Mean  $d'$  values for the intensity  $\times$  location  $\times$  age interaction were collapsed across emotion in the fearful/neutral condition. Error bars represent the standard error.



For the anger/neutral condition, the ANOVA revealed main effects of intensity,  $F(1, 36) = 40.161, p < .001, \eta_p^2 = .527$ , and location,  $F(5, 180) = 31.720, p < .001, \eta_p^2 = .468$ , which were qualified by an intensity  $\times$  location interaction,  $F(5, 185) = 5.100, p < .001, \eta_p^2 = .121$  (Figure 3). Each increase in eccentricity resulted in participants performing worse on detection; however this was more apparent for higher intensity anger. In the high intensity condition, both age groups performed significantly above chance from -15 degrees to + 15 degrees (young:  $ts(18) = 3.45-6.77, ps < .001$ ; old:  $ts(19) = 1.94-9.46, ps < .04$ ).

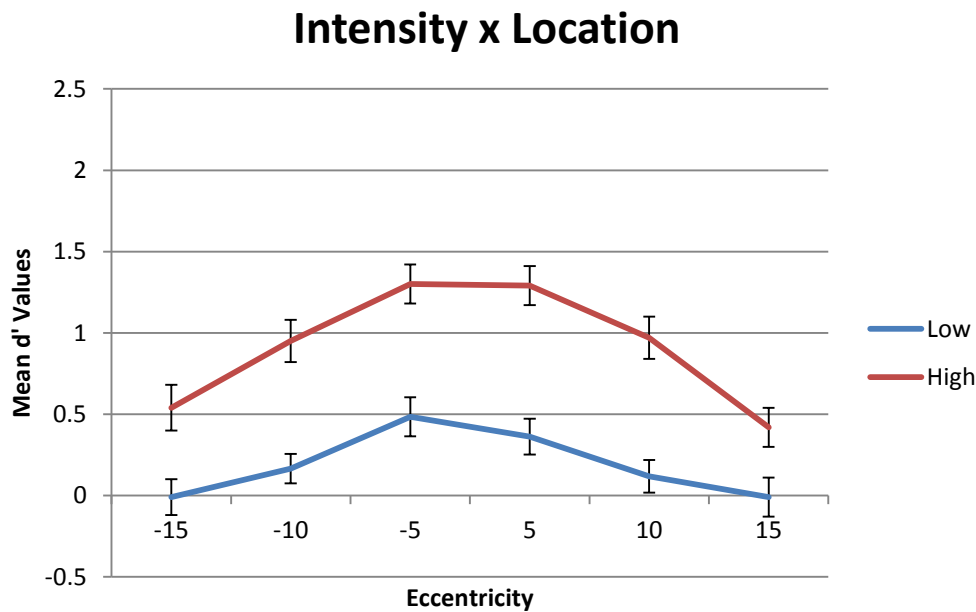
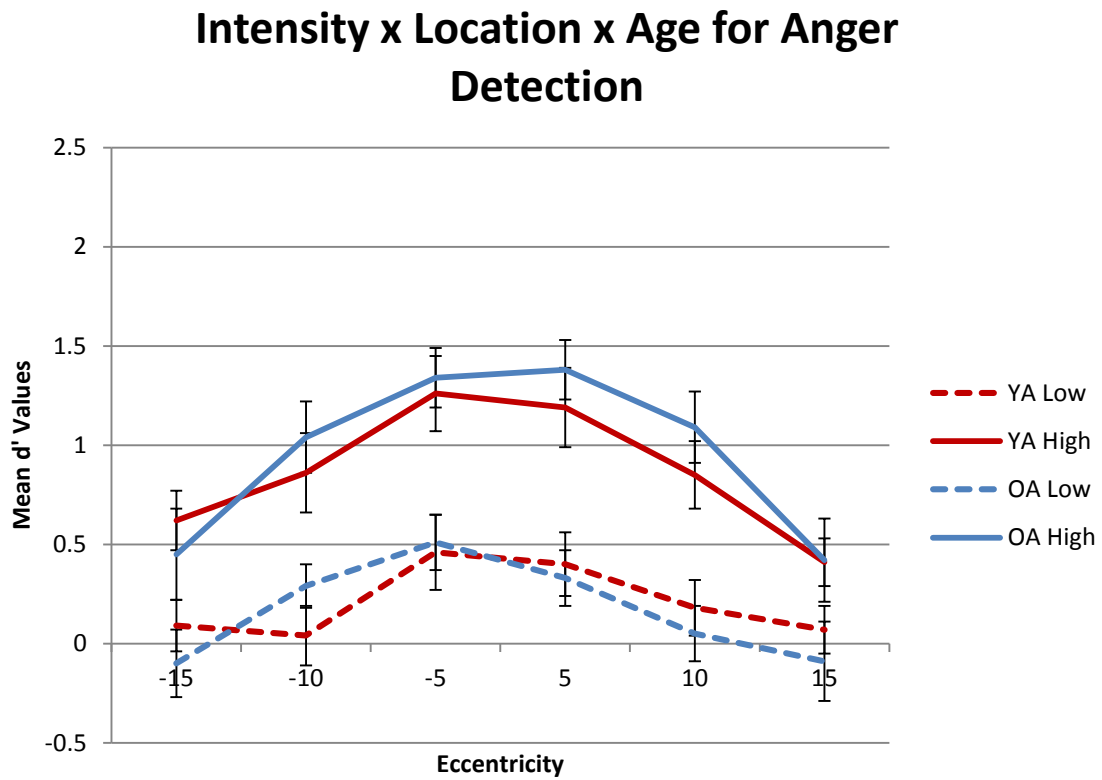


Figure 3. Mean  $d'$  values for the intensity  $\times$  location interaction were collapsed across age groups in the anger/neutral condition. Error bars represent the standard error.

Performance was closer to chance for lower intensity expressions. Younger adults performed above chance at -5 and +5 degrees,  $ts(18) = 2.5, ps < .03$ , but older adults performed above chance at -10 degrees, - 5 degrees, and + 5 degrees,  $ts(19) = 2.32-3.54$ ,

$ps < .033$ . Although the intensity  $\times$  location  $\times$  age interaction was not significant,  $F(1, 37) = 2.634, p = .113, \eta_p^2 = .066$ , the means and standard errors for younger and older adults'  $d'$  values for each expressive intensity and at each location are presented in Figure 4.  $d'$  values were greater for high intensity expressions than low intensity expressions. Least significant difference post-hoc tests revealed that  $d'$  values were greatest at -5 and +5 degrees and declined significantly with each additional 5 degree increment in each direction.



*Figure 4.* Mean  $d'$  values for the non-significant intensity  $\times$  location  $\times$  age interaction were collapsed across emotion in the anger/neutral condition. Error bars represent the standard error.

In sum, older adults did not always display poorer emotion discrimination than younger adults. For angry expressions, both younger and older adults displayed a discriminability deficit for low intensity expressions relative to high. Additionally, both age groups demonstrated a significant decline in performance with each 5° increment of distance between the fixation point and target face location. A different pattern of results emerged for the fearful/neutral task. For high intensity expressions, younger and older adults displayed a similar main effect of location observed in the angry/neutral task. However, for low intensity expressions, younger adults outperformed older adults at the stimulus locations closest to the fixation point, and older adults performed no better than chance beyond - 5 degrees and +5 degrees from fixation.

***Criterion Location (c) Values.*** The criterion location,  $c$ , is an index of response bias found within participants (Macmillan & Creelman, 2004, pp. 29-31). The  $c$  value sums the hit rate and false alarm rates, as opposed to the difference of these values found in calculating detection sensitivity with  $d'$ . The formula for  $c$  is  $c = - [Z(\text{hit rate}) + Z(\text{false alarm rate})]/2$ . The resulting value ranges from -1 to 1, and the sign of the value is meaningful to interpreting the response bias. A positive  $c$  bias score indicates the tendency for an individual to need a more distinctive cue or to be more confident that the stimulus is what it appears to be. For example, if the stimulus is fearful, the participant would need a more salient or distinctive cue in order for the individual to respond that the stimulus is in fact fearful. In other words, the criterion used to make the judgment is more strict. A positive value occurs when the false-alarm rate is lower than the miss rate (i.e.,  $1 - \text{hit rate}$ ). A negative  $c$  bias score indicates that perceptual cues do not need to be more

salient for an individual to report that the stimulus was fearful, for example. A negative bias value occurs when the false-alarm rate exceeds the miss rate.

A 2 (Age Group: younger and older adults) by 2 (Intensity: typical and extreme) by 6 (Angle of Eccentricity: -15, -10, -5, +5, +10, +15 degrees) mixed-model, multi-factorial ANOVA was conducted to examine the impact of each independent variable on *c* values for the fearful/neutral condition and the angry/neutral condition. Expressive intensity and angle of eccentricity were within-subjects factors, and age group was the between-subjects factor.

For the fearful/neutral task, the ANOVA revealed main effects of intensity,  $F(1, 38) = 6.701, p = .014, \eta_p^2 = .150$ , and location,  $F(5, 190) = 11.093, p < .001, \eta_p^2 = .226$ . *C* values were higher for the low expressive intensity condition ( $M = .271, SE = .078$ ) compared to high intensity expressive condition ( $M = .090, SE = .048$ ). Generally, *c* values were larger when stimuli were presented in the right visual field than in the left, and, for stimuli presented in the left visual field, *c* values were larger at  $-5^\circ$  than at  $-10^\circ$  and  $-15^\circ$  (Table 4).

Table 4

*Response Bias in Fearful/Neutral Condition*

<u>Eccentricity</u>	<u>Mean</u>	<u>SE</u>
-15	.01	.07
-10	.04	.06
-5	.18	.06
+5	.30	.06
+10	.22	.06
+15	.32	.08

For the anger/neutral task, the ANOVA revealed main effects of intensity,  $F(1, 37) = 13.981, p = .001, \eta_p^2 = .274$ , location,  $F(5, 185) = 9.591, p < .001, \eta_p^2 = .206$ , and age,  $F(1, 37) = 8.453, p = .006, \eta_p^2 = .186$ . Older adults ( $M = .596, SE = .084$ ) had a larger positive c value than did younger adults ( $M = .247, SE = .086$ ). C values were higher for the low intensity condition ( $M = .560, SE = .076$ ) compared to high intensity condition ( $M = .283, SE = .064$ ). With respect to the main effect of location, the same pattern was observed for the anger/neutral task that was observed for the fearful/neutral task (Table 5).

Table 5

*Response Bias in Angry/Neutral Condition*

<u>Eccentricity</u>	<u>Mean</u>	<u>SE</u>
-15	.28	.07
-10	.32	.07
-5	.46	.07
+5	.58	.06
+10	.49	.06
+15	.41	.08

**Response Time.** In addition to sensitivity performance and response bias, an individual's response time is also taken into account when examining the task difficulty. If  $d'$  was low and there was a fast reaction time, the participant was likely not taking the task seriously as they may have been button pressing. In addition, if the  $d'$  was low and the response time was slow, this indicates that the task was extremely difficult as the

participant was unable to correctly identify the stimulus even with a slower response time.

A 2 (Age Group: younger and older adults) by 2 (Intensity: typical and extreme) by 6 (Angle of Eccentricity: -15, -10, -5, +5, +10, and +15 degrees) mixed-model, multi-factorial ANOVA was conducted to examine the impact of each independent variable on response times for the fearful/neutral condition and for the angry/neutral condition. Expressive intensity and angle of eccentricity were within-subjects factors, and age group was the between-subjects factor.

The analysis for the fearful/neutral task revealed that main effects of location,  $F(5, 185) = 6.282, p < .001, \eta_p^2 = .145$ , and age,  $F(1, 37) = 11.169, p = .002, \eta_p^2 = .232$  were qualified by emotion  $\times$  age,  $F(1, 37) = 4.710, p = .036, \eta_p^2 = .113$ , and intensity  $\times$  emotion,  $F(1, 37) = 5.695, p = .022, \eta_p^2 = .133$ , interactions. Both interactions were disordinal interactions. Younger adults responded more quickly for fearful expressions, and older adults responded more quickly for neutral expressions (Table 6). In the lower intensity condition, participants responded faster for neutral expressions than fearful expressions, but vice versa in the higher intensity condition.

Table 6

*Age  $\times$  Emotion interaction Response Time*

Eccentricity	Younger		Older	
	<u>Mean</u>	<u>SE</u>	<u>Mean</u>	<u>SE</u>
Fear	782	28	975	27
Neutral	788	26	965	26

Note: Response times reported in milliseconds

The analysis for the angry/neutral task revealed that a main effect of age  $F(1, 37) = 34.276, p < .001, \eta_p^2 = .481$  was qualified by emotion  $\times$  age,  $F(1, 37) = 11.612, p = .002, \eta_p^2 = .239$ , and intensity  $\times$  location,  $F(5, 185) = 2.893, p = .015, \eta_p^2 = .073$ , interactions. Once again, the emotion  $\times$  age interaction was disordinal. Younger adults responded more quickly for angry expressions, and older adults responded more quickly for neutral expressions. No discernable pattern emerged when examining the mean response times for the intensity  $\times$  location interaction (Table 7).

Table 7

*Age  $\times$  Emotion interaction Response Time*

Eccentricity	Younger		Older	
	<u>Mean</u>	<u>SE</u>	<u>Mean</u>	<u>SE</u>
Anger	766	22	1026	21
Neutral	778	23	1006	23

Note: Response times reported in milliseconds

### Discussion

The aim of this study was to better understand how individuals of different age groups detect emotions in their peripheral vision. The data collected supported four of our hypotheses. Younger adults performed better than older adults for both the fearful and angry conditions (Hypothesis 1). Both age groups performed better when emotion was expressed at a more extreme intensity than when at a lower intensity, but older adults performed more poorly than younger adults when emotion was expressed at a lower intensity (Hypothesis 2). Emotion detection was more difficult in the peripheral visual field (Hypothesis 3), and the decline in emotion detection was steeper for typical (or lower) expressive intensity stimuli compared to stimuli with more extreme (or higher) expressive intensity (Hypothesis 4). The fifth hypothesis was not supported. Relative to

younger adults, older adults displayed a larger difference in performance between high and low intensity fearful expressions at each eccentricity. For angry expressions, younger and older adults did not differ in performance as the angle of eccentricity increased (Hypothesis 5).

### **Fear Detection**

Detection of fearful expressions in an individual's surroundings is important for survival. In the fearful/neutral condition, younger and older adults were both able to detect fearful expressions in the periphery, but performance was much better for more intense expressions. More intense or arousing expressions, such as extreme intensity expressions are more readily identified compared to other expressions that are less arousing (Chiao et al., 2008; Righart & Gelder, 2008). The distinctiveness of these stimuli, specifically the raised and arched eyebrows and wide-open eyes, allows individuals to more quickly identify emotions (Adolphs et al., 2005; Calvo et al. 2014b). It is possible that the distinctiveness of the eye-region is adequate for participants to use this single cue, especially when emotion is expressed in an intense manner, to correctly classify a fearful facial stimulus (e.g., Calvo et al., 2014a). Both younger and older adults responded more quickly to fearful faces than to neutral faces when the fearful cues were more intense but required more time to respond to fearful faces than to neutral faces when the fearful cues were more subdued. This supports the possibility that the saliency of the facial features, specifically the eyes and eyebrows, may reduce the difficulty associated with classifying intense fearful expressions (Calvo et al., 2014a). Further support lies in the bias scores (c) in the fearful/neutral condition, as these scores were much lower when more expressive stimuli were presented, suggesting a lower threshold



of “fearness” was necessary for participants to classify the extreme intensity expressions relative to the more typical intensity expressions. Perhaps the more intense expressions draw more perceptual resources toward them, consistent with prior research demonstrating that fearful stimuli may be more predisposed to capturing attention (Öhman et al., 2001a, 2001b).

### **Anger Detection**

Similar to the fearful/neutral condition, participants in the angry/neutral condition were also able to detect anger in the periphery. Anger detection performance was much better for higher intensity expressions than for lower intensity expressions. In fact, for the more subtle angry expressions, peripheral emotion detection did not exceed chance performance (except older adults + 10 degrees). As mentioned for fearful expressions, it is possible that the detection of anger in the more intense expressions was driven by the salience of anger-specific cues that may allow for one to bypass of a more configural analysis of the facial stimuli. However, the response time data are less definitive here. Participants did generally use a reduced criterion for judgment when classifying more intense angry expressions relative to less intense angry expressions. For the intense expressions, younger and older adults performed above chance at the 10° and 15° locations, but, as with the intense fearful expressions, it is clear that emotion detection become more challenging as the faces emerge in the visual field at distances further away from its center.

### **Stimulus Location**

For this study, the largest effects emerged due to the manipulation of the location of the stimuli on the display. Emotional expressions presented in peripheral locations

were more difficult to detect than the stimuli presented at +/- 5°. Participants in the current study struggled with increased eccentricities, supporting previous studies examining the difficulty of peripheral emotion detection (Anderson et al., 1991; Rossion et al., 2011). The ability to detect emotion, specifically fear, in peripheral regions of the visual field may serve as a defense mechanism. Interestingly, regardless of age, participants were generally able to do this out to 15° for intense fearful expressions. The ability to detect fear in peripheral vision is less affected than other emotional stimuli (Bayle et al., 2011). Although not tested directly in this study, this finding was replicated in the current study with the younger adults when considering angry and fearful expressions.

### **Age Differences**

Prior research examining age differences in emotion recognition is replete with examples of younger adult samples outperforming older adult samples (Isaacowitz et al., 2007; Orgeta & Phillips, 2008). The reasons proposed for these age differences are generally linked to age-related differences in the motivation to process negative emotions or to cognitive deficits that lead to slower and less accurate judgments. In the current study, age differences did emerge in emotion detection, but these differences were not found under all circumstances. With respect to the angry/neutral condition, younger and older adults did not differ in emotion detection performance, regardless of the expressive intensity of the emotion cues, and despite older adults generally having worse peripheral acuity than younger adults. Of course, there are three important caveats here: (1) face stimuli were presented for a longer duration for older adults than for younger adults; (2) older adults required more time to respond than did younger adults; and (3) older adults

generally were less inclined than younger adults to respond that they observed emotion in the angry/neutral condition. When taken together, these three points fail to exonerate older adults from an emotion recognition deficit and support prior research which suggests that older adults generally have more difficulty than younger adults in interpreting facial emotion cues.

In the fearful/neutral condition, younger and older adults performed similarly to one another when detecting fear in more intense fearful facial stimuli relative to neutral facial expressions (See Figure 2). However, when the fearful faces expressed less intense emotion, younger adults outperformed older adults at every location, and the older adults failed to perform above chance beyond 5°. It appears that when fear cues are the most salient, the visual processes involved in distilling the appropriate emotional information the facial stimuli remain intact with age. Granted, the process takes older adults more time, they are still able to detect fear, and they do it quite well at 5° and 10°. However, for lower intensity expressions, the subtlety of the facial cues may produce enough error in the perceptual and cognitive judgment processes to impair older adults' performance.

This interpretation is supported by previous research demonstrating that older adults are less accurate than younger adults at emotion discrimination when facial stimuli express lower intensity emotion (Mienaltowski et al., 2013; Orgeta & Phillips, 2008). Prior research demonstrated this outcome for centrally presented stimuli that were presented in a self-paced manner. In the current study, participant viewing time was limited (140 ms for young and 200 ms for old) and face stimuli were presented in the periphery, creating additional challenges for accurate emotion detection. Despite these challenges, younger and older adult performance for extreme intensity expressions was

similar in both emotion tasks. For the less intense expressions, age differences emerged in fear detection but not anger detection.

At least two possible explanations emerge. First, older and younger adults differ in the facial features on which they fixate to determine the emotion being presented on the face. Older adults are less likely to look at the eyes, where fear is more salient, and older adults are worse at detecting changes in this region compared to younger adults (Chaby, Hupont, Avril, Luherne-du Boullay, & Chetouani, 2017; Mather, 2016). The current study supports this finding as older adults performed worse on detecting fearful faces than younger adults in the typical, less extreme intensity, which more common to social interaction. Older adults' tendency to fixate proportionally longer on the mouth region than younger adults when evaluating emotion might have benefited the older adults' performance. Perhaps older adults spontaneously fixate more on those facial landmarks that serve to cue anger in interaction partners, minimizing age differences in anger detection.

Second, perhaps aging impacts the sensitivity of the amygdala to more subtle threat cues in one's environment. Although we did not measure age-related changes in the brain, we can infer how the brain detects emotions based on responses to emotional stimuli. If younger adults serve as the baseline for a comparison to older adults, in the fearful/neutral condition, younger adults responses were more rapid suggesting that the neural pathways used to process fearful expressions – be they conscious and cortical or non-conscious and subcortical – are more efficient (Cecere et al., 2013; Pessoa, 2013; Pessoa & Adolphs, 2010). If fearful stimuli are appropriately processed by the amygdala very early on after their onset, then the amygdala should facilitate a shift of attention

toward the stimulus and reduce the time needed to respond that one sees a fearful expression (Troiani et al., 2014). Interestingly, younger and older adults displayed a disordinal interaction in which younger adults responded faster to fearful stimuli than to neutral but older adults responded faster to neutral than to fearful. If fearful faces detected by participants have evoked a stronger neural response compared to neutral ones (Pessoa, 2013), one would expect to observe the response time difference displayed by younger adults but not the one displayed by older adults. This evidence suggests that aging may serve to disrupt the neural pathways that may facilitate threat detection when threat cues are more subtle. Of course, the mean response times to fearful and neutral stimuli were no different within each age group, so the support for this interpretation is not absolute. Studies of the functional connectivity of the amygdala to the visual system have been limited to younger adult samples. However, there is some evidence that older adults display less amygdala reactivity to emotional expressions (Wright, Dickerson, Feczko, Negeira, & Williams, 2007) and to negative (non-facial) stimuli (Mather et al., 2004) relative to younger adults.

### **Limitations**

Although the current study found interesting and novel results, there were several limitations of the study. First, this study was performed in a lab setting on a computer where there were few distractors, as compared with life outside of the lab. This may be an issue as participants were not asked to assess a crowded situation in which there were many distractors that participants would need to sort through to determine if there was a threatening situation at hand. In addition, fixation of the eyes was not measured to ensure that participants were looking directly at the fixation point. Researchers attempted to

reduce the effects of this limitation by presenting the facial stimuli at a duration that would create a substantial cost to performance if one re-fixated away from the central fixation point. The participants' ability to move their head in the direction of the stimuli was reduced by requiring all participants to use a chin rest at a fixed distance from the computer display. In addition, stimuli were randomized in terms of presentation so participants did not anticipate where the next stimulus would be presented. Finally, stimuli had a longer duration for older than for younger adults to minimize floor effects for older participants. This difference in stimulus duration tempers the interpretability of null findings which suggest no difference in performance between the younger and older adult samples.

## **Conclusion**

In conclusion, the current study supported previous research in which younger adults performed better than older adults in perceiving emotion on facial expressions. Performance was better for higher intensity than for lower intensity expressions, and was better at peripheral locations that were less distant from the central fixation point. Consistent with age difference in peripheral acuity, older adults displayed poorer detection performance than did younger adults at the most peripheral locations. The current study found for the first time, to our knowledge, that older and younger adults performed similarly when presented with extreme intensity emotional expressions. Like younger adults, older adults were able to detect high intensity anger and fear expressions at above chance levels from  $-15^{\circ}$  to  $+15^{\circ}$ . Interestingly, older adults were less able than younger adults to detect peripherally presented low intensity fear expressions. Future research should examine if this deficit persists if participants are only presented with the

eye-region of the fearful facial stimuli or if the age differences that were observed carry over to known neurocorrelates of facial emotion perception.

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## Appendix A

### Center for Epidemiological Studies Depression Inventory (CES-D)

#### Feelings Scale

**Instructions:** In this booklet, there are statements about the way that most people feel at one time or another. There is no such thing as a "right" or "wrong" answer because all people are different. All you have to do is answer the statements according to how you have felt during the past week. Don't answer according to how you USUALLY feel, but rather how you have felt DURING THE PAST WEEK. Each statement is followed by four choices. Circle the letter corresponding to your choice. Mark ONLY ONE letter for each statement. For example:

During the past week, I was happy.

- a. Rarely or none of the time (less than one day)
- b. Some or a little of the time (1 - 2 days)
- c. Occasionally or a moderate amount of time (3 - 4 days)
- d. Most or all of the time (5 - 7 days)

In the example, you could, of course, choose any ONE of the answers. If you felt really happy, you would circle "d". If you felt very unhappy, you would circle "a". The "b" and "c" answers give you middle choices. Keep these following points in mind.

1. Don't spend too much time thinking about your answer. Give the 1<sup>st</sup> natural answer that comes to you.
2. Do your best to answer EVERY question, even if it doesn't seem to apply to you very well.
3. Answer as honestly as you can. Please do not mark something because it seems like "the right thing to say".

---

1. During the past week, I was bothered by things that don't usually bother me.

- a. Rarely or none of the time (less than one day)
- b. Some or a little of the time (1 - 2 days)
- c. Occasionally or a moderate amount of time (3 - 4 days)
- d. Most or all of the time (5 - 7 days)

2. During the past week, I did not feel like eating. My appetite was poor.

- a. Rarely or none of the time (less than one day)
- b. Some or a little of the time (1 - 2 days)
- c. Occasionally or a moderate amount of time (3 - 4 days)
- d. Most or all of the time (5 - 7 days)

3. During the past week, I felt that I could not shake off the blues even with help from my family or friends.

- a. Rarely or none of the time (less than one day)
- b. Some or a little of the time (1 - 2 days)
- c. Occasionally or a moderate amount of time (3 - 4 days)
- d. Most or all of the time (5 - 7 days)

4. During the past week, I felt that I was just as good as other people.

- a. Rarely or none of the time (less than one day)
- b. Some or a little of the time (1 - 2 days)
- c. Occasionally or a moderate amount of time (3 - 4 days)
- d. Most or all of the time (5 - 7 days)

To continue, please turn to page 2

1

5. During the past week, I had trouble keeping my mind on what I was doing.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
6. During the past week, I felt depressed.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
7. During the past week, I felt that everything I did was an effort.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
8. During the past week, I felt hopeful about the future.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
9. During the past week, I thought my life had been a failure.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
10. During the past week, I felt fearful.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
11. During the past week, my sleep was restless.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
12. During the past week, I was happy.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)

13. During the past week, I talked less than usual.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
14. During the past week, I felt lonely.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
15. During the past week, people were unfriendly.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
16. During the past week, I enjoyed life.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
17. During the past week, I had crying spells.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
18. During the past week, I felt sad.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
19. During the past week, I felt that people dislike me.
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)
20. During the past week, I could not get "going".
- a. Rarely or none of the time (less than one day)
  - b. Some or a little of the time (1 - 2 days)
  - c. Occasionally or a moderate amount of time (3 - 4 days)
  - d. Most or all of the time (5 - 7 days)

## Appendix B

### BIS/BAS

**Instructions:** Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me

2 = somewhat true for me

3 = somewhat false for me

4 = very false for me

- \_\_\_\_\_ 1. A person's family is the most important thing in life.
- \_\_\_\_\_ 2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
- \_\_\_\_\_ 3. I go out of my way to get things I want.
- \_\_\_\_\_ 4. When I'm doing well at something I love to keep at it.
- \_\_\_\_\_ 5. I'm always willing to try something new if I think it will be fun.
- \_\_\_\_\_ 6. How I dress is important to me.
- \_\_\_\_\_ 7. When I get something I want, I feel excited and energized.
- \_\_\_\_\_ 8. Criticism or scolding hurts me quite a bit.
- \_\_\_\_\_ 9. When I want something I usually go all-out to get it.
- \_\_\_\_\_ 10. I will often do things for no other reason than that they might be fun.
- \_\_\_\_\_ 11. It's hard for me to find the time to do things such as get a haircut.
- \_\_\_\_\_ 12. If I see a chance to get something I want I move on it right away.
- \_\_\_\_\_ 13. I feel pretty worried or upset when I think or know somebody is angry at me.
- \_\_\_\_\_ 14. When I see an opportunity for something I like I get excited right away.

- \_\_\_\_\_ 15. I often act on the spur of the moment.
- \_\_\_\_\_ 16. If I think something unpleasant is going to happen I usually get pretty "worked up."
- \_\_\_\_\_ 17. I often wonder why people act the way they do.
- \_\_\_\_\_ 18. When good things happen to me, it affects me strongly.
- \_\_\_\_\_ 19. I feel worried when I think I have done poorly at something important.
- \_\_\_\_\_ 20. I crave excitement and new sensations.
- \_\_\_\_\_ 21. When I go after something I use a "no holds barred" approach.
- \_\_\_\_\_ 22. I have very few fears compared to my friends.
- \_\_\_\_\_ 23. It would excite me to win a contest.
- \_\_\_\_\_ 24. I worry about making mistakes.

## Appendix C

### Lab Demographics Questionnaire

**Instructions:** The items in this questionnaire ask you for personal information that we can use to get a sense for how similar our group of volunteers is to those who participate in research at other institutions in the United States. All information that we collect from individuals will not be linked back to their identities. However, if you are uncomfortable providing a response for any of the following items, please do not respond to them. For the remaining items, please *fill in the blank spaces* or *circle the response* which best describes you.

1. Please indicate your gender: 1. Female 2. Male
2. Please indicate your marital status: 1. Single  
2. Married  
3. Domestic Partnership  
4. Divorced  
5. Widowed  
6. Other (specify) \_\_\_\_\_
3. Please indicate how many children you have raised or are currently raising. \_\_\_\_\_
4. Date of birth: \_\_\_\_/\_\_\_\_/\_\_\_\_ and current age: \_\_\_\_\_ years
5. Do you consider yourself to be Hispanic or Latino? 1. YES 2. NO
6. Please indicate your racial background:
  1. American Indian/ Alaska Native
  2. Asian
  3. Native Hawaiian or Other Pacific Islander
  4. Black or African American
  5. Caucasian
  6. More than one race (specify) \_\_\_\_\_
  7. Other (specify) \_\_\_\_\_
6. Is English your native language? 1. Yes 2. No
7. Please indicate your religious faith: 1. Christian (Protestant or Catholic)  
2. Jewish  
3. Hindu  
4. Muslim  
5. Buddhist  
6. None (e.g., atheist)  
7. Other (specify) \_\_\_\_\_
8. Are you a student? 1. Yes - full time 2. Yes - part time 3. No
9. If you are a student, please indicate your academic major:
  1. Arts (specify) \_\_\_\_\_
  2. Business (specify) \_\_\_\_\_
  3. Engineering (specify) \_\_\_\_\_
  4. Humanities (specify) \_\_\_\_\_
  5. Science (specify) \_\_\_\_\_
  6. Health (specify) \_\_\_\_\_
  7. Education (specify) \_\_\_\_\_
  8. Other (specify) \_\_\_\_\_

To continue, please turn to the other side of this page 1

**Lab Demographics Questionnaire**

- 10. What is your highest level of formal education (circle the highest level completed):**
- A. Less than 12 years (How many of years completed? \_\_\_\_\_ years)
  - B. GED (Age when you completed your GED: \_\_\_\_\_ )
  - C. High school diploma
  - D. Technical/ Vocational/ Trade school diploma or certificate
  - E. College Freshman
  - F. College Sophomore
  - G. College Junior
  - H. Associate's Degree
  - I. Bachelor's degree
  - J. Master's degree
  - K. J.D., M.D., or Ph.D.
- 11. Are you presently employed:** 1. Yes - full time      2. Yes - part time      3. No
- 12. Are you presently retired?** 1. Yes      2. No
- 13. If you are currently or have recently been employed, what field is your job in?**
- \_\_\_\_\_
- 14. If you are currently or have recently been employed, please describe the duties of your job?**
- \_\_\_\_\_
- 15. In the past 5 years, have you engaged in volunteer activities to assist or instruct young adults (i.e., individuals aged 18-30)?** 1. Yes      2. No
- 16. To what extent do you interact with young adults throughout the course of a typical week (including time spent at work, in classes, and/or during volunteer or extracurricular activities)?**
- 1. Rarely or none of the time (less than one day)
  - 2. Some or a little of the time (1 - 2 days)
  - 3. Occasionally or a moderate amount of time (3 - 4 days)
  - 4. Most or all of the time (5 - 7 days)
- 17. How would you rate your overall health at the present time? (please circle one rating)**
- 1. Poor      2. Fair      3. Good      4. Very Good      5. Excellent
- 18. How much do health problems stand in your way of doing things that you want to do? (please circle one rating)** 1. Not at all      2. A little      3. Moderately      4. Quite a bit      5. A great deal
- 19. Are you presently seeking psychological or psychiatric consultation and/or receiving therapy?**
- 1. Yes      2. No
- If yes...**
- a. Are you currently being treated for depression? 1. Yes      2. No
  - b. Are you currently being treated for excessive anxiety or nervousness? 1. Yes      2. No
- 20. Do you currently have any noticeable difficulty with vision for which correction, such as eyeglasses, has NOT been made?** 1. Yes      2. No
- 29. Do you currently have any noticeable difficulty with hearing for which a correction, such as a hearing aide, has NOT been made?** 1. Yes      2. No
- 30. Do you currently have any difficulty with writing?** 1. Yes      2. No



## Appendix D



### INFORMED CONSENT DOCUMENT

**Project Title:** Emotion Detection: Peripheral Vision

**Investigators:** Brittany Groh and Dr. Andrew Mienaltowski,  
Department of Psychological Sciences, Western Kentucky University, (270) 745-2353

You are being asked to participate in a project conducted through Western Kentucky University. The University requires that you give your signed agreement to participate in this project.  
**You must be 18 years old or older to participate in this research study.**

The investigator will explain to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the researcher any questions you may have.

If you then decide to participate in the project, please sign this form in the presence of the person who explained the project to you. You should be given a copy of this form to keep.

**1. Nature and Purpose of the Project:** This project examines how people process and detect emotions on faces that are presented on a computer screen in various locations.

**2. Explanation of Procedures:** The purpose of this research is to evaluate how individuals process and detect various emotions on the screen in peripheral vision. During the study, you will be asked to indicate whether a face displayed on the screen has a neutral or emotional expression. The location of each face will vary between the trials. In addition to this task on the computer, you will be asked to complete an eye test and various paper-and-pencil questionnaires that include tests of perceptual speed and vocabulary, personality, and mood. The purpose of these assessments is to determine how similar our participants are to those who participate at other universities and to determine if individual differences in these assessments might explain how people perform on the emotion detection task.

**3. Discomfort and Risks:** There are no known risks associated with participation in this study. If you become fatigued at any point, you are free to take a break. There are also opportunities built in during the experiment to take breaks. Should you have any questions, please do not hesitate to ask the experimenter.

**4. Benefits:** Your participation in this study will help to further our efforts to understand how our visual perception of emotional faces is impacted by factors like the environment in which the face appears or the expressive cues available on the faces that are used to read emotions. Understanding how individuals identify emotions is important in understanding how we communicate and interact in social situations. Once the study is complete, we would be happy to share the results with you.

WKU IRB# 17-130  
Approval - 10/19/2016  
End Date - 8/15/2017  
Expedited  
Original - 10/19/2016

**Compensation:** If you are a student participant you will receive Study Board credit for every 15 minutes of participation, up to 8 credits. If you are a non-student participant you will receive a \$20 gift card.

**5. Confidentiality:** During this study, you will be asked for some personal information (name, age, gender, etc.). This information will be confidential and will only be used by the experimenter. The data that are collected about you will be kept private. To protect your privacy, your records will be kept under a code number rather than by name. Your records will be kept in locked files and only study staff will be allowed to look at them. We are only interested in group information. The reporting of the experimental results will only contain aggregated group findings and will contain no personal information about individual participants, including performance during the experiment.

**6. Refusal/Withdrawal:** Refusal to participate in this study will have no effect on any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time with no penalty.

*You understand also that it is not possible to identify all potential risks in an experimental procedure, and you believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks.*

\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Date

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT  
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY  
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD  
Paul Mooney, Human Protections Administrator  
TELEPHONE: (270) 745-2129



WKU IRB# 17-130  
Approval - 10/19/2016  
End Date - 8/15/2017  
Expedited  
Original - 10/19/2016