DOES PREGNANCY ENHANCE SENSITIVITY TO EMOTIONAL DISPLAYS OF THREAT?

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Abstract

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The human face provides us with an abundant amount of social and biological information. It is important for us to be able to recognize emotions quickly and accurately, some emotions may be more important and therefore draw more of our attention than others, specifically “threat-relevant” emotions (fear, disgust, anger). To date few studies have investigated how pregnancy impacts emotion recognition abilities. These studies have shown that women have higher accuracy in encoding emotional expressions signaling threat or harm. To determine if pregnancy increases attentional bias to threat, 43 pregnant women and 45 non-pregnant women (controls) performed an emotion recognition task. Although it was predicted that pregnant women would show enhanced sensitivity to threat-relevant emotional displays, no differences were observed between pregnant women and non-pregnant controls. Women were relatively accurate at detecting anger, disgust, happiness, and surprise (all above 75% accuracy). They were relatively less adept at detecting fear and sadness (accuracy between 50% and 75%). Additional analyses did not detect any effect of pregnancy duration (in weeks) on threat-relevant emotion recognition. Our results suggest that there is no difference in emotion recognition ability between pregnant women and non-pregnant women. There was also

no main effect of pregnancy status, suggesting that pregnant women were not more sensitive to displays of emotion overall. The current study does not support the prediction that the dramatic increases in both estrogen and progesterone that occur as a function of becoming pregnant increase sensitivity to threat-relevant stimuli.

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Introduction

The purpose of the current study was to determine if pregnancy increases sensitivity to emotional displays of threat. This was investigated by comparing pregnant women to non-pregnant women in an emotion recognition task. Progesterone levels will be much higher in pregnant vs non-pregnant women, allowing us to speculate about the role of progesterone in emotion recognition.

Emotional Expressions

The human face provides us with an abundant amount of social and biological information – with one glance we infer a wealth of information about an individual. Within a few milliseconds of viewing a face we start making judgements about an individual's character. For example, Borkenau (2009) found that exposure to strangers faces for 50 ms is sufficient to make accurate inferences regarding someone's extraversion. Similarly, Sell (2009) found that people are able to accurately estimate the physical strength of others based on images of the face alone. Other examples of the social judgements we make from facial cues include deceptiveness (Bond, 2010), status in the workplace (Mast & Hall, 2004) and competence of electoral candidates (Todorov, 2005). In addition to these trait-inferences we make from faces, we also make state-inferences that provide a judgment of a conspecific's current state and facilitate more effective social interactions. Of paramount importance to social interactions is the ability to detect emotional expressions from the face that signal internal feelings and reflect another's mental state (Chan, 2014); sensitivity to these otherwise invisible internal states is critical for facilitating effective social interactions (Riggio, 1986).

Facial expressions of emotion are considered one type of nonverbal communication. Nonverbal communication refers to gestures and signals, other than words, to which meaning will be attributed (Knapp, 2005). The ability to recognize emotions rapidly and accurately is an important skill for humans as social species. Accuracy in recognizing and labeling emotions is associated with our emotional and social intelligence – a set of abilities that are key to social functioning. Emotional intelligence, in particular, is what aids in our understanding of other's feelings and interpersonal relationships (Chan, 2014; Wilhelm et al., 2010).

Threat-Relevant Emotions

Ekman has described six basic emotions (anger, happiness, fear, surprise, disgust and sadness) that are considered "universal" as they are easily recognizable cross culturally (Ekman & Friesen, 1971; but see Gendron et al., 2014). While it's important for us to be able to recognize emotions quickly and accurately some emotions may be more important and, therefore, draw more of our attention than others. In particular, responding to potential threat in our environment is important for survival. As such, the ability to accurately detect the expression of a threat-relevant emotion in a conspecific may be particularly important given the survival advantage this would confer (Thompson & Voyer, 2014). Among the six basic emotions, fear, anger, and disgust are commonly considered to be threat-relevant emotions (Babchuck,1985; Hampson, 2006)

Research shows that the human perceptual system is well designed to detect human faces (Hansen, 1988) and this mechanism of face processing is especially efficient at attending to signals of potential threat, such as angry faces (Hansen, 1988), suggesting some sort of automatic threat detection in the human perceptual system whereby negatively valanced stimuli may be processed pre-attentively by specialized feature detectors (Horstmann, 2007). The evolutionary perspective suggests that this preferential attentional allocation to threatening stimuli has an adaptive value. The processing of negative or threatening stimuli takes precedence over positive or beneficial stimuli due to the high fitness costs associated with false negatives in the perception of threat (Haselton & Buss, 2000); those able to detect signals of threat quickly and efficiently, have better chances of survival (Lobue, 2009). Using visual search paradigms, research has supported the notion of a pre-attentive threat advantage, meaning signs of threat are detected even before attention is directed to it (Horstmann, 2007). Feature detectors, which are sensitive to signs of biologically fear-relevant stimuli, operate at an early stage of stimuli analysis and can direct attention toward potentially relevant areas of a visual scene (Mogg & Bradley, 1999). A number of studies have investigated preferential processing of threat stimuli and whether it occurs automatically, outside awareness. For example, Hansen and Hansen (1988) used a “face in the crowd” design to demonstrate that we can more easily and rapidly detect angry faces in a crowd of happy ones. Threat stimuli are processed with higher priority due to automatic threat detection systems that rapidly shift our attention (Feldmann-Wusterfeld, 2011).

Potential threats or dangerous situations require fast responses for survival (Goos & Silverman, 2002), and perception of each of these emotions has been shown to trigger physiological and/or behavioral responses that would facilitate survival. For example, a conspecific displaying a fearful facial expression signals that there may be danger in the shared environment. Recognizing this expression of fear in another triggers a physiological response that enhances awareness of our surroundings (Taylor, 2000). Similarly, a conspecific displaying an angry facial expression signals a potential attack or act of aggression (Goos & Silverman, 2002). Previous research has demonstrated that people are more sensitive to displays of anger in conspecific faces than other emotions, particularly when viewing male faces as males are more likely to externalize anger as aggressive action (Rotter & Rotter, 1988), and vigilance about displays of anger is heightened when women are in close proximity to children or infants (Ransom, 1981). Finally, a conspecific displaying a disgusted facial expression signals a potential source of contagion or violation of social norms in the environment (Aleman & Swart, 2008; Conway, 2007). Neuroimaging work has demonstrated that simply viewing a conspecific with a disgusted facial expression is sufficient to trigger neural activity consistent with the personal experience of disgust, suggesting that a conspecific displaying a disgusted facial expression can facilitate avoidance behaviors in an individual who may not even be aware of the source of the potential contagion or threat (Wicker et al., 2004).

Sex Differences in the Perception of Emotional Expressions

Evolutionary theory suggests that although threat detection would be beneficial to all, women may demonstrate superiority in emotion recognition especially when it comes to recognizing these threat-relevant emotions; the “Fitness Threat Hypothesis” (Hampson, van Anders, & Mullin, 2006) posits that this female superiority in negative emotion recognition arises because these negative emotions signal a potential threat to infant survival which requires a caretaking response to protect the infant. Because humans invest their reproductive resources in just a few offspring, it’s likely that humans have evolved precautionary behaviors to protect those limited offspring (Hahn-Holbrook, 2011). While both sexes are invested in offspring survival, the ability to detect potential threats quickly and accurately is of particular importance for the sex responsible for gestation (i.e., the mother) as well as the primary caregiver (which has traditionally been the mother; Babchuck, 1985). The observed female advantage in negative emotion recognition may therefore reflect the high energetic cost incurred during pregnancy (Hahn-Holbrook, 2011) as well as the fact that females have historically been the primary caretaker and are thus responsible for their offspring survival in addition to their own survival (see also the “Primary Caretaker Hypothesis; Babchuk et al., 1985). It is important to note that there are benefits for males being sensitive to emotional displays of threat, such as male-male aggression as a mating strategy (Goos & Silverman, 2002; Rotter & Rotter, 1988). However, the much of the existing research suggests that females generally show superiority in accuracy and response time when identifying emotional expressions.

Studies of emotion perception and recognition have repeatedly shown that women outperform men in emotion perception/recognition tasks (Thompson & Voyer, 2014) and show enhanced memory for highly emotional events (Canli et al. 2002). In their meta-analysis (Thompson & Voyer, 2014) lay out several ways in which females outperform males in emotion recognition tasks. They found that the female advantage is more pronounced under realistic conditions, meaning that the efficiency in which females can respond to emotional stimuli is higher when studies integrate visual and auditory stimuli (as compared to visual or audio alone). They also found that females were more accurate in identifying emotions in male actors compared to female actors, perhaps because male conspecifics may pose a greater threat due to differences in physical size and aggressive behavior.

Neuroimaging studies also support the notion of a female superiority in emotion perception. Women show more bilateral processing than do men, which suggests better interhemispheric communication and allows better integration of the emotional experience (Thompson & Voyer, 2014). Women also have been found to have more grey matter volume in specific parts of the limbic system involved in emotion processing such as the left hippocampus, the left amygdala and the insular cortex (Kong et al., 2014; Montagne, 2005; Good et al. 2003; George et al, 1996). We also see greater activation of the left amygdala in processing of memory for emotionally arousing material in women (Cahill, 2001), as well as a right hemisphere advantage in the processing of negative emotions (Schepman et al., 2012). Together, these findings suggest that women may have more specialized processing of negative emotions, supporting the fitness threat hypothesis (Thompson & Voyer, 2014).

In particular, past research has repeatedly shown a larger female advantage in the recognition of threat-relevant emotions specifically (e.g. anger, fear, disgust; Hampson et al., 2006). There is a growing body of evidence that suggests that there are specific sex differences in the recognition of disgust and anger, with women being more accurate than men (Campbell, 2002; Caseras, 2007). These findings are further supported by neuroimaging research demonstrating stronger amygdala activation in women compared to men in response to viewing disgust expressions (Aleman & Swart, 2008). Women also report higher disgust and fear ratings for aversive pictures and perceived those images as more negative and arousing than men (Schienle, 2004).

Role of Sex Hormones

Steroid hormones (i.e., sex hormones) may be a potential underlying mechanism of such sex differences as they play an important role in cognitive and emotional processing, in addition to their well-studied role in reproductive behavior and sexual dimorphisms in physiology (Osorio et al., 2018). In rodent models, exposure to estrogen levels that mimic pregnancy have been linked to increased dendritic spine density in the amygdala and hippocampus (Kinsley et al., 2006). In humans, increases in sex hormone levels have been linked to enhanced activity in a number of neural structures associated with the processing of emotional stimuli (e.g., amygdala, Goldstein et al., 2005; and the prefrontal cortex, Keenan et al., 2001). Indeed, based on an extensive review of the neuroimaging literature, Van Wingen and colleagues (2011) posit that neural activity in brain areas associated with emotional processes (e.g., the amygdala, medial prefrontal cortex, and orbitofrontal cortex) is associated with circulating sex hormones. Importantly for the current study, studies of responses to emotional displays from faces have also suggested that fluctuating levels of sex hormones may impact emotion recognition abilities (e.g., Derntl et al., 2008; Farage et al., 2008; Poromaa & Gingnell, 2014).

Recent studies examining attentional bias and/or sensitivity to emotional displays of threat have found that both estrogen and progesterone affect women's accuracy when detecting potential threats in their environments (Osorio, 2018). Women with higher levels of estrogen responded more vigilantly to negatively valanced words in a dot probe task (Graham et al, 2018), while women with higher progesterone were better detectors or threatening expressions when viewing face stimuli (Conway, 2007). Increased progesterone, in particular, has been suggested to be associated with increased response bias for negative emotions (Osorio et al., 2018). Conway et al. (2007) found that women were more sensitive to facial cues signaling nearby contagion and physical threat when their progesterone levels were high. A correlation between progesterone levels and amygdala response to emotional faces (Gingnell, 2014), especially fearful faces, has also been observed across several studies (Derntl, 2008; Van Wingen et al., 2008). Evidence for a causal relationship between hormone levels and neural activity comes from a study done by Van Wingen et al., (2008). Participants were administered progesterone during the early follicular phase which increased progesterone levels during typically observed during the luteal phase. This rise in progesterone led to increased amygdala activity in response to threatening faces (Van Wingen et al., 2008). In a review by Osorio and colleagues (2018) some studies have reported that increased progesterone levels were associated with global impairment of facial emotion processing – including increased response time, increased response biases and decreased accuracy of emotional judgement (Osorio et al., 2018; Conway et al., 2007). Alternatively, some studies found that increased progesterone levels were associated with improved recognition of fearful and disgusted expressions and increased response bias for angry expressions (Osorio et al., 2018; Derntl et al., 2008). Overall, there seems to be mixed results in respect to the potential influence of pregnancy hormones in relation to ability to encode emotional expressions. Although there is some mixed evidence, many studies have observed links between progesterone and responses to emotional stimuli that support the idea that progesterone increases during pregnancy may modulate women's responses to threat-relevant emotional displays.

Changes in Emotion Recognition During Pregnancy

Given the previously observed link between progesterone and sensitivity to emotional displays, it stands to reason that women may experience enhanced emotional sensitivity during life events that correspond to increases in progesterone; one such event is pregnancy. Pregnancy is characterized by extreme biological changes, including increases in gonadal hormones such as progesterone and estrogen (Alliende, 2002). Progesterone rises more than 10-fold during pregnancy (as compared to the "high progesterone" luteal phase of the menstrual cycle; Pearson-Murphy, 2001; Zonana et al., 2005). If progesterone increases sensitivity to potential threats, then increased progesterone during pregnancy may be beneficial for the survival of both mother and fetus, especially considering the physiological changes during pregnancy that may limit a female's ability to fight or flee a threat in the environment. Negative emotions may signal potential threats to both the mother and the fetus' survival, and thus may warrant enhanced attention during the vulnerable period of pregnancy.

To date, few studies have investigated how pregnancy impacts emotional recognition abilities, and those that do exist have looked at performance during different phases of pregnancy rather than comparing pregnant versus non-pregnant women. These studies have shown that women have higher accuracy in encoding emotional expressions signaling threat or harm during late pregnancy compared to early pregnancy suggesting elevated progesterone at later stages of pregnancy may contribute to enhanced abilities as pregnancy progresses (Pearson et al., 2009). Pearson and colleagues (2009) presented pregnant women with a facial expression recognition task from the "Schedules for the Assessment of Social Intelligence" (SASI) to assess their ability to encode facial expressions of emotion. Participants were tested two times, once before 14 weeks and again at 34 weeks. They found an improved ability to encode emotional faces during late pregnancy compared to early pregnancy. They found that the influence of late pregnancy on women's ability to encode emotional facial expressions was not limited by the expression itself (Pearson et al., 2009). They also found that symptoms of anxiety were associated with a greater ability to encode faces that signal threat, with increased ability from early to late pregnancy, which they attribute the rise in anxiety symptoms during late pregnancy to hyper vigilant emotion processing. Similarly, Roos et al. (2011) found that during pregnancy there is an association between increased selective attention to fearful faces, increased distress and altered prefrontal cortex function. Specifically, when comparing pregnant women to healthy controls, they found increased activation across the prefrontal cortex in response to fearful faces in pregnant women, particularly at trimester 2. Increased PFC activation during pregnancy was associated with general distress and state trait anxiety. While decreased activation was associated with selective attention to threat. Suggesting that during pregnancy prefrontal circuitry is altered allowing for increased response to potential threating stimuli (Roos et al, 2012). This increased responsiveness to threat may also be related to hormonal changes. Although these studies inform our understanding of how responses to threat may change during the stages of pregnancy, they do not determine if pregnancy is linked to enhanced threat detection as compared to a non-pregnant state.

The Current Study

The purpose of this study was to investigate whether pregnancy increases sensitivity to identification of threat-based emotions. To do this I compared pregnant females' to non-pregnant females' performance on an emotion recognition task. Given the well-documented endocrine changes that occur during gestation (i.e., progesterone levels will be much higher in pregnant vs non-pregnant women), this group comparison will allow me to speculate about the potential role of progesterone in emotion recognition. If progesterone upregulates emotion sensitivity generally, a main effect of pregnancy would be expected. If, however, progesterone upregulates threat detection specifically, then an interaction between pregnancy and emotion such that pregnant women show enhanced recognition of threatening emotions only would be expected.

Method

Participants

Eighty-eight women completed the study online. This sample represented 76% white, 11% Latina, .01% East Asian, and 11% mixed race women. An *a priori* power analysis indicated that 42 women were required in each group in order to obtain statistical power at the recommended .80 level with a between groups comparison effect size of (d=0.3). The final sample consisted of 43 pregnant women (mean age = 30.03, *SD* =5.01) and 45 control women (mean age = 31.17, *SD* = 9.13). There were no significant age differences between these groups $t(68.91) = 0.730$, $p= .467$, d=0.153. Although I had originally intended to only include women who did not report using hormonal contraceptives in the control group, data collection was impacted by COVID-19 and the control group includes 19 women who reporting using hormonal contraceptives. Participants were recruited through the Humboldt State University's SONA research participation pool and community-based sampling (i.e., adverts at local OBGYN offices, and online pregnancy forums/apps). All participants gave informed consent prior to participation.

Stimuli

Stimuli faces were obtained from the RADIATE face database (available online through http://fablab.yale.edu/page/assay-tools; Conley et al., 2018; Tottenham et al., 2009). This database contains 1721 images available in black, white and color (color images were used here; See Figure 1). The ethnically diverse stimulus set is useful by providing more diverse and representative stimuli that more accurately reflects the diversity of potential participants (Conley, 2018). These images depict the same individual displaying the six basic emotions (fear, anger, happiness, sadness, surprise, disgust). Following Pearson et al. (2009), 10 identities (5 male, 5 female) were randomly selected such that one identity from each of the four ethnic groups included in the database was represented for both male and female faces (with two white faces selected in order to achieve the target of 5 identities). Images of each of the six basic emotions were used for each identity for a total of 60 stimulus faces.

Figure 1. An example of the six different emotional expressions pulled from the RADIATE set (from top left: anger, disgust, fear, happiness, sadness, surprise)

Emotion Recognition Task

Following Pearson et al. (2009), a facial expression recognition task was used to assess ability to encode facial expressions of emotion. The task presented individual faces expressing one of six different emotions. Participants were asked to select which emotion the face displayed from a list of emotions. Options included the six basic emotions (happiness, sadness, fear, anger, disgust, and surprised; see Figure 2). Participants were given as long as needed to indicate their response. Stimuli were presented in a fully randomized order. This task generates accuracy scores out of 10 for recognition of each emotion (Pearson et al., 2009).

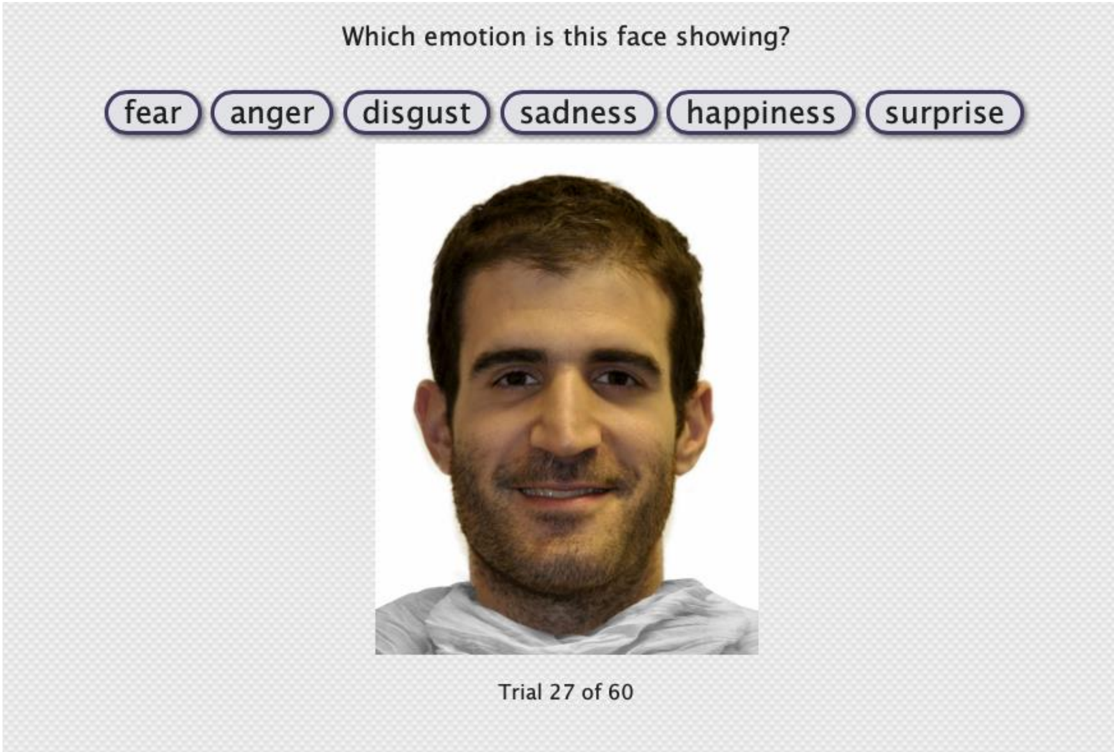

Figure 2. An example of participants view when completing the Emotion Recognition Task, including the six emotion type buttons.

Procedure

Due to COVID-19 all participants completed this study online. Participants were given an electronic consent form and asked to complete a demographic questionnaire followed by the emotion recognition task. The demographic questionnaire assessed participant age, ethnicity, and pregnancy status or contraceptive use. For the emotion recognition task, participants were given as much time as needed for the task and no individual trial feedback was given. At the end of the procedure, participants were debriefed regarding the nature of the study and assigned extra credit (if applicable) through the SONA participation pool website.

Analysis

Analyses was performed using R (4.0.3) a free software environment for statistical computing (R Core Team, 2019). A 2 X 6 analysis of variance (ANOVA) using the ezANOVA (4.4-0) package (Lawrence, 2016) to examine differences between groups (pregnant, non-pregnant) and emotions (happiness, sadness, fear, anger, disgust, and surprised).

Results

Main Analyses

A 2x6 repeated measures ANOVA was conducted to examine differences between groups (pregnant, non-pregnant) and emotions (happiness, sadness, fear, anger, disgust, surprise). There were no significant differences between the pregnant and control women in detecting emotions ($F(1,86) = 0.015$, $p = .901$ $\eta^2_G < .00$ see Figure 3) indicating that pregnant women were not more sensitive to emotional displays overall. There was a significant main effect for emotion ($F(5,430) = 130$, $p < .001$ $\eta^2_G = .544$); see Figure 5. To examine this effect of emotion type, post hoc pairwise comparisons were conducted using a Bonferroni correction. Results indicated that accuracy was different for all emotions except anger vs. disgust ($p = .99$) and sadness vs. fear ($p = .34$). As evidenced in Figure 4, women were most accurate in recognizing happiness (98.9%) followed by surprise (92.5%), anger (85.3%), disgust (83.9%), sadness (60.1%), then fear (53.4%). These results were similar to validity ratings for emotional expressions when developing the RADIATE face set, see Table 1 (Conley et al.,2018). Contrary to my hypothesis, there was no significant interaction between pregnancy status and emotion ($F(5,430) = 1.807$, $p = .110$, $\eta^2_G = .016$; see Figure 5).

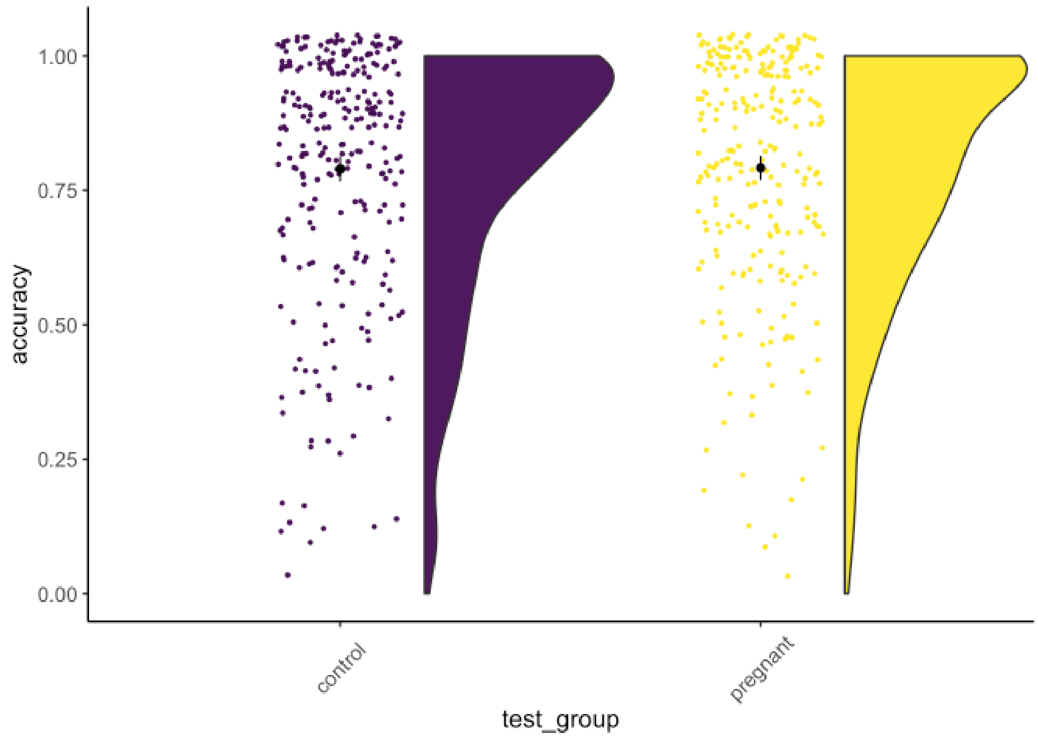

Figure 3. The non-significant main effect of pregnancy (*p*=.901) suggests that there were no differences in sensitivity to emotional displays generally between pregnant women and non-pregnant controls

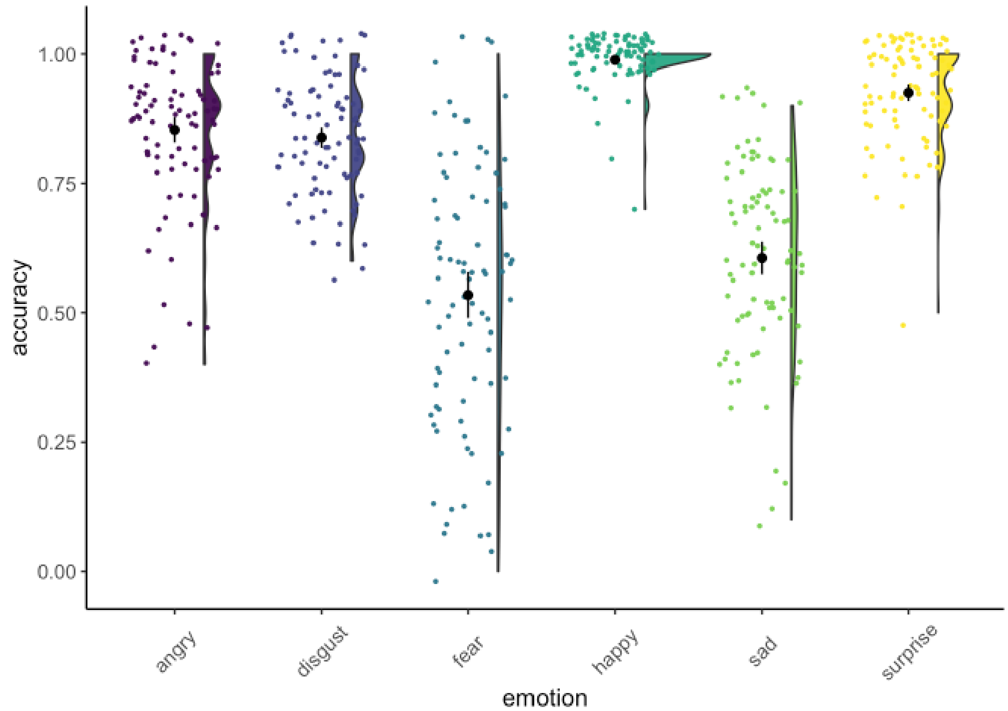

Figure 4. Main effect of emotion indicated that accuracy was different for all emotions except anger vs disgust (p = 1) and sadness vs fear (p = .34).

Table 1 Mean proportion correct by emotion type

Expression	Mean (S.D.) proportion correct Current Study	Mean (S.D.) proportion correct RADIATE
Angry	0.85 (0.13)	0.69 (0.24)
Disgust	0.83 (0.11)	0.81 (0.19)
Fear	0.53 (0.25)	0.48 (0.22)
Happy	0.98 (0.04)	0.98 (0.06)
Surprise	0.92 (0.09)	0.84 (0.14)
Sad	0.60 (0.18)	0.34 (0.24)

Note. Side by side comparison of accuracy of ratings for emotional expression categories from our study compared to the RADIATE face set (Conley et al., 2018)

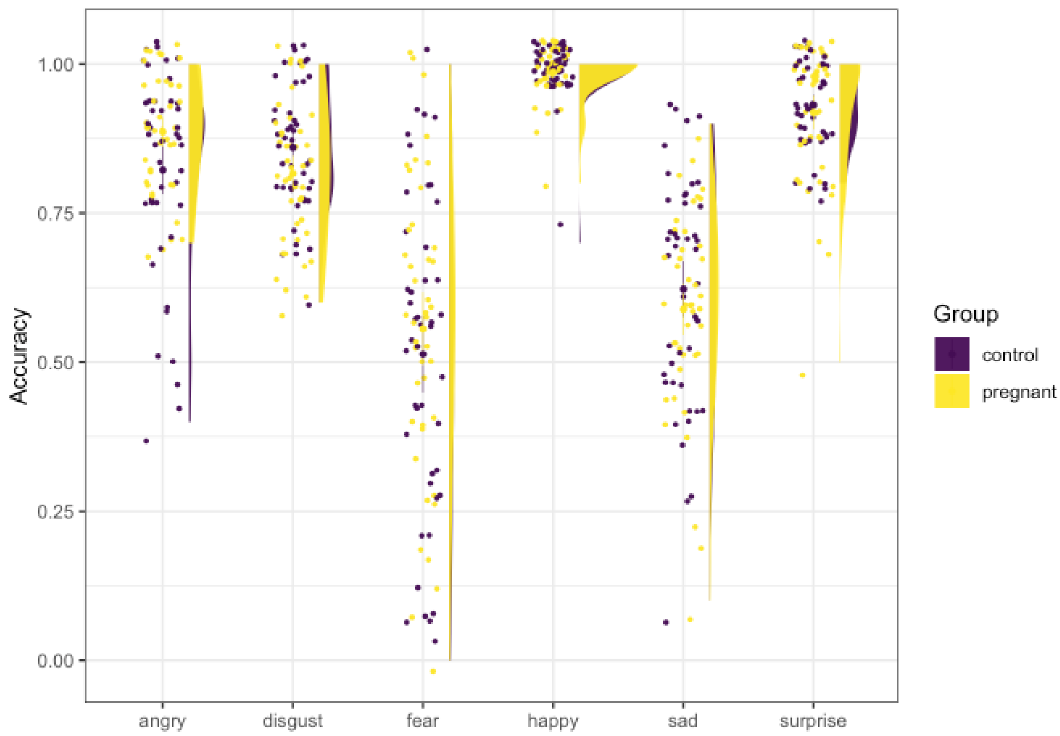

Figure 5. The non-significant predicted interaction between test groups and emotion (p=.110) suggests that there were no differences in sensitivity to emotional displays between pregnant women and non-pregnant controls by emotion type.

Exploratory Analyses

Although there was not a significant interaction between pregnancy status and emotion, this interaction term had a *p*-value of p=.11 in the model (notably, however, the corresponding effect size was small) and visual inspection of the interaction plot suggested there could be a group-level difference worth exploring for sensitivity to displays of anger. Given the theoretical reasoning to predict differences in the threat-based emotions, I compared pregnant versus control women's accuracy for recognition of anger using a paired-samples *t*-test. This exploratory analysis indicated that sensitivity to anger may in fact differ as a function of pregnancy status (t (72.96) =-2.23, p = .029, d=0.469), with pregnant women (M=88.6%) outperforming non-pregnant women (M=82.2%).

To confirm that contraceptive use did not impact the control sample (hormonal contraceptives can artificially elevate progesterone, although note that this effect is nowhere near the magnitude seen during pregnancy), a 2x6 ANOVA was run on the control sample comparing naturally cycling women to women using hormonal contraceptives. No significant effect of hormonal contraceptive use was detected(F(1,43)=0.131, p=.71, η^2_G=0.0006) nor was there an interaction between contraceptive use and emotion type (F(5,215)=0.261, p=.933, η^2_G=.0047)

Previous work investigating changes in sensitivity to emotions during pregnancy has suggested that sensitivity to threat relevant emotions (anger, fear, disgust) changed from early to late pregnancy (Pearson et al., 2009) with accuracy increasing as length of pregnancy increased. To explore whether stage in pregnancy impacted sensitivity to threat-relevant emotions, a multivariate multiple regression analysis was conducted with accuracy for anger, disgust, and fear as dependent variables and week of pregnancy as a predictor variable. However, this analysis indicated that there was no significant effect of pregnancy duration for any of the threat-relevant emotions (all $t < 1.24$, all $p > .22$).

Discussion

Given the fundamental importance of detecting potential threats in the environment, it has been suggested that humans display an attentional bias to threat. More recent research has suggested that women's attentional biases to threat may change throughout pregnancy. To date, few studies have investigated how pregnancy impacts emotional recognition abilities, and those that do exist have primarily looked at performance during different phases of pregnancy rather than comparing pregnant versus non-pregnant women. The current study aimed to determine whether pregnancy increases sensitivity to identification of threat-based emotions by comparing pregnant women to an age-matched non-pregnant control group in an emotion recognition task. Accuracy of emotion recognition was assessed for threat-relevant (anger, disgust, fear) and non-threat-relevant (happiness, sadness, surprise) faces. We hypothesized, if progesterone upregulates emotion sensitivity generally, then we should see main effect of pregnancy. If, however, progesterone upregulates threat detection specifically, then we should see an interaction between pregnancy and emotion such that pregnant women show enhanced accuracy in recognition of threatening emotions only.

Contrary to my hypothesis there was no significant interaction between pregnancy status and emotion type in observed recognition abilities, indicating that pregnant women were not more sensitive to faces displaying threat-relevant emotions than non-pregnant women were. There was also no main effect of pregnancy status, suggesting that pregnant women were not more sensitive to displays of emotion overall. Pearson and colleagues

(2009) observed improved ability to encode threat-relevant emotional faces during late pregnancy compared to early pregnancy while additional hormonal studies have implicated both estrogen and progesterone as upregulators of threat detection (Conway et al., 2007; Graham et al., 2018; Osorio et al., 2018). The current study does not support the prediction that the dramatic increases in both estrogen and progesterone that occur as a function of becoming pregnant increase sensitivity to threat-relevant stimuli. Given Pearson's finding that sensitivity to threat-based emotions changed from early to late pregnancy, I conducted an additional exploratory analysis with week of pregnancy as a predictor variable for recognition accuracy of the threat-relevant emotions (anger, fear, disgust) in the subset of pregnant women. This analysis did not indicate that week of pregnancy affected emotion recognition for any of the emotions. Of note, however, is the between-subject design utilized. This design is not ideal for detecting causal changes associated with becoming pregnant. A longitudinal design that assessed sensitivity to threat-relevant stimuli in women before and during pregnancy, or as they transition through different stages of pregnancy, would be better suited to answer this question.

There were, however, differences in recognition abilities for the 6 different emotions tested here. Participants were most accurate in recognizing happiness followed by surprise, anger, disgust, sadness, then fear. It is clear in looking at these data that participants did not display an advantage in the recognition of threat-relevant emotions overall. Notably, however, previous studies have consistently reported very high accuracy with the detection of happiness (Hampson et al., 2006).

An exploratory analysis suggested that pregnant women may show enhanced recognition of anger relative to non-pregnant women, however caution should be used when interpreting this finding given the lack of significant interaction between pregnancy and emotion in the omnibus analysis. The perception and recognition of anger is important for survival (Goos & Silverman, 2002). Traditionally anger displayed by males is more dangerous to females especially if they are carrying offspring. Females have shown more vigilance towards threating males or those in close proximity to infants (Goos & Silverman, 2002). There is reason to surmise that sensitivity to emotional displays of anger may be evolutionary beneficial for women (Rotter & Rotter, 1988). Future studies may benefit from examining differences in accuracy with male vs female faces. Research has shown that anger posted by males is more accurately perceived than anger posed by females (Goos & Silverman, 2002).

Limitations

Although it is possible to speculate about the potential role of steroid hormones (estrogen and progesterone) when comparing pregnant women to non-pregnant controls, the current study did not directly measure these hormones. Due to the scope of our research, we did not run hormone analysis for our participants. Significant increases in sex hormones during pregnancy allowed us to speculate about the role they play in emotion recognition. While we did not find a group difference it still may be valuable to examine the effects of hormones, especially including a more longitudinal design and larger sample size. Previous research has shown significant differences in emotion recognition as length of pregnancy increases (Pearson et al., 2009). As discussed earlier, sex hormones exponentially increase as pregnancy stage increases. A longitudinal, within subjects design may be better suited to examine the potential role that hormones play in emotion recognition.

It is important to note the time at which this data was collected; this data was collected during the COVID-19 pandemic. Heightened perceived risk may play a role in response to recognition of threat-based emotions. New studies have identified increased experiences of anxiety, financial insecurity, fear of infection and rumination associated with the COVID-19 pandemic (Kim, Nyengerai &Mendenhall, 2020). Additionally, the authors found that while most people did not think that COVID-19 affected their mental health they found a variety of stressors related to COVID-19 in about 20% of adults, including deep worry, anxiety, and rumination (Kim, Nyengerai &Mendenhall, 2020). This heightened state of anxiety could have influenced responses to identifying cues of threating emotions in our sample.

Conclusions

The current study aimed to determine whether pregnancy increases attentional bias to threat by comparing pregnant women to an age-matched non-pregnant control group in an emotion recognition task. Accuracy of emotion recognition was assessed for threat-relevant (anger, disgust, fear) and non-threat-relevant (happiness, sadness, surprise) faces.

Contrary to my hypothesis there was no significant interaction between pregnancy status and emotion type in observed recognition abilities, indicating that pregnant women were not more sensitive to faces displaying threat-relevant emotions than non-pregnant women were. There was also no main effect of pregnancy status, suggesting that pregnant women were not more sensitive to displays of emotion overall. Future studies including hormone analysis and changes across pregnancy may be better suited to examine the potential role that hormones play in emotion recognition.

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