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Original Article

Recognition of Novel Faces After Single Exposure is Enhanced During Pregnancy

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Abstract: Protective mechanisms in pregnancy include Nausea and Vomiting in Pregnancy (NVP) (Fessler, 2002; Flaxman and Sherman, 2000), increased sensitivity to health cues (Jones et al., 2005), and increased vigilance to out-group members (Navarette, Fessler, and Eng, 2007). While common perception suggests that pregnancy results in decreased cognitive function, an adaptationist perspective might predict that some aspects of cognition would be enhanced during pregnancy if they help to protect the reproductive investment. We propose that a reallocation of cognitive resources from nonessential to critical areas engenders the cognitive decline observed in some studies. Here, we used a recognition task disguised as a health rating to determine whether pregnancy facilitates face recognition. We found that pregnant women were significantly better at recognizing faces and that this effect was particularly pronounced for own-race male faces. In human evolutionary history, and today, males present a significant threat to females. Thus, enhanced recognition of faces, and especially male faces, during pregnancy may serve a protective function.

Keywords: pregnancy, cognition, face recognition

Introduction

Violence perpetrated by males against females has played a significant, albeit varied, role in primate evolutionary history (Smuts, 1992). Converging lines of evidence, including osteological (Martin and Frayer, 1997), ethnographic (Burbank, 1992; Hill and Hurtado, 1996; Shostak, 1981), and comparative (Boesch et al., 2008; Wrangham, Wilson, and Muller, 2006), suggest that conspecific males, including both in-group and out-group males, posed a significant threat to women. Women were recipients of lethal and non-lethal violence and may also have been abducted or killed in raiding attempts by neighboring groups.

Recent research is revealing cognitive processes designed to manage the threat posed by conspecific males. For example, Navarette et al. (2009) found that conditioned fear of out-group male exemplars resists extinction in male and female participants. They argued that, much like other fear-prepared stimuli (e.g., snakes and spiders), out-group males activate fear-preparedness mechanisms while in-group males and in-group and out-group females do not. Miller, Maner, and Becker (in press) have also found that male sex is a heuristic cue signaling threat. They used a threat-based framework drawing on Error Management Theory to show that heuristic cues influence threat categorization. Heuristic cues are useful in that they allow quick and efficient processing of threat and therefore serve a self-protective function. These self-protective mechanisms are sensitive to both target and perceiver factors. Heuristic cues that trigger self-protective mechanisms associated with the target include male gender, especially masculine males, while self-protective mechanisms associated with the perceiver include chronic vulnerability.

Because pregnancy impacts nearly all bodily systems, pregnant organisms are uniquely vulnerable. In the first trimester, when the fetus is undergoing organogenesis and the woman is immunosuppressed as a consequence of tolerating the foreign fetal genome, pregnant women often experience a host of symptoms including extreme fatigue and nausea and vomiting in pregnancy (NVP) (Lacroix, Eason, and Melzack, 2000; van Lier, Manteuffel, and Dilorio, 1993). A new set of challenges begins in the second trimester and continues into the third trimester, of which increased body mass is the most obvious. An increase of 10-12.5 Kg is typical in North American women (Dawes and Grudzinskas, 1991). Increased body mass as a result of pregnancy has been shown to inhibit locomotor performance, and hence modify foraging and predator avoidance behaviors. Pregnant lizards, birds, fish, and snakes (Ghalambor, Reznick, and Walker, 2004; Kullberg, Houston, and Metcalfe, 2002; Lee, Witter, Cuthill, and Goldsmith, 1996; Plaut, 2002; Schwarzkopf and Shine, 1992; Shine, 2003; Webb, 2004), have been shown to move more slowly and respond to environmental threats in a distinctive fashion compared to non-pregnant conspecifics. Thus, physiological changes associated with pregnancy modify threat avoidance behaviors across a variety of taxa.

Threat avoidance is salient for pregnant women who are not immune to male violence. Gazmararian et al. (2000) argue that violence towards pregnant women is common, with studies reporting rates of 4-8%, which is a higher prevalence than gestational diabetes and preeclampsia. Second only to motor vehicle accidents, homicide is the leading cause of death of pregnant and postpartum women in the United States (Chang, Berg, Saltzman, and Herndon, 2005). While most violence against pregnant women comes from partners, partner violence highlights the potential for male perpetrated violence in pregnancy (Burch and Gallup, 2004), and also makes plain the potentially profound costs associated with violence during pregnancy. Compared to non-pregnant women, pregnant women are not only more vulnerable, they also have more to lose as they increasingly invest their reproductive efforts in the current pregnancy.

Violence perpetrated against pregnant females may result in harm to the mother and the fetus, and has been found to negatively impact pregnancy outcomes. Rachana, Suraiya, Hisham, Abdulaziz, and Hai (2002) found that 21.9% of the 7105 women in their study reported physical violence during pregnancy and that physical violence in pregnancy was associated with obstetrical complications such as increased risk of cesarean section, abruptio-placenta, and fetal distress. These contemporary statistics highlight how costly non-lethal violence and abduction would have been for ancestral pregnant women due to the stress they would impose on the fetus.

Considering the emotional, physiological, and cognitive changes associated with pregnancy, an expansive range of psychological mechanisms designed to keep the mother and the fetus safe should be expected. However, scientific exploration of self-protective processes in pregnancy is still in its infancy. NVP is now thought to serve a protective function by limiting the ingestion of foods that may result in illness during a period when the mother is immunosuppressed (Fessler, 2002; Flaxman and Sherman, 2000). Even more relevant to our predictions, there is also evidence of self-protective social processing in pregnancy. Navarette et al. (2007) reported that women in their first trimester exhibit increased negativity towards out-group members. They interpret their results as reflecting a disease avoidance mechanism. Pathogen avoidance would be particularly important during the first trimester when the fetus is most susceptible to developmental perturbations and the woman is immunosuppressed. High progesterone, as is associated with pregnancy (Gregoire, 2005) and the luteal phase of the menstrual cycle, has also been shown to modify the way social information is processed. Conway et al. (2007) found that relatively high progesterone was associated with increased vigilance to threat in naturally cycling women.

While enhanced cognition during pregnancy should be predicted in order to safeguard the vulnerable mother and fetus, decreased memory function as the result of pregnancy is widely accepted and supported by past research (reviewed in Brett and Baxendale, 2001; Buckwalter et al., 1999; de Groot, Vuurman, Hornstra, and Jolles, 2006; de Groot, Hornstra, Roozendaal, and Jolles, 2003; Keenan, Yaldoo, Stress, Fuerst, and Ginsburg, 1998; Sharp, Brindle, and Brown, 1993). Although recent evidence suggests that the cognitive decline thought to occur as the result of pregnancy may have been exaggerated (Christensen, Poyser, Pollit, and Cubis, 2010; Crawley, Grant, and Hinshaw, 2008; Mickes, Wixted, Shapiro, and Scarff, 2008), brain imaging studies show that the hormones associated with pregnancy do result in a decline in visual face recognition (van Wingen, et al., 2007), and a majority of pregnant women report reduced cognitive and especially memory function during pregnancy (Crawley, 2002; Janes, Casey, Huntsdale, and Angus,1999). In contrast, Christensen, Poyser, Pollit and Cubis (1999) found that pregnant women have a recognition advantage when stimuli were pregnancy related. They argue that pregnant women will show improved memory function when the information is relevant. In light of the high stakes and vulnerability associated with pregnancy, enhanced memory function in pregnancy should be expected when the information is fitness-relevant.

Survival-related materials, including materials denoting threat, have been found to increase memory performance. In an eye tracking study paired with a disguised recognition task, Becker et al. (2010) found that, when self-protective mechanisms are triggered, women and men become more efficient at encoding facial information and that, despite truncated looking times, efficient coding of threatening faces results in enhanced recognition accuracy of out-group males. Otgaar, Smeets and van Bergan (2010) found that recall was enhanced when scenarios evoked survival processing. Thus, memory function is facilitated when materials denote threat and when self-protecting processing is activated.

Conspecific faces serve as an important tool for assessing the relative threat or safety in a given context. Faces denote a wealth of information and past research has shown that pregnant women are alert to facial cues (Jones et al., 2005; Navarette, Fessler, and Eng, 2007). Cues that signal a potential health impact have been found to be particularly salient to pregnant women. Navarette, Fessler, and Eng (2007) argue that sensitivity to health cues during pregnancy works much the same as NVP; women are sensitive to health cues for prophylactic purposes. Jones et al. (2005) found that women with high progesterone (i.e., pregnant women, women using oral contraceptives, and naturally cycling women in the luteal phase of the menstrual cycle), a hormone strongly associated with early pregnancy, also show increased attraction to apparent health in faces. They suggest that increased attraction to apparent health in faces during periods of high progesterone serves as a mechanism to avoid infectious disease during pregnancy when the fetus is vulnerable and the mother is immunosuppressed (Jones et al., 2005; reviewed in Jones et al, 2008).

The current research examines the possibility that pregnant women are more vigilant to social threats than non-pregnant women. We propose that pregnant women are better at detecting and remembering threatening stimuli, whether they are physical or social. As a consequence of our evolutionary history, and the unique threat that conspecific males may pose to vulnerable pregnant women, we predict that pregnant women will show improved memory of male faces but not female faces. Like Becker et al. (2010), we believe that increased vigilance to threat ultimately results in more efficient processing and enhanced memory function, and specifically facilitated face recognition. This study was part of a larger project examining how pregnancy impacts cognition and social perception.

Materials and Methods

The aim of this study was to test whether pregnant women are better able to recognize faces than non-pregnant women. We ran a between-subjects experiment with each participant viewing the male or the female face set. Groups of participants were matched on key demographic variables including age, household income, and IQ.

Participants: Male condition

The participants who viewed male models were 20 pregnant (age: mean = 29.05 years, ± 5.36, range = 20-38) and 20 non-pregnant women (age: mean = 27.05 years, ± 7.76, range = 19-44 years). IQ, as measured by the Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1997) (pregnant: mean = 106.15, ± 12.82, range = 85-137; non-pregnant: mean = 108.30, ± 12.94, range = 78-129), was matched across groups ($t_{38} = 0.53$, $p =$ n.s.), as was household income ($t_{34} = -0.19$, $p =$ n.s.). Participants also identified their ethnicity/race (White = 16 pregnant, 14 non-pregnant, Multiracial = 1 pregnant, 2 non-pregnant, Asian/Pacific Islander = 2 pregnant, 3 non-pregnant, East Indian = 2 non-pregnant, Aboriginal = 1 pregnant). Pregnant women were significantly more likely to be in a committed relationship, with 85% reporting being in a committed relationship compared to only 50% of the non-pregnant women in our sample ($t_{34} = -2.48$, $p = 0.02$). Pregnant participants were also more likely to have children, with 70% of pregnant women having one or more children compared to 30% of non-pregnant women ($t_{34} = -1.82$, $p = 0.08$). The results of one control participant and two pregnant participants were lost due to equipment failure (Table 5 shows demographic information by group). The excluded participants are additional participants not included in the analysis.

Participants: Female condition

The participants who viewed female faces were 19 pregnant (age: mean = 30.16 years, ± 4.17, range = 21-36) and 19 non-pregnant women (age: mean = 30.47 years, ± 5.67, range = 19-42 years). IQ, as measured by the WAIS (Wechsler, 1997) (pregnant: mean = 108.42, ± 13.41, range = 87-143; non-pregnant: mean = 108.39, ± 10.36, range = 94-130), was not significantly different between the groups (t_{34} = -0.01, p = n.s.), nor was household income (t_{34} = -1.10, p = n.s.). Participants again identified their ethnicity/race (White = 17 pregnant, 15 non-pregnant, Multiracial = 2 pregnant, 3 non-pregnant, Latino = 1 non-pregnant). Women in the pregnant group were significantly more likely to be in a committed relationship (t_{18} = -2.88, p = 0.01). The results of one control participant and one pregnant participant were lost due to technical error. The results of a second pregnant participant were excluded as she fell below the cut-off score of 70 on the WAIS (Wechsler, 1997) (Table 1). Again, the excluded participants are additional participants not included in the analysis.

Table 1. Demographic characteristics for pregnant and non-pregnant participants in the male and female conditions

Model Sex	Pregnancy Status	Age (years)	Percent in Committed Relationship	Annual Household Income ($)	WAIS
Male Condition	Pregnant (20)	29.05 (± 5.37)	85%	40,000-50,000	106.15 (± 12.82)
	Non-pregnant (20)	27.05 (± 7.76)	50%	40,000-50,000	108.30 (± 12.94)
Female Condition	Pregnant (19)	30.16 (± 4.17)	100%	50,000-74,000	108.42 (± 13.41)
	Non-pregnant (19)	30.47 (± 5.67)	68%	50,000-74,000	108.39 (± 10.36)

Participant comparison across conditions

Pregnant participants viewing the female face set had significantly higher household income (as measured in blocks) than pregnant participants viewing the male face set (Female Face set mean = 5.79, Male face set = 4.55) (t_{37} = -2.02, p = 0.05). IQ, as measured by the WAIS, was matched across groups (Female Face Set: mean = 108.42, ± 12.82, range = 85-137; Male Face set = 106.15, ± 12.94, range = 78-129), as was relationship status (Female Face Set: 100% Committed; Male Face set: 85% Committed) (t_{19} = 1.83, p = 0.08), age (Female Face set mean = 30.16 years, ± 4.17, Male face set = 29.05 years, ± 5.36) (t_{36} = 0.72, p = n.s., and motherhood (Female Face set mean = 63%, Male face set = 50%) (t_{37} = 0.81, p = n.s.). (The number of pregnant participants in the first through third trimester for the male and female conditions can be found in Table 2.)

Table 2. Participant characteristics: Pregnant participants, male and female condition

	1st Trimester	2nd Trimester	3rd Trimester
Male Condition	2	9	9
Female Condition	2	8	9

Non-pregnant participants viewing the male and female face sets were matched on all of the key variables including household income (Female Face set mean = 5.05, Male face set = 4.63) (t_{34} = 0.51, *p* = n.s.), IQ (Female Face set mean = 108.39, ± 10.36, Male face set = 108.05) (t_{37} = -2.02, *p* = 0.05), relationship status (Female Face set mean = 68%, Male face set = 53%) (t_{36} = 0.98, *p* = n.s.), age (Female Face set mean = 30.47 years, ± 5.67, Male face set = 27.05 years, ± 7.76) (t_{33} = -1.41, *p* = n.s.), and motherhood (Female Face set mean = 47%, Male face set = 26%) (t_{29} = 1.34, *p* = n.s.).

Procedure

The total set of 24 male and 24 female target face images came from six face database sets (The AR Face database, Martinez and Benavente, (1998) (Male models, *n* = 5); Minear and Park, (2004), (Male models, *n* = 14, Female models, *n* = 17); Nottingham Scans (http://pics.psych.stir.ac.uk/), (Male models, *n* = 4), (Female models, *n* = 1); US Prison Database, Florida (n.d.) (Female models, *n* = 6); Yale Face Database (Georgiades, Belhumeur, and Kriegman, 2001) (Male models, *n* = 1). An additional 141 male and 141 female face images were drawn from the above datasets to serve as distractor images. The images were altered with Photoshop in order to produce a uniform appearance: conspicuous clothing and jewelry were removed and size of face and background were standardized. The set includes faces ranging in age from early twenties to late seventies, and were of Black, Caucasian and East Indian origin (Table 3 shows the characteristics of the target faces).

Table 3. Face model characteristics by model sex

Model Sex	Apparent Age				Apparent Race		
	20	30	45	60 +	White	Black	East Indian
Male	11	10	2	1	20	3	1
Female	10	6	7	1	19	4	1

The training session of a surprise memory test was disguised as a health rating. In the training period, the "Perceived Health Rating", participants were seated in front of a Macintosh laptop computer. The program displayed the 24 target images of male or female faces in random order, each for 750 ms. Participants then rated the faces on how healthy they seemed on a scale of 1 (*not at all healthy*) to 7 (*very healthy*). Approximately an hour and a half later, after the participants had completed the WAIS (Wechsler, 1997), the test period occurred. In the test, the participants were again seated in front of a Macintosh laptop computer. They were shown twenty-seven displays consisting of a six-photo line-up with three faces images presented in the top half of the screen and three face images presented in the bottom half of the screen. Twenty-four of these displays contained one target image from the original health rating grouped with five foil face images. Foils were selected to match for apparent race, approximate age, and facial hair. Three of the displays contained only foil images. Displays containing only foil images forced participants to chose a face and were not included in the analysis. The program displayed the six photo-line ups in randomized order. The position of the target face was also presented in random order within the six-photo line-up. Participants were asked to select the one familiar face from the initial health rating, as quickly and as accurately as possible, using the keypad.

Results

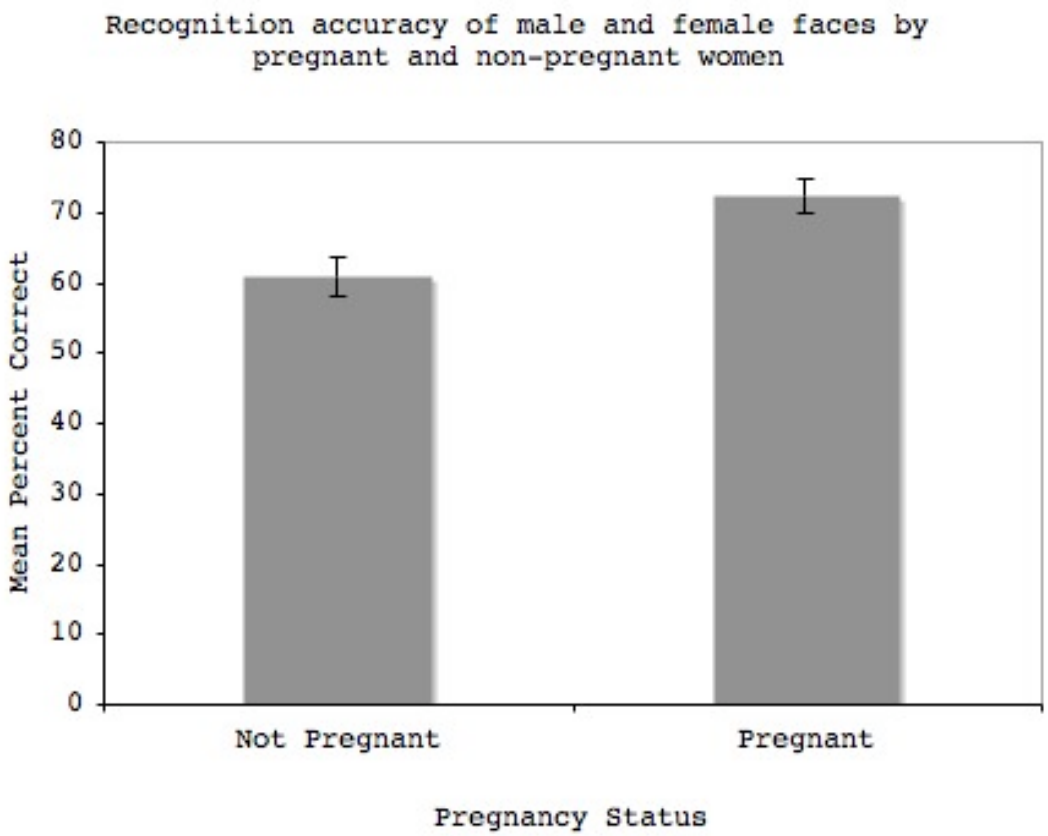
We used an ANOVA to compare the four groups of participants: Pregnant and non-pregnant in the male model condition and pregnant and non-pregnant in the female model condition. We found a significant main effect of pregnancy [$F_{1,74} = 8.30$, $p = 0.005$], with pregnant women showing enhanced recognition of faces (Pregnant mean correct = 72.48%, ± 15.13; non-pregnant mean correct = 60.79%, ± 16.80). The main effect of model gender was not significant [$F_{1,74} = 0.64$, p = n.s.]. The pregnancy by model gender interaction was also not significant [$F_{1,74} = 2.41$, p = n.s.] (Figure 1).

As apparent health in faces has been shown to be particularly salient to pregnant women (Jones et al., 2005) we next examined whether the initial health ratings influenced recognition accuracy for pregnant or non-pregnant participants. A regression with the initial health rating score as the predictor variable and recognition accuracy as the dependent variable showed that the initial health rating did not predict recognition for pregnant or non-pregnant participants in the male condition [$F_{3,36} = 3.47$, p = n.s.] or the female condition [$F_{3,34} = 0.64$, p = n.s.].

Controlling for the other-race effect

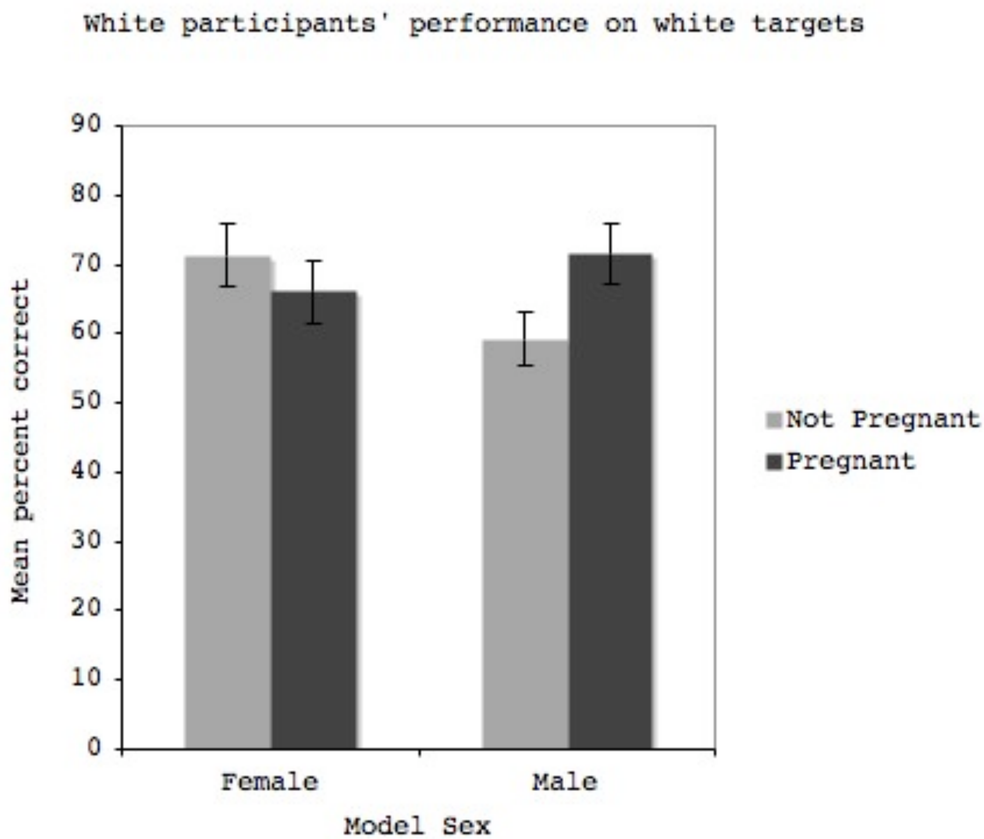
Past research has shown that the other race effect influencing recognition is robust; participants consistently show enhanced recognition of own-race over other-race faces (Meissner and Brigham, 2001). Since the majority of our participants were White and target images were apparently White, we next performed an ANOVA of White participant's performance on White targets in order to eliminate noise caused by the other race effect. Here we found a significant model sex by pregnancy interaction [$F_{1,53} = 3.90$, $p = 0.05$], (Pregnant mean correct Male condition= 71.56%, ± 17.39, Pregnant mean correct Female condition = 66.14%, ± 20.02 ; Non-pregnant mean correct Male condition = 59.23%, ± 14.27, Non-pregnant mean correct Female condition = 71.33%, ± 15.90). Neither of the main effects were significant [Model Sex: $F_{1,53} = 0.21$, p = n.s.; Pregnancy = $F_{1,53} = 0.65$, p = n.s.]. Follow-up tests using the Bonferroni correction revealed that White pregnant women are better than White non-pregnant women at recognizing White male, but not White female, faces ($t_{27} = -2.05$, $p = 0.05$) (Figure 2).

Figure 1. Recognition accuracy of male and female faces by pregnant and non-pregnant women (error bars indicate SEM)



Finally, past research has also suggested that out-group males elicit specialized threat processing. We therefore examined whether out-group faces influenced recognition accuracy for pregnant or non-pregnant participants. We ran a 2X2X2 mixed-design ANOVA with group membership status as the within subject factor (out-group vs. in-group) and model sex (male vs. female) and pregnancy status (pregnant vs. non-pregnant) as between-subject factors. Results revealed a significant model sex by pregnancy interaction [$F_{1,53}$ = 6.97, p = 0.01.]. The main effect of pregnancy was not significant [$F_{1,53}$ = 0.19, p = n.s.], nor was the main effect of model sex [$F_{1,53}$ = 0.70, p = n.s.] or group membership [$F_{1,53}$ = 1.42, p = n.s.]. The group membership by pregnancy interaction was also not significant [$F_{1,53}$ = 0.82, p = n.s.]. Follow up tests of simple main effects using the Bonferroni correction showed that pregnant women are significantly better at recognizing out-group males, but not females, compared to non-pregnant women (Pregnant mean correct Male condition= 81.25%, ± 26.62, Pregnant mean correct Female condition = 69.88%, ± 25.36; Non-pregnant mean correct Male condition = 55.77%, ± 29.14, Non-pregnant mean correct Female condition = 76.67%, ± 18.75) (t_{27} = -2.46, $p < 0.05$). These results do need to be interpreted with caution as of the 24 target male faces only 4 were out-group (three black and one East Indian), and for the 24 target female faces only 5 were out-group (one East-Indian and four black).

Figure 2. Recognition accuracy of White male and female faces by White pregnant and non-pregnant women (error bars indicate SEM)



Discussion

Using a disguised recognition task we found that, compared to non-pregnant women, pregnant women show enhanced recognition of faces. Faces convey information about the relative threat or safety of a given context and may therefore serve as a critical resource to vulnerable pregnant women invested in the safekeeping of their reproductive investment. Past research has found that memory function is enhanced when fitness-relevant information is presented (Becker et al., 2010; Otgaar et al., 2010). Our results demonstrate that memory in special populations may be facilitated when the stimuli presented are especially relevant.

Pregnancy is energetically costly and somatically demanding. Increased vigilance to faces may be a low-cost means of attending to threat and pregnant women who were especially vigilant to the information presented by faces may have had a fitness advantage over pregnant women who were less attentive. This increased vigilance results in enhanced memory function of fitness-relevant information: male and female faces. As has been found in other species (Shine, 2003; Schwarzkpof and Shine, 1992; Lee et al., 1996) pregnant humans exhibit increased vigilance to threat cues in their environment in order to effectively implement threat avoidance behaviors at a time when the physiological changes associated with pregnancy result in impeded mobility, NVP, and extreme fatigue that limit the ability to effectively defend against environmental stressors and dangers. Hence, faces are cues that pregnant women may use in order to successfully navigate their environment.

In contrast to our threat-avoidance hypothesis for increased recognition of faces in pregnancy, an alternative hypothesis is suggested by past research: pathogen-avoidance. Jones et al. (2005, 2008) suggest that women with high progesterone profiles, such as is found in pregnancy, show increased attraction for apparent health in faces as a mechanism for avoiding infectious disease. Pregnant women have also been shown to exhibit increased ethnocentrism in the first trimester of pregnancy, a result that has also been attributed to a pathogen avoidance mechanism (Navarette, Fessler, and Eng, 2007). Apparent health in the individual models as measured by the initial health ratings did not impact recognition accuracy for pregnant or non-pregnant women, suggesting that these data are not best explained by a pathogen-avoidance mechanism. However, given that we had so few participants in the first trimester of pregnancy when disease-avoidance is most salient, our sample did not adequately allow a test of the impact of pathogen-avoidance on recognition of faces during pregnancy. Had we been able to separate trimester effects and analyze women in the first trimester, when the fetus is most vulnerable to pathogens, it is possible that we may have seen a different pattern of results. While the pathogen-avoidance, and violence-avoidance hypotheses are not mutually exclusive, our results suggest that pregnant women are vigilant to faces in general and to male faces in particular.

When we limited our analysis to White participant's performance on White targets, eliminating interference from the own-race effect, we found that pregnant women show enhanced recognition of male, but not female, faces. In examining recognition accuracy of out-group males we also found that pregnant women show enhanced recognition of male, and not female, faces. Moreover, when all targets and perceivers are included, our results suggest that pregnant women have enhanced recognition of male faces, not in comparison to female faces, but in comparison to non-pregnant women. If we take non-pregnant women to be the female baseline, then women have facilitated recognition of female compared to male faces. Indeed, a large body of research suggests that humans from infancy show facilitated processing of female faces and that adult women and girls exhibit increased recognition of females (Ramsey-Rennels and Langlois, 2006; Lewin and Hertlitz, 2002; Rehman and Herlitz, 2006). What is most interesting about our results, then, is why pregnant women show enhanced recognition of male faces and why male faces are equally as memorable to pregnant women as female faces. Evidently, pregnant women are especially vigilant to stranger males.

Our results contribute to an emerging body of empirical evidence that suggests that conspecific males trigger self-protective mechanisms in men and women. Out-group males in particular have been found to activate self-protective processing. Thus, enhanced recognition of male faces in pregnancy may be explained by these same self-protective mechanisms. Given that males present a significant threat to pregnant and non-pregnant women, one might expect that vigilance towards males would translate into facilitated recognition regardless of reproductive status. However, pregnant women are not only more vulnerable to violence as a result of the physiological challenges associated with pregnancy; their fetus is also vulnerable. Pregnant women may be extending their out-group, and thus their vigilance, to all unfamiliar males, although perceiver and target race may mediate this effect. In hominid evolutionary history males presented a threat; women were at risk of violence from in-group and out-group males. Vigilance towards this threat, and violence-avoidance mechanisms, are evidently a component of cognitive processing in pregnant women.

This study is an initial step in exploring adaptive cognitive changes in pregnancy. Future research will explore the mechanism underlying pregnant women's enhanced recognition of faces. Future research should also consider individual differences in pregnant women, such as physical condition and access to resources, and delineate the distinct challenges that occur within each trimester. Finally, future research could also obtain menstrual cycle information from non-pregnant participants. Evidence suggests that menstrual cycle phase influences cognitive processing of male, but not female, faces (Roberts, Newell, Simoes-Franklin, and Garavan, 2008), alters face preferences (Penton-Voak et al., 1999) and that naturally cycling women in the peak progesterone phase of the menstrual cycle are more attentive to threat than women in other phases of the menstrual cycle (Conway et al., 2007). Menstrual cycle phase may allow a different pattern of results to emerge.

Pregnancy is a unique life phase characterized by specific adaptations designed to keep the fetus and the mother safe. While faces in general provide critical information, social others, and especially conspecific males, present a significant source of threat to women, including pregnant women, and psychological mechanisms designed to mitigate this threat are emerging. Just as NVP may result in a fitness advantage, pregnant women and their fetuses may benefit from increased vigilance towards, and recognition of, faces. Kinsley (2008) has argued that the demands of motherhood result in a superior "maternal" brain. There is no reason to confine cognitive advantages to the postpartum period. We would suggest that certain advantages of a maternal brain, insofar as one exists, begin at conception.

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