

Facial recognition during early motherhood: Investigating the persistence of age and affect biases

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Highlights

- Emotion facial recognition speed was assessed in mothers within one year postpartum
- Mothers responded to happy and sad infant and adult faces in a morph task
- The happy face advantage and the own-age bias were present in mothers
- Findings replicate the results of prior research during pregnancy

Abstract

Converging evidence demonstrates increased levels of sensitivity to infant faces in mothers. This may be reflective of a series of psychological and neurobiological changes that occur in the transition to, and during, early parenthood for the purpose of appropriate caregiving; however, this enhanced infant facial recognition is in contrast with the general adult literature regarding facial processing. In the current study, we aimed to replicate a prior study of emotion facial recognition in pregnant women in a sample of mothers with children under a year old, utilizing a paradigm in which adult and infant faces gradually changed from neutral expressions to either happy or sad expressions. Mothers were faster at the recognition of adult faces in comparison to infant faces, and were also faster at happy faces in comparison to sad faces.

Results are discussed in context of the current processing literature regarding the perinatal period, and implications for the persistence of the own-age bias and happy face advantage are considered.

Keywords: motherhood; postpartum; facial recognition; emotion recognition; happy face advantage; own-age bias

Classification codes: 2300; 2323; 2340; 2956

1. Introduction

The ability to process and understand the facial expressions of those around us is an integral part of daily human interactions (Darwin & Prodger, 1998). It is one of the most important factors in our ability to communicate and interact with others (e.g., Fridlund, 1991). Its significance is further emphasized in the interactions between a caregiver with their infant, in which the use of facial expressions is one of the critical ways in which a young child is able to communicate (Ferrey et al., 2016). It has been suggested in previous research that in the transition to parenthood, parents—with research focusing primarily on mothers—undergo a series of psychological and neurobiological changes that prepare them for caregiving (e.g., Mayes, Rutherford, Suchman, & Close, 2012). For example, converging evidence demonstrates increased levels of sensitivity to auditory and facial infant cues in mothers when compared to non-mothers (Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006; Purhonen et al., 2001). These appropriate levels of responsiveness and sensitivity from a caregiver are essential to nurturing healthy development in the child (Barba-Müller, Craddock, Carmona, & Hoekzema, 2019; Kim, 2016).

These shifts in sensitivity towards infant cues, particularly facial cues, may be at odds with patterns of behavior of typical adult face recognition. Two biases present in facial processing in the general population are the *own-age bias* and the *happy face advantage* (e.g., Kirita & Endo, 1995; Rhodes & Anastasi, 2012). The own-age bias is the tendency of having better memory for faces that are part of one's own age group in comparison to faces of another age group. Thus, as an adult, memory tends to be superior for adult faces, rather than child or infant faces (Rhodes & Anastasi, 2012). This is thought to occur because individuals are most likely to have higher levels of contact and exposure, and thus more expertise, in the process of recognizing one's own age group (e.g., Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008; Valentine, 1991). The second bias is linked to affect; it has been repeatedly observed that, when compared to sad faces, happy faces are processed more quickly and holistically. This is partially thought to be explained by the unique changes in facial features for happy faces in

comparison to other emotional expressions, as happy features tend to have less overlap with other emotions (Johnston, Katsikitis, & Carr, 2001) and can also stand alone as a representation of happiness (e.g., a smile; Adolphs, 2002). The happy face advantage follows a larger general trend, in which positive stimuli are more quickly categorized than negative stimuli, even in the case of words or non-social pictures (e.g., Matlin & Stang, 1978).

However, it should be noted that a majority of facial processing research that establishes these biases primarily utilizes adult or adolescent faces. Less information is known overall about the processing of infant faces, despite the fact that infant faces differ structurally from other age categories. Conceptualized by Lorenz (1943, 1971) as *Kindchenschema*, or baby schema, infant facial features tend to be configured with larger heads, more expansive foreheads, bigger eyes, and more rounded cheeks. These features overall are typically perceived as more cute and attractive, thus prompting a differing response in the general population in comparison to adult faces (e.g., Endendijk, Spencer, van Baar, & Bos, 2018; Glocker et al., 2009; Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010). Therefore, as the structure of, and the response elicited by, an infant face differs in comparison to an adult face, the examination of facial processing as it pertains specifically to infant faces, rather than the adult faces typically used in the general literature, warrants further investigation.

Due to the aforementioned changes that happen during the transition into parenthood (e.g., Hoekzema et al., 2017; Kim, Strathearn, & Swain, 2016; Mayes et al., 2012) and the differential features of infant faces, previous research has investigated how two of the consistent biases in facial processing—the own-age bias and the happy face advantage—may or may not differ during early parenthood or when infant, in comparison to adult, faces are used. There is some evidence that mothers, in comparison to non-mothers, have greater attentional engagement with emotional expressions and infant faces. These cues are thought to be biologically salient to the mother while also generating an incentive for caregiving behaviors (e.g., Ferrey et al., 2016; Thompson-Booth et al., 2014a; Thompson-Booth et al., 2014b). This maternal bias towards infant emotion has also been found at a neurobiological level, with maternal

response differing in regards to infant crying in comparison to laughter (Seifritz et al., 2003). The findings of these studies suggest that increased attentional allocation to infant distress may be an essential part of the parent-child interaction, as it allows the mother to prioritize relevant infant signals and subsequently react in a sensitive and appropriate way to resolve the source of distress (Thompson-Booth et al., 2014b). Attention to distress is important not only in the immediate moment of caregiving, but also in the formation of long-term mother-child attachment and overall development of the child (e.g., Ainsworth, 1979; Goldberg, Grusec, & Jenkins, 1999; McElwain & Booth-LaForce, 2006).

Building upon this research, Byrne et al. (2019) investigated whether or not differences in facial age and affect recognition occurred in pregnant women viewing infant and adult faces. To address this, an experimental paradigm in which faces slowly morph from a neutral expression to a happy or sad expression was employed. Facial morphing tasks such as this have been widely employed to measure emotion recognition (e.g., Joormann & Gotlib, 2006; Lowyck et al., 2016). Byrne et al., (2019) found that pregnant women were faster and more accurate at the recognition of adult faces and happy faces (across infant and adult faces), with the fastest and most accurate category being adult happy faces, and the slowest and least accurate category being sad infant faces (Byrne et al., 2019). Although these findings are supported by the general adult literature (i.e., own-age bias and happy face advantage; Kirita & Endo, 1995; Rhodes & Anastasi, 2012), research around maternal attention allocation literature would suggest that a mother would be the fastest and most accurate at recognizing sad infant faces. Further understanding of maternal facial processing is critical, as emotion recognition may provide a mechanism by which mothers are able to respond appropriately and sensitively to the needs of their infant. This communication process is integral to the formation of a robust and healthy attachment between mother and infant, and evidence overwhelmingly indicates that healthy attachment is one of the most important factors in a child's development (e.g., Bowlby, 1997; Snyder, Shapiro, & Treleaven, 2012).

Given the significance of maternal facial processing, and in light of the potential implications for later development, the current study investigates and seeks to replicate the aforementioned findings of

Byrne et al. (2019). As Byrne et al. (2019) employed a sample of women in pregnancy, the goal of the current study is to extend usage of the same facial morph paradigm in order to examine facial affect recognition in an independent sample of recent mothers. We present competing hypotheses. On the one hand, in light of recent evidence (Byrne et al., 2019), we hypothesized that mothers will more quickly recognize affect in both own-age and happy faces, patterns which are consistent with the general adult literature. On the other hand, given the increased saliency of infant cues to mothers, particularly infant distress, we hypothesized that mothers may also demonstrate faster recognition of affect in sad infant faces.

2. Methods and Materials

2.1. Participants

70 mothers, independent of the sample utilized in Byrne et al. (2019), participated in the current study. All participants were recruited through the Yale Baby School (YBS) database, which is an educational research collaborative that recruits women who have recently given birth in local community hospitals (<https://babyschool.yale.edu/>). The women completed the current task as part of an introductory visit to the YBS. The women (M age = 32.59 years, $SD = 7.168$) classified their ethnicity as either non-Hispanic ($n = 58$) or Hispanic ($n = 12$). A majority of women ($n = 61$) were either married or in a domestic partnership. As an estimate for socioeconomic status, all mothers also reported their highest level of education; 6 mothers had completed a high school diploma or less and 63 completed some form of higher education past a high school diploma, with data missing on 1 mother. The sample consisted of both first-time ($n = 24$) and experienced ($n = 46$; M children = 2.39; range of 2 to 6) mothers. The mothers also reported the length of the postpartum period since their most recent child ($M = 2.90$ months; $SD = 4.53$) and whether their most recent child was female ($n = 32$) or male ($n = 38$). Information on feeding mode was also collected, with 41 mothers solely breastfeeding, 14 solely formula feeding, and 15 doing a combination of both. A full breakdown of all demographic information collected

on the sample is presented in Table 1. Yale School of Medicine's Human Investigation Committee approved all procedures prior to recruitment. All participants consented to participation and were compensated for their involvement.

Characteristic	<i>n</i> (%)
Maternal Age (years), mean \pm <i>SD</i>	32.59 \pm 7.168

Ethnicity	
Non-Hispanic	58 (83%)
Hispanic	12 (17%)
Relationship Status	
Single	7 (10%)
Never Married	2 (3%)
Married or in domestic partnership	59 (84%)
Divorced	2 (3%)
Education Level	
Some high school	1 (1%)
High school diploma	5 (7%)
Vocational or trade school	2 (3%)
Some college	10 (14%)
Associate's degree	4 (6%)
Bachelor's degree	5 (7%)
Master's degree	10 (14%)
Bachelor's or master's degree	22 (31%)
Doctoral degree	10 (14%)
N/A	1 (1%)
Parity	
Primiparous	24 (34%)
Multiparous, mean; range	46 (66%), 2.39; 2-6
Postpartum Period (months), mean \pm <i>SD</i>	2.90 \pm 4.53
Hours with Infant, mean \pm <i>SD</i>	22.29, \pm 3.72
Sex of Infant	
Male	38 (54%)
Female	32 (46%)

Feeding Mode	
Breastfeeding	41 (59%)
Formula feeding	14 (20%)
Both breast and formula feeding	15 (21%)

Table 1. Demographic characteristics for all participants (n = 70).

2.2. Design

Procedure: All procedures were completed within a designated research room. As part of the broader visit, participants first viewed an oral presentation of the YBS and completed consent forms. They then completed demographic measures and self-report questionnaires. Following the self-report questions, participants completed a facial morph task. The task has been utilized and described in full detail in previous studies (e.g., Byrne et al., 2019). The facial morph task consists of the transformation of a neutral expression into either a happy or sad expression, for both adult and infant faces. Participants read the on-screen instructions themselves and were also offered the opportunity to have the instructions read aloud to them for clarification before beginning the task. During the task, they selected buttons on the screen labelled “happy” or “sad” as soon as they were able to recognize the emotion expressed by the face. Participants were able to change their response as many times as desired, and could do so until the full facial emotion appeared. The participants had a practice trial to familiarize themselves with the task requirements while a research assistant monitored for participant understanding. The entire facial morph task took approximately 10 minutes to complete.

Face Stimuli Description: The stimuli were presented on a Dell Optiplex 7010 computer, using a 17-inch LCD monitor at a screen resolution of 1280 x 1024. The experiment was run using E-Prime 2.0 (Schneider, Eschman, & Zuccolotto, 2012). There were four morph conditions (happy adult, sad adult, happy infant, and sad infant) with 14 trials each for a total of 56 trials. Seven different adult and seven

different infant facial identities were randomly presented. The morphs were created utilizing MorphAge software (MorphAge version 4.0, Creaceed, at <http://www.creaceed.com>). The NimStim Set of Facial Expressions (Tottenham et al., 2009) provided the adult face stimuli. The NimStim models (closed mouth) used for this experiment were 01, 02, 09, 23, 24, 34, and 36. Infant faces were obtained from a former study by Strathearn and McClure (2002). All models were Caucasian and unfamiliar to the participant. To address potential intensity level differences between each of the full-blown emotional expressions, 24 nulliparous females (mean age 24 years; SD 3 years) rated each full-blown emotional face (happy, sad, infant, adult) employing a scale from “1” – “not at all intense” to “7” “very intense”. Happy faces ($M = 4.36$; $SD = 0.60$) were rated as less intense than sad ($M = 5.07$; $SD = 0.72$) faces, $t(23) = -6.23$, $p < .001$. Infant ($M = 4.82$; $SD = 0.75$) and adult ($M = 4.61$; $SD = 0.58$) faces were rated as comparable in their intensity, $t(23) = -1.69$, $p = .10$.

Faces were presented in grey scale inside of a black box, located centrally on a white screen. All faces were approximately 8cm x 11cm. After the initial face presentation, the participant had to click to begin the morphing. Once started, the morph involved 20 total frames, with 500ms allotted per frame. Each frame increased emotional expression in 5% increments, until 100% expression was presented and the trial ended. In total, each trial took at least 10,000ms, but time could be increased by either waiting to click to begin the trial, or by waiting to make a response until the complete facial expression appeared. An example presentation of the adult happy condition is presented in Figure 1.



Figure 1. Examples of the face stimuli for a trial in the adult happy condition. Faces here are shown at the initial frame, frame 7, frame 14, and the final frame, with intermediate morphs also presented. Participants respond as soon as they recognize the emotional expression.

2.3. Self-Report Measures

Demographic Questions: Participants began by reporting a variety of demographic information about themselves, as represented in Table 1.

Generalized Anxiety Disorder, 7-item: The GAD-7 (Spitzer, Kroenke, Williams, & Löwe, 2006) was completed by participants before the task. The GAD-7 is a 7-item self-report measure of anxiety symptoms that have been experienced in the last two weeks. Respondents report how much each symptom has bothered them on a scale of “not at all” to “nearly every day”, and can score between 0 (very little anxiety) and 21 (severe anxiety). Participant levels of anxiety can be classified as mild (5-9), moderate (10-14), or severe (15-21). This measure has been well-tested and established as a reliable measure of anxiety symptomology (Spitzer et al., 2006). The mean score for the GAD-7 was 2.68 (median = 2.00, $SD = 3.13$), indicating overall low levels of anxiety in this sample.

Patient Health Questionnaire, Short Form: The PHQ-2 (Kroenke, Spitzer, & Williams, 2003) was completed by participants before the task. The PHQ-2 is a 2-item self-report measure of depressive symptoms that have been experienced in the previous two weeks. Participants report how much each problem has bothered them on a scale of “not at all” to “nearly every day”, and can score between 0 (minimal depression) and 6 (serious depression). Participants are considered to have a positive screen when they score a 3 or above. This measure has been thoroughly researched for both reliability and validity in the measurement of depression (Kroenke et al., 2003). The mean score for the PHQ-2 was 0.38 (median = 0.00, $SD = 0.74$), indicating minimal levels of depression in this sample.

2.4. Data Analysis

4 women were excluded from data analysis due to either incompleteness of the task ($n = 1$), situational distraction such as a fussing infant ($n = 2$), or as an extreme outlier based on their reaction time during the task ($n = 1$). There were no demographic differences between excluded mothers and those included in the analysis. Data from a total of 66 women was then analyzed.

Mean reaction times (RTs) were calculated in milliseconds (ms) for the four morph conditions: happy adult, sad adult, happy infant, and sad infant. Only the participant's initial response was included in the analysis. The mean accuracy for each response was also calculated for the participant's first response as a proportion, in which a score of 1.00 is equivalent to 100% accuracy across all trials within a condition. Only trials with correct responses for each condition were included in analyses. RTs were not normally distributed and were log transformed for analysis purposes. Log transformation improved the skewness and distribution of the data, justifying this approach.

For the main analysis, mean log-transformed RT was analyzed using a 2×2 repeated measures ANOVA, with within-subjects factors of facial age (adult vs. infant) and facial affect (happy vs. sad). Partial eta squared (η^2) was also calculated to examine effect size, where .01 represents a small effect size, .06 represents a medium effect size, and .14 represents a large effect size (Cohen, 1988).

3. Results

3.1. Preliminary Analysis

Accuracy was highest for adult happy faces ($M = .99$, $SD = .03$), followed by adult sad ($M = .98$, $SD = .04$), infant happy ($M = .97$, $SD = .06$), and infant sad faces ($M = .83$, $SD = .15$). To be more representative of the data analyzed, Figure 2 presents the anti-log of the mean RTs for correct trials for each condition.

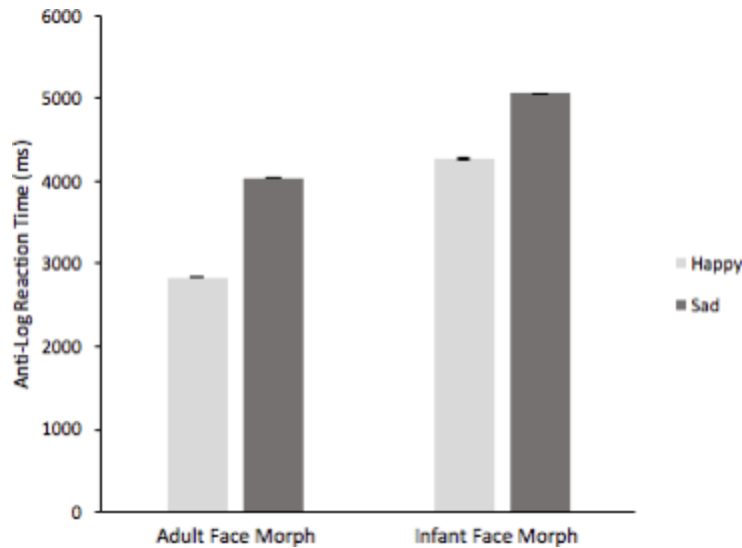


Figure 2. Mean maternal anti-log RTs for initial emotion recognition in adult and infant happy and sad face morph trials. Error bars represent standard error of the mean anti-log RT.

After log transformation, bivariate correlations between participants' RTs for each morph condition and demographic variables were examined. None of the demographic variables were associated with one another. Furthermore, when controlled for multiple comparisons, none of the demographic factors were correlated with participant RTs. Our depression and anxiety measures were associated with one another ($r = .27, p = .03$), but were also not correlated with participant RTs.

3.2. Main Analyses

Reaction Time: A 2 x 2 repeated measures ANOVA revealed a main effect of facial age on RT, where participants were faster at recognition of adult faces than infant faces, $F(1, 65) = 330.86, p < .001, \eta^2 = .84$. In addition, there was also a main effect of facial affect, with participants more quickly recognizing happy faces rather than sad faces, $F(1, 65) = 313.69, p < .001, \eta^2 = .83$. Facial age and affect also interacted, $F(1, 65) = 66.83, p < .001, \eta^2 = .51$. As evidenced in Figure 2, the interaction appears to be driven by a greater difference in recognition speed for happy and sad adult faces in comparison to the smaller difference in recognition speed for happy and sad faces in the infant condition.

To test this interpretation, we examined the difference in response times (sad minus happy) between the infant and adult conditions, finding that the difference was statistically larger for adult faces as compared to infant faces, $t(65) = 8.18, p < .001$. We further examined whether there was a difference between the happy and sad conditions within the infant conditions, and mothers were faster for recognizing happy faces than sad faces, $t(65) = -9.72, p < .001$. This was consistent with the faster recognition for happy faces than sad faces that was also present in the adult condition, $t(65) = -17.98, p < .001$.

4. Discussion

In the current study, we investigated the speed of responding in mothers when recognizing happy or sad expressions in adult and infant faces. Mothers were faster when recognizing affect in adult faces compared to infant faces, reflecting the same own-age bias demonstrated in the general adult literature (e.g., Rhodes & Anastasi, 2012). Mothers were also faster when recognizing happy versus sad faces in both conditions, in line with the happy-face bias observed in the general adult population (e.g., Kirita & Endo, 1995).

Importantly however, we found an interaction between facial age and affect for reaction time, wherein the reaction time difference in happy versus sad face recognition conditions were more similar for infant faces than adult faces. These findings in mothers of children under one year old replicate the previous findings of Byrne et al. (2019) who employed the same paradigm in an independent sample of pregnant women.

As earlier discussed, motherhood may represent a time when greater sensitivity to infant cues may lead to greater attentional allocation to infant stimuli (e.g., Brosch, Sander, & Scherer, 2007; Proverbio et al., 2006; Thompson-Booth et al., 2014a; Thompson-Booth et al., 2014b). This heightened salience to infant cues may explain the slower responding to affect in infant faces, as well as smaller discrepancy between responding to happy and sad infant faces relative to the adult face condition. Furthermore, attentional research demonstrates that there are also greater levels of attention, and greater difficulties disengaging attention from stimuli, when negative emotion is involved (e.g., Brosch et al., 2007;

Eastwood, Smilek, & Merikle, 2003). In the current study, a similar pattern of responding can be observed in Figure 2 where maternal reaction times were slowest for the sad infant face condition. Thus, distressed infant faces may represent particularly salient stimuli requiring a significant allocation of attentional resources that leads to disrupted attention disengagement and redirection. This difficulty disengaging attention may then result in a slower overall reaction time, as the mother's attention may be held longer by the distressed infant expression, and she would need an effortful redirection of attention to attend to the morph task's response buttons. Given greater attentional bias to, and difficulty disengaging attention from, distressed infant expressions has been previously correlated with higher quality mother-infant relationships (Pearson, Lightman, & Evans, 2011). Therefore, the current findings may hold value for the delivery of appropriate caregiving responses, formation of mother-healthy infant attachment, and the child's subsequent development later on. This will be an important direction for future research to further examine.

Our results can also be interpreted in the context of the broader emotion recognition literature regarding the happy face advantage and the own-age bias. The demonstrated faster responding to happy faces within both infant and adult conditions may be considered with respect to the unique facial features for happy faces. Prior research suggests that happy expressions are processed using more holistic processing approaches (Kirita & Endo, 1995). The happy expressions in both age conditions featured smiles that may have led to increased ability and speed in recognizing this unique feature (Adolphs, 2002), allowing for a faster response time. Conversely, sad expressions have been found to be processed in a more analytic manner (Kirita & Endo, 1995) given their greater comparative complexity, which therefore slows reaction time and may explain the slower reaction time to sad faces in both conditions. The happy face advantage findings are unlikely to be explained by intensity differences between each emotional expression condition given that sad faces were rated as more intense than happy faces (counter to what would be predicted for a happy face advantage). In combination with the own-age bias, in which recognition is superior for faces within same-age group, we may presume that the cumulative effect of both a happy expression as well as a same-aged expression resulted in the fastest reaction time for adult happy expressions.

There were a number of limitations of the current study. Despite its use in previous studies, the facial morph task may not be reflective of real-life experiences that require the recognition of age and affect, and may be oversimplified. It is important to note that given the very nature of the stimulus set, infant facial expressions may appear more naturalistic and adults expressions more posed; however, we did not see this reflected in intensity ratings of infant as compared to adult faces suggesting their comparability in this dimension. The facial morph task's previous limitation, as noted by Byrne et al. (2019), still stands in that it only includes Caucasian faces as stimuli. Although no correlation between ethnicity and processing performance was found in the current study, it is of consequence that the current study collected information only in terms of whether mothers identified as Hispanic or Non-Hispanic. Racial differences have been noted in other studies of the own-race versus other-race impact (e.g., Hodsoll, Quinn, & Hodsoll, 2010; Lee et al., 2008), but our demographic information may not have been detailed enough to thoroughly investigate this potential processing bias. Furthermore, the socioeconomic status of our sample (as determined by education) was moderately high, which may limit the generalizability of our findings to a more socioeconomically diverse group.

It may also stand that the current facial morphing paradigm is more useful for establishing general patterns of behavior, and is not as sensitive for delineating differences between individuals. This possible limitation may serve as an explanation in regard to our null findings for the impact of various demographic variables, as well as both anxiety and depression symptoms, on task performance. Furthermore, although the current study focused only on a sample of mothers, caregiving behaviors apply to both mothers and fathers. It may prove useful to examine whether or not fathers perform similarly on the facial morphing task in further research. Finally, it may be of worth to examine if there are differences between parental performance and non-parental performance on the morphing paradigm in future iterations of the task, including careful consideration of potential confounding socio-demographic factors. While this will provide important insight into the maternal specificity of the findings, and its exclusion may be considered a limitation of the current design, our main goal of the

current study was to examine the replicability of facial emotion recognition performance previously observed prenatally to a postpartum sample.

5. Conclusions

The current study reinforces that both the own-age bias and the happy face advantage are robust in the maternal postpartum period. Furthermore, the replication of Byrne et al. (2019)'s findings further suggests the use of the current methodology as a reliable tool in examining facial emotion recognition. Understanding and continuing to investigate these processes is relevant to parenthood in particular due to the necessity of facial processing in appropriate caregiving behaviors. The current study raises additional research queries regarding paternal emotion recognition and potential differences between parent and non-parent samples. The answering of these questions, as well as others, will continue to contribute to a growing body of knowledge on the way in which cognitive and affective processes impact maternal behavior and communication with their infant, and thus the development of the child overall.

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