Facial Emotion Recognition in Women with Symptoms of Polycystic Ovary Syndrome

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M.A. Thesis

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Abstract

Prior research suggests that hormones, notably androgens, influence facial emotion recognition (FER). Most women with Polycystic Ovary Syndrome (PCOS) have elevated androgen levels and related androgenic symptoms, yet no study has directly explored the relationship between PCOS symptoms and FER. This thesis addressed this gap by investigating FER and self-reported PCOS symptoms. During the FER task, men and women identified emotions (anger, disgust, happiness, sadness or neutral) in images of emotional facial expressions. Both overall FER and accuracy recognizing each individual emotion were examined. PCOS symptom severity was assessed in women via self-report measures, including the Polycystic Ovary Syndrome Questionnaire (PCOSQ). Consistent with previous research, women were more accurate than men on FER. Additionally, women with provisional PCOS diagnoses were significantly less accurate at overall facial emotion recognition than women without provisional PCOS diagnoses, but this effect was driven by less accurate fear recognition. There was also a significant negative correlation between FER performance for fear and PCOS symptom severity (e.g., Hair Severity). A significant linear trend emerged for overall facial emotion recognition, revealing men as the least accurate, followed by women with provisional PCOS, and women without PCOS. These findings are consistent with the theory that androgens affect emotion recognition and suggest implications for PCOS symptoms on women's emotional well-being. The results may partly explain higher rates of mood disorders in women with PCOS and allow women with PCOS and healthcare providers to better understand the effects of PCOS.

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Facial Emotion Recognition in Women with Symptoms of Polycystic Ovary Syndrome

Recognizing emotions in faces is an essential social skill, and research suggests it is affected by many factors. Some of the factors include age (Abbruzzese et al., 2019), alcohol use (Khouja et al., 2019), other drug use (e.g., cannabinoids (Hindocha et al., 2015), cocaine (Kuypers et al., 2015), exercise (Brand et al., 2019), sleep (de Almondes et al., 2016), emotional affect (Schmid & Schmid Mast, 2010), mental illnesses (e.g., Bourke et al., 2010; Rocca et al., 2009), pregnancy (Pearson et al., 2009), menstrual cycle phase (Osório et al., 2018), personality traits (Megreya & Bindemann, 2013), oral contraceptive [OC] use (e.g., Gamsakhurdashvili et al., 2021), sex (e.g., Abbruzzese et al., 2019), and hormones (e.g., Osório et al., 2018)). Research on hormones and facial emotion recognition suggests testosterone (T), an androgen, may affect our ability to identify emotions from faces (e.g., Bos et al., 2013). Androgen levels differ between men and women, and there are also individual differences in endogenous androgen levels between women. Endogenous androgen levels have been found to be altered and elevated in women with Polycystic Ovary Syndrome (PCOS) when compared to women without PCOS (Azziz, 2006). Despite evidence suggesting that androgens may affect our ability to identify emotions from faces, no published study has explicitly examined any links between PCOS symptomology and facial emotion recognition. The present study addresses this gap in the literature by examining whether PCOS symptoms are related to facial emotion recognition performance.

Facial Emotion Processing and Emotion Recognition

Facial emotion processing may be conceptualized as a hierarchy, with certain parts of the process requiring less cognitive resources than others (Mohanty & Sussman, 2013). One aspect of facial emotion processing is the detection of an emotion on a face (i.e., being aware that a face

has an emotion), which occurs because emotional stimuli capture our attention involuntarily (Mohanty & Sussman, 2013). For example, angry faces are detected faster than neutral faces in a crowd, likely because the emotional (angry) faces capture attention over the non-emotional (neutral) faces (Mohanty & Sussman, 2013). Another aspect of facial emotion processing is the recognition of what emotion is being shown on a face, which requires categorization of the emotion (e.g., as happy, sad, angry), which is more cognitive based than emotion detection (Goren & Wilson, 2006). Importantly the literature reviewed in this thesis focuses on several aspects of the facial emotion processing, including facial emotion recognition.

Sex Differences in Emotion Recognition Abilities

As mentioned above, the ability to recognize emotions from facial expressions seems to differ across the sexes, with women being faster and more accurate at identifying emotions than men. The most recent review on the topic of gender differences in emotion recognition was published by Thompson and Voyer (2014) who reviewed 166 studies. The review identified that women had a small overall advantage over males, for both accuracy and speed measures, and this advantage is present for all emotions (Effect Size [ES] = small). There were no differences in effect size depending on how the emotion was presented (e.g., using pictures, using videos, or using voice only). However, there was a difference in effect size depending on the emotion, with the smallest sex difference for surprise (ES = small) and the largest sex difference for anger (ES = small). Overall, the results from the meta-analysis provide evidence of a female advantage for all emotions (i.e., happy, angry, sad, fear, surprise, and disgust) and an even greater advantage for the emotion of anger. These six emotions are referred as the basic emotions by Thomson and Voyer (2014). They mention that these emotions are the ones for which studies often find a

larger female advantage. As well, these emotions are often used in the facial emotion research methodology, with a few studies adding in neutral expressions (Wingenbach et al., 2018).

Since the meta-analysis by Thompson and Voyer (2014) looked only at studies until December 2012, it is important to determine what relevant articles have been published after 2012. A search of PsychInfo and PubMed was conducted using the search terms ("*emotion recognition"* or "*affect recognition"* or "*nonverbal communication"* or "*emotion detection")* and (*gender* or *sex)* for studies published after December 2012. The search obtained 44 results, but only four results were relevant to the topic of facial emotion processing. One study of older (above 60) adults (n = 32) and younger adults (below 60) (n =28) had participants complete two tasks (Abbruzzese et al., 2019). In the first task, participants identified which emotion was shown on a face out of six possible emotions (fear, anger, happiness, sadness, disgust, surprise, and neutral). In the second task, participants compared two faces with an emotional expression and indicated if the emotion was the same or different across the faces. Only in the older adult group did women were both more accurate (number correct) and faster (RT) than men at identification and discrimination tasks, with older women being more accurate at recognizing anger and surprise compared to men (Abbruzzese et al., 2019). In another study, Connolly et al. (2019) had young adults (N = 303) identify which emotion was shown on a face out of six possible emotions (fear, anger, happiness, sadness, disgust, surprise, and neutral), and women were more accurate and faster at identifying only disgust when compared to men. However, Wingenbach et al. (2018) found that when viewing one-second-long video clips of facial expressions, women were more accurate than men at identifying the correct emotional expression across the different emotions and that the female advantage was at a similar magnitude across all the emotion types (N = 111). A fourth study employed a slightly different methodology, looking at emotion

discrimination where they presented emotional faces and asked participants to identify a happy or angry face amongst a crowd of neutral faces (Sawada et al., 2014). They found that women and men ($N = 90$) were comparable in how quickly they were able to find angry or happy faces. But this methodology likely assesses other aspects of facial emotion processing, and cognitive skills, including visual scanning, visual attention, and processing speed. Overall, three of the four studies were in line with the findings of Thompson and Voyer (2014) and found women tend to be faster and more accurate at identifying facial emotions. However, amongst the three studies, there was no consensus on which emotions women had better performance men on. Some studies (e.g., Abbruzzese et al., 2019; Connolly et al., 2019) found sex differences in specific emotions (anger, surprise and disgust), and other studies (e.g., Wingenbach et al., 2018) found a sex difference across all the emotions.

Overall, Thompson and Voyer's (2014) review and the four studies reviewed here suggest that there are sex differences in emotion recognition across women and men, with women having a slight advantage over men across all emotions. Given that men and women differ in gonadal hormone levels such as androgens, the evidence of sex differences suggests gonadal hormones may play a role in facial emotion recognition.

Androgens and Facial Emotion Recognition

In addition to research suggesting that facial emotion recognition abilities differ on average between men and women, there is also research on how gonadal hormones such as testosterone (T) may affect this ability. One study that included both men and women found that those with higher salivary T levels had a bias towards angry faces. That is, they miscategorized neutral expressions as anger, and spent longer looking at images of angry faces than individuals with lower levels of T (Wirth & Schultheiss, 2007).

In addition to studies that included both men and women, some research has focused on how T levels affect emotion recognition in each group (i.e., only men or only women). Several studies have examined correlations between T levels and performance on emotion recognition tasks in men because men have a higher level of endogenous T compared to women (e.g., Derntl et al., 2009). One study reported a significant negative correlation (r_s = -.395) between T levels and emotion recognition accuracy for disgust (Rukavina et al., 2018). Furthermore, when men were divided into high T (above median) and low T (below median), the largest difference between groups was present when detecting fear, with the lower T group being more accurate the higher T group (Rukavina et al., 2018). However, some studies contradict Rukavina et al. (2018), finding that men with higher T levels have higher accuracy levels than men with lower T levels across different emotions, including anger, sadness, disgust, and fear (e.g., Lausen et al., 2020; Zilioli et al., 2014). As a result of these contradictory findings, researchers have hypothesized that other hormones, such as cortisol, moderate the effect of T on FER, explaining why the relationship between T and emotion recognition is positive in some instances and negative in others. For example, Lausen et al. (2020), found that for men with lower cortisol levels, there was a positive correlation between T levels and accuracy, and in men with higher cortisol levels, there was a negative correlation between T levels and accuracy (Lausen et al., 2020). An interaction between T and cortisol on emotion recognition suggests future studies need to consider stress and history of stressful events (e.g., adverse childhood events), because the hormone cortisol is often linked to stressful experiences (e.g., Iob et al., 2020; Kalmakis et al., 2015; Oresta et al., 2021).

Unlike the research on men, which has focused on how endogenous T levels affect emotion recognition, there are no published studies that have examined associations between

endogenous T and facial emotion processing in women. Only one study examined endogenous T in women and emotion processing in women, but this study did not include behavioural measures (e.g., accuracy) of facial emotion processing. Stanton et al. (2009) found no correlation between endogenous T levels and the amount of blood oxygenation to women's amygdala while women were viewing angry and neutral faces. Most of the research on women has focused on exogenous T levels (due to the administration of T) and these studies suggest that exogenous T affects women's response to facial emotions. In a study with healthy young women, those who received T sublingually showed an increased cardiac response to angry faces compared to controls who did not receive T (van Honk et al., 2001). Also, when women received T sublingually, they spent more time looking at angry faces than when they did not receive exogenous T (Terburg et al., 2012). Hermans et al. (2008) found an increase in women's amygdala response to angry faces after a sublingual dose of T. In addition to the findings with angry faces, research has also found increased amygdala activity when viewing fearful faces in women after receiving T sublingually (Bos et al., 2013). One study also found women given sublingual T spent less time attending to fearful faces during an emotional Stroop task than women who were not given T (van Honk et al., 2005). While past research suggests that women given exogenous T respond to angry and fearful faces with increased levels of brain activation, spend longer looking at angry faces, and spend less time looking at fearful faces (Romero-Martínez et al., 2021), no published studies have examined associations between T levels or androgenic symptoms and women's facial emotion recognition performance, highlighting the need for such research.

As mentioned by Handelsman (2000), T is a principal androgen. So, comparing the emotion recognition performance of women with naturally elevated androgen levels to women

with lower androgen levels could help address the gap in the literature on how women's emotion recognition is affected by endogenous T levels. Furthermore, research on women who differ in physical indicators of androgenicity (e.g., hirsutism or bodily hair growth) or androgen sensitivity (e.g., number of androgen receptors, androgen receptor sensitivity, physical/somatic indicators of androgen sensitivity) would also help explain the role of testosterone or androgens in emotion recognition. One group of women who have naturally elevated androgen levels or higher sensitivity to androgens (as reflected by androgenic traits) are women with PCOS and women with symptoms of PCOS. Recruiting women along the full continuum of PCOS symptoms (none to a diagnostic level) may be a valuable way to study the role of androgens in facial emotion perception.

Polycystic Ovary Syndrome (PCOS)

PCOS is a heterogeneous condition, often involving observable symptoms of androgen excess. There are several sets of diagnostic criteria for PCOS, and the Rotterdam diagnostic criteria is a common criterion used to diagnose PCOS (Azziz, 2006). The Rotterdam criteria requires two of the following three PCOS features: oligo-ovulation or anovulation, polycystic ovarian morphology on ultrasound, and clinical or biochemical features of androgen excess (Azziz, 2006). Some common and observable signs of androgen excess in women with PCOS include hirsutism, acne, and androgenic alopecia (Azziz, 2003). Since features of androgen excess (e.g., hirsutism) are observable and used in diagnostic settings, some researchers have suggested measuring PCOS symptoms along a continuum and in the general population where sub-clinical symptom presentation may be present (Azziz, 2003; Sjaarda et al., 2018; Tzalazidis & Oinonen, 2021). Furthermore, women with PCOS or high PCOS symptoms may serve as a

valuable population for examining the behavioural effects of androgens (e.g., Rellini et al., 2013; Tzalazidis & Oinonen, 2021).

A recent review paper suggested that androgens play an important role in causing and maintaining PCOS symptoms (Ye et al., 2021). It is hypothesized that excessive androgen production from the ovaries and adrenal glands is considered to be the most important contributor to the reproductive symptoms and the development of metabolic syndrome in PCOS (Ye et al., 2021). In women with PCOS with androgenic symptoms (e.g., hirsutism), there are elevated levels of several androgens, including testosterone (T), androstenedione (A_4), dehydroepiandrosterone sulphate (DHEAs), and the enzyme required to convert pro-androgens to bioactive androgens (Ye et al., 2021). While there is consistent data indicating elevations in androgens in women with androgenic symptoms and PCOS, the exact role of androgens in PCOS is still unclear. As well, not all women with PCOS have excess androgen levels, as approximately 20% of women with PCOS have normal-range androgen levels (Azziz, 2003). It has been suggested that women with PCOS who have normal range androgen levels may have altered androgen sensitivity, as opposed to excess androgen levels (e.g., Tzalazidis & Oinonen, 2021). Support for the androgen sensitivity hypothesis derives from research on the genetic determinants of PCOS and work on sensitivity to androgens in PCOS patients. For example, a CAG repeat in the androgen receptor gene has been implicated in androgen sensitivity. Women with PCOS have fewer CAG repeats than healthy controls, suggesting that inherited alterations in androgen sensitivity may contribute to PCOS (Shah et al., 2008). Research by Ditkoff et al. (1995) on androgen response to hormones such as corticotrophin-releasing hormones (CRH) provides some additional support for the hypothesis that sensitivity to androgens is altered in PCOS patients. When controls and women with PCOS were given ovine corticotrophin-releasing

hormone (oCRH) intravenously, they had different androgen responses to the hormone (Ditkoff et al., 1995). In the PCOS group, the levels of androgens increased following the administration of oCRH, as seen in healthy individuals. Following an increase in androgens, the system should regulate and provide negative feedback to decrease the amount of ACTH (Adrenocorticotropic Hormone). However, in women with PCOS the increase in androgens did not initiate a negative feedback loop, resulting in higher ACTH levels than controls. Thus, ACTH levels may not decrease in response to increased androgen levels in individuals with PCOS (as they would in a healthy individual) because of a dysregulated feedback system that lacks sensitivity to androgens. However, Ditkoff et al. (1995) caution that their results are specific to a proportion of PCOS patients as their sample of women with PCOS had elevated androgen levels prior to the administration of oCRH.

Overall, the presentation of PCOS symptoms differs across women, and so do the hormonal profiles of women with PCOS (e.g., elevated androgen levels, sensitivity to androgens), so studies should capture this heterogeneity as recommended by experts in the area (Perović et al., 2022). To capture and study the full range of androgenic symptoms, it is valuable to measure PCOS symptoms across the full continuum (e.g., Tzalazidis & Oinonen, 2021). Also, since observable features of androgen excess (e.g., hirsutism) exist on a continuum, it would be useful to observe these traits in a general population where women with sub-clinical symptoms may be present (Azziz, 2006; Sjaarda et al., 2018). The evaluation of the full continuum of PCOS symptoms may provide a measure of androgenicity that reflects both current/recent androgen levels and androgen sensitivity.

Studies on Visual Perception and PCOS

Because facial emotion recognition involves the recognition and categorization of visuospatial features, it can be helpful to understand visuospatial ability in PCOS. A search of PsychInfo using the search terms ("Polycystic Ovary Syndrome" OR PCOS OR POS) AND (cognit* OR vis* OR "visual spatial" OR "visuospatial" OR "mental rotation" OR "visual perception") obtained 30 unique results of which six were relevant because they directly examined PCOS and some type of visuospatial performance. A review article by Perović et al. (2022) using different search criteria identified the same six studies that were also identified by the current literature review, as being the only studies examining the relationship between PCOS and visuospatial tasks. Each of those studies are reviewed below. Previous studies have investigated differences in visuospatial ability between women with and without PCOS (Barry et al., 2013a; Franik et al., 2019; Marsh, 2016; Soleman et al., 2016; Sukhapure et al., 2022; Udiawar et al., 2014). Barry et al. (2013) tested women with and without a formal diagnosis of PCOS and found that only the diagnosed women showed a positive correlation between T levels and performance on the mental rotation task (r = .376, n = 56)). A positive correlation between T levels and mental rotation task performance was also found in men and post-menopausal women who had elevated T levels. Franik et al. (2019) found that women with PCOS who had higher androgen levels took longer to inhibit their responses to the visual stimuli on the Stroop task, suggesting that higher androgen levels are associated with poorer inhibition. Similarly, Soleman et al. (2016) used fMRI neuroimaging and found that women with PCOS showed greater activation of brain regions associated with executive functioning while performing an N-Back task, where participants were shown letters and had to respond only when certain patterns of letters were shown (e.g., pressing a button when two of the same letters appeared in a row), as

compared to women without a PCOS diagnosis. This suggested that women with PCOS require greater neural resources than women without PCOS to complete the visual working memory task. A recent paper by Sukhapure et al. (2022) revealed that women diagnosed with PCOS had poorer performance on a maze learning task, a measure of visuospatial learning, and on a timed chase test which measures psychomotor speed. Overall, the research on visuospatial differences between women with PCOS and those without PCOS show that there are some differences in the visuospatial domain (e.g., on mental rotation tasks, maze learning task). At the same time, it is unclear whether women with PCOS have worse or better visuospatial performance than those without PCOS because there are some studies that found better performance in women with PCOS (e.g., Barry et al., 2013) and others that found poorer performance in women with PCOS (e.g., Soleman et al., 2016; Sukhapure et al., 2022). Further research is needed to replicate the findings from the six studies given that each examined different types of visuospatial ability.

The contradictory results that have been identified in the literature specific to the visuospatial domain are in line with the conclusions of the review by Perović et al. (2022). In addition, Perović et al. (2022) examined studies that looked at relationships between other cognitive domains (e.g., verbal memory) and PCOS, and noted that on tasks where there is a general female advantage, women with PCOS tend to have poorer performance than women without PCOS. Facial emotion recognition involves visuospatial cognition, yet women tend to perform better than men on average. Thus, the research on PCOS and visuospatial ability does not provide a strong directional hypothesis about the relationship between PCOS symptoms and facial emotion recognition performance.

Facial Processing and PCOS

Despite six studies on visuospatial perception in women with PCOS, there are no published studies examining the behavioural responses (e.g., accuracy, reaction time) of facial emotional processing in women with PCOS. Lai et al. (2020) did look at the resting state brain activity (i.e., brain activity when patients are relaxed with their eyes closed) of patients with PCOS and controls but did not explicitly look at facial processing. The authors did find, however, decreased brain activity in the left inferior occipital gyrus, a brain region associated with the initial stages of face processing. Because participants in this study did not perform a face-processing task, it is impossible to know whether PCOS, PCOS symptoms, or differences in T levels between women with and without PCOS affected the perception of emotion in faces.

The only study looking at facial emotion recognition and PCOS is from an unpublished thesis by Sukhapure (2019), who compared the facial emotion recognition task performance of 54 women without PCOS to 53 women with PCOS. Participants saw 144 pictures of facial expressions of six different emotions (happy, sad, anger, disgust, fear, and neutral), and on each trial, they were asked to identify which of the six emotions were presented, as quickly as possible (i.e., participants had an unlimited amount of time to respond). Women with PCOS had a lower recognition accuracy score than women without PCOS across all emotions (ES = small), and there was also a significant group difference on emotions of fear (ES = small) and sadness (ES = small). The smallest group difference effect size was for the emotion of happiness (ES = small), which was not significant. These findings suggest that those with a diagnosis of PCOS are less accurate at identifying negative emotions such as fear and sadness, compared to women without a PCOS diagnosis. Because Sukhapure (2019) did not measure the symptoms of women with PCOS on a continuous scale, it is not possible to relate the severity of PCOS symptoms with

performance on a facial emotion recognition task. This study requires replication and studies are needed to further examine the extent to which androgenicity or PCOS symptoms relate to facial emotion recognition by examining associations between these variables. The present study was focused on replicating and extending the previous studies by examining PCOS symptoms on a continuum to see whether androgenic symptoms in women are associated with facial emotion recognition performance.

Present Study

The present study aimed to examine whether symptoms of PCOS are related to facial emotion recognition performance. The proposed study addresses the gap in knowledge regarding the relationship between facial emotion perception and PCOS symptomology by examining whether facial emotion recognition performance differs as a function of women's PCOS symptoms and symptom severity.

The background literature reviewed above has focused on (1) sex differences in emotion recognition that may result from differences in androgens between and within men and women, (2) associations between endogenous androgen levels and emotion recognition, and (3) differences in visuospatial performance across women with PCOS and those without. The research on sex differences indicates an advantage for women in the identification of emotional expression over men (e.g., Thompson & Voyer, 2014), particularly for anger, suggesting that those with higher levels of testosterone (i.e., men) may have poorer performance than those with lower testosterone (i.e., women). Hence the **first hypothesis is that women (as a group) will be more accurate than men on the facial emotion recognition task.**

Given findings of poorer facial emotion recognition in women with PCOS, particularly for fear and sadness (Sukhapure, 2019), evidence of negative associations between androgens

and facial emotion recognition (Rukavina et al., 2018; van Honk et al., 2005), and that most women with PCOS symptoms have higher androgen levels than healthy women (Azziz, 2006), the **second hypothesis is that women with higher PCOS symptoms will perform worse on the facial emotion recognition task than women with fewer PCOS symptoms (i.e., a negative association between PCOS symptoms and facial emotion recognition)**.

The third hypothesis involves a comparison of facial emotion recognition performance across three groups with the predicted pattern of performance being that **women with low PCOS symptoms will perform better than those with high symptoms, who will perform better than men (i.e., low symptoms > high symptoms > men).**

Finally, while there are some contradictory studies (e.g., Abbruzzese et al., 2019; Connolly et al., 2019; Wingenbach et al., 2018) a meta-analysis by Thompson and Voyer (2014) found the largest difference in emotion recognition accuracy between males and females for the emotion of anger (i.e., women > men). At the same time, an unpublished study by Sukhapure (2019) found participants with PCOS performed worse than participants without PCOS on a facial emotion recognition task, and significant group differences were reported for the identification of sadness and fear. Based on all these findings, the **fourth hypothesis is focused on recognition of negative emotions: women with high PCOS symptoms will perform worse than women with low PCOS symptoms for recognition of negative emotions (e.g., anger, sadness, and fear).**

Method

Participants

A total of 236 participants initiated the survey, and 192 (52 men, 140 women) completed the study and met the inclusion criteria (see below). The mean age of the final sample was 22.91 (*SD* = 6.59). While 8 of 132 (6 %) self-identified as having a diagnosis of PCOS, 19 of 132 (14 %) women had a PCOSQ score ≥ 2, thereby meeting the criteria for a provisional diagnosis of PCOS (113 (86 %) did not meet PCOSQ criteria (Pedersen et al., 2007)). All the women who self-identified as having a PCOS diagnosis also met the criteria for a provisional PCOS diagnosis. The study received ethical approval from Lakehead University's Research Ethics Board before recruitment began (see Appendix A for Ethics Board Approval). Participants were recruited from Lakehead University and the local community. University students were primarily recruited through the SONA psychology department research recruitment system and classroom visits or indirectly through emails and posters. From the larger community, participants were recruited using posters, emails, and online social media advertisements (e.g., Facebook, LinkedIn). Appendix B includes a list of recruitment materials (i.e., posters, emails, and communications bulletins). Local organizations and healthcare providers were approached as possible partners in recruitment (e.g., local Naturopathic practitioners). All participants were told that the project investigated the effects of hormones on emotional perception. Participants recruited through the Psychology Research Pool were given course credit for their participation (i.e., 1 bonus point), and participants from the community were given a chance at winning a 20-dollar gift card to a store of their choice, with five gift cards available.

The initial participation inclusion criteria were: (1) the ability to understand English, (2) access to a laptop or computer with an internet connection, (3) at least 16 years of age for

Lakehead University students and at least 18 for community participants. Before the main analyses, the following exclusion criteria were applied to reduce the effects of potential confounding variables: (1) currently experiencing nicotine withdrawal (n = 4), and (2) consuming alcohol within three hours of participating or having three or more drinks in the past eight hours (n = 2), (3) post-menopausal (n = 4), (4) currently pregnant (n = 2), (5) currently lactating/breastfeeding (n = 3), (6) history of brain injury (n = 3), (7) taking any antipsychotic medication (n = 2), and (8) diagnosed with bipolar disorder (n = 4). Women who were menopausal and pregnant/lactating were excluded because these changes significantly affect women's hormone levels (Brzozowska & Lewiński, 2020; Makieva et al., 2014). Some participants met multiple exclusion criteria, and for analyses where only data from women were examined, 22 participants were excluded based on the eight exclusion criteria. Due to an administrative error, male participants had no data on diagnoses of bipolar disorder, antipsychotic use, or history of brain injury. Thus, for analyses where data from men were included, exclusion criteria (6), (7), and (8) were not applied to any participants. In these analyses, 15 participants were excluded.

Measures

Initial Questionnaire

The Initial Questionnaire (see Appendix C) contained questions about demographics (e.g., age, sex, sexual orientation, ethnicity, weight, and height), mental health history, and a variety of factors that are hypothesized to have potential effects on emotion perception (e.g., stress, sleep, alcohol use, caffeine consumption, medications, medical and psychological conditions, exercise, and diet). The Initial Questionnaire also included questions on reproductive health such as OC (status, brand, duration), menstrual cycle length, age at menarche, cycle

regularity, hormonal sensitivity, parity, pregnancy, and lactation. Questions on OC use were included because OCs can alter androgen levels and are commonly prescribed as a treatment for PCOS (Vrbíková & Cibula, 2005). Many of these measures were developed and have been used in past studies within our lab (Keir, 2015; Tzalazidis & Oinonen, 2021a; Venkateshan et al., 2022). As well, in a Follow Up Questionnaire (see Appendix C) participants were asked about any adverse childhood events (ACEs) because early childhood maltreatment may affect emotion perception (Bérubé et al., 2021) and those with PCOS are more likely to have experienced adverse childhood events such as childhood maltreatment (Pringle et al., 2022; Tay et al., 2020). A measure of perceived stress, the Perceived Stress Scale (PSS) was also included because psychosocial stress can affect how people attend to emotions (von Dawans et al., 2020), may interact with androgens to affect facial emotion recognition (Lausen et al., 2020), and women with PCOS report high levels of stress (Yin et al., 2020). Additional measures include the Positive and Negative Affect Schedule - short form (PANAS) (Watson et al., 1988) and measures of PCOS symptoms. The latter three measures are described in detail below.

Adverse Childhood Experiences (ACEs) Questionnaire

The Adverse Childhood Experiences (ACEs) Questionnaire (Felitti et al., 1998) consists of 10 items and assesses 10 types of childhood trauma. Five questions pertain to personal trauma (e.g., physical neglect), and another five questions relate to family trauma (e.g., loss of a parent through death). The ACEs questionnaire, has been administered to several populations, and there is evidence for retrospective validity as evidenced by agreement among children of the same caregiver (Kidman et al., 2019).

Positive and Negative Affect Schedule (PANAS)

The Positive and Negative Affect Schedule (PANAS) consists of 20 adjectives that describe affective states, with 10 items for negative affect (NA) and 10 items for positive affect (PA) (Watson et al., 1988). Participants rated the degree to which they experienced each emotion at the time of testing (i.e., present moment). Response options range from 1 (*very slightly or not at all*) to 5 (*extremely*). Regarding internal consistency, Watson and colleagues reported coefficient alphas for the PA and the NA subscales of .89 and .87, respectively. The PANAS was used to assess participants' affect and examine group differences, as affect may affect perception of emotion.

Perceived Stress Scale (PSS)

The Perceived Stress Scale (PSS) is a 10-item questionnaire that measures the extent to which respondents perceive aspects of their life as uncontrollable, unpredictable, and overloading (Cohen, 1988; question 40 in Appendix C). Participants used a 5-point Likert scale ranging from 0 (never) to 4 (very often) to indicate how often they felt or thought a certain way within the past month. Composite scores can range from 0 to 40 with higher scores indicating greater levels of perceived stress. Cohen (1988) reported an overall internal consistency of .78 for the PSS scale. Further, studies have found a two-factor structure of the PSS where the six negatively phrased items load on the perceived helplessness factor, and the four positively phrased items load on the perceived self-efficacy factor (Taylor, 2015). The PSS was used to measure the perceived stress levels of participants over the month prior to the study.

Polycystic Ovary Syndrome Questionnaires

Three questionnaires were used to assess PCOS symptoms. Descriptions are found below, and full measures are found in Appendix C (questions 34 to 38). Since this research has an impact on women's lives, feminist perspectives on the survey components of the current study are important. Feminist researchers suggest designing questions in a way that are adapted to all women participating in the study, including those with language barriers (Hesse-Biber, 2013). As a result, women in this study were given different ways to represent their PCOS symptoms, including ways that may not be as impeded by proficiency in understanding English. Having several measures of PCOS, some that have worded questions with symptom descriptions, and other measures that include pictograms may have helped ensure that everyone completing the study had a chance to adequately represent their symptoms. For example, participants who experienced any difficulty conveying or quantifying their level of hair severity on the verbal Hair Severity measure, may have found the pictures of Ferriman-Gallwey (1961) which were used to calculate mFG (modified Ferriman Gallwey) scores useful to quantify their hair growth or hirsutism.

Polycystic Ovarian Syndrome Questionnaire (PCOSQ)

This screening measure consists of five items designed to measure symptoms associated with a diagnosis of PCOS (Pedersen et al., 2007; question 34 in Appendix C). Scores on the PCOSQ range from -1 to 3, and 2 is the cut-off used to suggest symptoms consistent with a provisional diagnosis of PCOS (i.e., ≥ 2). Items ask about the length of the menstrual cycle, growth of dark coarse hair on the face and body (e.g., chin, chest), obesity, nipple discharge, and severity of acne on the face and body. The PCOSQ has a sensitivity of 85% for the diagnosis of

PCOS and a specificity of 93.4%. The PCOSQ was used to categorize women into those who do (vs. do not) meet the PCOSQ criteria for a provisional diagnosis of PCOS.

Hair Growth Questionnaire

The second questionnaire, was a hair growth severity measure with questions on dark coarse hair growth (question 35 and 36 in Appendix C). The hair growth questions were used to assess the severity of hair growth on eight different body parts (Tzalazidis & Oinonen, 2021). The original hair growth severity scale was created by M. Bong and K. Oinonen and ranges from 0 (much lower) to 5 (much greater). It was modified by asking women to rate the severity of their hair growth "compared to other women of your same age and ethnicity/race when you don't engage in any hair removal practices (e.g., shaving/plucking/waxing).” This helped control for ethnic/genetic factors involved in hair growth severity (Engmann et al., 2017). Total scores on the hair growth severity scale can range from 0 to 40. Some validity evidence for the hair growth severity questionnaire is reflected by the positive correlation between Hair Severity scores and PCOSQ total scores (r_s = .51, N = 455; Tzalazidis & Oinonen, 2021).

Modified Ferriman-Gallwey (mFG)

This measure assesses the symptom of hirsutism commonly seen in women with PCOS (e.g., Azziz, 2006; Bedrick et al., 2020). The modified Ferriman-Gallwey (mFG) is a frequently used visual image scoring system (shown in question 37 in Appendix C) that examines hair growth on nine androgen-sensitive regions of the body: upper lip, chin, chest, upper and lower back, upper and lower abdomen, upper arm, and thigh (Bedrick et al., 2020; Ferriman & Gallwey, 1961). Women select images on the mFG that correspond with the level of their hair growth on that specific body part. A total of six body parts (i.e., chin, chest, upper lip, upper abdomen, lower abdomen, and thigh) were shown, and each body part had five images depicting

hair growth, ranging from no hair growth to complete hair growth (as shown in Appendix C). The scoring of the original mFG was modified, and each body part was scored on a scale of 0 (*no hair*) to 8 (*completely covered in hair*); the total score on the mFG can range from 0 to 48. Increasing the range of the scale from 0 to 4 allowed women to be more precise when rating their hair growth. In a study by Bedrick et al. (2020), where the six body parts were shown and items ranged from 0 to 4, having a summed score of 3 or higher across the upper lip, lower abdomen and upper abdomen regions predicted a PCOS diagnosis with a specificity of 76% and a sensitivity of 70%. Bedrick and colleagues also found that practicing any depilatory practices (i.e., waxing, shaving, bleaching the hair, or electrolysis) on the face, chest or abdomen and scoring 3 or higher on the mFG resulted in a higher sensitivity of 93% but a lower specificity of 52%. The mFG and the question on depilatory practices were included in this study to serve as markers of androgenic symptoms related to hair growth and hirsutism. The inclusion of objective visual images in the mFG provides an alternate format for measuring hair growth.

Facial Emotion Recognition Task

The Facial Emotion Recognition Task was presented through Survey Monkey. The task involved first presenting the instructions and three practice trials of the Facial Emotion Recognition Task. An example of the Practice Trial is shown in Figure 1. The practice trials were identical to the actual trials, with the exception that instructions were abbreviated on the actual trials. On each trial participants were presented with an image of an actor emoting an emotion (angry, disgust, fear, sad, happy, surprise, or neutral). Participants used their mouse or keyboard to identify which emotion they perceived on the face. The next trial began at the next face. Then, 149 faces were shown to participants with 75 medium intensity images and 74 low intensity images. In the present study, the low-intensity images were recognized at 61% accuracy (SD =

8.43), and the medium-intensity images were recognized at 73% accuracy (SD = 7.95). Accuracy scores could range from 0 to 24 for each emotion, and the total FER task accuracy scores could range from 0 to 149.

Stimuli for Facial Emotion Recognition Task

Stimuli were adapted from the Bath Intensity Variations (ADFES-BIV) database (Wingenbach et al., 2016). The ADFES-BIV contains videos of actors expressing 10 emotions: anger, contempt, disgust, embarrassment, fear, happiness, neutral, pride, sadness, and surprise. The emotions of anger, disgust, fear, sadness, surprise, and happiness are classified as basic emotions, and the other three emotions of contempt, embarrassment, and pride are classified as complex emotions (Montagne et al., 2007). The present study tested seven emotions overall, which included the six basic emotions (anger, disgust, fear, happiness, sadness, and surprise) and neutral (where the actor was not expressing any emotions), which follows a similar design to Sukhapure (2019), who examined facial emotion recognition in women with PCOS. The present study used the ADFES-BIV dataset because it includes different emotion intensities, which added to the sensitivity of the present task.

Each of the emotions in the ADFES-BIV is expressed by 12 Caucasian actors (five female and seven male) at three different intensities: low, medium, and high. Each video from the ADFES-BIV includes an actor emoting the expression (e.g., anger) from a neutral state to the appropriate intensity in the last frame (i.e., low, medium, or high intensity). For the neutral emotion, there was only one intensity. In both the pilot study and the primary experiment, participants only saw the image from the final frame of the video. For the pilot study, only the medium-intensity and low-intensity images were used to avoid ceiling effects due to the high accuracy rates for the high-intensity images. Past research using this ADFES-BIV database

suggests the low-intensity images were recognized at 56% accuracy (SD = 11.1), and the medium-intensity images were recognized at 68% accuracy (SD = 10.51) by observers who chose which of the 10 emotions were portrayed in the video clip (Wingenbach et al., 2016). The original ADFES-BIV database had a total of 156 images (12 actors x 2 levels x 6 emotions, 12 images for neutral), at medium and low intensity. In the pilot study, any images that were not correctly identified by at least one of the 10 participants was removed and a total of 7 images (3 male and 4 females images, across 2 female and 2 male actors) were excluded. In the final 149 images that were shown to participants, 23 were sad, 23 were happy, 23 were surprise, 23 were fear, 23 were disgust, 24 were angry, and 10 were neutral.

Procedure

Participants were recruited for a study called " Factors Affecting Facial Emotion Recognition." Participants who were interested and eligible for online participation accessed a link, that linked to the Survey Monkey Platform. They were presented with an information letter and a consent form (see Appendix D), where they provided consent. Then participants proceeded to the Initial Questionnaire (See Appendix C) and the Facial Emotion Recognition Task. The questionnaire took approximately 10 to 20 minutes to complete, and the Facial Emotion Recognition task took approximately 40 minutes to complete. Once participants completed the Questionnaire and Facial Emotion Recognition task, they were given a debriefing form (see Appendix E). Participants who were participating for course credit were given course credit automatically (i.e., 1.0 bonus points).

Results

Data Screening and Statistical Considerations

All analyses were completed using IBM SPSS Statistics. Prior to analyses, data were examined for accuracy, outliers, normality, and homoscedasticity. The main hypotheses were examined using Multivariate Analyses of Covariance (MANCOVAs) and linear regressions. For all analyses, a significance level of $< .05$ was chosen. A significance level of $< .10$ was chosen to represent nonsignificant trends. Pillai's trace criterion was used to evaluate multivariate significance. Significant MANCOVAs were followed up with univariate tests (i.e., Analysis of Covariance [ANCOVAs]). The Bonferroni adjustment was used for follow-up comparisons to reduce Type I errors. All means reported are untransformed unadjusted means unless otherwise indicated (i.e., figures represent adjusted means and their standard errors).

Missing Data

Data for each scale and task were inspected for missing data. If less than 10% of data was missing for a scale, mean or mode imputation was used to replace missing data (Tabachnick et al., 2019; Xu, 2020) (i.e., PANAS NA and PA subscales [1 item each maximum], ACES-Q [1 item maximum], PSS [1 item maximum], and FER task [2 items per emotion maximum]). Mode imputation based on individual item scores was used for FER variables, as mode imputation is required when data are skewed or scored dichotomously (Xu et al., 2020). With the FER data, participants with more than 10% missing data (i.e., more than 2 items per emotion) were excluded from relevant analyses. For the remaining participants, missing performance scores at the trial level were replaced by mode imputation. Mean imputation was used on individual item scores that were missing from the PANAS NA and PA subscales, ACEs-Q, and PSS. In cases where women indicated hair growth on the Bedrick questionnaire and had unanswered hair

questions on the PCOSQ, the relevant items from the Bedrick questionnaire were used to populate items on the PCOSQ (e.g., if a participant indicated having hair on their upper lip in the Bedrick questionnaire, their answers on the PCOSQ would reflect them having hair on the upper lip area). In cases in which missing values comprised more than 10% of the data, no data was replaced, and participants were excluded from the relevant analyses.

Assessing Statistical Assumptions

Prior to running analyses to test the main hypotheses, the data were examined to ensure that statistical assumptions were met. The main outcome variables from the FER task (i.e., accuracy scores for each of the seven emotions) were tested for outliers and normality. Outliers were identified by looking for z-scores larger than an absolute value of 3.29 (Tabachnick et al., 2019). The distribution of scores for all outcome variables was also examined for normality as a function of the groups utilized within each hypothesis. Normality was examined using the following criteria: skewness divided by the standard error of skewness < 3; kurtosis divided by the standard error of kurtosis < 3 (Tabachnick et al., 2019).

Examination of the accuracy scores for each of the emotions identified the following outliers: happy accuracy scores (n = 1), sad accuracy scores (n = 2), neutral accuracy scores (n = 3), and surprise accuracy scores (n = 1). One participant was identified as an outlier for both surprise and sad. Initially, methods such as transformations and assigning the outlier to be the next highest score plus one were considered to reduce the influence of these six outliers, however they remained as outliers after these methods and thus the outliers were removed (Tabachnick et al., 2019). After the removal of outliers, the happy, sad, angry, and fear accuracy scores met assumptions of normality across all groups. Analyses were run both with and without outliers. As the results did not change, analyses without outliers are presented here.

The accuracy scores for surprise and neutral exceeded skewness and kurtosis values of 3 and appeared visibly skewed upon inspection. Following the recommendations of Tabachnick et al. (2019) these scores were reflected, transformed, and re-reflected to allow for higher scores to be interpreted as indicating greater accuracy. The surprise scores were square-root transformed, and the neutral scores were log-transformed.

All scales examined as potential covariates or as variables to characterize the groups were also scrutinized for normality and outliers. All other scales had no outliers and met criteria for normal distributions. To ensure that the assumption of homogeneity of variance was met, Levene's Test for Equality of Variances and Box's Test for Equivalence of Covariance Matrices were conducted with all multivariate analyses. These homogeneity tests confirmed that the homogeneity assumption was met for all analyses.

Group Equivalencies

To determine potential covariates that should be included in the main analyses and to identify any expected group differences, ANOVAs, *t*-tests, and chi-squares were run to identify group differences. The groups associated with each hypothesis ([H1: men vs. women]; [H3: men, women with a provisional PCOS diagnosis, women without a provisional diagnosis]; [H4: women with vs. without a provisional PCOS diagnosis]) were examined for equivalency on the following variables: age, BMI, typical alcohol, number of typical drinks, hours of sleep last night, PANAS positive affect scores, PANAS negative affect score, history of ACEs, ethnicity (Caucasian vs. non-Caucasian), hormonal contraceptive use, and amount of exercise in the past 24 hours.

As shown in Tables 1 and 2, the groups of men and women differed on exercise frequency and positive affect. Men exercised more than women over the past 24 hours, t (183) =

-2.01, p = .023, and amount of exercise was significantly negatively correlated, $r(190)$ = - .158, p = .028, with participants' accuracy with neutral expressions, so it was used as a covariate. As well, men had lower positive affect than women, t (183) = 3.16, p = < .001. However, positive affect was not significantly correlated with any of the FER variables as correlations ranged from $r(157)$ = -.02, p = .794 (fear) to $r(157)$ = .14, p = .067 (surprise). Thus, it was not used as a covariate.

As indicated in Tables 3 and 4, men, women with a provisional PCOS diagnosis, and women without a provisional diagnosis differed on the following two variables: the amount of exercise in the past 24 hours, F (2,175) = 5.26, p = .002; BMI, F (2,175) = 20.62, p = < .001; and PSS scores, F (2,175) = 3.30, p = .040. Follow up t-tests with Bonferroni correction, suggested that men exercised more than women with a provisional diagnosis of PCOS (p = .014) and than women without a provisional diagnosis of PCOS (p = .036). Despite the overall significant group effect for PSS, there no significant group differences in the follow-up. There was, however, a non-significant trend for group differences (p = .089) with men scoring higher than women on the PSS, and there were no significant correlations between the outcome variables and PSS scores. Correlations ranged from, $r(163)$ = -.01, p = .842 (sad) to $r(163)$ = .21, p = .793 (happy). Women with a provisional diagnosis of PCOS reported higher BMIs than women without a provisional diagnosis. This finding is in line with research indicating that women with PCOS tend to have higher BMI (Mantzou et al., 2021), suggesting that this is a characteristic of the sample. Hence BMI was not included as a covariate.

As indicated in Tables 5 and 6, women with a provisional diagnosis differed from those without a provisional diagnosis (N = 104), for two variables: BMI, F (1,124) = 30.08, p < .001, and the rate of thyroid disorders, X^2 (1, N = 122) = 4.94, p = 0.026. These groups represented the

ones with stricter exclusion criteria than the ones examined above. Both BMI and rate of thyroid disorder diagnoses were higher in the group with the provisional diagnosis (e.g., 13.3% vs. 1% for thyroid disorders) This distribution of thyroid disorders is consistent with past research indicating higher rates of thyroid disorder in women with PCOS compared to healthy controls (Rommitti et al., 2018). Hence thyroid disorder was not used as a covariate in the analyses. The same rationale applied to BMI, as discussed above.

Based on the group equivalency analyses outlined above, the one covariate included in all analyses was the amount of exercise over the past 24 hours due to group differences and correlation with participants' neutral expression accuracy trial scores.

Convergent Validity of PCOS & Hair Measures

To examine the validity of the PCOS measures used in the current study, the intercorrelations between the PCOS variables (i.e., PCOSQ score, Hair Severity Score, modified Ferriman-Gallwey (mFG) and simplified Ferriman-Gallwey (sFG)) were examined and are reported in Table 7. It was noted that there was a significant positive correlation between the Hair Severity scores and the following measures of hair growth: mFG, $r(119) = .630$, $p < .001$; and sFG, $r(119) = .542$, $p < .001$. The moderate correlation (regarded as any Pearson correlation between .3 to .7 [Rusakov, 2023]) between these measures, suggests that there is concurrent validity between the different hair severity measures that are based on the Ferriman-Gallwey system as used by Bedrick et al. (2020) and the PCOSQ Hair Severity scores as used by Tzalazidis and Oinonen (2021).

Hypothesis 1: Women (as a group) will be more accurate than men on the facial emotion recognition task.

Visual inspection of means in Table 8 and in Figure 2 indicated that women were more accurate than men in identifying all emotions. An ANCOVA with total FER scores (i.e., sum of scores across all emotions) as the dependent variable (DV), group (men, women) as the independent variable (IV), and the covariate of exercise, indicated a significant difference between groups with women being more accurate than men, $F(1,189) = 24.04$, $p = < .001$, $\eta_p^2 = .11$. Similarly, a MANCOVA with group (men, women) as the independent variable, the seven emotions (i.e., angry, disgust, fear, happiness, sadness, surprise, and neutral) as the DVs was completed. There was an overall significant multivariate group effect, $F(7,183) = 4.43$, $p < .001$, $\eta_p^2 = .14$, supporting this group difference. Follow-up univariate ANCOVAs (see Table 9) showed significant group effects whereby women were more accurate than men for the following four facial emotions: Angry, $F(1,189) = 7.24$, $p = .008$, $\eta_p^2 = .04$; Disgust, $F(1,189) = 8.94$, $p = .003$, $\eta_p^2 = .04$; Fear, $F(1,189) = 9.93$, $p = .002$, $\eta_p^2 = .05$; and Surprise, $F(1, 189) = 6.90$, $p = .009$, $\eta_p^2 = .03$. These group differences are all illustrated in Figure 2.

Hypothesis 2: Women with higher PCOS symptoms will perform worse on the facial emotion recognition task than women with lower PCOS symptoms (i.e., a negative association between PCOS symptoms and facial emotion recognition).

Four separate linear regression analyses were performed to test hypothesis two and to look at the associations between the PCOS symptoms and FER variables. For each regression, a different PCOS-related outcome/dependent variables was used: (1) PCOSQ scores, (2) Hair Severity, (3) sFG scores, and (4) mFG scores. The seven emotion recognition accuracy scores were used as predictor variables in all four regressions (i.e., accuracy for angry, disgust, fear,

sadness, happy, surprise, and neutral). Amount of exercise in the past 24 hours was included as a covariate. Bivariate Pearson correlations and partial correlations (including the covariate of exercise) between the FER scores and the PCOS related variables are shown in Table 11. There were significant negative correlations between FER accuracy for Fear and both Hair Severity, $r(124) = -.16$, $p = .037$; and sFG, $r(127) = -.18$, $p = .017$. There was also a non-significant trend for a negative correlation between FER accuracy on Fear and PCOSQ, $r(118) = -.14$, $p = .070$. The results of the four regressions are shown in Table 11. After controlling for exercise, the FER variables altogether were not significantly associated with any of the PCOS variables (PCOSQ scores, R^2 change = .036, $p = .609$; Hair Severity scores, R^2 change = .063, $p = .356$; sFG scores, R^2 change = .065, $p = .820$; and mFG scores, $R^2 = .047$, $p = .72$). Thus, none of the individual PCOS symptom variables were associated with overall emotion recognition when the full continuum of symptoms was examined.

Hypotheses 3 & 4: Facial emotion recognition performance will follow the following pattern: woman with low PCOS symptoms > women with higher PCOS symptoms > men (H3). Also, women with high PCOS symptoms will perform worse than women with low/no PCOS symptoms in detecting negative emotions (e.g., anger, disgust, fear, and sadness; H4).

The low and high PCOS symptom groups were created based on the PCOSQ, with the high PCOS group being women whose symptoms are consistent with a provisional diagnosis of PCOS (i.e., a score of ≥ 2 on the PCOSQ, Pedersen et al., 2007). Overall, visual examination of means for the three groups suggest: (a) women with a provisional diagnosis were more accurate than men at identifying 6 of the 7 emotions (see Table 12 and Figure 3), (b) women without a provisional diagnosis were more accurate than men at identifying all emotions (see Table 12 and

Figure 3), and (c) women with a provisional PCOS diagnosis were less accurate at identifying 5 of 7 emotions than woman without PCOS (see Table 13 and Figure 4).

To test hypotheses three and four, eight linear trend analyses, two ANCOVAs, and three MANCOVAs were conducted with exercise in the 24 hours prior to testing as a covariate. Eight linear contrast analyses (see Table 14) were completed to examine whether there was a linear trend in emotion recognition scores across the three different groups (men, women with provisional PCOS, and women without a provisional PCOS diagnosis) with the DVs being total FER scores (sum of all FER scores across all emotions), and the accuracy scores for each emotion. The results suggested a significant linear trend across the three groups with women without provisional PCOS > women with provisional PCOS > men for the following six accuracy scores: total FER $F(1,174) = 6.37$, $p < .001$; Angry $F(1,174) = 3.00$, $p = .003$; Disgust $F(1,174) = 3.58$, $p < .001$; Fear $F(1,174) = 3.77$, $p < .001$; Surprise $F(1,174) = 2.82$, $p = .006$; and Neutral $F(1,174) = 1.36$, $p = .021$. These linear trends can be seen in Figure 3.

The results from the first 3-group ANCOVA (see Table 13 and Figure 5) examining total FER scores, indicated significant group differences, $F(2,174) = 21.27$, $p < .001$, $\eta_p^2 = .20$, such that women without provisional PCOS > women with provisional PCOS > men. A similar 2-group ANCOVA (see Table 15, and Figure 5) compared women with vs. without provisional PCOS diagnoses. The results also indicated that women without a provisional diagnosis were significantly more accurate than women with provisional PCOS in overall facial emotion recognition, $F(1,117) = 5.54$, $p = .020$, $\eta_p^2 = .04$.

The first MANCOVA (see Table 14 and Figure 3) compared the three groups on the seven FER accuracy scores (DVs). The MANCOVA confirmed significant group differences across all emotions, $F(7,169) = 7.01$, $p < .001$, $\eta_p^2 = .13$. The significant MANCOVA was

followed up with univariate ANCOVAs (see Table 14), the results of which suggested the groups perceived the following five emotions differently: Disgust, $p < .001$, $\eta_p^2 = .083$; Fear, $p < .001$, $\eta_p^2 = .086$; Angry, $p = .012$, $\eta_p^2 = .049$; Surprise, $p = .010$, $\eta_p^2 = .051$; and Happy $F(2,174) = p = .042$, $\eta_p^2 = .036$. Follow-ups for all univariate ANCOVAs are described below.

The second MANCOVA (see Table 15 and Figure 4) included PCOS group (with vs. without provisional diagnosis) as the independent variable and also used FER accuracy scores for all seven emotions as the dependent variables. The MANCOVA did not indicate a significant difference between the two groups across all the emotions, $F(7,111) = 1.59$, $p = .143$, $\eta_p^2 = .092$. Follow-up univariate analyses were completed given the weak nonsignificant trend and medium-large effect size (see Table 15). Follow-up ANCOVAs suggested women with a provisional diagnosis were less accurate than women without a provisional diagnosis in recognizing fear, $F(1,117) = 4.91$, $p < .001$, $\eta_p^2 = .040$, and there was a similar non-significant trend for disgust, $F(1,117) = 3.703$, $p = .057$, $\eta_p^2 = .031$.

The third MANCOVA compared the two groups of women on the four negative emotions instead of all seven (i.e., angry, disgust, fear, and sad). Results indicated a non-significant trend for an overall multivariate group effect, $F(4,114) = 2.36$, $p = .058$, $\eta_p^2 = .08$. Follow-up univariate ANCOVAs showed only a significant group effect for Fear, $F(1,117) = 5.67$, $p = .029$, $\eta_p^2 = .040$ (see Table 13).

Post-hoc between-group comparisons with Bonferroni corrections are reflected in Table 16. In terms of Total FER, women with PCOS were significantly more accurate than men (*mean diff.* = 9.89, *SE* = 1.55, $p < .001$) and women with PCOS were less accurate than women without PCOS (*mean diff.* = 5.88, *SE* = 2.24, $p = .029$). Women without PCOS were significantly more accurate than men at identifying the following four emotions: Anger, (*mean diff.* = 1.83, *SE* =

0.61, $p = .009$); Disgust, (*mean diff.* = 2.172, *SE* = 0.60, $p = .001$); Fear, (*mean diff.* = 2.83, *SE* = 0.75, $p < .001$); and Surprise (*mean diff.* = 0.27, *SE* = 0.10, $p = .017$) (See Table 16). Finally, women with the provisional diagnosis of PCOS were significantly less accurate than women without PCOS when identifying Fear (*mean diff.* = 2.57, *SE* = 1.16, $\eta_p^2 = .040$) (See Tables 15 and 15).

Discussion

Summary of Results

Women were more accurate than men at recognizing facial emotions when all seven emotions were examined together. Women were also significantly more accurate than men when recognizing anger, disgust, fear, and surprise, supporting hypothesis one. While there were no significant negative associations between PCOS symptoms (i.e., PCOSQ score, Hair Severity, mFG and sFG) and all the FER variables, women with more coarse dark hair (i.e., Hair Severity, sFG) were less accurate at detecting fear in facial emotion expressions, which lends some partial support to hypothesis two. The present results indicated significant linear trends across total FER scores, angry, disgust, fear, surprise, and neutral scores, where men are the least accurate, followed by women with a provisional PCOS diagnosis, and women without a provisional PCOS diagnosis were the most accurate. These significant linear trends are consistent with hypothesis three. However, group differences were not always significant as there were no significant differences between women with a provisional PCOS diagnosis and men, which is inconsistent with hypothesis three (i.e., women with provisional PCOS performed similarly to men). Thus, there is partial support for hypothesis three. Additionally, there is some support for hypothesis four because women with a provisional PCOS diagnosis were significantly less accurate than women without a provisional diagnosis in detecting emotions across all faces. However, this was

due to a significant effect for fear, and there were no significant group differences in detecting other individual emotions.

Sex Difference: Women were more accurate than men on the facial emotion recognition task

In the current study, women were more accurate than men in detecting emotions (total FER scores). There was also a significant difference between women and men in identifying anger, disgust, fear, and surprise, which aligns with the existing literature and supports hypothesis 1. While many studies have not examined neutral faces (i.e., images with actors not emoting an emotion), one study by Wingenbach et al. (2018), also used the same images as those in the present study and found no significant difference in performance between men and women when recognizing neutral faces. Their finding aligns with the findings from the present study. The result that women are more accurate than men in emotion recognition across all emotions aligns with Wingenbach et al.'s (2018) findings and Thompson and Voyer's (2014) meta-analyses in terms of the magnitude of effect size (classified based on Cohen, 2013) and directionality. Both studies noted higher accuracy in women than men in identifying the six emotions (anger, disgust, fear, sadness, surprise, and happiness).

In the present study, women were not significantly more accurate than men at identifying sad and happy expressions, which is inconsistent with previous findings (Thompson & Voyer, 2014). There are four possible explanations for this inconsistency.

First, the inconsistency could be because participants completed the task online in different settings, leading to lower experimental control of the environment. However, it is unclear why this lower experimental control would selectively affect happy and sad emotion recognition.

A second explanation for this disparity could be the absence of data on the history of brain injury, antipsychotic use, and bipolar disorder for males, which prevented their exclusion based on these criteria. Previous studies propose that these factors—brain injuries (Ietswaart et al., 2008), antipsychotic use (Penn et al., 2009), and bipolar disorder (Bozorg et al., 2014) — could hinder facial emotion recognition abilities. While it might be that removing participants with such conditions might lead to significant sex differences for happy and sad, it is unclear why sad and happy would be the only emotions that are differentially affected by these exclusionary criteria. Furthermore, previous studies have not explicitly excluded participants with these characteristics (e.g., Connolly et al., 2019; Wingenbach et al., 2016).

A third possibility might be that the emotions of sadness and happiness have the smallest sex difference effect size across all emotions, which may contribute to the non-significant findings. This explanation is unlikely because past studies indicate that the effect size for happy and sad is larger than surprise, which has the smallest effect size (Thompson & Voyer, 2014; Wingenbach et al., 2018), and in the present study there was a significant difference between men and women on surprise. So, it is unclear why a significant difference was not detected for happy and sad.

The fourth explanation is that the active recruitment of women with PCOS (e.g., online PCOS Facebook groups) may have resulted in a higher representation of women with PCOS in the current sample than in previous research on sex differences. This explanation seems plausible because excluding women with a provisional PCOS diagnosis and comparing men to women without a PCOS diagnosis resulted in a non-significant trend ($p = .064$), with women being more accurate at recognizing happiness. At the same time, a similar comparison between women without a provisional PCOS diagnosis to men did not result in a significant sex difference in

recognition of sadness (p =.636), so it is still unclear why we did not find a significant difference between men and women in emotion recognition accuracy for sadness.

Overall, the finding of the expected sex differences on the facial emotion recognition task provides support for existence of sex differences, but also for the validity of this measure. These findings increased confidence in the power of this facial emotion task to detect differences between women high and low in PCOS symptoms, if such differences exist. However, it is possible that the facial stimuli used for assessing happiness and sadness may not have been as sensitive as the stimuli for assessing the other emotions.

Relationship between PCOS symptoms and facial emotion recognition accuracy

The current results suggest that women with more severe PCOS-related symptoms (e.g., women with more severe hair growth) were less accurate at identifying fear, which is consistent with hypothesis two and aligns with Sukhapure's (2019) unpublished dissertation indicating that women with PCOS were less accurate at detecting fear than those without the condition. This study is the only one to have previously examined facial emotion recognition in PCOS, and no studies have examined the full continuum of PCOS symptoms, like the present study.

While some of the present findings are consistent with the previous study and hypothesis two (i.e., a small effect size for fear recognition), the lack of a significant association between facial emotion recognition performance across all the emotions and the four PCOS variables (PCOSQ scores, Hair Severity score, sFG score, mFG score) does not support hypothesis two. There are two possible explanations for the lack of strong support for hypothesis two. Firstly, previous research comparing women with PCOS to women without PCOS found that the largest difference between groups was for accuracy in fear recognition, which suggests that PCOS may be more strongly associated with lower fear recognition than other emotions. This likely explains

why fear recognition was the only emotion significantly correlated with any PCOS variables in the present study. The power of the present analyses and methodology to detect individual differences in emotion recognition may have been lower due to the methodology (e.g., an online study) and due to the examination of the continuum of symptoms as opposed discrete groups of women with and without PCOS. Thus, it is not surprising that only the emotion with the largest effect size (i.e., fear) was found to be associated with PCOS symptoms.

Diminished fear recognition in women with a provisional diagnosis of PCOS

In the present study, the distribution of FER total scores, and five individual emotion recognition scores (i.e., angry, disgust, fear, surprise, and neutral), demonstrated significant linear trends such that women without a provisional diagnosis of PCOS performed better than women with a provisional diagnosis of PCOS, who performed better than men. This finding along with the result of an overall group difference when examining total FER scores provide support for hypothesis three. When examining group differences, the following group differences are consistent with hypotheses three and four: (a) women without a provisional diagnosis were significantly more accurate at recognizing emotions overall, and specifically fear, than women with a provisional PCOS diagnosis and men; and (b) although there were no statistically significant differences between means, the direction of the means indicated that women with a provisional diagnosis were more accurate than men at recognizing all the seven emotions. As well, it appears that women with a provisional diagnosis of PCOS performed similarly to men. Thus, women with provisional PCOS performed worse than expected, as it was hypothesized that they would still have better recognition accuracy than men.

The findings that women without a PCOS diagnosis had higher accuracy on the FER task than women with a provisional PCOS diagnosis in recognizing emotions overall as well as with

fear, is consistent with the one previous study by Sukhapure (2019) that compared the FER accuracy of women with and without PCOS. The current findings are comparable in directionality and magnitude (small effect sizes) to the findings of Sukhapure (2019), who found that women with a PCOS diagnosis performed worse than women without the diagnosis, especially when identifying fear. As well, the present findings are in line with studies examining the relationship between sublingual T administration and women's responses to emotional faces. For example, Bos et al., (2013) found that, after receiving T sublingually, women showed an increased amygdala activity when viewing fearful faces. van Honk et al., (2005), found women given sublingual T spent less time attending to fearful faces in an emotional Stroop task compared to women not receiving any sublingual T. The results of these two studies suggests that androgen levels (measured as T levels) may affect emotion recognition related to fearful faces. The current findings are also in line with research by Rukavina et al. (2018), who reported that men with lower levels of naturally occurring testosterone (a type of androgen) were more accurate than men with higher testosterone at recognizing fear on a FER task and the findings by Thompson and Voyer (2014) who reported that women (who naturally have lower endogenous androgen levels than men) were better at recognizing emotions than men. Correspondingly, considering that most women with PCOS symptoms have higher androgen levels (e.g., testosterone levels) than those without PCOS (Azziz, 2006), it is likely that women in the present study with provisional PCOS have higher androgen levels than those without the provisional diagnosis. Thus, the current findings provide support for the theory that androgens, including testosterone, have an adverse influence on facial emotion recognition (Perović et al., 2022) as women without PCOS (who likely have lower androgen levels) were more accurate at recognizing fear than women with the provisional diagnosis.

An alternative explanation, as to why women with PCOS perform worse on cognitive tasks that usually have a female advantage, such as a facial emotion recognition task, may be related to metabolic issues (e.g., insulin dysregulation) as opposed to androgenic factors. For example, women with PCOS performed worse than women without PCOS on mental rotation in the study by Jarrett et al., (2019) and the decrease in performance was significantly correlated with elevated levels of hemoglobin (which is related to insulin dysregulation) and not significantly correlated with androgen levels (e.g., testosterone levels). On the other hand, a study by Barry, Parekh, and Hardiman, (2013) found women with PCOS were more accurate at mental rotation tasks than women without PCOS. While reasons for this discrepancy is unclear, it is possible that androgens or testosterone are not the primary or only reason why women with and without PCOS differ in FER. It is important to acknowledge theories that factors other than androgens may play a role in the cognitive differences observed between women with and without PCOS (Perović et al., 2022).

While some of the present findings were consistent with hypotheses three and four, two results were inconsistent with the hypotheses. Firstly, there were no significant differences in emotion recognition accuracy between women with a provisional diagnosis of PCOS and men across all the emotions or on the total FER score. This suggests that women with provisional PCOS actually had similar performance to men, which is somewhat inconsistent with hypothesis three, which proposed women with provisional PCOS would perform better than men regarding FER performance (i.e., best performance in women without a provisional diagnosis and worst performance in men). Thus, the women with provisional PCOS performed even worse (relative to men) than was hypothesized. There are two potential explanations for the lack of a significant difference in FER performance between men and women with a provisional diagnosis of PCOS.

First, when comparing the three groups, differences between the groups were small to medium effect sizes, which suggests the current study might not have had enough participants/power, especially in the group of women with a provisional diagnosis, to detect a significant effect. Second, in the present sample, approximately 50% (8 out of 19) of women with a provisional PCOS diagnosis also self-reported a medical diagnosis of PCOS. Notably, a considerable proportion of women (approximately 60%) diagnosed with PCOS have been observed to exhibit elevated androgen levels (Azziz, 2003) or distinctive physiological responses to androgens (Ditkoff et al., 1995). It is conceivable that women within the provisional PCOS category in our study might have experienced a similar hormonal milieu. Given the established norm of higher androgen levels in men compared to women, it is possible that the hormonal environment—such as androgen levels and their responsiveness—of women with provisional PCOS might have had greater similarity to men than originally hypothesized. This potential overlap in hormonal profiles could offer insight into why women with PCOS exhibited performance patterns more akin to men than women without PCOS. It's important to note that this study represents the first attempt at comparing women with provisional PCOS diagnoses (or those with PCOS) to men. As such, the observed findings warrant replication and further investigation.

The failure to find significant differences in recognizing sadness between women with vs. without a provisional diagnosis of PCOS, was inconsistent with the findings of Sukhapure (2019). They found that women with PCOS were significantly worse at recognizing sadness than women without PCOS. There are three possible reasons for this inconsistency. One potential explanation could be that the differences between groups may be of a small effect size and a small effect size combined with low power (i.e., small sample size) would have resulted in no significance. The second possibility is that there may be no group differences between women

with PCOS (or provisional PCOS) and without PCOS, and that the finding reported by Sukahpure (2019) was a spurious finding. The other possible explanation for this inconsistency is that women in the present study were classified into categories based on self-reported PCOS symptoms instead of being classified by medical diagnosis, as was the case in Sukhapure's (2019) study. Thus, it could be that women included in the provisional PCOS category had subclinical PCOS symptoms, which would make them different from the women in the Sukhapure (2019) study who had a clinical diagnosis of PCOS, thereby explaining the discrepancies between the studies. The use of medical diagnoses of PCOS in the previous study would have been a more powerful design and could explain the inconsistent findings between the two studies.

Limitations and Strengths

This section presents an analysis of limitations and strengths related to three aspects, (1) the FER task, (2) the measurement and classification of PCOS, and (3) the sample of the current study. In the following section each aspect will be reviewed, along with its limitations and strengths.

Limitations and Strengths Related to FER Task

The task in the present study was completed online which has two potential limitations. First, reaction time could not be measured, and effects related to reaction time measures could not be studied. Second, there was significantly less experimental control compared to a lab setting. While the prior study by Sukhapure (2019) measured both accuracy and reaction time for women completing a FER task, they found that women with and without PCOS differed significantly in accuracy but not reaction time. Thus, their findings suggest that accuracy may be a more important variable to measure than reaction times. Even though participants completed

the task in a less controlled setting, sex differences which have been reported in previous literature were detected. These findings provide support for the task's ecological validity. One other limitation related to the stimuli presented for the FER task, is the use of only Caucasian actors which may have led to an other-race bias (Zhao et al., 2014) for non-Caucasian participants.

The present study had a number of strengths related to the FER task. The task used in the current study differs slightly from other FER tasks because it included neutral expressions, two facial emotion intensities instead of three (Wingenbach et al., 2018), and had significantly more trials that traditional tasks (Connolly et al., 2019; Hall, 1978). These are all strengths of the present study. Traditionally, studies focused on sex differences and facial emotion recognition (e.g., Biele & Grabowska, 2006; Connolly et al., 2019; Montagne et al., 2007) have examined the six primary emotions (i.e., anger, disgust, fear, sadness, and happiness) without including neutral expressions. The inclusion of images with neutral expressions is a strength of the current study as it includes assessment of the ability to recognize when no emotion is present and ensures that high accuracy on other tests is not due to any biases to identify emotions when they are not actually present. The ADFES-BIV database from which stimuli for this study were adapted consisted of images with three different intensities (high, medium, and low), but in the present study, only medium and low-intensity images were used to increase task difficulty. Despite this difference, we found significant sex differences in FER performance, with women being more accurate than men, which suggests that the task used in the present study, which is shorter than the original task, is a valid/sensitive method of testing FER performance. Despite the small sample size, the present study included over 100 trials per participant, contributing to a powerful design.

Limitations and Strengths Related to Measurement and Classification of PCOS

The current study measured self-reported PCOS symptoms on a continuum and women were classified as either meeting or not meeting criteria for a provisional PCOS diagnosis. One potential limitation of grouping women based on their PCOS symptoms, is that women who would not meet the threshold for a clinical diagnosis of PCOS could be included in the provisional PCOS group, thereby reducing the difference between the two groups of women (with vs. without provisional PCOS). The other study focused on FER and PCOS by Sukhapure (2019) examined women with a clinical diagnosis of PCOS vs. those without, and this might have led to a more powerful design than the current study when looking at group differences. However, our finding of group differences when using provisional diagnoses based on self-report data suggests that differences in FER between women with and without PCOS is a robust finding.

Despite the limitations related the classification of women into those with vs. without a provisional PCOS diagnosis, examining the full spectrum of PCOS symptoms allows examination of whether subclinical symptoms are associated with reduced FER. As suggested by other researchers (Perović et al., 2022; Rellini et al., 2013; Tzalazidis & Oinonen, 2021b), including women with subclinical symptoms of PCOS and measuring PCOS symptoms along a continuum is an important way to examine the full range of PCOS symptoms. Furthermore, the participants in the current study reported on various androgenic symptoms (e.g., hair severity) associated with PCOS, contributing to a more nuanced examination of how each symptom could be distinctly associated with FER performance. The present study is only the second study to examine the association between androgenic symptoms and FER accuracy in women, and the first to examine the full continuum of PCOS symptoms. Sukhapure (2019) noted that women

diagnosed with PCOS were less accurate at identifying fear and sadness than those without the diagnosis (small effect size). This study expanded upon Sukhapure's work by investigating the relationships between FER performance and the full continuum of women with PCOS symptoms, encompassing women with subclinical symptoms and no symptoms. The current study also included a group of men, which had not been done previously.

Limitations and Strengths Related to Participant Sample

The sample included in the current study was recruited primarily from a university population, which means that generalizing the findings of the present study to the larger population is restricted (i.e., lower generalizability to older, less educated, less affluent people). One additional limitation related to the current sample, is that due a clerical error, men in the current study were not asked about their history of brain injury, bipolar disorder, or antipsychotic use, precluding the exclusion of such individuals from analyses that involved men. However, it is noteworthy that excluding men based on these criteria is uncommon in research focusing on FER (e.g., Biele & Grabowska, 2006; Connolly et al., 2019; Montagne et al., 2007). It was the case that women with characteristics that were related to facial emotion recognition such as brain injuries (Ietswaart et al., 2008), antipsychotic use (Penn et al., 2009), and bipolar disorder (Bozorg et al., 2014), were excluded from the relevant analyses that did not involve men, even though these variables are not commonly used as exclusionary criteria (Connolly et al., 2019). The exclusion of people with a history of brain injury, anti-psychotic use, and bipolar disorder, also helped ensure that other potential confounds were removed. An additional limitation could be related to the absence of exclusion criteria based on caffeine, nicotine, and cannabis use. This is noteworthy because use of caffeine, nicotine, and cannabis have been associated with FER performance (Miller et al., 2015). However, many FER studies do not exclude participants based

on exclusion criteria related to caffeine, nicotine, and cannabis use (Connolly et al., 2019; Hall, 1978), so this was not a unique limitation of the present study.

Future Studies

Given that this is the first study to examine the relationship between FER and the continuum of PCOS symptoms, future studies should replicate the present findings. Future studies could also examine the relationship between FER performance and other specific PCOS symptoms in women diagnosed with PCOS because there are several phenotypes of PCOS (Azziz, 2006; Perovic et al., 2021). In addition to examining the symptoms of PCOS, future studies should examine biological markers (e.g., androgen levels, insulin dysregulation) that might also mediate or moderate the relationship between FER performance and PCOS symptoms. The current findings need to be examined with a sample the includes older women who may be experiencing menopausal symptoms, because some research suggests that PCOS symptoms can change with age (Perović et al., 2022).

Prior studies indicate an association between FER performance and use of caffeine, nicotine, and cannabis (Miller et al., 2015). Thus, it may be important to assess participants' consumption of these substances and control for them. While we did assess alcohol use, these other variables were not included in the present study, representing a limitation which could be addressed in future studies.

Implications

Accurate recognition of fear in facial expressions is a critical aspect of human social cognition, serving as an early warning system for potential threats and aiding in effective decision-making. Notably, individuals who struggle to accurately identify emotions in others might be less sensitive to subtle cues indicating danger and might consequently experience

challenges in accurately identifying risk. For example, individuals with cerebellar stroke who experience deficits in emotion recognition were identified as being more likely to engage in risky decision making than healthy controls, when in simulated life-threatening situations (e.g., deciding not to brake even when seeing a child in front of the car in a driving simulator) (van den Berg et al., 2020). The findings from the present study suggest that women with a provisional PCOS diagnosis are less accurate at identifying emotions as compared to women without a provisional PCOS diagnosis, and it might be that women with PCOS symptoms are also more likely to experience deficits in accurately assessing and responding to risk. In certain contexts that demand quick assessment of others' fear expressions (e.g., in situations of perceived threat), those who are less accurate in recognizing fear would be at greater risk of making a dangerous choice (e.g., choosing to approach rather than flee the danger).

The ability to recognize facial emotions and fear in others may also affect women's ability to form social connections. One theory around child-rearing hypothesizes that women are more accurate at recognizing emotions than men because, as primary caregivers, they need to be more sensitive to emotional expressions so that they can form connections by responding to their children's needs (Hampson, van Anders & Mullin, 2006). In addition to the adaptive value of fear recognition for parenting, women with lower fear recognition would be less likely to recognize fear (and possibly anxiety) in those around them, thus missing out on an opportunity to comfort and build connections with those individuals. It is noteworthy that adolescent girls with social anxiety who have deficits in forming social connections, are also found to have lower accuracy in recognizing fear on a FER task when compared to those without social anxiety (Wieckowski et al., 2016). Overall having lower fear recognition could negatively affect the ability of women with PCOS symptoms to form social bonds and connections with others.

Poorer emotion recognition, especially lower accuracy in detecting fear, is a common deficit associated with mood disorders such as bipolar disorder and depression (Kohler et al., 2011), and women with PCOS are at greater odds of having both of these disorders (Brutocao et al., 2018). The current study suggests that women with PCOS likely exhibit lower overall emotion recognition accuracy, including fear recognition. This finding adds to our understanding of how potential emotion recognition deficits observed in women with PCOS symptoms could be related to the higher rates of mood disorders that are present in women with PCOS. This potential relationship implies that deficits in emotion recognition might both contribute to and result from mood disorders in the context of PCOS.

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Tables

Table 1

Examination of Group Equivalency Between Men and Women (t-Tests): Means (SDs).

Variable	Men (n = 52)	Women (n = 140)
Age (years)	23.46 (7.67)	22.33 (5.10)
Typical number of drinks	4.33 (2.36)	3.75 (1.41)
Typical alcohol use score	2.25 (0.95)	2.02 (0.69)
Exercise in the past 24 hours [a] *	3.75 (1.41)	3.00 (1.46)
Hours of sleep last night	7.13 (1.37)	7.38(1.80)
BMI (kg/m^2)	24.63 (6.23)	24.35 (7.02)
PSS	20.06 (5.82)	22.19 (6.14)
Positive affect (now) ***	20.80 (8.11)	23.86 (8.17)
Negative affect (now)	20.10 (8.73)	18.97 (7.31)
ACEs score	1.53 (2.30)	2.21 (2.44)

Note: Variables above the line were examined as potential covariates, and variables below the line reflect ones expected to differ or be of theoretical interest.
[a] Variable represents a physical activity score in the past 24 hours
BMI = Body Mass Index (kg/m^2); PSS = Perceived Stress Scale; Positive Affect (now) = PANAS Positive Affect; Negative Affect (now) = PANAS Negative Affect Scale; ACEs = Adverse Childhood Experiences.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2

Examination of Group Equivalency Between Men and Women (Chi-Square Tests): Frequencies (Percentages).

Variable	Men (n = 52)	Women (n = 140)
Ethnicity		
White	35 (67.30)	103 (73.57)
Other	17 (32.70)	37 (26.42)
Highest Education		
Completed High school	15 (28.84)	30 (21.42)
Some College	3 (5.76)	2 (1.42)
Completed College	6 (11.53)	23 (16.42)
Some University	24 (46.15)	77 (55.00)
Completed University	4 (7.69)	4 (2.85)
Some graduate studies	0	1 (0.71)
Completed a graduate degree	0	3 (2.14)

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3

Examination of Group Equivalency Between Men, Women With, and Women Without a Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis (Analysis of Variance (ANOVAs)): Means (SD).

Variable	Men (n = 52)	Provisional PCOS Diagnosis [a] (n = 19)	No Provisional PCOS Diagnosis [a] (n = 107)
Age (years)	23.46 (7.67)	24.89 (6.87)	22.12 (4.82)
Typical number of drinks	4.33 (2.36)	3.69 (1.78)	3.89 (2.06)
Typical alcohol use	2.25 (0.95)	2.10 (0.87)	2.03 (0.62)
Exercise in the past 24 hours [b] *	3.75 (1.41)	2.68 (1.45)	3.08 (1.46)
Hours of sleep last night	7.13 (1.37)	7.68 (2.11)	7.28 (1.76)
BMI (kg/m^2) ***	24.63 (6.23)	32.69 (7.44)	23.18 (5.79)
PSS [t]	20.06 (5.82)	24.18 (4.77)	21.76 (6.02)
Positive affect (now)	20.80 (8.11)	22.33 (8.25)	23.87 (7.73)
Negative affect (now)	20.10 (8.73)	17.85 (6.76)	19.34 (7.79)
ACEs score	1.53 (2.30)	3.00 (2.50)	2.01 (2.43)

Note: Variables above the line were examined as potential covariates, and variables below the line reflect ones expected to differ or were examined for theoretical interest.
[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007). [b] Variable represents a physical activity score in the past 24 hours
BMI = Body Mass Index (kg/m^2); PSS = Perceived Stress Scale; Positive Affect (now) = PANAS Positive Affect; Negative Affect (now) = PANAS Negative Affect Scale; ACEs = Adverse Childhood Experiences.

[t] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4

Group Equivalency Between Men, Women With, and Women Without a Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis (Chi-Square Tests): Frequencies (Percentages).

Variable	Men (n = 52)	Provisional Diagnosis [a] (n = 19)	No Provisional Diagnosis [a] (n = 107)
Ethnicity			
White	35 (67.30)	15 (78.94)	80 (74.76)
Other	17 (32.69)	4 (21.10)	27 (25.23)
Highest Education			
Completed High School	15 (28.84)	5 (26.31)	19 (17.75)
Some College	3 (5.76)	1 (5.26)	1 (0.93)
Completed College	6 (11.53)	2 (10.52)	21 (19.62)
Some University	24 (46.15)	9 (47.36)	60 (56.07)
Completed University	4 (7.69)	1 (5.26)	3 (2.80)
Some graduate studies	0	0	1 (0.93)
Completed a graduate degree	0	1 (5.26)	2 (1.86)
Oral Contraceptive Use			
Yes	--	4 (21.05)	33 (30.84)
No	--	15 (78.94)	74 (69.15)
Taking Hormonal Medication			
Yes	--	9 (47.36)	55 (51.90)
No	--	10 (52.63)	51 (48.10)

Note: [a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5

Examination of Group Equivalency Between Women With and Without a Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis (t-Tests): Means (SDs).

Variable	Provisional Diagnosis [a] (n = 16)	No Provisional Diagnosis [a] (n = 104)
Age (years)	24.13 (6.04)	22.01 (4.81)
Typical number of drinks	3.35 (1.59)	3.88 (2.05)
Typical alcohol use score	2.12 (0.88)	2.04 (0.63)
Exercise in the past 24 hours[b]	2.68 (1.40)	3.08 (1.47)
Hours of sleep last night	7.56 (1.96)	7.31 (1.73)
BMI (kg/m^2) ***	32.38 (7.97)	27.25 (6.99)
PSS	24.06 (4.86)	21.62 (6.00)
Positive affect (now)	21.81 (8.18)	23.77 (7.46)
Negative affect (now)	18.00 (6.87)	19.42 (7.89)
ACEs score	3.00 (2.72)	1.91 (2.30)

Note: Variables above the line were examined as potential covariates, and variables below the line reflect ones expecting to differ or be of theoretical interest.
[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007). [b] Variable represents a physical activity score in the past 24 hours
BMI = Body Mass Index (kg/m^2); PSS = Perceived Stress Scale; Positive Affect (now) = PANAS Positive Affect; Negative Affect (now) = PANAS Negative Affect Scale; ACEs = Adverse Childhood Experiences.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6

Examination of Group Equivalency Between Women With and Without a Provisional PCOS Diagnosis (Chi-Square Tests): Frequencies (Percentages).

Variable	Provisional Diagnosis (n = 16)	No Provisional Diagnosis (n = 104)
Ethnicity		
White	12 (75.00)	78 (75.00)
Other	4 (25.00)	26 (25.00)
Highest Education		
Completed Highschool	4 (25.00)	19 (18.30)
Some College	1 (6.25)	1 (0.96)
Completed College	2 (12.50)	19 (18.26)
Some University	8 (50.00)	59 (56.73)
Completed University	0	3 (2.88)
Some graduate studies	0	1 (0.96)
Completed a graduate degree	1 (6.25)	2 (1.92)
Oral Contraceptive Use		
Yes	4 (25.00)	32 (30.76)
No	12 (75.00)	72 (69.23)
Taking Hormonal Medication [b]		
Yes	9 (56.25)	50 (48.07)
No	7 (43.75)	53 (50.96)
Thyroid Disorder *		
Yes	2 (12.50)	1 (0.96)
No	13 (81.25)	101 (97.11)
ADHD Diagnosis [c]		
Yes	2 (12.50)	9 (8.65)
No	14 (87.50)	95 (91.34)

Note: [a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007). [b] This variable represents whether a woman is taking any hormonal medication, including hormonal or oral contraceptives.
ADHD = Attention Deficit Hyperactivity Disorder.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7

Intercorrelations Between Polycystic Ovary Syndrome (PCOS) Variables: Pearson Correlations (Spearmen's rho)

	PCOSQ score (n = 120)	Hair Severity score (n = 126)	sFG score (n = 129)
PCOSQ Score	--	.062 (.08)	.24 (.16) *
Hair Severity Scores	.06 (.08)	--	.54 (.58) ***
sFG Score	.24 (.16) ***	.54 (.58) ***	--
mFG Score	.18 (.14) *	.63 (.68) *	.93 (.93) *

Note: The Hair Severity score and PCOSQ score had overlapping question content. The sFG and mFG had overlapping question content. Significance values are based on the Pearson correlations. When women had unanswered hair questions on the PCOSQ but reported having hair growth on the Bedrick Questionnaire, corresponding Bedrick items were used to fill in the PCOSQ item (e.g., if upper lip hair was reported on Bedrick, PCOSQ reflected upper lip hair). PCOSQ = Polycystic Ovary Syndrome Questionnaire; Hair Severity Score = Sum of Hair items from PCOSQ; sFG = simplified Ferriman-Gallwey Score; mFG = modified Ferriman-Gallwey Score.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 8

Means and SDs for Hypothesis 1 Variables: Accuracy on Facial Emotion Recognition Variables (FER) as a Function of Group (Men vs. Women).

FER Variable	Men (n = 52)	Women (n = 140)
Total FER	97.69 (9.96)	106.20 (9.95)
Angry *	13.78 (3.53)	15.48 (3.60)
Disgust *	11.02 (3.84)	12.89 (3.53)
Fear *	9.51 (4.61)	11.83 (4.36)
Sadness	15.03 (2.18)	15.57 (2.23)
Surprise [a] *	19.53 (2.81)	20.70 (2.48)
Happy	18.01 (2.29)	18.71 (2.42)
Neutral [b]	9.09 (1.11)	9.25 (1.06)

Note: Higher scores represent better accuracy. Means are unadjusted and untransformed.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 9

Hypothesis 1 Group Differences on Facial Emotion Recognition (FER) Scores (Men vs. Women): Analysis of Covariance (ANCOVAs)

FER Variable	*df*	*F*	*p*	η_p^2	*mean diff.*	*SE*
Total FER ***	1,189	24.04	< .001	.11	8.13	1.66
Angry *	1,189	7.24	.008	.04	1.61	0.60
Disgust *	1,189	8.94	.003	.04	1.81	0.60
Fear *	1,189	9.93	.002	.05	2.33	0.74
Sadness	1,189	1.69	.195	.009	0.48	0.37
Surprise [a] *	1,189	6.90	.009	.03	0.25	0.09
Happy	1,189	2.59	.109	.01	0.64	0.40
Neutral [b]	1,189	0.023	.489	.003	0.25	0.04

Note: Positive mean differences reflect higher scores for women than men, and negative mean differences indicate higher scores for men than women. The covariate of exercise, which is the amount of exercise in the past 24 hours, was used. The overall multivariate analysis of covariance (MANCOVA) with the seven emotions was significant, F (7,183) = 4.43, $p < .001$, $\eta_p^2 = 0.14$.

[a] Scores were square-root transformed.

[b] Scores were log-transformed.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 10

Hypothesis 2: Correlations Between Polycystic Ovary Syndrome (PCOS) Variables and Facial Emotion Recognition (FER) Variables in Women: Bivariate Pearson Correlations (Partial Correlations)

	PCOS Variables			
FER Variables	PCOSQ score (n = 120)	Hair Severity score (n = 126)	sFG score (n = 129)	mFG score (n = 129)
Total FER	-.14 (-.13)	-.07 (-.07)	-.04 (-.04)	-.007 (-.008)
Angry	-.059 (-.04)	.01 (.01)	.30 (.30)	.03 (.03)
Disgust	-.12 (-.13)	-.06 (-.06)	-.04 (-.04)	-.01 (-.01)
Fear	-.14 (-.13)[t]	-.16 (-.16) **	-.18 (-.18) **	-.14 (-.14)
Sadness	.02 (.01)	-.02 (-.02)	.05 (.05)	.04 (.04)
Surprise [a]	.02 (.01)	.08 (.08)	.11 (.11)	.08 (.09)
Happy	.004 (.01)	.13 (.13)	.04 (.04)	.07 (.07)
Neutral [b]	.021 (-.01)	-.05 (-.05)	.04 (.05)	.05 (.05)

Note: The Hair Severity score and PCOSQ score had overlapping question content. The sFG and mFG had overlapping question content. Significance values are based on the Pearson correlations. When women had unanswered hair questions on the PCOSQ but reported having hair growth on the Bedrick Questionnaire, corresponding Bedrick items were used to fill in the PCOSQ item (e.g., if upper lip hair was reported on Bedrick, PCOSQ reflected upper lip hair). PCOSQ = Polycystic Ovary Syndrome Questionnaire; Hair Severity Score = Sum of Hair items from Hair Growth Questionnaire; sFG = simplified Ferriman-Gallwey Score; mFG = modified Ferriman-Gallwey Score.

[a] Analyses were done using square root transformed scores

[b] Analyses were done using log-transformed scores.

[t] indicates non-significant trend

[t] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 11

Hypothesis 2: Multiple Regressions Examining the Overall Relationship Between the Seven Facial Emotion Recognition (FER) Variables and Variables Related to Polycystic Ovary Syndrome (PCOS)

Predictors	PCOSQ			Hair Severity			sFG			mFG		
	ΔR^2	β	sr^2	ΔR^2	β	sr^2	ΔR^2	β	sr^2	ΔR^2	β	sr^2
Step 1	.029			.001			.002			.000		
Exercise		-.17	-.17		.03	.03		.05	.05		.45	-.10
Step 2	.036			.063			.065			.047		
Angry		.01	.01		.07	.06		.09	.09		.08	.08
Disgust		-.12	-.12		-.05	-.05		-.03	-.03		-.002	-.002
Fear		-.15	-.13		-.20	-.17		-.25	-.21		-.22	-.18
Sadness		.04	.04		.001	.001		.10	.10		.07	.06
Surprise [a]		-.20	-.01		.009	.008		.01	.01		-.006	-.005
Happy		.04	.04		.18	.17		.08	.08		.11	.11
Neutral [b]		.11	.02		-.02	-.02		.07	.07		.07	.07
R^2		.06			.06			.06			.04	
F		3.58			0.99			1.08			0.75	
N		120			126			129			129	

Note: The Hair Severity score and PCOSQ score had overlapping question content. The sFG and mFG had overlapping question content. Significance values are based on the Pearson correlations. When women had unanswered hair questions on the PCOSQ but reported having hair growth on the Bedrick Questionnaire, corresponding Bedrick items were used to fill in the PCOSQ item (e.g., if upper lip hair was reported on Bedrick, PCOSQ reflected upper lip hair). PCOSQ = Polycystic Ovary Syndrome Questionnaire Score; sFG = simplified Ferriman-Gallwey Score; mFG = modified Ferriman-Gallwey Score

[a] Analyses were done using square root transformed scores [b] Analyses were done using log-transformed scores

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 12

Means (SDs) for Hypothesis 3 Variables: Accuracy on Facial Emotion Recognition (FER) Variables as a Function of Group (Men vs. Women With vs. Without Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis).

Variable	Men (n = 52)	Provisional PCOS Diagnosis [a] (n = 19)	No Provisional PCOS Diagnosis [a] (n = 107)
Total FER	97.69 (9.96)[d]	102.00 (7.78)[e]	107.77 (8.65)[e]
Angry *	13.78 (3.53)[d]	14.94 (3.64)	15.60 (3.50)
Disgust *	11.02 (3.84)[d]	11.31 (3.43)	13.31 (3.35)
Fear *	9.51 (4.61)[d]	9.84 (4.68)[e]	12.29 (4.15)[e]
Sadness	15.03 (2.18)	15.84 (1.86)	15.64 (2.31)
Surprise [b] *	19.53 (2.81)[d]	21.15 (2.24)	20.78 (2.27)
Happy	18.01 (2.29)	18.15 (2.26)	18.96 (2.20)
Neutral [c]	9.09 (1.11)	9.05 (1.02)	9.37 (0.86)

Note: Asterisks reflect the results of the 3-group ANCOVAs. Means are unadjusted and untransformed. The overall multivariate analysis of covariance (MANCOVA) with all seven emotions was significant, $F(7,169) = 4.51$, $p < .001$, $\eta_p^2 = 0.13$.

[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).[b] Scores were square root transformed. [c] Scores were log-transformed. [d] Significant difference between men and women without provisional diagnosis [e] Significant difference between women with and without provisional diagnosis.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 13

Means (SDs) for Hypothesis 4 Variables: Accuracy on Facial Emotion Recognition (FER) Variables as a Function of Group (Women without Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis vs. Women with Provisional Diagnosis).

Variable	No Provisional PCOS Diagnosis [a] (n = 104)	Provisional PCOS Diagnosis [a] (n = 16)
Total FER*	107.77 (8.68)	102.37 (6.88)
Angry	15.66 (3.54)	15.06 (3.73)
Disgust	13.29 (3.38)	11.62 (2.98)
Fear *	12.20 (4.16)	9.62 (5.05)
Sadness	15.61 (2.32)	16.00 (1.50)
Surprise	21.06 (2.40)	20.80 (2.27)
Happy	19.02 (2.09)	18.25 (1.98)
Neutral	9.12 (1.08)	9.35 (0.86)

Note: Means are untransformed and unadjusted. Asterisks reflect the results of the 2-group ANCOVAs. The overall multivariate analysis of covariance (MANCOVA) with all seven emotions was significant, $F(7,111) = 1.59$, $p = .143$, $\eta_p^2 = 0.09$, indicating that women with provisional PCOS performed worse than those without PCOS.

[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 14

Hypothesis 3: Multivariate Analysis of Covariance (MANCOVAs) and Linear Contrasts: Facial Emotion Recognition (FER) Scores When Comparing Three Groups (Men vs. Women With vs. Without a Provisional PCOS Diagnosis[a])

	ANCOVAs				Linear Contrasts	
Variable	*df*	*F*	*p*	η_p^2	*F* [d]	*p* [d]
Total FER	2,174	21.27***	< .001	.20	6.37***	< .001
Angry	2,174	4.51[t]	.012	.049	3.00*	.003
Disgust	2,174	7.83***	< .001	.083	3.58***	< .001
Fear	2,174	8.21***	< .001	.086	3.77***	< .001
Sadness	2,174	1.35	.262	.015	1.51	.133
Surprise [b]	2,174	4.70**	.010	.051	2.82**	.006
Happy	2,174	3.24	.161	.021	2.32	.179
Neutral [c]	2,174	1.84*	.042	.036	1.36*	.021

Note: The overall multivariate analysis of covariance (MANCOVA) with all seven emotions was significant, $F(7,169) = 4.51$, $p < .001$, $\eta_p^2 = 0.13$.
[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).[b] Scores were square-root transformed. [c] Scores were log-transformed. [d] Statistics for the linear contrast analyses

[t] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 15

Hypothesis 4: Group Differences on Facial Emotion Recognition (FER) Scores (Women With and Without a Provisional PCOS Diagnosis): Multivariate Analysis of Covariance (MANCOVAs)

	Women with vs. without a Provisional PCOS Diagnosis [a]					
Variable	*df*	*F*	*p*	η_p^2	*mean diff.*	*SE*
Total FER*	1,117	5.54	.020	.04	5.41	2.29
Angry	1,117	0.26	.609	.002	0.49	0.96
Disgust [t]	1,117	3.70	.057	.03	0.90	0.90
Fear *	1,117	4.91	.029	.04	2.57	1.16
Sadness	1,117	0.34	.561	.003	0.60	0.14
Surprise	1,117	0.19	.661	.002	0.064	0.14
Happy	1,117	1.79	.183	.01	0.754	0.56
Neutral	1,117	1.03	.310	.009	0.057	0.05

Note: Positive mean differences reflect higher scores for women without a provisional diagnosis, and negative mean differences indicate higher scores for women with a provisional diagnosis. The overall multivariate analysis of covariance (MANCOVA) with all seven emotions was significant, $F(7,111) = 1.59$, $p = .143$, $\eta_p^2 = 0.09$, indicating that women with provisional PCOS performed worse than those without PCOS.

[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).

[t] $p < 0.10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 16

Hypotheses 3 and 4: Mean Differences on Facial Emotion Recognition (FER) Scores (Men vs. Women With vs. Without Provisional Polycystic Ovary Syndrome (PCOS) Diagnosis): Mean Diff (SE)

Variable	Provisional PCOS Diagnosis [a] vs. Men	No Provisional PCOS Diagnosis [a] vs. Men	With vs. Without Provisional PCOS Diagnosis [a]
Total FER	4.00 (2.46)	9.90 (1.55) ***	-5.88 (2.24) *
Angry	1.18 (0.97)	1.83 (0.61) *	-0.65 (0.88)
Disgust	0.10 (0.96)	2.17 (0.60) *	-2.07 (0.87)
Fear	0.40 (1.19)	2.83 (0.75) ***	-2.45 (1.09) [t]
Sadness	0.77 (0.61)	0.58 (0.38)	0.184 (0.55)
Surprise [b]	0.36 (0.15)	0.27 (0.97) *	0.09 (0.14)
Happy	0.06 (0.61)	0.89 (0.38) [t]	-0.83 (0.56)
Neutral [c]	-0.03 (0.05)	0.48 (0.03)	-0.08 (0.05)

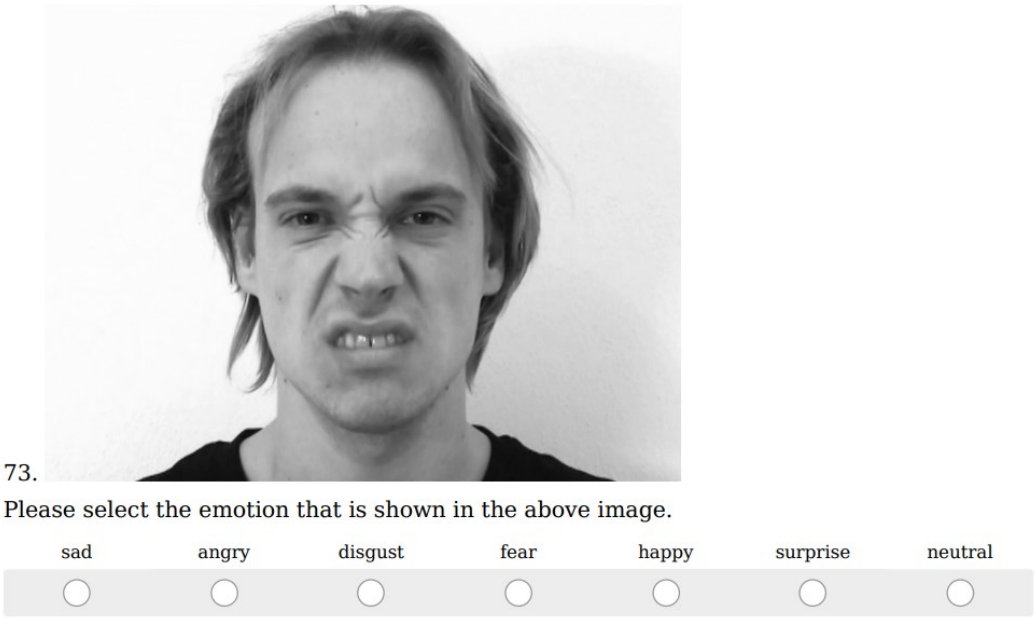
Note: Means are unadjusted. Negative differences indicated that the first group had lower accuracy scores than the second group being compared.
[a] Women with a Provisional PCOS Diagnosis scored ≥ 2, and women without a Provisional PCOS Diagnosis scored < 2 on the Polycystic Ovary Syndrome Questionnaire (Pedersen et al., 2007).[b] Scores were square root transformed. [c] Scores were log-transformed.

[t] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Figures

Figure 1

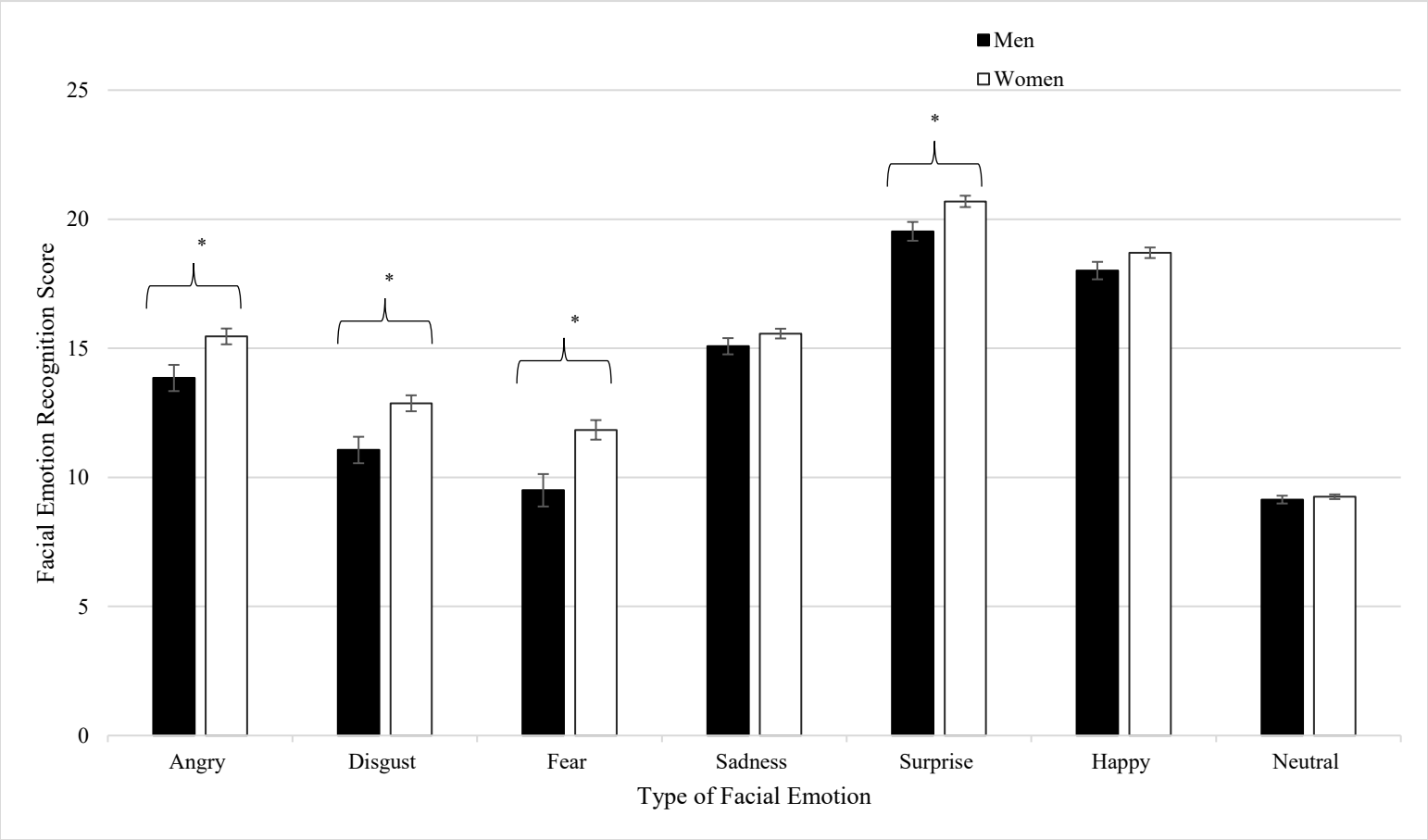
Example of a Facial Emotion Recognition Trial



Note: All images were shown in color. Image adapted from Wingenbach, T.S.H., Ashwin, C., & Brosnan, M. (2016). Validation of the Amsterdamdynamic facial expression set – Bath intensity variations (ADFES-BIV): A set of videos expressing low, intermediate, and high intensity emotions. *PLOS ONE*, *11*(1), e0147112. https://doi.org/10.1371/journal.pone.0147112

Figure 2

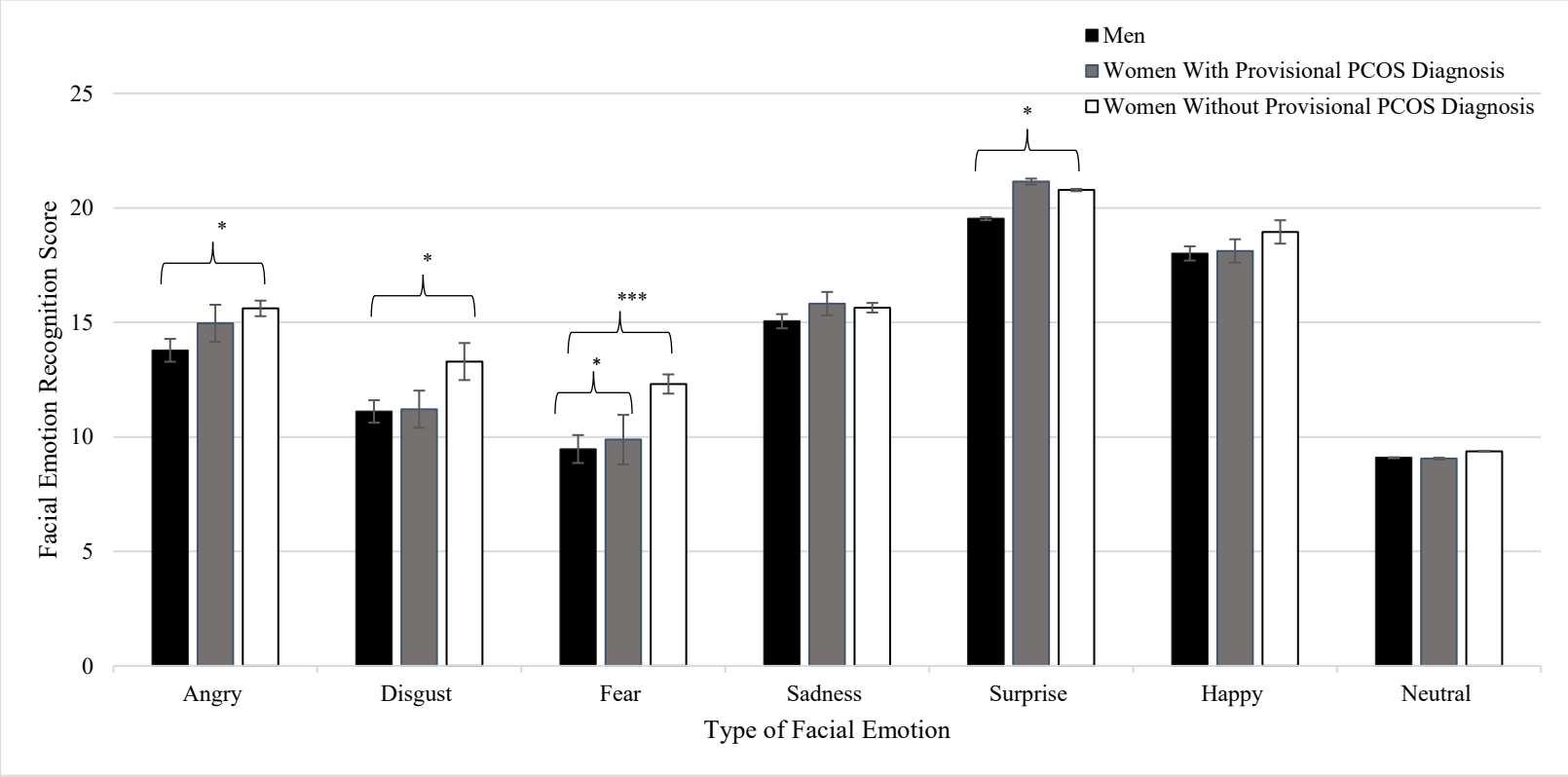
Accuracy on Facial Emotion Recognition (FER) Variables as a Function of Sex (Men vs. Women)



Note: Accuracy scores for each FER variable are reported for men and women (error bars show standard errors). Untransformed means are adjusted for the covariate of exercise. The overall multivariate analysis of covariance (MANCOVA) indicated a multivariate group effect, $F(7,183) = 4.43$, $p < .001$, $\eta_p^2 = .14$, indicating a sex difference across all the emotions.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Figure 3

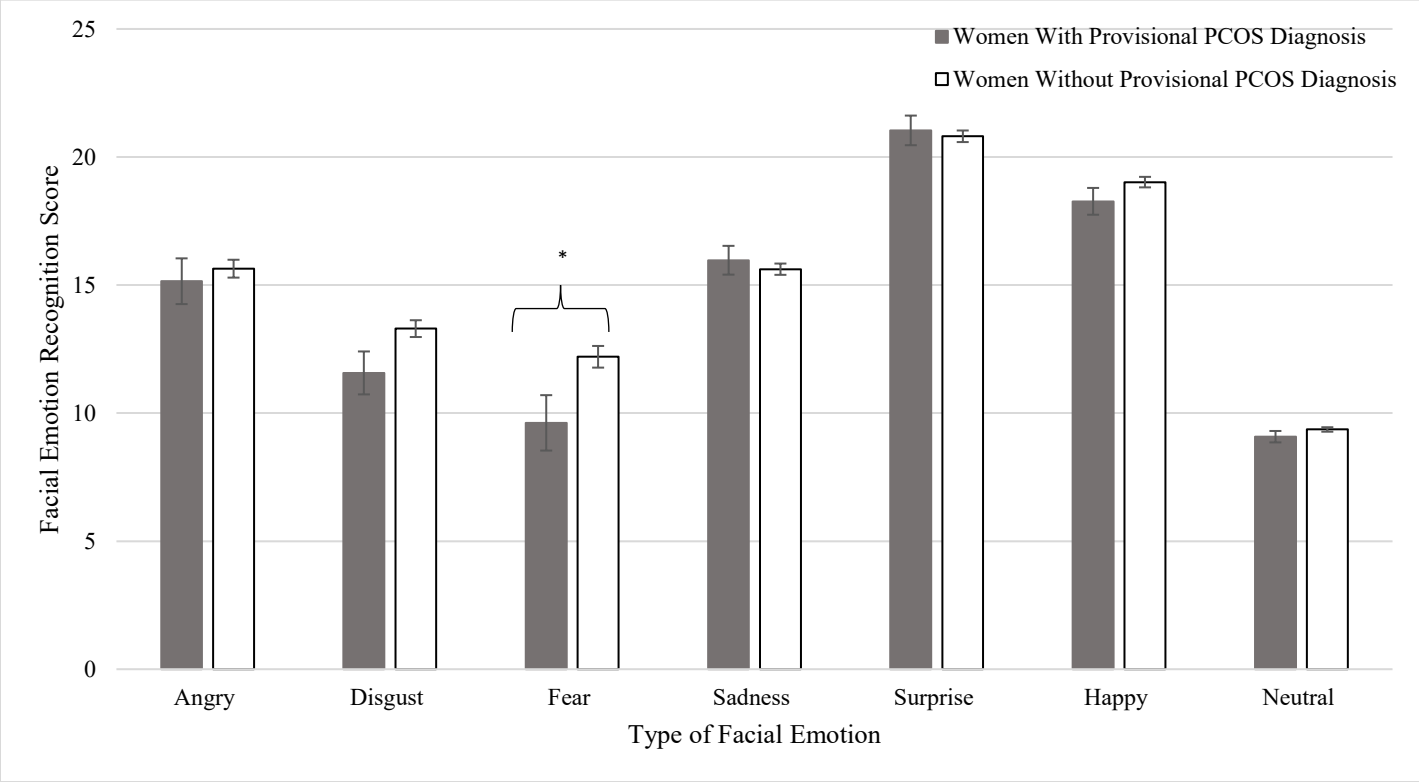
Accuracy on Facial Emotion Recognition Variables (FER) as a Function of Group (Men vs. Women With vs. Without Provisional Polycystic Ovary Syndrome (PCOS) Diagnoses).



Note: Accuracy scores for each FER variable are reported for men, women with provisional PCOS, and women without a provisional PCOS diagnosis (error bars show standard errors). Means are untransformed and are adjusted for the covariate of exercise. The overall multivariate analysis of covariance (MANCOVA) indicated a multivariate group effect across all emotions, $F(7,169) = 7.01$, $p < .001$, $\eta_p^2 = .13$.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Figure 4

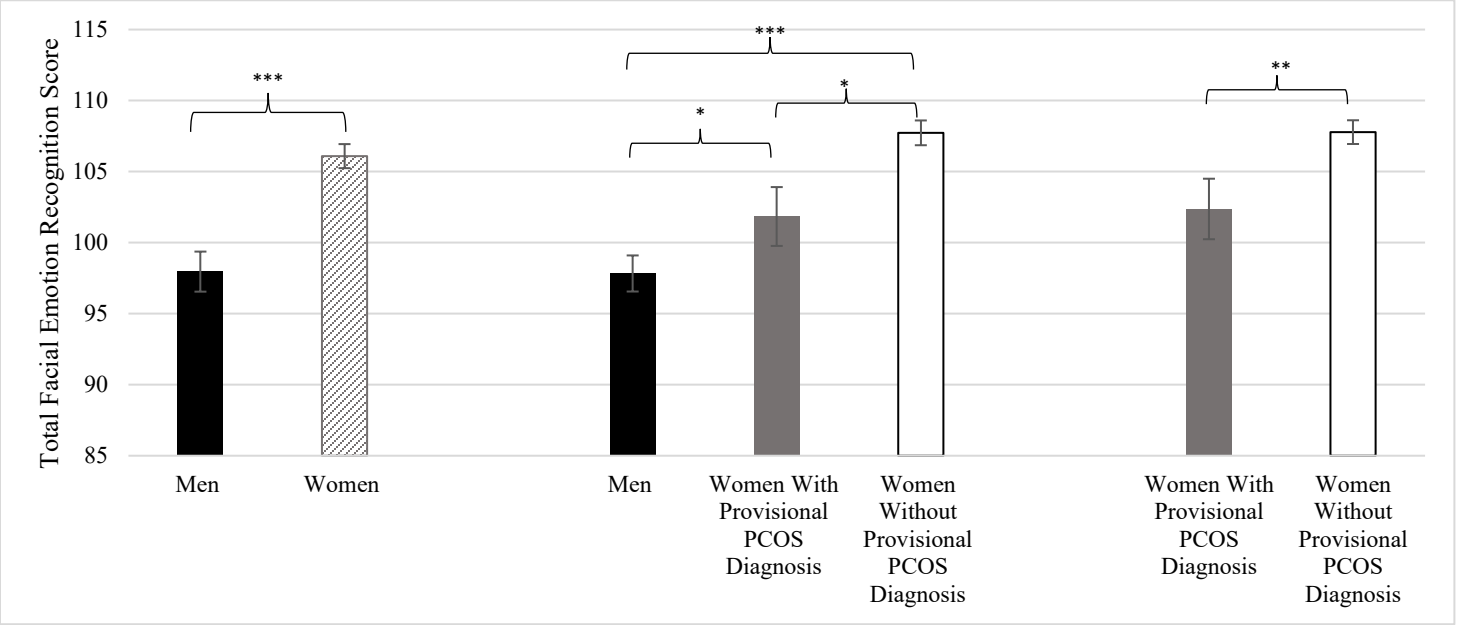
Accuracy on Facial Emotion Recognition (FER) Variables as a Function of Group (Women With vs. Without Provisional Polycystic Ovary Syndrome (PCOS) Diagnoses).



Note: Accuracy scores for each FER variable are reported for women with vs. without a provisional PCOS diagnosis (error bars show standard errors). Means are untransformed and are adjusted for the covariate of exercise. Exclusion criteria for these analyses were stricter than those in Figure 3, as participants with brain injury, antipsychotic use, and bipolar disorder were excluded. The overall multivariate analysis of covariance (MANCOVA) indicated a non-significant trend across all emotions, F (4,114) = 2.36, p = .058, η_p^2 = .08.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Figure 5

Total Facial Emotion Recognition (FER) Scores as a Function of Group.



Note: Scores for total FER are reported for men vs. women (including women with and without a provisional PCOS diagnosis) (left panel), men vs. women with vs. without a provisional PCOS diagnosis (middle panel), and women with vs. without provisional PCOS diagnosis (right panel). Error bars show standard errors. Means are untransformed and are adjusted for the covariate of exercise. Exclusion criteria for these final analyses with women with vs. without a provisional PCOS diagnosis (bars on far right) were stricter than those for the groups in the other two analyses, as participants with brain injury, antipsychotic use, and bipolar disorder were excluded. PCOS = Polycystic Ovary Syndrome.The above graphs reflects the results of three separate analysis of covariance (ANCOVA). The ANCOVA comparing women and men was significant, $F(1,189) = 24.04$, $p = < .001$, $\eta_p^2 = .11$. The 3-group ANCOVA indicated significant group differences, $F(2,174) = 21.27$, $p < .001$, $\eta_p^2 = .20$. Finally, the ANCOVA comparing women with vs. without PCOS was also significant, $F\ (1,117) = 5.54$, $p = .020$, $\eta_p^2 = .04$.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Appendix A: Research Ethics Board (REB) Approval Letter

January 27, 2023

Principal Investigator: Dr. Kirsten Oinonen

Student: Smruthi (Shree) Venkateshan

Health and Behavioural Sciences\Psychology Lakehead University

955 Oliver Road

Thunder Bay, ON P7B 5E1

Dear Dr. Kirsten Oinonen and Shree:

Re: Romeo File No: 1469560 Granting Agency: n/a Agency Reference #: n/a

Research Ethics Board

t: (807) 343-8283

research@lakeheadu.ca

On behalf of the Research Ethics Board, I am pleased to grant ethical approval to your research project titled, "Facial Emotion Recognition in Women with Symptoms of Polycystic Ovary Syndrome".

Ethics approval is valid until January 27, 2024. Please submit a Request for Renewal to the Office of Research Services via the Romeo Research Portal by December 27, 2023, if your research involving human participants will continue for longer than one year. A Final Report must be submitted promptly upon completion of the project. Access the Romeo Research Portal by logging into myInfo at:

https://erpwp.lakeheadu.ca/

During the course of the study, any modifications to the protocol or forms must not be initiated without prior written approval from the REB. You must promptly notify the REB of any adverse events that may occur.

Best wishes for a successful research project. Sincerely,

Dr. Claudio Pousa

Chair, Research Ethics Board

Appendix B: Recruitment Materials

Subject: Factors Affecting Facial Emotion Perception

Body: You are invited to participate in a psychology study looking at the factors affecting facial perception. Additionally, we are interested in how hormonal markers (e.g., hormonal history or physical characteristics) influence facial emotion perception. We are seeking both female and male participants to complete a questionnaire and facial emotion recognition task online that will take less than an hour to complete. Alternatively, please contact svenkat2@lakeheadu.ca if you would like to complete the experiment in person in the laboratory.

Students enrolled in Introductory Psychology or other select Psychology courses (where bonus points are permitted) will receive 1 bonus point for completing the study. Participants who are not Lakehead University students will be entered in a draw to win one of five 20-dollar gift cards.

This study has been reviewed and approved by the Lakehead University Research Ethics Board, (807) 343-8283.

Please follow the link below to participate: **LINK TO SURVEY**

If you have any questions regarding this study, please email the researchers (contact information below).

Your time and participation are greatly appreciated.

Sincerely,

Shree Venkateshan, H.BSc, MSc.

MA Student, Department of Psychology,

Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1

email: svenkat2@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych

Professor, Department of Psychology

Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1

email: koinonen@lakeheadu.ca

Email Recruitment for Students

Subject: PARTICIPANTS NEEDED FOR STUDY ON FACTORS AFFECTING FACIAL EMOTION PERCEPTION

Body: Researchers are looking for MEN and WOMEN to participate in a study looking at individual differences in how faces are perceived. It involves completing a questionnaire and a facial perception task online, that should take less than an hour. Eligible Psychology students can receive 1 bonus point for completing the study online, and 1.5 points for completing the study in person.

This study has received ethical approval by the Lakehead University Ethics Board, (807) 343-8283. Please contact Shree Venkateshan at svenkat2@lakeheadu.ca to participate or if you would like further information on the study.

Thank you, your time and participation are greatly appreciated.

Sincerely,

Shree Venkateshan, H.BSc, MSc.
MA Student, Department of Psychology,
Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1
email: svenkat2@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych
Professor, Department of Psychology
Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1
email: koinonen@lakeheadu.ca

Email Recruitment for Non-Student Participants

Subject: PARTICIPANTS NEEDED FOR STUDY ON FACTORS AFFECTING FACIAL EMOTION PERCEPTION

You are invited to participate in a psychology study looking at factors affecting facial perception. Additionally, we are interested in how hormonal markers influence facial emotion perception (via facial emotion recognition task). We are seeking both female and male participants to complete a questionnaire and facial emotion recognition task online that will take less than an hour to complete. Anyone 18 years and older can participate. Please use the link below to complete the study online or contact svenkat2@lakeheadu.ca if you would like to complete the experiment in person. Participants who are not Lakehead University students will be entered in a draw to win one of five 20-dollar gift cards.

This study has been reviewed and approved by the Lakehead University Research Ethics Board, (807) 343-8283.

Please follow the link below to participate: **LINK TO SURVEY**

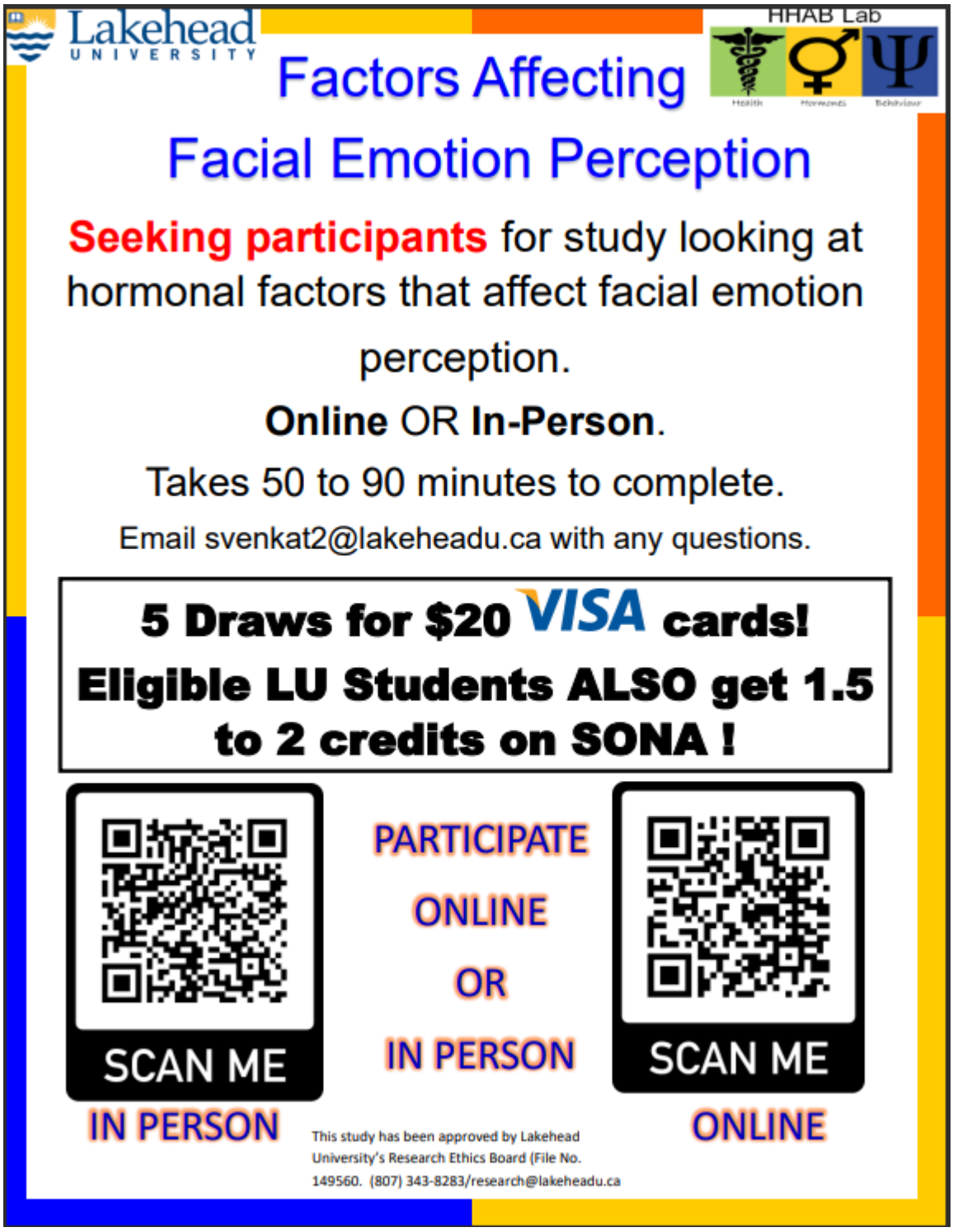
If you have any questions regarding this study, please email the researchers (contact information below).

Thank you, your time and participation are greatly appreciated.

Sincerely,

Shree Venkateshan, H.BSc, MSc.
MA Student, Department of Psychology,
Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1
email: svenkat2@lakeheadu.ca

Dr. Kirsten Oinonen Ph.D., C. Psych
Professor, Department of Psychology
Lakehead University, 955 Oliver Road,
Thunder Bay, Ontario P7B 5E1
email: koinonen@lakeheadu.ca


Lakehead UNIVERSITY
HHAB Lab
Factors Affecting
Facial Emotion Perception
Seeking participants for study looking at hormonal factors that affect facial emotion perception.
Online OR In-Person.
Takes 50 to 90 minutes to complete.
Email svenkat2@lakeheadu.ca with any questions.
5 Draws for $20 VISA cards!
Eligible LU Students ALSO get 1.5 to 2 credits on SONA !
SCAN ME
IN PERSON
PARTICIPATE
ONLINE
OR
IN PERSON
SCAN ME
ONLINE
This study has been approved by Lakehead University's Research Ethics Board (File No. 149560. (807) 343-8283/research@lakeheadu.ca


Lakehead UNIVERSITY
HHAB Lab
Factors Affecting
Facial Emotion Perception
Seeking participants for study looking at hormonal factors that affect facial emotion perception.
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ONLINE
OR
IN PERSON
SCAN ME
ONLINE
This study has been approved by Lakehead University's Research Ethics Board (File No. 149560. (807) 343-8283/ research@lakeheadu.ca

Appendix C: Questionnaire

Note: Some copyrighted measures were removed from this version of the thesis including the images from the Modified Ferriman-Gallwey, Perceived Stress Questionnaire, and Positive and Negative Affect Schedule

Initial Questionnaire

Demographics

1. What is your age?
2. What sex were you assigned at birth?
    a. Female
    b. Male
    c. Intersex
    d. Other:
3. What is your current gender identity?
    a. Male
    b. Female
    c. Other (e.g., Two-Spirit) Specify:_____
4. What is your current sexual orientation?
    a. Heterosexual
    b. Gay
    c. Lesbian
    d. Queer
    e. Bisexual
    f. Pansexual
    g. Asexual
    h. Something else that is not already listed here: Specify: _____

5. Please indicate your degree of sexual attraction to women

Not at all attracted to women								Extremely attracted to women
1	2	3	4	5	6	7	8	9

6. Please indicate your degree of sexual attraction to men

Not at all attracted to men								Extremely attracted to men
1	2	3	4	5	6	7	8	9

7. Enter your height in, inches, centimeters, or feet. Use the drop down menu to indicate which measurement you are using (inches, cm, or feet).
   _____ (feet and inches) or _____ (cm)
8. Enter your weight in pounds or kilograms. Use the drop-down menu to indicate which measurement you are using (pounds or kilograms)
   _____ (pounds) or ____ (kg)

9. Please choose the response that represents your ethnic background. Check all that apply.
    a. White, or Euro-American/Canadian
    b. Indigenous
    c. Latin American
    d. Arab
    e. South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
    f. Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai, etc.)
    g. West Asian (e.g., Iranian, Afghan, etc.)
    h. Chinese
    i. Black, Afro-Carribean, or African-American or African-Canadian
    j. Filipino
    k. Korean
    l. Japanese
    m. Other (please specify):

10. What best describes the highest level of education that you have completed?

    a. Some elementary
    b. Completed grade 8
    c. Some high school
    d. Complete high school
    e. Some college
    f. Completed college
    g. Some university
    h. Completed university
    i. Some graduate studies
    j. Completed a graduate degree
11. If you are or were a University/College student what is/was your Major? (e.g., psychology, biology, English, nursing). _____
12. How many hours of sleep did you get last night? (# hours, 0 - 24 hours) *This question used a drop down menu.*
13. During the past 24 hours how many minutes were you physically active at a moderate to intense level?
    a. 0 minutes
    b. 1 to 15 minutes
    c. 16 to 30 minutes
    d. 31 to 45 minutes
    e. 46 or more minutes
14. Have you had any drinks today (since waking up this morning)?
    a. Yes
    b. No
15. If yes, how many drinks did you consume today (e.g., ONE drink is equal to 1.5 oz distilled alcohol i.e., vodka, rum, whiskey etc., 5 oz glass of wine, or 12 oz bottle of beer).

Please indicate: _____

16. If you drank alcohol in the past 24 hours, how many hours ago was your last drink? ___ hours

17. What is your typical frequency of alcohol consumption?
    a. Never
    b. Once or twice a month or less
    c. Once or twice a week
    d. Three to four times a week
    e. Almost everyday
18. When you drink alcohol, how many drinks do you typically have on a typical drinking occasion? *(drop down menu with options from 0 to 30+, in increments of 1)*
19. Do you smoke cigarettes, vape, or use other types of nicotine?
    a. Yes
    b. No
20. If you are a smoker or use another form of nicotine, are you currently experiencing nicotine withdrawal (e.g., craving nicotine, feeling angry, irritable, having difficulty concentrating, feeling restless, or anxious)? YES NO MAYBE

Health Information

21. Are you currently taking oral contraceptives (i.e., the birth control pill)?
    a. Yes
    b. No, I have never taken them
    c. No, I used the birth control pill previously and stopped
22. If you are currently using an oral contraceptive, please check the type of oral contraceptive you are currently taking.

Oral Contraceptives:

[ ] Alesse	[ ] Ortho-Cept	[ ] Yaz
[ ] Apri	[ ] Ortho 0.5/35	[ ] Yasmin
[ ] Aviane	[ ] Ortho 7/7/7	[ ] Other: _____
[ ] Brevicon 0.5/35	[ ] Ortho 10/11	
[ ] Brevicon 1/35	[ ] Synphasic	
[ ] Cyclen	[ ] Tri-Cyclen	
[ ] Demulen 30	[ ] Triphasil	
[ ] Loestrin 1.5/30	[ ] Triquilar	
[ ] Levora	[ ] Demulen 50	
[ ] Marvelon	[ ] Norlestin 1/50	
[ ] MinEstrin 1/20	[ ] Ovral	
[ ] Min-Ovral	[ ] Ortho 1/35	
[ ] Norinyl	[ ] Ortho-Novum 1/50	

23. Are you currently taking a hormonal contraceptive that is not the oral contraceptive pill (e.g., hormonal IUD, hormonal patch, vaginal rings, injections)?
    a. Yes
    b. No, I have never taken them

c. No, I used a hormonal contraceptive previously (not including the pill) and stopped

24. Which category best describes your experience with hormonal medication OTHER THAN contraceptives (e.g., hormonal therapy for transitioning, hormone replacement therapy, progestin-only for endometrial cancer, tamoxifen for breast cancer etc.)
    a. Yes
    b. No, I used such a hormonal medication previously and stopped
    c. No, I have never taken them
25. Are you a woman who is currently going through, or has gone through, menopause?
    a. Yes
    b. No
    c. Maybe
26. Are you currently pregnant?
    a. Yes, I'm currently pregnant.
    b. No, I'm not pregnant.
    c. I may be pregnant.
27. Have you ever been pregnant?
    a. Yes, I have been pregnant
    b. No, I have never been pregnant
28. Are you currently breastfeeding?
    a. Yes
    b. No
29. If you have ever attempted to breastfeed following a pregnancy, did you have any difficulties with breast milk supply?

    0 1 2 3 4 5

    No difficulties Yes extreme difficulties
30. Are you currently taking any medications?
    a. Yes
    b. No
        i. If yes, please list what medications you are taking.

        _____
31. Have you ever had any head injuries that resulted in permanent changes to your functioning or abilities?
    a. Yes
    b. No
    c. Maybe
32. Please indicate if you ever been diagnosed with or treated for any of the following:

	Yes	No
Depression		
Anxiety		
Bipolar Disorder		
Polycystic Ovary Syndrome		
Diabetes		
Obesity		
Hyper/Hypo Thyroidism		

Cushing's Syndrome		
Acromegaly		

33. Please list any other medical or psychological conditions which you have been diagnosed with.

---

34. Please answer this question, NOT INCLUDING any time spent pregnant, receiving birth control pills or injections, after menopause, or after having both ovaries or the uterus surgically removed. Between the ages of 16 and 40, about how long was/is your average menstrual cycle (time from first day of one period to the first day of the next period).
    i. Less than 25 days
    ii. 25-34 days
    iii. 35-60 days
    iv. More than 60 days
    v. Totally variable

    b. Between the ages of 16 and 40, did you have a tendency to grow dark coarse hair on your (check yes or no)
        i. Upper lip (Yes or No)
        ii. Chin (Yes or No)
        iii. Breast (Yes or No)
        iv. Chests between the breast (Yes or No)
        v. Back (Yes or No)
        vi. Belly (Yes or No)
        vii. Upper arms (Yes or No)
        viii. Upper thighs (Yes or No)

    c. Were you ever obese or overweight between the ages of 16 and 40?
        i. Yes
        ii. No

    d. Between the ages of 16 and 40 have you ever noticed a milky discharge from your nipples (not including during pregnancy or recent childbirth)?
        i. Yes
        ii. No

35. During your menstruating years (not including during pregnancy), and when you don't engage in any hair removal practices (e.g., shaving/plucking/waxing/laser hair removal/hair bleaching/threading), **please indicate the overall amount/coverage of your hair growth on the areas listed below as compared to other women of your same age and ethnicity/race**.

- Upper lip
- Chin
- Breast
- Chest Between Breast
- Back
- Belly
- Upper arms
- Upper thighs

0	1	2	3	4
Much lower	Slightly Lower	About the same	Slightly Greater	Much Greater

36. During your menstruating years (not including during pregnancy), and when you don't engage in any hair removal practices (e.g., shaving/plucking/waxing/laser hair removal/hair bleaching/threading), please indicate the amount of hair you have had on each area on the scales provided.

	No Hair					Complete Coverage
Upper Lip						
Chin						
Breast						
Chest Between Breast						
Back						
Belly						
Upper arms						
Upper Thighs						

37. Please indicate the amount of hair you have had on each area on the scales provided during your menstruating years (not including during pregnancy). *Please answer these questions about periods when you don't engage in any hair removal practices (e.g., shaving/plucking/waxing/laser hair removal/hair bleaching/threading).* **Please note that the even numbers correspond to the images, and the odd numbers correspond to hair growth that is between two images.**

    Items not reported for Copyrighted measures.

    Bedrick, B. S., Eskew, A. M., Chavarro, J. E., & Jungheim, E. S. (2020). Self-administered questionnaire to screen for polycystic ovarian syndrome. *Women's Health Reports, 1*(1), 566-573.

38. Think about the time in your life when your acne was at its worst and when you were NOT taking any acne medication or treatment for your acne (e.g., Accutane, hormonal contraceptives). Please indicate the severity of your acne at the time.

	No Acne					Severe Acne
Face						
Neck						
Chest						

Back						
Arms						
Legs						

FER Task Practice Trial Example

73. 

Please select the emotion that is shown in the above image.

sad	angry	disgust	fear	happy	surprise	neutral
○	○	○	○	○	○	○

Follow Up Questionnaire

39. This next section asks questions about your childhood when you were less than 18 years old.
    a. Did a parent or other adult in the household often or very often …. Swear at you, insult you, put you down, or humiliate you? Or act in a way that made you afraid that you might be physically hurt?
        i. Yes
        ii. No
    b. Did a parent or other adult in the household often or very often… Push, grab, slap, or throw something at you? or Ever hit you so hard that you had marks or were injured?
        i. Yes
        ii. No
    c. Did an adult or person at least 5 years older than you ever… Touch or fondle you or have you touch their body in a sexual way? or Attempt or actually have oral or anal intercourse with you?
        i. Yes
        ii. No
    d. Did you often or very often feel that …

    No one in your family loved you or thought you were important or special? or Your family didn't look out for each other, feel close to each other, or support each other?
        i. Yes

ii. No

e. Did you often or very often feel that … You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you? or Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
   i. Yes
   ii. No

f. Was a biological parent ever lost to you through divorce, abandonment, or other reason?
   i. Yes
   ii. No

g. Was your mother or stepmother: Often or very often, pushed, grabbed, slapped, or had something thrown at her? Or sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? Or ever repeatedly hit over at least a few minutes or threatened with a gun or knife?
   i. Yes
   ii. No

h. Did you live with anyone who was a problem drinker or alcoholic or who use street drugs?
   i. Yes
   ii. No

i. Was a household member depressed or mentally ill? Or did a household member attempt suicide?
   i. Yes
   ii. No

j. Did a household member go to prison?
   i. Yes
   ii. No

40. The Perceived Stress Questionnaire (PSS)

Items are not reported for Copyrighted measures.

Cohen, S. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan & S. Oskamp (Eds.), *The social psychology of health* (pp. 31-67). Sage Publications, Inc.

41. The Positive and Negative Affect Schedule (PANAS)

Items are not reported for Copyrighted measures.

Watson, D., Clark, L. A., & Tellegren, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063-1070.

Menstrual Cycle Phase:

42. How old were you when you first started menstruating (started your period)? __ yrs old
43. What is average length of your menstrual cycle when you are not taking oral contraceptives? (i.e., how many days is it from first day of one period to the day before the first day of the next period? Most people's periods last between 21 to 35 days)

    _____
44. What is the average length of your menstrual period (i.e., how many days does your period last? Most people's periods last between 1 and 10 days). _____
45. Which statement best describes your menstrual cycle when you are not taking oral contraceptives?
    a. I never have my period.
    b. My period is very unpredictable. Sometimes very few days pass before I get my next period, sometimes months pass before I get my next period.
    c. My period is somewhat unpredictable. I usually get my period within four to seven days of when I expect it.
    d. My period is somewhat predictable. I usually get my period within two or three days of when I expect it.
    e. My period is very predictable. I can predict within one day when my next period will start.
    f. My periods have stopped as a result of menopause or a hysterectomy.

46. Referring to a calendar, please indicate the first day of your last menstrual period (i.e. When was the FIRST DAY of your most recent period?). If you are not completely sure, please estimate the day that you believe you started menstruating on.
    DATE: dd/mm/yy _____
47. On a scale of 0 to 100 %, how confident are you that the above-indicated day was the first day of your last period?
    _____ %
48. Referring to a calendar please indicate your estimation of the first day of your NEXT menstrual period. If you are not completely sure, please estimate the day that you believe you will start menstruating on.

DATE: dd/mm/yy _____

49. On a scale of 0 to 100 %, how confident are you that the above-indicated day is the day that you will next get your period?
    _____ %
50. Are you currently menstruating today?
    a. Yes
    b. No
51. If you are currently menstruating today, how many days including today have you menstruated? *This question will use a drop-down menu.*
    1, 2, 3, 4, 5, 6, 7, 8, 9, 10 days, greater than 10 days

Department of Psychology

Appendix D: Letter to Participants and Consent Form

Factors Affecting Facial Emotion Perception Study

Dear Potential Participant,

You are invited to take part in a study on Factors Affecting Facial Emotion Perception. Taking part in this study is voluntary. Before you decide whether you would like to participate, please read this letter carefully to understand what is involved. After you have read the letter, please ask any questions you may have by emailing the student researcher at svenkat2@lakeheadu.ca.

PURPOSE

This study is being conducted by Ms. Shree Venkateshan (student researcher) and Dr. Kirsten Oinonen (principal investigator) from the Health Hormones and Behaviour Laboratory (HHABLAB) in the Department of Psychology at Lakehead University. The purpose of this study is to investigate what factors affect facial emotion perception, including hormones and other factors. A part of this project will be used to complete a Master's thesis for Shree Venkateshan. Additional exploratory research questions in the same area may also be examined. This study is open to Lakehead University students 16 years or older as well as members of the public who are 18 years or older.

WHAT INFORMATION WILL BE COLLECTED?

The anonymous questionnaires involve answering personal questions about your health, reproductive history, childhood experiences, emotions, and personality. Responses on a facial emotion detection task will also be collected.

WHAT IS REQUESTED OF ME AS A PARTICIPANT?

The study will consist of anonymous questionnaires and facial emotion perception tasks. The study will usually be completed online and take 40 to 60 minutes to complete (both questionnaires will take approximately 10 to 30 minutes to complete, and the facial task will take approximately 30 minutes to complete), Participants may also choose to participate in person, at Lakehead University.

WHAT ARE MY RIGHTS AS A PARTICIPANT?

Participation in this study is voluntary and you may withdraw at any time without explanation and without penalty. You also have the right to choose not to answer any specific questions. Your decision to participate or not will not affect your academic status or employment. No one, including the researchers, will be able to connect any information gathered to a specific individual. Thus, the data provided in this experiment will be anonymous and cannot be withdrawn once submitted.

WHAT ARE THE RISKS AND BENEFITS?

There are no obvious risks involved in participating in this study. However, some participants may feel uncomfortable answering personal questions or have new positive or negative thoughts about themselves after answering the questions (i.e., new personal insight). For participants completing this study in person, there are risks of contracting COVID-19 during in-person research. Personal benefits to you for participating in this experiment include the knowledge that you have contributed to the research, learning about psychological research (e.g., some of the methods used), possibly gaining personal insight, gaining a bonus point towards your course mark (for those in relevant Lakehead psychology courses), and being entered into a draw for one of five $20 gift cards.

HOW WILL MY CONFIDENTIALITY BE MAINTAINED?

All information collected in this study will be anonymous and confidential. Any reports of the study will not identify you as a participant. For participants completing the study online, all responses will be anonymous. For participants completing the study in person, a unique confidential code number will be used to link the data from Survey Monkey to data from the Facial Emotion Recognition Task. Once the data is linked, all codes will be deleted, and the data will be *anonymous* and confidential. There is no obligation to provide an email address or any other identifying information. Survey instruments will not be labelled in any way that will make identifying you possible. However, it should be noted that the online survey tool used in the study (i.e., Survey Monkey), is hosted by a server located in the USA. The US Patriot Act permits U.S. law enforcement officials, for the purpose of anti-terrorism investigation, to seek a court order that allows access to the personal records of any person without the person's knowledge. As a result of this, we cannot absolutely guarantee the full confidentiality and anonymity of your data. With your consent to participate, you acknowledge this.

WHERE WILL MY DATA BE STORED?

All the data collected as part of the study will be stored on electronic devices and all the data will be password protected. As part of the REB protocol, the anonymous data will be stored for a minimum of 7 years on a computer in Dr. Oinonen's laboratory with password protection. Anonymous data may also be posted in online repositories as part of the publication process and to support the Tri-Council Agency policy on open data.

WHAT WILL MY DATA BE USED FOR?

The data collected will be used to complete a portion of the student researcher's Master's thesis, for presentations, and for papers submitted to peer-reviewed journals. The anonymous data may also be analyzed by members of the lab in future to examine related research questions.

HOW CAN I RECEIVE A COPY OF THE RESEARCH RESULTS?

Upon completion of the study, interested participants are welcome to contact the student researcher at svenkat2@lakeheadu.ca to request a summary of the results once the study is completed.

WHAT IF I WANT TO WITHDRAW FROM THE STUDY?

You may withdraw from the study at any time by closing your browser or by stopping responding. For in-person participants, you may withdraw at any time prior to submitting your data, by quitting the browser on which your experiment is being run. As all of the surveys and tasks are completed anonymously and it is not possible to connect data to any participants, the data cannot be withdrawn once responses are submitted. Withdrawal from the study will not result in any loss of remuneration or have any effect on your academic status.

RESEARCH ETHICS BOARD REVIEW AND APPROVAL:

This research study has been reviewed and approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team, please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca.

Thank you very much for your time. We very much appreciate your contribution to our research.

RESEARCHER CONTACT INFORMATION:

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Dr. Kirsten Oinonen Ph.D., C. Psych.
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CONSENT FORM

I agree to the following:

- ✓ I have read and understand the information contained in the Information Letter
- ✓ I agree to participate
- ✓ I understand the risks and benefits to the study
- ✓ That I am a volunteer and can withdraw from the study prior to completing it, and I may choose not to answer any question
- ✓ That the data will be securely stored at Lakehead University for a minimum period of 7 years following completion of the research project
- ✓ I understand that the research findings will be made available to me upon request

- ✓ I will remain anonymous
- ✓ All of my questions have been answered

By consenting to participate, I have not waived any rights to legal recourse in the event of research-related harm. I have read and agree to the above information and by completing and submitting this survey and online experiment, agree to participate.

If completing this study in person, then please complete the following section:

_____

Name of participant (Printed)

_____

Signature of participant

_____

Date

Lakehead UNIVERSITY

Department of Psychology

Appendix E: Debriefing Form

Debriefing Form - Factors Affecting Facial Emotion Perception

Thank you for your participation in our study. This study aimed to investigate how factors such as sex hormones influence facial emotion recognition. Additionally, we are interested in how hormonal markers, such as hair growth, acne, and menstrual cycle regularity, influence facial emotion perception (via facial emotion recognition task). Previous research has suggested that there may be differences in emotion recognition depending on specific hormonal markers. We hope that the experience of being a research participant, either online or in-laboratory has helped enhance your understanding of research methods. To enhance your learning from participation in this study, we invite you to think about variables (e.g., past experiences or hormonal factors) that might affect one's ability to accurately detect emotions in faces. *Question for thought:* What are some of these factors and what would be the implications of not being able to accurately and quickly detect facial emotions? Please see the references below if you are interested in reading more about issues in hormonal research.

Some of the questions we have asked may have prompted you to feel negative emotions or to gain personal insights that you wish to discuss further with a professional. If you have any concerns about your health and want to see a mental health care professional, we have provided you with a list of such resources on the attached sheet.

Should you have further questions, do not hesitate to contact the researchers noted below. The Lakehead University Research Ethics Board approved this study, and they can also be contacted about any concerns (807)-343-8283 or research@lakeheadu.ca).

We hope you have enjoyed participating in our study and thank you very much for your assistance. As noted on the consent form, you will receive a summary of the study's results (i.e., nature and findings of the research) at its completion if you have indicated an interest by contacting Shree Venkateshan at svenkat2@lakeheadu.ca.

Principal Investigators:

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Mental Health Resource Sheet

Sometimes people can feel upset when thinking about their mood. Thus, it is possible that something occurred during your participation in the study that may have upset you. If you feel as though you would like to talk to a mental health practitioner for any reason please consider the resources listed below:

- **Lakehead University Health and Counseling Centre: (807) 343-8361**
- **Family Services Thunder Bay: (807) 343-6100**
- **Emergency services are available at the Thunder Bay Health Sciences Centre**
- **Thunder Bay Crisis Response phone line (24 hours): (807) 346-8282.**

References

Bos, P. A., van Honk, J., Ramsey, N. F., Stein, D. J., & Hermans, E. J. (2013). Testosterone administration in women increases amygdala responses to fearful and happy faces. *Psychoneuroendocrinology*, 38(6), 808–817. https://doi.org/10.1016/j.psyneuen.2012.09.005

Burton, L. A., & Levy, J. (1989). Sex differences in the lateralized processing of facial emotion. *Brain and Cognition*, *11*(2), 210–228. https://doi.org/10.1016/0278-2626(89)90018-3

Thompson, A. E., & Voyer, D. (2014). Sex differences in the ability to recognise non-verbal displays of emotion: A meta-analysis. *Cognition and Emotion, 28(7),* 1164–1195.