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Intrasexual Competition and Rival Derogation in Women Are Associated With Visual Processing of Emotional Facial Expressions

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Abstract
Intrasexual competition is when members of the same sex compete for access to desirable mates. In women, the use of non-physical strategies, such as verbal and indirect aggression, are often preferred to mitigate potential risks of being targeted or to prevent partner desertion. To act accordingly, women have to attend to cues, such as facial expressions, to be able to discern if an individual is a potential threat. The current study ($N = 136$) aimed at investigating the role of women's intrasexual competition and rival derogation strategies in women's visual attention and vigilance to angry, happy, and neutral facial expressions. Using an eye-tracking paradigm, women viewed images of women's emotional facial expressions in pairs (e.g., angry-neutral, angry-happy, happy-neutral) followed by rating faces for their perceived levels of threat. Women who reported higher levels of intrasexual competition demonstrated attentional biases to angry and neutral facial expressions, while rival derogation strategies also moderated the relationship between facial expressions and visual attention. These findings demonstrate the proximate mechanisms involved in women's intrasexual competition when scanning images of potential intrasexual rivals.

Keywords Intrasexual competition · Emotional expressions · Rival derogation · Eye-tracking · Visual attention

Introduction

Intrasexual competition is the process of competing with the same sex for access to desirable mates (Andersson, 1994). For females, the use of intrasexual competitive tactics are different than men, whereas men are more likely to utilize physical tactics, women are more likely to incorporate verbal and indirect means to derogate their rivals, mainly other women. It has been suggested that women are more covert in their intrasexual competitive displays, and they may interpret subtle cues as potentially aggressive (Bjorkqvist; 1994; Campbell, 2013; Krems et al., 2015). Considering the obligatory parental investment in women (i.e., 9-month gestation, weaning) (Trivers, 1972), using a non-physical approach to same-sex rivals would be a less risky strategy, as physical confrontation could harm the mother and her offspring (Bjorkqvist, 1994; Cambell, 1999). Although women are more likely to use indirect means intrasexually, whether they attend and perceive potential threats in the environment as a function of intrasexual competition and rival derogation remains to be explored.

Women employ a diverse array of strategies in intrasexual competition with other women. They may incorporate strategies of self-promotion (Arnocky, 2023; Blake et al., 2018), attempt to guard their partners from attractive women (Garza & Pazhoohi, 2023; Garza et al., 2022), and engage in rival derogation tactics against their competitors (Schmitt & Buss, 2001). Women are aware of potential intrasexual threats from other women and are also aware of what men prefer in mate preferences, which amplifies their awareness towards women that are considered physically attractive (Schmitt & Buss, 2001). Because men place a premium on physical attractiveness, women may be more vigilant to other women that possess physical features valued by men in their mate choice. For instance, women who perceive other women as threats rate them as less attractive, less friendly, less intelligent (Burch & Widman, 2021, 2022, 2024), and they are less likely to introduce them to their current romantic partner (Fisher & Archibald, 2022). Women with desirable physical features (i.e., low waist to hip ratios, large-firm breasts) are also more likely to be considered threatening (Fink et al., 2014), and

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women are likely to engage in tactics to shield their romantic partners from interacting with such women. Increased vigilance to potential intrasexual threats has been shown to be moderated by individual differences in intrasexual competition. Women who report higher levels of intrasexual competition, indexed by considering other women as potential threats, are more likely to enhance their appearance (Arnocky et al., 2023), have a more positive outlook towards using cosmetic surgery (Arnocky & Piche, 2014; Dubbs et al., 2017), and are more likely to consider women with attractive features as sexually promiscuous (Garza & Pazhoohi, 2024; Pazhoohi et al., 2022).

Rival Derogation Strategies

One manifestation of intrasexual competitive behaviors is rival derogation (Vaillancourt, 2013). Rival derogation are strategies, such as gossiping and rumor spreading, that can cause a lot of harm to a victim without the perpetrator being in close proximity. Due to its long-lasting effects, such as a damaged reputation, this indirect method can be an effective strategy at targeting other women who are considered threats to oneself and their current relationship. Indeed, young women are often the primary targets of indirect competitive tactics, suggesting that reproductive value and fertility significantly predict being a target in intrasexual competition and play a crucial role in male mate selection criteria (Campbell, 1999). The impact of rival derogation can result in the social exclusion of a competing female, and socially excluded women are subsequently less likely to be considered by other males. Women are attentive to potential threats in the environment, particularly from other women who may threaten their current relationship (Ein-Dor et al., 2015). This attentiveness suggests the involvement of underlying cognitive mechanisms that influence how women perceive and assess potential threats from rivals. When women perceive a risk of losing their partner, they may increase their use of gossip and rumor spreading (Massar et al., 2012), which can serve as a strategy to mitigate potential threats within the mating arena. Although physical confrontation among females is less frequent compared to males, physical aggression may result as a defense strategy when being targeted with rumor spreading and gossip (Campbell, 2004, 2013).

Perceptions of Threats

Most research in women's intrasexual competition and rival derogation has primarily focused on the conscious evaluations of perceived threats. However, humans process information by scanning for relevant threats and interpreting them accordingly. The visual system plays a crucial role in this process, enabling individuals to receive critical information and fixate longer on relevant stimuli or automatically attend to information that is immediately salient or perceived as threatening (Weierich et al., 2008). Identifying and attending to emotional expressions is an important aspect of social interactions, as interpreting these expressions can inform individuals of the perceived intent of others (Wells et al., 2016). Understanding the underlying attentional system as it relates to intrasexual competitive behaviors in women can elucidate the proximate mechanisms involved in interpreting perceived threats. One method for investigating the cognitive mechanisms underlying information processing is eye-tracking technology. Eye-tracking approaches can reveal the attentional processes important in perception, such as measuring overall interest and vigilance to stimuli. In the evolutionary behavioral sciences, eye-tracking research has primarily focused on assessing physical traits, such as waist-to-hip ratios (Dixson et al., 2011a; Garza et al., 2016; Pazhoohi et al., 2019), breast morphology (Dixson et al., 2011b), and facial masculinity (Garza & Byrd-Craven, 2023; Wen & Zuo, 2012). However, examining the attentional processes involved in assessing facial expressions using an intrasexual competition framework remains understudied.

In the cognitive literature, measuring facial stimuli using eye-tracking methods has illuminated the salience of emotional expressions. Women display an attentional bias to emotional facial expressions of disgust, possibly due to their higher levels of disgust sensitivity (Kraines et al., 2017). Angry facial expressions have been shown to elicit early-onset attention (Shasteen et al., 2014), and individuals are more likely to detect and attend to them longer (Fox et al., 2000). Other research has shown that happy facial expressions elicit faster responses and are fixated on longer compared to angry facial expressions (Bucher & Voss, 2019). People react positively to happy facial expression, and happy faces have a strong motivational power to induce approach behavior (Nikitin & Freund, 2019). Further studies have indicated that attention to threatening stimuli may also be modulated by individual differences in traits. For instance, individuals with anxiety and fear-related symptoms display higher vigilance, particularly toward threat related stimuli (Armstrong & Olatunji, 2012). Pertinent to the current study, we examine whether individual differences in women's intrasexual competition are associated with increased visual attention to facial expressions.

It has been proposed that women have a unique cognitive system that influences how they perceive and process emotional expressions. Compared to men, women are better at identifying angry facial expressions (Goos & Silverman, 2002) and show greater accuracy and speed in recognizing emotional expressions overall (Wells et al., 2016). Women show a superior ability compared to men to decode emotional signals (Hall, 1978), which may also aid in detecting subtle and covert forms of threat (Stockley & Cambell, 2013). To minimize risk, women may be more responsive and attentive

to threatening facial expressions, yet this attentiveness may extend to neutral facial expressions, as neutral expressions may be masking a potentially angry response (Krems et al., 2015). Given that neutral expressions may be masking anger, it would be beneficial for women to be able to respond to a neutral facial expression to mitigate the risk of being targeted by another woman (Krems et al., 2015). It has been suggested that there are cognitive patterns in interpreting neutral facial expressions as negative, and this is amplified by individuals who have higher dispositional levels of trait anger (Rohrbeck et al., 2023).

Current Study

The current study investigated the underlying mechanisms involved in women's intrasexual competition, specifically examining whether women attend more to facial expressions that convey threatening information compared to non-threatening information. Furthermore, the study explored whether women's cognitive systems are modulated by dispositional levels of intrasexual competition. If women have developed strategies to mitigate threats from same-sex rivals, they may possess attentional systems that are aimed at detecting that threat and attending to relevant information. Although emotional expressions that convey threat, such as angry facial expressions, can capture automatic visual processing (Shasteen et al., 2014), women may also attend to neutral facial expressions, as a neutral face might mask an underlying emotional state (Krems et al., 2015). It was predicted that intrasexual competition, indexed by self-reported competitive behaviors against other women, would be associated with increased visual attention and fixation frequency to angry expressions when paired with happy or neutral ones. Following Krems et al. (2015), it was predicted that intrasexual competition would be associated with increased visual attention and fixations on neutral expressions when paired with happy expressions. Furthermore, we predicted that intrasexual competition would be associated with higher perceptions of threat to angry and neutral facial expressions compared to happy ones. Finally, we investigated the role of self-reported intrasexual competitive behaviors, such as being a victim or perpetrator of physical, verbal, and indirect aggression, on participants' visual attention to facial expressions.

Method

Participants

A total of 136 self-identified heterosexual women ($M = 23.18$ years, $SD = 6.11$) participated in this in-lab study. Participants were from a predominantly Hispanic institution and they received course credit for their participation. In total, 132 women identified as being Hispanic of Mexican descent and four participants indicated Other in their ethnic identification.

Measures

Direct and Indirect Aggression Scale

The Mini-DIAS (Österman et al., 2010) was used to measure women's experiences with being a victim and perpetrator of aggressive tactics, such as physical, verbal, and indirect aggressiveness. It is a 6-item measure that is divided into two subscales (i.e., victim vs. perpetrator) and it includes items such as "Someone has, for example, gossiped maliciously about you, spread harmful rumors about you, or tried to socially exclude you from others" (indirect aggression-victim), and "Have you, for example, gossiped maliciously about someone, spread harmful rumors about someone, or tried to socially exclude someone?" (indirect aggression-perpetrator). The response options for the scale vary from, "0 = never" to "4 = very often". The instrument can be assessed individually, as each item pertains to a different type of aggression, or it can be assessed as a composite to indicate rival derogation. For this study, we assessed each item independently creating six variables: victim physical aggression, victim verbal aggression, victim indirect aggression, perpetrator physical aggression, perpetrator verbal aggression, and perpetrator indirect aggression.

Intrasexual Competition Scale

We assessed individual differences in intrasexual competition in women using the Intrasexual Competition Scale (Buunk & Fisher, 2009). It is a 12-item measure, which includes items such as "I can't stand it when I meet another woman who is more attractive than I am", with response options varying from "1 = strongly disagree" to " 7 = strongly agree". Higher scores on this measure indicate more competitive behaviors within the same sex. The measure demonstrated good reliability, Cronbach's alpha = .88. We used the total score of the Intrasexual Competition Scale for this study.

Stimuli

The facial stimuli used were from the FACES database (Ebner et al., 2018). It includes a comprehensive facial database of adults displaying different facial expressions, such as anger, neutral, happy, sad, and disgust. The image set includes three age categories: young, middle-aged, and older-aged adults. The young-aged ($M_{age} = 26.2$, $SD_{age} = 2.6$) female image set was used for this study. For this study, we used anger, happy, and neutral as the facial expression presentations. In total, participants viewed 30 presentations comprised of five different women's facial expressions that were paired to display

three comparisons, angry vs. happy, angry vs. neutral, and happy vs. neutral, see Fig. 1. This resulted in 60 total observations. Each image was randomized and counterbalanced to present the emotional expression an equal number of times on the left or right side of the presentation sequence.

Eye-Tracking Device

The eye-tracker used was a Tobii Pro Fusion 250, which records eye-movements at a sample rate of 250 Hz. It is a binocular eye-tracking device that records eye-movements from both eyes, and it does not require a chinrest to constrain participants. The eye-tracker is magnetically placed at the bottom of a 24″ Dell monitor with a display resolution of 1920 × 1080, and the computer was stationed on a booth with dividers to minimize lateral distractions. The eye-tracker was positioned at approximately 70 cm from the participant. Tobii Pro Lab was used to create interest areas and in data processing. Eye-tracking data were processed using the Tobii I-VT fixation filter, which discards fixations that are less than 60 ms and uses an angular velocity threshold of 30°/sec. To account for missing data caused by blinking, a linear interpolation 'max gap length' of 75 ms was used. The physical dimensions of each image was W:4in x H: 4in with a visual angle of 8° for each image, and a visual angle of 10° between the two images.

Eye-Tracking Metrics

There were two eye-tracking metrics recorded, total visit duration and number of fixations. Total visit duration was defined as the amount of time in milliseconds a participant viewed a region of interest, defined here as an angry, neutral, or happy facial expression. Total visit duration is a metric used to indicate overall attention as it captures the average amount of time participants viewed a face across trials. Number of fixations is defined as the average number of fixations made towards a region of interest across trials, and it is used as a method to indicate looking behavior and frequency. Fixations are defined as the period in which a non-moving stimulus is being viewed (Holmqvist et al., 2011). Regions of interest were created by outlining the facial region of women's faces in the image set by outlining her face and excluding the visible neck and shirt region.

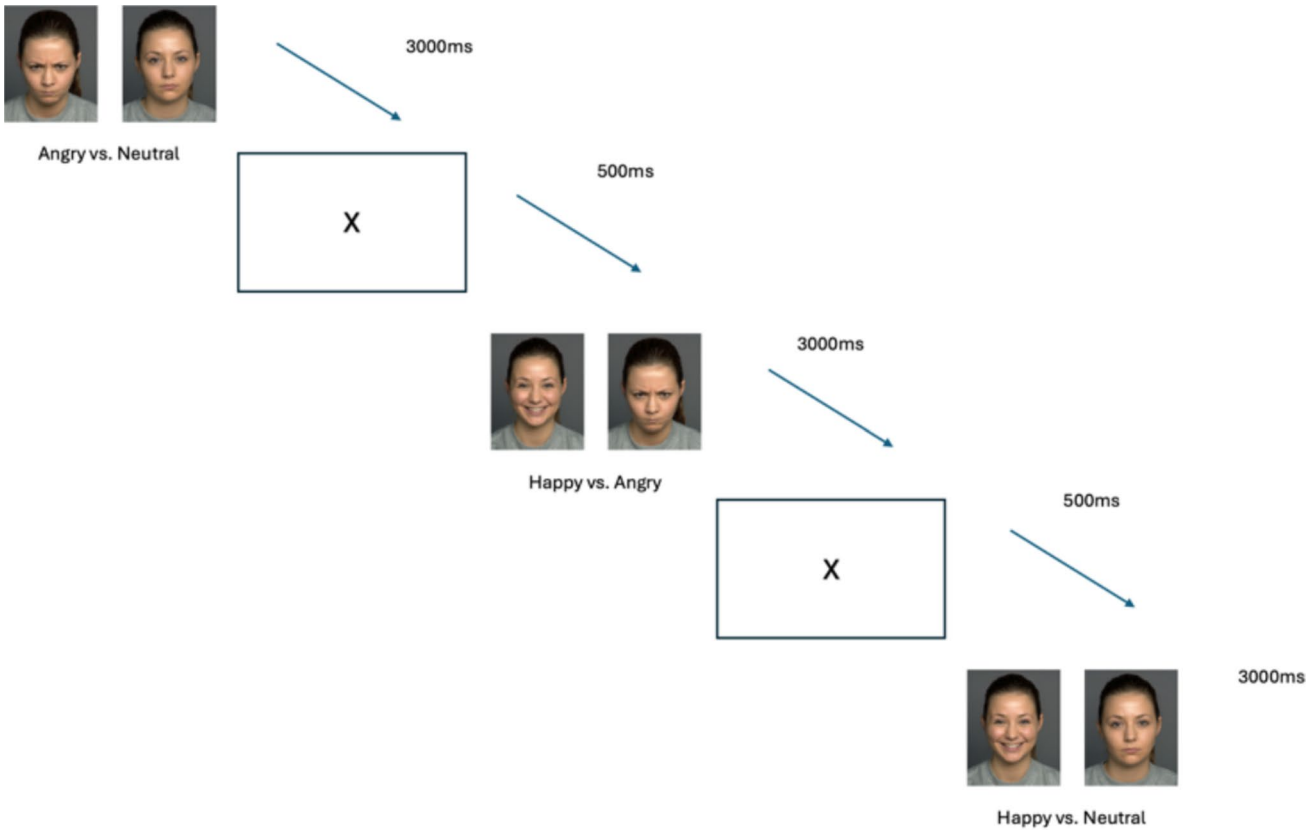

Fig. 1 A sample of one female presentation sequence of facial expressions in pairs. In total, five women were used from the FACES image set to present three facial expressions

Threat Perceptions

Participants rated perceptions of threat using a 1–7 Likert scale, where response options varied from "1 = not very threatening" to "7 = very threatening", to each of the images presented.

Procedure

Participants signed up for this in-lab study using the university's SONA system. Upon consent, they completed a series of demographic questions, followed by the Intrasexual Competition Scale and Mini-DIAS. After completing these survey instruments, participants were given instructions on how to proceed with the eye-tracking portion of the study. They were instructed to sit in front of the computer and follow the Tobii Pro Lab visual positioning guide. This allowed for participants to sit at the appropriate distance between the computer monitor and their seated position. When at the appropriate seated position, the eye-tracker calibrated and validated eye-movements by using a 9-point calibration task, which was a task where participants were to follow a white dot across the screen to determine if eye-movements could be recorded accurately. From there, they were instructed that they were to be presented with a series of female faces presented in pairs. Participants were instructed to view the pairs of faces as they typically would view images on a computer screen or photo album. The image pairs displayed an angry vs. neutral, angry vs. happy, and happy vs. neutral visual presentation which was counterbalanced to present each of the emotional expressions on the left and right side of the screen. Participants viewed a total of 30 presentation slides which totaled 60 visual observations for each participant. Each visual presentation was displayed for 3000 ms, followed by a fixation cross "X" for 500 ms. The eye-tracking portion of the study lasted approximately 4–5 min. After completing the eye-tracking portion, participants returned to the Qualtrics survey, where they were asked to provide numerical ratings using a 1–7 Likert scale assessing the perceived threat level of the female faces. For these ratings, the images were shown sequentially and in random order rather than in pairs. Upon completion, participants were dismissed from the study.

Data Analyses

Data were analyzed using JAMOVI (Version 2.5). A repeated measures ANOVA was run to determine threat perceptions with angry, happy, and neutral facial expressions as within-subjects factors. For linear mixed-effect models, we included facial expressions, intrasexual competition, victim rival derogation (physical, verbal, and indirect) and perpetrator rival derogation (physical, verbal, and indirect), and the interaction between facial expressions and intrasexual competition, and facial expressions and rival derogation measures as fixed effects, and subjects were entered as a random effect. A linear mixed-effect model (LME) was run for each facial comparison (i.e., angry vs. neutral, angry vs. happy, and happy vs. neutral). For each LME model, the categorical predictors of facial expression were dummy coded for each pairing, angry (1) vs. neutral (0), angry (1) vs. happy (0), and happy (1) vs. neutral (0). The intrasexual competition scale and rival derogation measures were centered in all models. For all significant interactions, we probed the simple slopes for intrasexual competition and rival derogation measures at each level of facial expressions to better understand the direction of the relationships.

Results

Descriptive Statistics

Table 1 presents the correlations for the intrasexual competition scale, rival derogation measures, and threat perceptions for angry, happy, and neutral facial expressions. Table 2 presents the descriptives for the Intrasexual Competition Scale and rival derogation measures (Mini-DIAS). The individual measures for intrasexual competition and rival derogation were not significantly associated with threat perceptions of facial expressions (all $ps > .05$). With the exception of being a victim of indirect aggression, women who reported being a victim of physical and verbal aggression were more likely to be preparators of physical, verbal, and indirect aggression. Furthermore, intrasexual competition was positively associated with victim indirect aggression and perpetrator verbal and indirect aggression.

Threat Perceptions

A repeated measures ANOVA was run on the perception of women's facial expressions. The ANOVA was significant, $F(2, 270) = 41.51$, $p < .001$, $\eta^2_p = .24$. Pairwise comparisons were significantly different. Women rated angry facial expressions as more threatening ($M = 1.97$, $SE = .09$, $p = .004$) compared to neutral ($M = 1.53$, $SE = .07$) and happy ($M = 1.11$, $SE = .03$, $p < .001$) facial expressions, and neutral facial expressions were more threatening compared to happy facial expressions ($p < .001$), see Fig. 2.

Eye Tracking

For the eye-tracking portion of the study, four participants were removed because their eyes would not calibrate correctly resulting in high data loss and an inability to accurately track visual movements. Therefore, the eye-tracking analyses includes the sample of 132 women. Tables 3–5

Table 1 Zero-order correlations between intrasexual competition, rival derogation measures, and threat perceptions

	1	2	3	4	5	6	7	8	9
1. Intrasexual competition									
2. Physical aggression (victim)	.04								
3. Verbal aggression (victim)	.03	.56***							
4. Indirect aggression (victim)	.21*	.29***	.39***						
5. Physical aggression (perpetrator)	.08	.48***	.28***	.09					
6. Verbal aggression (perpetrator)	.26**	.31***	.49***	.40***	.43***				
7. Indirect aggression (perpetrator)	.20*	.25**	.21*	.42***	.18*	.33***			
8. Angry (threat perception)	− .03	− .05	.006	− .07	.06	− .02	− .06		
9. Happy (threat perception)	− .007	− .03	.04	.07	.05	.11	.11	.08	
10. Neutral (threat perception)	− .10	− .04	− .10	− .02	− .01	− .01	.15	.16	.29***

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

Table 2 Descriptive statistics for intrasexual competition and rival derogation measures (victim and perpetrator)

	M	SD
Intrasexual Competition Scale	21.3	10.8
Physical aggression (victim)	1.77	.98
Verbal aggression (victim)	2.99	1.08
Indirect aggression (victim)	2.65	1.17
Physical aggression (perpetrator)	1.49	.69
Verbal aggression (perpetrator)	2.33	.87
Indirect aggression (perpetrator)	1.69	.83

The absolute range of scores for the Intrasexual Competition Scale are 12–84, and all other aggression measures from the Mini-DIAS are from 1–5

include the complete linear mixed-effects analysis for total visit duration and number of fixations for each emotional facial comparison (Table 3: Angry vs. neutral; Table 4: Angry vs. happy; Table 5: Happy vs. neutral).

Angry vs. Neutral

Total Visit Duration

There was a significant main effect for facial expressions. Neutral facial expressions ($M = 1288$, $SE = 25.2$) were viewed longer compared to angry facial expressions ($M = 1044$, $SE = 25.5$). There was a significant interaction between facial expressions and intrasexual competition. The interaction was probed further by running a simple slopes analysis. Women's intrasexual competition was

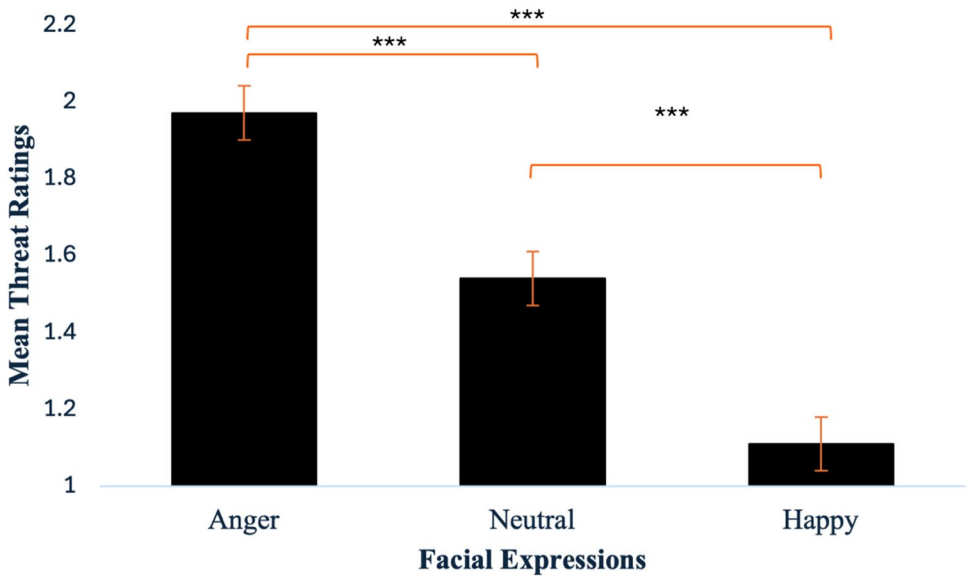

Fig. 2 Threat ratings comparisons across women's facial expressions (angry, neutral, and happy). *** denotes significance at the $p < .001$ level

Table 3 Linear mixed-effects models for visual attention and number of fixations to angry vs. neutral facial expressions

Angry vs. neutral (reference)	Total visit duration (ms)		Number of fixations	
	Estimate (SE)	*p*	Estimate (SE)	*p*
Intercept	1168.89 (23.68)	< .001	3.69 (.09)	< .001
Facial expression	-238.82 (17.03)	< .001	− .75 (.05)	< .001
Intrasexual competition	4.09 (2.33)	.08	.006 (.009)	.50
Physical aggression (perpetrator)	− 15.99 (43.60)	.71	.12 (.16)	.44
Verbal aggression (perpetrator)	− 61.03 (39.56)	.12	− .28 (.15)	.07
Indirect aggression (perpetrator)	54.57 (33.12)	.10	.26 (.12)	.04
Physical aggression (victim)	− 11.81 (33.68)	.72	− .03 (.13)	.76
Verbal aggression (victim)	29.68 (31.11)	.34	.17 (.12)	.15
Indirect aggression (victim)	18.05 (25.15)	.47	.03 (.09)	.74
Facial expression				
* Intrasexual competition	7.35 (1.67)	< .001	.01 (.004)	< .001
*Physical aggression (perpetrator)	11.61 (31.57)	.71	− .09 (.09)	.31
*Verbal aggression (perpetrator)	111.79 (28.80)	< .001	.32 (.08)	< .001
*Indirect aggression (perpetrator)	− 10.72 (25.54)	.64	− .15 (.06)	.02
*Physical aggression (victim)	16.04 (24.45)	.51	.01 (.07)	.83
*Verbal aggression (victim)	− 48.98 (22.30)	.02	− .13 (.06)	.04
*Indirect aggression (victim)	19.27 (17.74)	.27	.08 (.05)	.11

*Interaction

Table 4 Linear mixed-effects models for visual attention and number of fixations to angry vs. happy facial expressions

Angry vs. happy (reference)	Total visit duration (ms)		Number of fixations	
	Estimate (SE)	*p*	Estimate (SE)	*p*
Intercept	1156.52 (24.94)	< .001	3.60 (.09)	< .001
Facial expression	− 409.31 (17.54)	< .001	− .98 (.05)	< .001
Intrasexual competition	3.48 (2.45)	.15	.004 (.009)	.58
Physical aggression (perpetrator)	− 44.87 (45.92)	.33	− .009 (.16)	.95
Verbal aggression (perpetrator)	− 47.85 (41.67)	.25	− .15 (.15)	.29
Indirect aggression (perpetrator)	51.98 (34.88)	.13	.24 (.12)	.05
Physical aggression (victim)	− 10.32 (35.48)	.77	.04 (.13)	.70
Verbal aggression (victim)	24.07 (32.76)	.46	.03 (.12)	.75
Indirect aggression (victim)	24.12 (26.49)	.36	.008 (.09)	.92
Facial expression				
* Intrasexual competition	2.96 (1.72)	.08	.009 (.004)	.05
*Physical aggression (perpetrator)	47.28 (32.53)	.14	.15 (.09)	.08
*Verbal aggression (perpetrator)	151.59 (29.68)	< .001	.26 (.08)	.002
*Indirect aggression (perpetrator)	-38.39 (24.26)	.11	− .10 (.05)	.12
*Physical aggression (victim)	− 103.80 (25.19)	< .001	− .29 (.07)	< .001
*Verbal aggression (victim)	33.80 (22.98)	.14	− .005 (.06)	.92
*Indirect aggression (victim)	− 18.14 (18.28)	.32	− .10 (.05)	.04

positively associated with more visual time to angry facial expressions ($b = 8.89$, $SE = 2.37$, 95%CI [4.32, 13.57], $p = .0002$), but the relationship was not significant for neutral facial expressions ($b = -1.14$, $SE = 2.37$, 95%CI [− 5.82. 3.54], $p = .63$), see Fig. 3a.

There was a significant interaction for victim verbal aggression and facial expressions. We probed the interaction further, and the relationship between victim verbal aggression and visual attention was not significant for angry ($b = 3.18$, $SE = 22.8$, 95%CI [− 53.8, 60.1], $p = .91$) and neutral facial expressions ($b = 44.31$, $SE = 22.8$, 95%CI [− 12.6, 101.3], $p = .12$). A significant interaction for perpetrator verbal aggression and facial expressions showed that perpetrator verbal aggression was associated with less visual attention to neutral faces ($b = -123.16$, $SE = 38.12$, 95%CI [-198.6, − 47.7] $p = .001$), but the relationship was

Table 5 Linear mixed-effects models for visual attention and number of fixations to happy vs. neutral facial expressions

Happy vs. neutral (reference)	Total visit duration (ms)		Number of fixations	
	Estimate (SE)	*p*	Estimate (SE)	*p*
Intercept	1170.09 (24.45)	< .001	3.77 (.09)	< .001
Facial expression	314.45 (16.99)	< .001	.67 (.05)	< .001
Intrasexual competition	3.59 (2.41)	.13	.009 (.009)	.30
Physical aggression (perpetrator)	− 27.98 (45.02)	.53	.09 (.17)	.59
Verbal aggression (perpetrator)	− 52.58 (40.84)	.20	− .23 (.13)	.13
Indirect aggression (perpetrator)	42.50 (34.19)	.21	.25 (.13)	.05
Physical aggression (victim)	− 15.12 (34.78)	.66	− .05 (.13)	.68
Verbal aggression (victim)	21.25 (32.12)	.50	.14 (.12)	.23
Indirect aggression (victim)	32.74 (25.97)	.20	.02 (.10)	.77
Facial expression				
* Intrasexual competition	− 5.16 (1.66)	.001	− .01 (.004)	.008
*Physical aggression (perpetrator)	− 46.35 (31.51)	.14	− .19 (.09)	.04
*Verbal aggression (perpetrator)	− 155.32 (28.74)	< .001	− .39 (.08)	< .001
*Indirect aggression (perpetrator)	35.67 (23.49)	.12	.08 (.07)	.22
*Physical aggression (victim)	5.50 (24.40)	.82	-.05 (.07)	.42
*Verbal aggression (victim)	− 19.16 (22.26)	.38	.07 (.06)	.27
*Indirect aggression (victim)	5.63 (17.70)	.75	.03 (.05)	.47

*Interaction

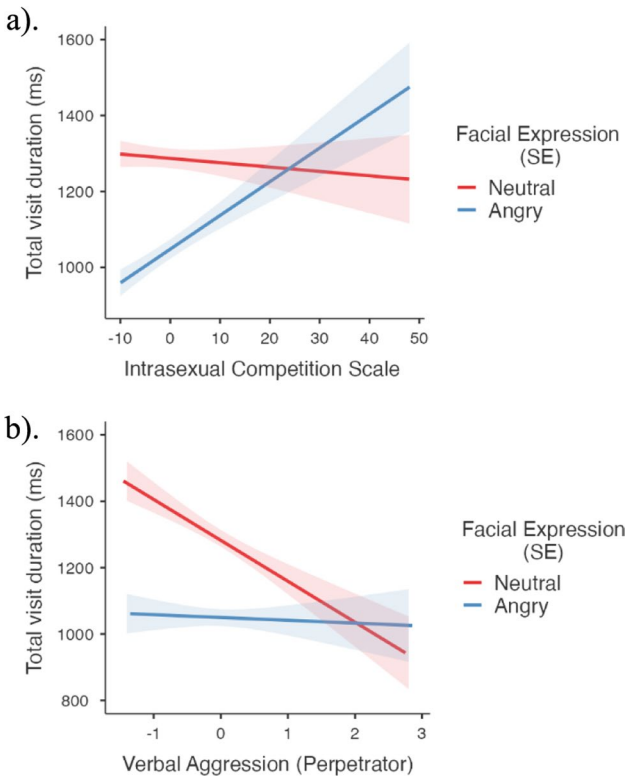

Fig. 3 The association between intrasexual competition **a** and perpetrator verbal aggression **b** on visual attention to neutral vs. angry faces

not significant for angry faces ($b = -8.45$, $SE = 38.2$, 95%CI [− 89.9, 67.0,], $p = .82$), see Fig. 3b.

Number of Fixations

There was a significant main effect for facial expressions. Women made more visual fixations towards neutral facial expressions ($M = 4.08$, $SE = .09$) compared to angry facial expressions ($M = 3.31$, $SE = .09$). There was a significant interaction between intrasexual competition and facial expressions, where women with higher levels of intrasexual competition viewed angry facial expressions more frequently compared to neutral facial expressions. The interaction was probed further by running a simple effects analysis. Women's intrasexual competition was marginally associated with more visual fixations to angry facial expressions ($b = .01$, $SE = .09$, 95%CI[-.0008, .03], $p = .06$), but the relationship was not significant for neutral facial expressions ($b = -.006$, $SE = .09$, 95%CI [− .02, .01], $p = .50$).

There was a significant interaction for victim verbal aggression and facial expressions. Victim verbal aggression was positively associated with more visual fixations to neutral faces compared to angry facial expressions; however, the simple slopes revealed a marginal positive association to neutral ($p = .05$) but not angry faces ($p = .39$). The interactions between facial expressions and perpetrator verbal and indirect aggression were significant. Women's perpetrator verbal aggression was associated with fewer visual fixations to neutral facial expressions ($b = -.37$, $SE = .14$, 95%CI [− .66, − .08], $p = .01$) but the association was not

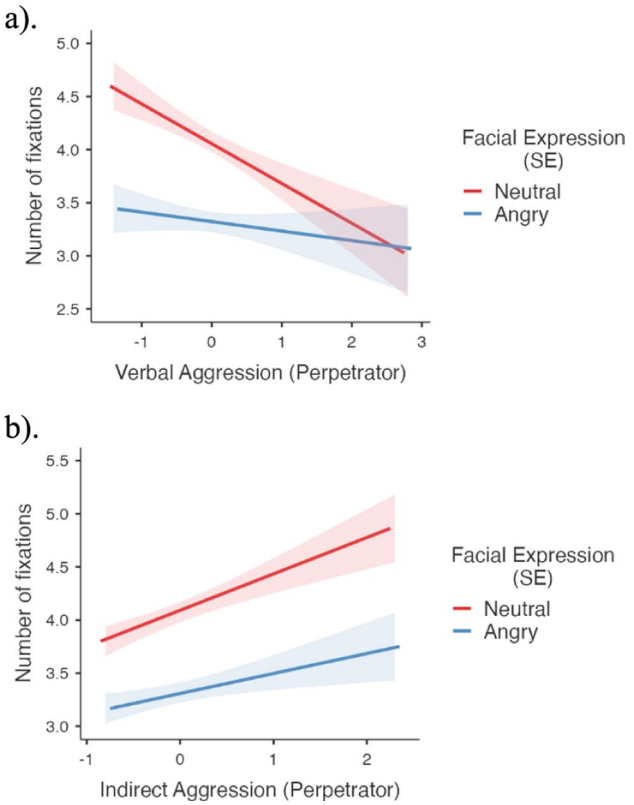

Fig. 4 The association between intrasexual competition **a** and perpetrator indirect aggression **b** on visual fixations to neutral vs. angry faces

significant for angry facial expressions ($b = -.08$, $SE = .14$, 95%CI [−.37, .19,], $p = .54$), see Fig. 4a. Perpetrator indirect aggression was associated with more visual fixations to neutral faces ($b = .34$, $SE = .13$, 95%CI [.08, .60], $p = .01$), but the association was not significant for angry facial expressions ($b = .18$, $SE = .13$, 95%CI [−.07, .44], $p = .15$), see Fig. 4b. The main effect for intrasexual competition and rival derogation measures (physical, verbal, and indirect) were not significant.

Angry vs. Happy

Total Visit Duration

There was a significant main effect for facial expression. Women viewed happy facial expressions ($M = 1360$, $SE = 27.1$) longer compared to angry facial expressions ($M = 951$, $SE = 27.1$).

The interaction between victim physical aggression and facial expression was significant. Victim physical aggression was marginally associated with more visual attention to happy facial expressions ($b = 71.2$, $SE = 36.5$, 95%CI [−1.75, 144], $p = .05$), but the association was not significant

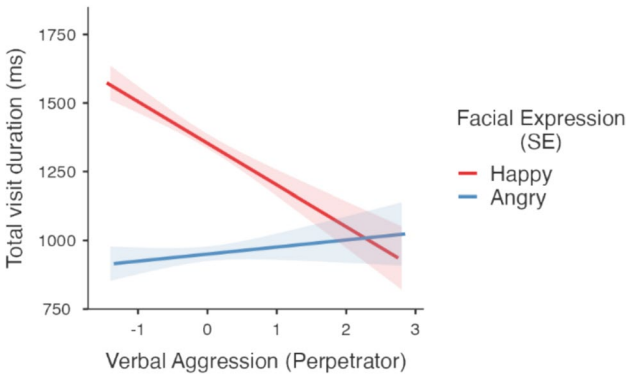

Fig. 5 The association between perpetrator verbal aggression on visual attention to happy vs. angry faces

for angry faces ($b = 32.8$, $SE = 36.9$, 95%CI [−40.13, 106], $p = .37$). There was a significant interaction for perpetrator verbal aggression and facial expressions. Perpetrator verbal aggression was associated with less visual attention to happy facial expressions ($b = -151.70$, $SE = 40.3$, 95%CI [−231.3, −72.1,], $p = .002$), but the association was not significant for angry facial expressions ($b = 25.7$, $SE = 40.3$, 95%CI [−53.8, −105.3], $p = .52$), see Fig. 5. The main effect

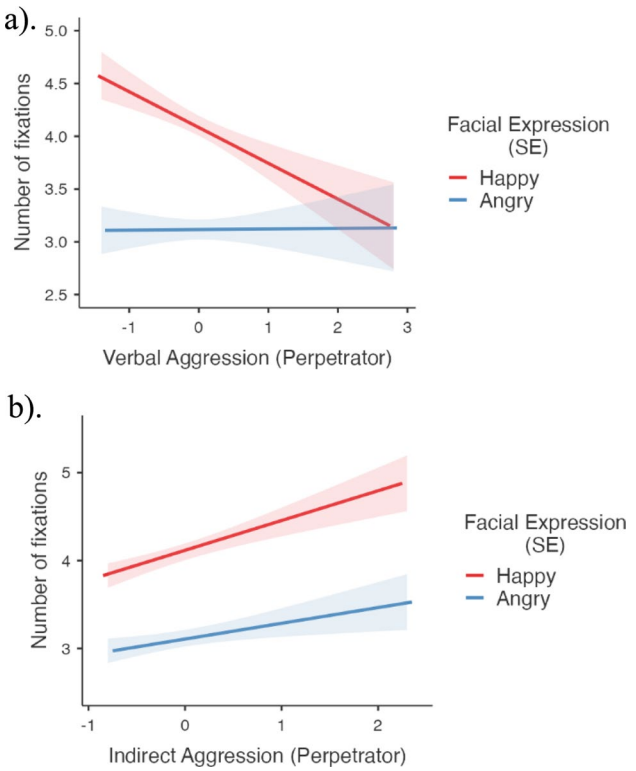

Fig.6 The association between intrasexual competition **a** and perpetrator indirect aggression **b** on visual fixations to happy vs. angry faces

for intrasexual competition and rival derogation measures (physical, verbal, and indirect) were not significant.

Number of Fixations

There was a significant main effect for facial expressions, where women made more visual fixations to happy facial expressions ($M = 4.09$, $SE = .09$) compared to angry facial expressions ($M = 3.11$, $SE = .09$). The interaction between victim indirect aggression and facial expressions was significant, however, the simple slopes analysis did not reveal significant associations across happy and angry facial expressions. The interaction between perpetrator verbal aggression and facial expressions was significant. Perpetrator verbal aggression was associated with fewer visual fixations to happy faces ($b = -.33$, $SE = .14$, 95%CI [−.62, −.05], $p = .01$), but the association was not significant for angry facial expressions ($b = .005$, $SE = .14$, 95%CI [−.27, .29], $p = .97$), see Fig. 6a. The association between perpetrator indirect aggression and visual fixations to happy faces was significant ($b = .33$, $SE = .13$, 95%CI [.08, .59,], $p = .01$), but the association was not significant for angry facial expressions ($b = .17$, $SE = 13$, 95%CI [−.07, .43], $p = .17$), see Fig. 6b. The main effect

for intrasexual competition and rival derogation measures (physical, verbal, and indirect) were not significant.

Happy vs. Neutral

Total Visit Duration

In comparing neutral vs. happy facial expressions, a significant main effect revealed that happy facial expressions ($M = 1327$, $SE = 26.5$) were viewed longer compared to neutral facial expressions ($M = 1012$, $SE = 26.5$). There was a significant interaction between facial expressions and intrasexual competition. The interaction was probed further by running a simple slopes analysis. Women's intrasexual competition was positively associated with more visual attention to neutral facial expressions ($b = .01$, $SE = .09$, 95%CI [.001, .03], $p = .03$), but the relationship was not significant for happy facial expressions ($b = -.001$, $SE = .009$, 95%CI [−.01, .01], $p = .91$), see Fig. 7a.

There was a significant interaction between perpetrator verbal aggression and facial expressions. Perpetrator verbal aggression was associated with less visual attention to happy facial expressions ($b = -145.0$, $SE = 39.5$, 95%CI [−222.9, -67.1,], $p = .003$), but the association was not significant

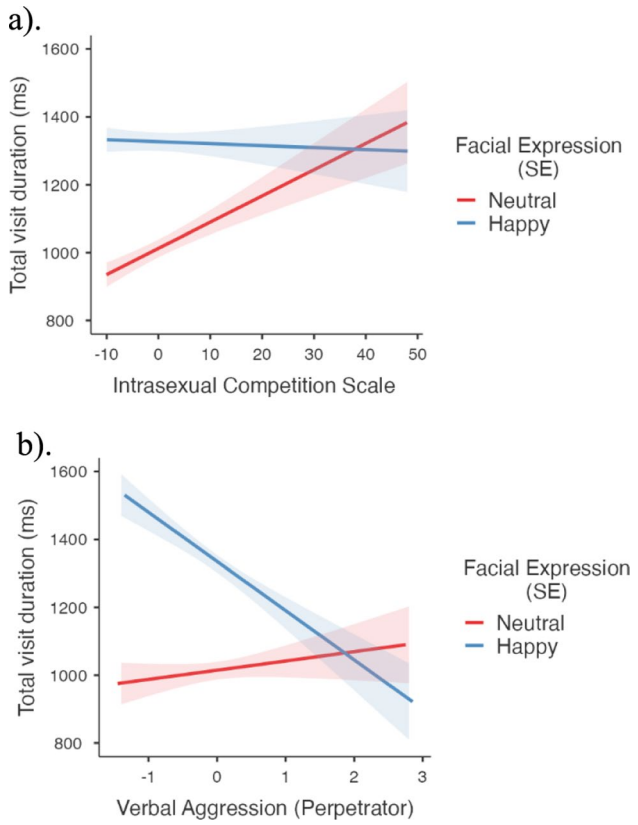

Fig. 7 The association between intrasexual competition **a** and perpetrator verbal aggression **b** on visual attention to neutral vs. happy faces

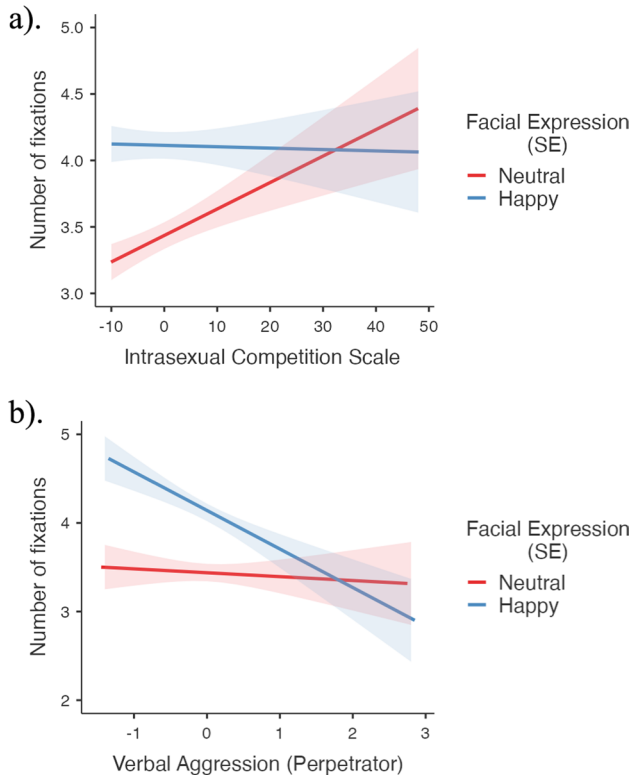

Fig. 8 The association between intrasexual competition **a** and perpetrator verbal aggression **b** on visual fixations to neutral vs. happy faces

for neutral facial expressions ($b = 27.2$, $SE = 39.5$, 95%CI [− 50.8, 105.1,], $p = .49$), see Fig. 7b. The main effect for intrasexual competition and rival derogation measures were not significant.

Number of Fixations

For number of fixations, a significant main effect for facial expressions showed that women made more visual fixations to happy ($M = 4.11$, $SE = .10$) compared to neutral facial expressions ($M = 3.43$, $SE = .10$). The results were further qualified by a significant interaction between facial expressions and intrasexual competition, where women's intrasexual competition was positively associated with more visual fixations to neutral facial expressions ($b = .01$, $SE = .09$, 95%CI [.001, .03], $p = .03$), but the relationship was not significant for happy facial expressions ($b = -.001$, $SE = .09$, 95%CI [− .01, .01], $p = .93$), see Fig. 8a.

The interaction between facial expressions and being a perpetrator of verbal and physical aggression was significant, where women's perpetrated verbal aggression was associated with fewer visual fixations to happy faces ($b = -.43$, $SE = .16$, 95%CI [− .72, -.13], $p = .008$), but the association was not significant for neutral faces ($b = -.04$, $SE = .16$, 95%CI [− .75, 11], $p = .78$), see Fig. 8b. For perpetrator physical aggression, the simple slopes did not reveal any significant associations for number of fixations to neutral ($b = -.18$, $SE = .18$, 95%CI [-.16, .54], $p = .29$), and happy faces ($b = -.002$, $SE = .18$, 95%CI [− .35, .35], $p = .99$). The main effect for intrasexual competition and rival derogation measures (physical, verbal, and indirect) were not significant.

Table 6 provides an overview of the main findings for the moderations across the eye-tracking metrics.

Discussion

The current study investigated the cognitive underpinnings of women's intrasexual competition. By incorporating an eye-tracking paradigm, we tested whether women attend to specific threats from other women in the environment, and whether this attention is modulated by dispositional levels of intrasexual competition and rival derogation (victim and perpetrator status). Our results showed that women perceived angry facial expressions as more threatening and demonstrated greater visual attention (i.e., total visit duration) and vigilance (i.e., number of fixations) to neutral faces when paired with angry faces, and more attention to happy faces when paired with angry or neutral faces. Moreover, their dispositional levels of intrasexual competition moderated their visual attention, with women who self-reported higher levels intrasexual competition being more likely to view angry faces compared to neutral faces and neutral faces compared to happy ones. Regarding neutral faces compared to happy faces, women who reported higher levels of intrasexual competition were more likely to view neutral faces for longer durations and made more visual fixations to them.

In addition to assessing dispositional levels of intrasexual competition, we used an additional measure associated with intrasexual competition, which was self-reported levels of rival derogation, specifically physical, verbal, and indirect aggression. Women who reported being victims of verbal aggression made more visual fixations to neutral faces

Table 6 Summary of main findings in the moderation analyses for visual metrics

	Angry vs. Neutral	Angry vs. Happy	Happy vs. Neutral
Intrasexual competition	Positive association to angry faces (TVD)	NS	Positive association to neutral faces (TVD/Fixations)
Verbal aggression (victim)	Positive association (marginal) with neutral faces (Fixations)	NS	NS
Indirect aggression (victim)	NS	NS	NS
Physical aggression (victim)	NS	Positive association to happy faces (TVD)	NS
Verbal aggression (Perpetrator)	Negative association to neutral faces (TVD/Fixations)	Negative association to happy faces (TVD/Fixations)	Negative association to happy faces (TVD/Fixations)
Indirect aggression (Perpetrator)	Positive association to neutral faces (Fixations)	Positive association to happy faces (Fixations)	NS
Physical aggression (perpetrator)	NS	NS	NS

TVD = total visit duration; Fixations = Number of fixations; NS = Not significant

when paired with angry faces. Given that visual fixations can serve as a proxy for vigilance (Weierich et al., 2008), as repeated eye movements to a specific region indicate interest and heightened focus, this may suggest that victims of verbal aggression are vigilant toward neutral faces that may potentially be masking an array of emotions, including anger. Further, women who reported being perpetrators of verbal aggression viewed neutral faces less and made fewer fixations. When angry faces were paired with happy faces, perpetrators of verbal aggression showed less attention and vigilance to happy faces. When happy faces were paired with neutral faces, perpetrators of verbal aggression focused less on happy faces and made fewer fixations. A common theme in our analyses was that perpetrators of verbal aggression viewed neutral and happy faces less when paired with other facial expressions. Perhaps, women with a history of using verbal aggression are less likely to find women with happy or neutral facial expressions salient and view them less.

The findings from this study elucidate the proximate mechanisms involved in facial perception and intrasexual competition. Angry facial expressions have been shown to elicit automatic visual attention (Shasteen et al., 2014); however, this attentional response may be heightened in women who are more competitive intrasexually. Women may be at a higher risk of being victimized if a perpetrator is showing explicit cues of potential harm, such as facial displays demonstrating anger, thereby increasing vigilance toward that expression. This result is in line with previous research indicating that angry facial expressions are detected more rapidly and sustain visual attention for longer durations (Fox et al., 2000); however, in this study, this is dependent on dispositional levels of intrasexual competition.

Furthermore, the results underscore the underlying mechanisms involved in women on both the receiving and perpetrating ends of rival derogation. Women who reported being victims of verbal aggression maintained their attention to neutral facial expressions, perhaps due to the covert nature of such facial displays. A neutral expression may be more ambiguous and harder to interpret compared to an angry or happy facial expression, which may pose a unique dilemma for women (Yoon & Zinbarg, 2008). Maintaining a level of vigilance could protect a female who may be at the receiving end of verbal aggression. This overestimation may function as a protective response, as failing to respond to a potentially concealed angry expression could have negative consequences if a rival is indeed harboring hostility (Krems et al., 2015). Thus, the tendency to overestimate anger in a neutral expression might allow women to mitigate potential risks if the person being observed is, in fact, angry. Nonetheless, this ambiguity of neutral facial expressions warrants further exploration, and future studies may investigate if women do perceive neutral facial expression as masking anger. Further, perpetrators of verbal aggression were less likely to view happy facial expressions when paired with angry or neutral faces, whereas perpetrators of indirect aggression were more likely to view happy and neutral faces. It is unclear why women who have perpetrated verbal and indirect aggression would be associated with different visual patterns to happy faces. Considering that happy faces evoke positive emotions (Nikitin & Freund, 2019), women who have perpetrated verbal aggression may not feel threatened by or attentive to happy expressions expressed by other women. However, for perpetrators of indirect aggression, a happy or neutral facial expression may be interpreted in an ambiguous manner, such as another woman laughing at their expense or concealing hostility. This, in turn, could elicit more attention from women who have used indirect aggressive behaviors, such as gossip or rumor spreading.

Taken together, the findings lend stronger support for women who are more intrasexually competitive and engage in verbal aggression as a rival derogation strategy in attention and vigilance. Faces that are threatening (i.e., angry) are more likely to be visually salient in women who are more prone to same-sex competitive strategies and in women who have used verbal aggression in the past. However, when neutral faces are paired with a non-threatening facial expression (i.e., happy), they are more likely to be viewed and attended to as a function of intrasexual competition and those that have used verbal aggression. In line with previous research highlighting differences in aggressive tactics in women (Campbell, 2004, 2013), we did not find strong support that perpetrating physical aggression was associated with attention or looking frequency. Instead, we find that being a victim of physical aggression is associated with more visual attention and looking frequency to happy compared to angry faces. This may suggest that when faced with a threatening response, women avert their visual attention to a face that is less threatening and likely to elicit positive emotions.

The results of the current study complement previous research on women's intrasexual competition strategies and rival derogation by incorporating an eye-tracking paradigm to shed light on the visual processing mechanisms. Specifically, an attentional bias appears toward angry facial expressions when paired with neutral faces, and toward neutral faces when paired with happy ones, as a function of women's levels of intrasexual competition. This attentional focus suggests that women may be more vigilant toward expressions signaling negative emotions or those with ambiguous cues (i.e., neutral expressions) to identify potential threats. These biases do not extend to happy expressions, implying that happy faces are not perceived as threats. Indeed, attention to these facial expressions maps on to the perceptions of threat, as women were more likely to consider angry and neutral facial expressions threatening compared to happy facial expressions. However, women's intrasexual competition did not moderate perceived threat ratings, only visual

attentional biases. This finding suggests that women with higher levels of intrasexual competition possess attentional systems more sensitive to potential threats from rivals, resulting in a cognitive mechanism aimed at maintaining vigilance toward these rivals.

The study does have a few limitations. First, the sample demographics were not diverse, consisting mostly of young Hispanic women who were not married. Nonetheless, the representation of Hispanic samples in evolutionary human sciences is limited (Pollet & Saxton, 2019), and including more Hispanic samples can provide a broader understanding of women's intrasexual competition. Some research has suggested that intrasexual competition is heightened in married women with children (Benenson & Markovits, 2023). Comparing married women with children to single women makes for a fruitful avenue of research. Further, the image presentations were shown in pairs, demonstrating a woman showing two expressions (e.g., neutral vs. angry, neutral vs. happy, angry vs. happy) which is an unlikely scenario in real life. Nonetheless, this approach allowed for consistency across all women's facial expressions. Another limitation is in the use of the facial expression images. The images did not include any information or actions that would prime participants that they were facing a threat to their current relationship, as it only included their facial expressions. This was a design of the study, as one goal was to assess if women would interpret subtle cues (i.e., neutral faces) as being more salient and therefore, vigilant to them. Future research could incorporate images of women interacting with men to determine if individual differences in intrasexual competition may heightened women's attention to potential rivals.

Conclusion

In summary, women's cognitive mechanisms are influenced by dispositional factors related to intrasexual competition, including experiences both as victims and perpetrators of rival derogation. These findings suggest that more competitive women are attuned to women who may potentially be threatening, and they may employ strategies to maintain awareness and vigilance in order to mitigate those threats. This study contributes to the existing literature on the proximate mechanisms underlying women's intrasexual competition.

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Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ray Garza and Jenna D. Arsuaga. The first draft of the manuscript was written by Ray Garza, Jenna D. Arsuaga, and Farid Pazhoohi, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The data is available upon request.

Code availability The data was analyzed using Jamovi program. The file is available upon request.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board at Texas A&M International University (# 2023–10-10).

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent to publish The authors affirm that human research participants provided informed consent for publication of the images in Figs. 2–7c.

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