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ARTICLE

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Relational insecurity heightens sensitivity to limbal rings in partnered women

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Abstract

Limbal rings augment perceived facial health and attractiveness. We thus expected sensitivity to their presence would depend on motives to seek alternative relationship partners among those feeling insecure about a current pairbond. Despite partnered women's relative insensitivity to good gene cues, partnered women feeling relationally dissatisfied might heighten acuity toward limbal rings. We primed single and partnered women with secure or insecure attachment before evaluating the health of male and female faces with and without limbal rings. Insecurity-primed partnered women demonstrated greater perceptual acuity toward limbal rings than security-primed partnered women; this sensitivity was reduced in single women. Findings contribute to literature implicating limbal rings as a health cue, demonstrating how dissatisfaction of mating goals modulates preferences for facial features.

KEYWORDS

evolutionary psychology, face perception, insecurity, limbal rings, relationship status

As part of IARR's encouragement of open research practices, the authors have provided the following information: This research was not pre-registered. The data/syntax and materials used in the research are available through the following OSF link: https://osf.io/sd9be/f.

1 | INTRODUCTION

Selecting healthy mates is critical in ensuring offspring possess traits capable of increasing their probability of survival and reproduction (i.e., good genes). Though much work focuses on identifying good genes cues, increasing evidence suggests identifying and avoiding unhealthy mates is more critical (Zebrowitz, Fellous, Mignault, & Andreoletti, 2003; Zebrowitz & Rhodes, 2004). It may be especially costly to sire unhealthy offspring as it would result in metabolic investment in offspring with reduced likelihood of survival and reproduction. In fact, human females experience spontaneous miscarriages of a developing embryo with significant chromosomal abnormalities that would impede survival to minimize investment in low-viability offspring (Duntley, 2015).

Women would thus benefit from the ability to identify cues in potential partners indicating low genetic quality (i.e., bad genes) prior to mate selection to avoid the metabolic costs of low-viability pregnancy. Humans indeed demonstrate considerable aversion toward facial features that putatively connote poor health, including asymmetry (Rhodes et al., 2001). Additionally, women perceive nonmasculine men as less dominant, a corollary to being perceived as unattractive (Luevano & Zebrowitz, 2007). The absence of limbal rings, dark rings around the iris that augment attractiveness (Peshek, Semmaknejad, Hoffman, & Foley, 2011), for example, has also recently garnered attention in this discussion because their absence elicits similar aversion. Specifically, women become avoidant of faces without limbal rings when mating motives are salient (Brown, Sacco, & Medlin, 2019) and perceive such faces as particularly unhealthy (Brown & Sacco, 2018).

Past research has focused on the signal value of limbal rings for women seeking short-term mates, although this work may not readily address partnered women's perceptions. Partnered women can fluctuate in attentiveness to these cues under certain conditions. Because limbal rings connote short-term mate value in prospective mates, partnered women may demonstrate relative insensitivity to this cue unless they experience dissatisfaction with a current partner. Given that devaluing a current partner motivates interest in extrapair mating opportunities (Johnson & Rusbult, 1989), a consequence of such motivation may be more critical social affordance judgments of prospective mates' and intrasexual competitions' connoted health. These judgments could include attention to attractive relational alternatives and vigilance toward rivals (Maner, Gailliot, Rouby, & Miller, 2007; Miller, Prokosch, & Maner, 2012). The current study offers a first test of whether situational insecurity moderates partnered (but not single) women's sensitivity to limbal rings as a specific cue to mate fitness manifested as favorable heath inferences connoted through them.

1.1 | Limbal rings as a fitness cue

The association between phenotypic cues of attractiveness and good health has resulted in the evolution of perceptual acuity toward health cues. The historical importance of face-to-face contact would make it advantageous to recognize cues to heritable fitness through discrete facial features. Human faces are indeed capable of communicating myriad social affordances, including health, to form the basis of subsequent mate preferences (Rhodes, 2006; Zebrowitz & Collins, 1997). For example, symmetrical faces are especially attractive, as facial symmetry is perceived as healthy (Rhodes et al., 2007) and may veridically connote immunological function (Thornhill & Gangestad, 2006; but see Pound et al., 2014). Women additionally prefer male faces with dominant structures (e.g., broader jawlines), particularly in short-term mating

contexts (Brown & Sacco, 2017; Jones et al., 2018), as such facial structures connote testosteronization (Whitehouse et al., 2015). Conversely, men prefer feminine female features (e.g., narrower, smaller noses), given their association with developmentally appropriate levels of estrogen (Smith et al., 2006).

The primacy of eye contact in social interactions has also led to the evolution of sensitivity to features in and around the eye indicating heritable fitness, making eyes critical for health inferences. White sclerata connote good chronic health and are subsequently perceived as attractive (Provine, Cabrera, Brocato, & Krosnowski, 2011; Russell, Sweda, Porcheron, & Mauger, 2014). One feature within the eye that increases scleral whiteness is the limbal ring, a dark annulus encircling the iris (Shyu & Wyatt, 2009). The presence of limbal rings is contingent upon one's chronic health, as they become less visible at the onset of degenerative diseases and age, thus implicating limbal rings as veridically connoting chronic health (Cavallotti & Cerulli, 2008). Perceivers are indeed sensitive to this information: Faces with limbal rings are perceived as healthier and more attractive than those without, particularly in women's evaluation of male faces (Brown & Sacco, 2018; Peshek et al., 2011; Sacco, Brown, & Medlin, 2019), suggesting their presence facilitates the identification of healthy mates.

The perceptions of faces with limbal rings as healthy may be guided less by preferences for apparent good genes and more by an aversion to inferred bad genes. In a line-bisection task, a task that assesses activation of behavioral approach and avoidance systems (e.g., Nash, McGregor, & Inzlicht, 2010; although see Leggett, Thomas, & Nicholls, 2016), mating-primed women demonstrated a left-visual field bias toward faces without limbal rings, a response indicating activation of avoidance systems, but no biases toward faces with limbal rings (Brown et al., 2019). Such aversion suggests women's inferences are rooted in vigilance to bad genes in prospective mates, eliciting derogation toward those appearing unhealthy.

This perceptual acuity toward limbal rings appears exclusive to women (Brown & Sacco, 2018), which could be rooted in women's greater tendency to identify trustworthiness through eye contact specifically. Women are especially sensitive to facial features connoting trustworthiness in the service of reducing the likelihood of exploitation. For example, women are more accurate in identifying Duchenne smiles, a facial expression indicating genuine affiliative intent (Sacco, Brown, Lustgraaf, & Young, 2017). In detecting Duchenne smiles is recognition of the contraction of muscles near the eye (i.e., orbicularis oculi), thereby increasing the importance of eye contact for women. This sensitivity to features in the eye may have downstream consequences in women's mating decisions for evaluating men's reproductive value through perceptually salient features.

Women indeed prioritize facial features connoting heritable fitness in short-term mating, whereas men prioritize bodily features in that context, suggesting men's general preference for short-term mating inferences are related to bodily cues (Confer, Perilloux, & Buss, 2010; Perilloux & Cloud, 2019). This perceptual acuity further carries over into domains of intrasexual competition, as mating-primed women additionally perceive female faces with limbal rings as healthier than those without in a capacity similar to their perceptions of men (Brown & Sacco, 2018), which could reflect heightened vigilance toward women who offer greater intrasexual competition. Taken together, inferences of health as critical in identifying both viable mates and potential rivals.

1.2 | Relationship status and face perception

Sensitivity toward facial features connoting mate value is partially contingent on the satisfaction of one's relevant mating goals. Individuals may not be as sensitive to cues indicating a

healthy potential mate if there is no situational pressure to do so. For example, sociosexually unrestricted women, or those utilizing a short-term mating strategy that prioritizes heritable fitness cues in mates, prefer sex-typical characteristics in male and female faces, but only if they are single (Sacco, Jones, DeBruine, & Hugenberg, 2012). Single men and women with this unrestricted sociosexual orientation are similarly more sensitive to facial symmetry compared to partnered individuals with a similar orientation (Lustgraaf & Sacco, 2015). Furthermore, single women high in dispositional perfectionistic tendencies valuate faces with limbal rings as particularly healthy, which could reflect an aesthetic basis in mate selection for single women (Sacco et al., 2019). Such findings may reflect the notion that partnered individuals, irrespective of preferred mating strategy, have continued access to reproductive opportunities through their mate, thereby leading them to downregulate their need to identify alternative mates. These findings indicate that single individuals motivated by short-term mating are particularly sensitive to facial features that indicate mates capable of satisfying their reproductive goals.

Single individuals typically demonstrate greater sensitivity toward fitness cues yet partnered individuals may nonetheless upregulate their sensitivity to such cues based on contextual factors that lead their perceptions to mirror single individuals. For example, when identifying whether masculinized or femininized versions of male faces are more attractive, partnered women more strongly prefer the masculinized versions than single women (Little, Jones, Penton-Voak, Burt, & Perrett, 2002). Partnered women with high levels of estradiol, a hormone predictive of fertility, are further particularly sensitive to the health-connoting properties of facial symmetry (Marcinkowska, Kaminski, Little, & Jasienska, 2018). This acuity toward good genes could reflect a desire to identify prospective mates to optimize the benefits associated with long- and short-term mating decisions, leading them to perceive prospective mates similarly to single women (i.e., strategic pluralism; Gangestad & Simpson, 2000). Although partnered women satisfy their long-term mating goals through a partner, heightened acuity toward healthy mates for short-term mating could additionally satisfy those goals.

1.3 | Relationship quality and face perception

Partnered individuals may additionally fluctuate in their sensitivity to attractive alternatives to their current pairbond following an evaluation of the quality of that pairbond. Such individuals are considerably inattentive to, and devalue, attractive relationship alternatives in the service of maintaining their current relationship (Miller & Maner, 2010; Plant, Kunstman, & Maner, 2010). Additionally, priming romantic love similarly mitigates this attention to attractive alternatives (Maner, Rouby, & Gonzaga, 2008). Conversely, maintenance responses appear limited to those committed to their partner, as partnered individuals who espouse less commitment to their partner exhibit more avoidance motivation after viewing attractive alternatives (Miller et al., 2012). Within their heightened sexual interest, ovulating partnered women are more prone to extrapair flirtation, particularly if their partner is less physically attractive (Pillsworth & Haselton, 2006; but see Arslan, Schilling, Gerlach, & Penke, in press). Such responses among uncommitted individuals suggest perceiving one's relationship as suboptimal may increase proclivity to identify alternatives toward one's current pairbond and heighten sensitivity to heritable fitness cues.

For this article, we explored this possibility by relying on an attachment theory framework. According to the theory, individuals have an innate need to seek close others for support in moments of distress (Bowlby, 1969). Successful support seeking reinforces trusting,

healthy expectations about close others (attachment security), whereas a history of insufficient social support (e.g., from neglect) causes persistent negative expectations about relational partners (attachment insecurity; Mikulincer & Shaver, 2007). This framework is helpful for testing situational variation in sensitivity to facial fitness cues for two reasons. First, although one's attachment style is thought as a function of experience, expectations are malleable and have been manipulated successfully in several previous studies (Gillath, Selcuk, & Shaver, 2008; Keefer & Landau, 2015; Mikulincer, Shaver, Gillath, & Nitzberg, 2005). This allows for a granular test of the extent to which chronic factors that influence receptivity to facial cues (e.g., relationship status) might interact with situational motives. Secondly, this framework has direct bearing on the aforementioned evolutionary model: That partnered women may be sensitive to fitness cues in part because of underlying motives to seek extradyadic mating opportunities. Insecurely attached individuals are more prone to infidelity, particularly those more anxiously attached, which could make them more sensitive to the presence and absence of health cues in prospective mates (Allen & Baucom, 2004; Fish, Pavkov, Wetchler, & Bercik, 2012). These individuals experience chronic fears of abandonment or neglect that often motivate extradyadic involvements that can provide additional emotional support and security. It is this need for greater intimacy that often, and ironically, drives anxiously attached individuals to cheat.

1.4 | Current research

The current study sought to extend previous findings investigating how the communicative properties of limbal rings are inferred differentially among single and partnered women (Sacco et al., 2019). Specifically, we sought to consider how the (dis)satisfaction of relational needs, as reflected by greater attachment (in)security, among partnered women may shift their perceptual acuity toward limbal rings as cues to heritable fitness that would facilitate acquisition of relevant mating goals.

Given that relational motives heighten women's perceptual acuity toward limbal rings, we predicted partnered women primed with attachment insecurity would perceive faces with limbal rings as especially healthy compared to partnered women primed with attachment security. However, when pursuing healthy partners, insecurity-primed women should additionally elicit a concomitant acuity toward cues to poor health. This acuity should emerge in the service of mitigating costly mating mistakes with an unfit partner (Brown et al., 2019; Zebrowitz et al., 2003). We thus predicted insecurity-primed partnered women would view male faces without limbal rings more negatively than security-primed partnered women.

The expectation of attachment insecurity eliciting perceptual acuity toward health cues in partnered women additionally leads us to predict that insecurity-primed partnered women would similarly perceive female faces with limbal rings as particularly healthy in the service of identifying potential intrasexual competition. Nonetheless, because limbal rings influence women's evaluations of prospective mates (Brown & Sacco, 2018), we additionally predicted such perceptual acuity toward the presence of limbal rings would be most apparent in male faces.

Additionally, because the immediate salience of relationships would be irrelevant to single individuals, we predicted the attachment primes would not elicit differences in perceptual acuity toward limbal rings. This consideration of attachment priming, relationship status, limbal rings, and women's simultaneous identification of intrasexual threats and reproductive

opportunities positioned us to conduct an experiment utilizing a 2 (Condition, between-subjects: Insecure vs. Secure Attachment) × 2 (Relationship, between-subjects: Single vs. Partnered) × 2 (Target Sex, within-subjects: Male vs. Female) × 2 (Limbal Rings, within-subjects: Present vs. Absent) mixed experimental design.

2 | METHOD

2.1 | Participants

Given the empirically derived import of limbal rings for women, we recruited 203 undergraduate women from a midsized public university in Southeastern U.S. for course credit. We excluded 12 participants from final analyses for being over 40-years-old to ensure our sample most accurately represented respondents within a typical reproductive window, as the average age onset of menopause is between 40 and 60 (te Velde & Pearson, 2002), or espousing no heterosexual attraction (Brown & Sacco, 2018). This resulted in a final sample of 191 (M_{Age} = 20.09 years, SD = 3.17, 70% White; 105 single, 86 partnered). Sensitivity analyses indicated our sample sufficed to detect small effects (Cohen's $f = 0.10$, $\beta = 0.80$).

2.2 | Materials and procedure

2.2.1 | Attachment primes

Participants responded to one of two writing prompts in which they reflected on a time in a relationship. Participants wrote either about a time their partner was "there for [them]," therefore priming attachment security, or a time a partner was "not there," priming insecurity (Mikulincer, Shaver, & Rom, 2011). Participants wrote about this experience for approximately five min. Following the prime, participants indicated their state-level attachment security using three ad hoc items: "At this moment, how good do you feel about relationships?", "Right now, how secure do you feel about relationships?", and "Do you feel like you could currently rely on a relationship partner?" (1 = *Not at All*; 5 = *Very Much*; $\alpha = 0.92$).

2.2.2 | Limbal ring targets

Participants evaluated faces of 20 unique Caucasian targets (10 male, 10 female) altered either to have a limbal ring encircling their iris and not (Peshek et al., 2011). Alteration of faces specifically involved imposing a new iris onto each target face, which had a radial gradient imposed onto the iris for 50% opacity to create a natural-looking limbal ring for one version of the face and no gradient for the other (Figure 1). Participants viewed each face in random order. Participants indicated the extent they perceived each face as healthy along a 7-point scale (1 = *Very Unhealthy*; 7 = *Very Healthy*; Brown & Sacco, 2018).

Consenting participants were initially assigned to one of the two priming conditions before responding to the manipulation check items. Then, they evaluated the target faces for their perceived health before providing demographics information.

FIGURE 1 Example stimulus faces with (left) and without limbal rings

3 | RESULTS

3.1 | Manipulation check

We conducted a 2 (Condition: Secure vs. Insecure Attachment) × 2 (Relationship: Single vs. Partnered) analysis of variance (ANOVA) to determine whether our manipulation effectively primed security and whether relationship status moderated these findings. Security-primed women reported greater security (mean = 3.48, $SD = 1.27$) than did insecurity-primed women (mean = 3.12, $SD = 1.15$), $F(1, 187) = 4.56$, $p = .034$, $\eta_p^2 = 0.024$. Additionally, partnered women reported greater security (mean = 4.14, $SD = 0.93$) than did single women (mean = 2.61, $SD = 0.98$), $F(1, 187) = 119.31$, $p < .001$, $\eta_p^2 = 0.390$. No interaction emerged, $F(1, 187) = 0.55$, $p = .459$, $\eta_p^2 = 0.003$.

3.2 | Primary analysis

We submitted our data to a 2 (Condition: Secure vs. Insecure Attachment) × 2 (Relationship: Single vs. Partnered) × 2 (Target Sex: Male vs. Female) × 2 (Limbal Rings: Present vs. Absent) mixed-model ANOVA with repeated factors over the latter two factors. As expected, a main effect of Limbal Rings indicated participants perceived faces with limbal rings as healthier

(mean = 4.49, $SD = 0.98$) than those without (mean = 4.38, $SD = 0.97$), $F(1, 187) = 38.56$, $p < .001$, $\eta_p^2 = 0.171$. Another main effect of Target Sex indicated participants perceived female targets (mean = 4.52, $SD = 0.97$) as healthier than male targets (mean = 4.35, $SD = 0.98$), $F(1, 187) = 16.87$, $p < .001$, $\eta_p^2 = 0.083$. Interestingly, a third main effect of Relationship indicated partnered participants perceived faces as healthier (mean = 4.60, $SD = 0.97$) than did single participants (mean = 4.30, $SD = 0.80$), $F(1, 187) = 4.71$, $p = .031$, $\eta_p^2 = 0.025$.

Effects were first qualified by a Target Sex × Relationship interaction, $F(1, 187) = 16.87$, $p < .001$, $\eta_p^2 = 0.083$. Simple effects tests using pooled variance revealed that partnered women perceived female faces as healthier (mean = 4.75, $SD = 0.97$) than male faces (mean = 4.45, $SD = 1.06$), $F(1, 187) = 20.90$, $p < .001$, $\eta_p^2 = 0.101$. No difference in perceptions of male (mean = 4.27, $SD = 0.88$) and female faces (mean = 4.34, $SD = 0.89$) emerged for single women, $F(1, 187) = 1.14$, $p = .287$, $\eta_p^2 = 0.006$.

Replicating recent findings (Brown & Sacco, 2018; Sacco et al., 2019), effects were further qualified by a Target Sex × Limbal Rings interaction, $F(1, 187) = 4.59$, $p = .033$, $\eta_p^2 = 0.024$. Simple effects tests indicated participants perceived male faces with limbal rings as healthier (mean = 4.42, $SD = 1.00$) than those without (mean = 4.28, $SD = 0.97$), $F(1, 187) = 34.04$, $p < .001$, $\eta_p^2 = 0.154$. Female faces with limbal rings were also perceived as healthier (mean = 4.56, $SD = 0.96$) than those without (mean = 4.49, $SD = 0.97$), albeit at a substantially reduced magnitude, $F(1, 187) = 9.72$, $p = .002$, $\eta_p^2 = 0.049$.

Most superordinately, effects were qualified by a Condition × Relationship × Limbal Rings interaction, $F(1, 187) = 7.34$, $p = .007$, $\eta_p^2 = 0.038$.[1] We decomposed this 3-way interaction by considering Single and Partnered women separately in subordinate multivariate analyses to identify motivational differences between single and partnered individuals (Braver, MacKinnon, & Page, 2003; Sacco et al., 2012). Effects for partnered women were further qualified by a subordinate two-way interaction, $F(1, 187) = 4.79$, $p = .030$, $\eta_p^2 = 0.025$. Simple effects tests indicated that insecurity-primed partnered women perceived faces with limbal rings as significantly healthier (mean = 4.48, $SD = 1.01$) than those without limbal rings (mean = 4.30, $SD = 0.97$), $F(1, 187) = 21.79$, $p < .001$, $\eta_p^2 = 0.104$. Conversely, security-primed partnered women perceived faces with limbal rings as marginally healthier (mean = 4.82, $SD = 0.96$) than faces without (mean = 4.76, $SD = 0.90$), $F(1, 187) = 3.23$, $p = .074$, $\eta_p^2 = 0.017$. Viewed another way, insecurity-primed partnered women perceived faces with limbal rings as marginally healthier than security-primed partnered women, $F(1, 187) = 3.06$, $p = .082$, $\eta_p^2 = 0.016$. Insecurity-primed partnered women additionally perceived faces without limbal rings as significantly less healthy than security-primed women, $F(1, 187) = 5.61$, $p = .019$, $\eta_p^2 = 0.029$ (Figure 2).

Effects for single women were not qualified by a significant interaction, $F(1, 187) = 2.62$, $p = .107$, $\eta_p^2 = 0.014$. Despite this lack of interaction, we conducted an exploratory analysis to identify how the primes influence single women's perceptions. Insecurity-primed single women reported faces with limbal rings were perceived as marginally healthier (mean = 4.33, $SD = 0.77$) than those without limbal rings (mean = 4.27, $SD = 0.79$), $F(1, 187) = 3.23$, $p = .074$, $\eta_p^2 = 0.017$. Conversely, security-primed single women perceived limbal rings as significantly healthier (mean = 4.37, $SD = 0.92$) than faces without (mean = 4.24, $SD = 0.92$), $F(1, 187) = 16.06$, $p < .001$, $\eta_p^2 = 0.080$. Viewed another way, no differences emerged in perceptions of health between faces with and without limbal rings as a function of Condition among single women, Fs < 0.06, ps > .827. No other main effects or superordinate interactions emerged, Fs < 2.40, ps > .100.

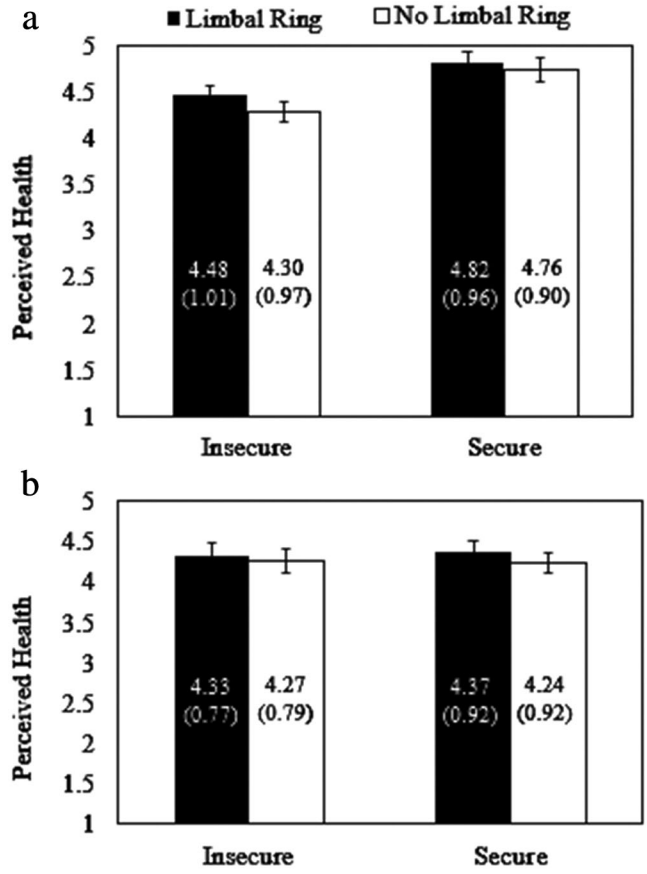

FIGURE 2 Perceived health of faces with and without limbal rings among security- and insecurity-primed partnered (a) and single (b) women (with SEs). *Note:* Effects for single women were not qualified by a significant interaction and should be interpreted cautiously

4 | DISCUSSION

The current study replicated and extended previous work implicating limbal rings as a health cue from which women can infer mate value in several critical capacities. Findings initially aligned with previous findings indicating women utilize limbal rings as a cue to health, particularly in male faces, thereby increasing the preponderance of evidence for the importance of limbal rings in women's mating decisions (Brown & Sacco, 2018; Sacco et al., 2019). We further demonstrated that partnered women become especially sensitive to the presence and absence of limbal rings. First, insecurity-primed partnered women perceived faces with limbal rings as healthier than faces without limbal rings. This acuity could reflect a newly heightened interest in identifying optimum mating opportunities, given the relative salience of the shortcomings in their current relationship.

Second, insecurity-primed partnered women were particularly derogative toward faces without limbal rings. This result is consonant with previous findings indicating heightened aversion to the potential costs of unhealthy mates, particularly among women who could have had an interest in extradyadic mating had been activated (Allen & Baucom, 2004; Fish et al., 2012; Zebrowitz et al., 2003). The preference for limbal rings demonstrated in previous findings appears largely rooted in the derogation of faces not possessing heritable fitness cues as unhealthy rather than recognition of the health benefits of faces possessing fitness cues (Brown

et al., 2019). This effect was apparent in the current study, as evidenced by partnered women whose relationship needs were temporally thwarted being especially derogative toward faces without limbal rings. Such a response could serve to increase women's mating opportunities following a relationship dissolution.

Unexpectedly, partnered women perceived faces as healthier than single women. This main effect could have been the result of a lack of effects among single women. That is, the favorability of faces with limbal rings among single women was at a substantially reduced magnitude compared to partnered women.

This relative lack of discrimination between health cues among single women could reflect a criterion shift that is consonant with error management theory, particularly for insecurity-primed single women (Haselton & Buss, 2000). That is, any partner seems equally acceptable to insecurity-primed single women, irrespective of their heritable fitness (Sacco, Young, & Hugenberg, 2014). Conversely, the salience of relationships in security-primed single women (and insecurity-primed partnered women) may have increased sensitivity to optimal mating opportunities. Nonetheless, because of the exploratory nature of the results for single participants, future research is necessary.

Although we predicted this perceptual acuity toward limbal rings, it would be especially strong for male faces in the service of identifying extrapair partners, insecurity-primed partnered women nonetheless demonstrated acuity toward limbal rings in female faces. This acuity toward women's limbal rings could be rooted in their heightened vigilance toward intrasexual competition to identify attractive rivals (Maner et al., 2007). These findings are additionally consonant with previous work indicating that anxiously attached individuals experience difficulty in disengaging from relationship threats (Mikulincer, Gillath, & Shaver, 2002) and engage in frequent mate-guarding (Barbaro, Pham, Shackelford, & Zeigler-Hill, 2016), suggesting this response could have a relationship maintenance function. Much like with previous findings demonstrating the signal value of limbal rings, perceptual acuity for women's limbal rings emerged primarily as derogation toward women without limbal rings following a prime that activated mating-relevant motives (Brown et al., 2019; Brown & Sacco, 2018). This derogation could facilitate women's focus on healthy rivals who could poach their mates.

Despite being sensitive to limbal rings' presence, security-primed partnered women's perceptions of faces with limbal rings as healthier was additionally magnitudinally weaker. This effect could reflect a combination of relationship maintenance measures individuals employ. For perceptions of male faces, women's perceptual acuity could have been muted, given the saliency of positives in their current pairbond that could motivate interest in maintaining one's current relationship by downregulating interest in relational alternatives (Lustgraaf & Sacco, 2015; Maner et al., 2008; Sacco et al., 2012). This security could have fostered greater regulation that would facilitate relationship maintenance despite the presence of heritable fitness cues in potential alternatives (Ritter, Karremans, & van Schie, 2010). The downregulation for perceptions of female faces may similarly represent a downregulation of a necessity for vigilance, as they could see their relationship being especially secure following the prime and therefore can afford to disengage rivals similarly to individuals who are not anxiously attached (Mikulincer et al., 2002). Highly committed partners demonstrate less defensive behavior in response to attractive relationship alternatives, suggesting a level of security in their relationship (Miller et al., 2012). A similar process could have occurred in identifying intrasexual rivals, wherein the perceived security would render heightened vigilance unnecessary. Unsurprisingly, as evidenced by the lack of interactive effects for single women, perceptual acuity toward limbal rings additionally appeared unaffected by salience of relational security. This could reflect a

lack of immediate relevance of the prime content to single individuals, given their lack of partnership.

4.1 | Limitations and future directions

Although our hypotheses were largely supported in the current study, we were not without limitations. One such limitation, much like one posed in previous findings (Brown et al., 2019), includes the lack of discernment in understanding the preferences for male and female faces in insecurity-primed single women's vigilance toward limbal rings. Male and female faces with limbal rings were perceived as healthier among such women, yet it stands to reason these perceptions served different functions that could not be captured with a single outcome. Future research would benefit from considering health perceptions as a mediator and identify how this could serve as the basis for downstream affordance judgments for male and female faces separately. Given the hypothesis that women could be seeking extrapair bonds with sufficiently healthy men, a potential outcome for male faces could be suitability as a mate (Brown & Sacco, 2018). Conversely, to identify how perceptions of health influence affordance judgments of female faces as a potent intrasexual threat, a future study could task women with explicitly indicating how intrasexually threatening female faces with and without limbal rings are (Vaillancourt & Sharma, 2011). However, given that this preference for faces with limbal rings is rooted more in aversion to bad genes, it could be possible that the effects for perceiving faces without limbal rings as unhealthy would be especially strong.

Future research would additionally benefit from identifying specific motivational states that could facilitate the inferences observed in the current study. For example, insecurity-primed partnered women's sensitivity to men's limbal rings could be specifically rooted in an activated desire for extradyadic mating; future research would benefit from specifically assessing participants' extradyadic mating interest (Pillsworth & Haselton, 2006). Additionally, when employing an interdependence theory framework (Rusbult, 1980), future studies could assess state-level derogation of relational alternatives, which could manifest as recognizing the health cue of limbal rings more readily (Miller et al., 2012; Rusbult, Martz, & Agnew, 1998). The motivational states for sensitivity to women's limbal rings could further be tested by assessing state-level differences in intrasexual competition interest, given that insecurely attached individuals are more intrasexually competitive (Barbaro et al., 2016).

In further bolstering, the explicit evidence of this body of findings indicating that perceptions of faces without limbal rings is rooted in derogation, future research would benefit from using paradigms that afford the opportunity for individuals to develop their own criterion for suitable health in prospective mates. One paradigm to address this criterion could include a progression of frames ranging from opacity of limbal rings to translucency with individuals indicating the point at which a prospective mate's face is considered no longer suitably healthy for a mate (Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). Such procedures have similarly provided evidence for how insecurely attached individuals perceive emotional expressions, particularly following a stressful experience (Niedenthal, Brauer, Robin, & Innes-Ker, 2002). This could lead to the prediction that insecurity-primed partnered women would more readily perceive prospective mates as unhealthy by rating a small amount of translucency sufficient for derogation. Additionally, as a potential test for women's vigilance toward rivals, future research could utilize a dot probe task, an attentional paradigm utilized to investigate the extent to which individuals engage with stimuli, to identify the amount of time for women to disengage

from rivals with limbal rings (Ackerman et al., 2009). Given the difficulty in disengaging cues to intrasexual threat among insecurely attached partners (Mikulincer & Shaver, 2007), insecurity-primed women could be particularly vigilant of women with limbal rings.

4.2 | Conclusion

The current study contributes to a growing body of research investigating the communicative properties of limbal rings. We found instances in which partnered individuals became particularly sensitive to the signal value of such features, with individuals seeking to satisfy relational goals identifying mates and rivals based on the presence of limbal rings. Findings emphasize the continued importance of health cues even within the confines of established pairbonds and how relationship dynamics shift acuity toward such cues.

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ENDNOTE

[1] We provide the results for a JASP (2019) analysis in the OSF link to provide a more conservative pooled analysis to decompose the 3-way interaction. Results in this analysis mirror those reported in the manuscript, albeit at a reduced magnitude.

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