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ORIGINAL ARTICLE

An Eye Tracking Study Examining the Role of Mating Strategies, Perceived Vulnerability to Disease, and Disgust in Attention to Pathogenic Cues

Ray Garza[1] · Farid Pazhoohi[2] · Laith Al-Shawaf[3] · Jennifer Byrd-Craven[4]

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Abstract
Disgust is an emotion that regulates disease avoidance and reduces the likelihood of pathogenic infections. Existing research suggests a bidirectional relationship between disgust and mating, where disgust inhibits sexual behavior and sexual behavior inhibits disgust. In the current study, we investigated the role of individual differences and mating motivations on visual attention to pathogenic cues. Participants (N=103) were randomly assigned to a mating prime or control condition, and they were asked to view images of pathogenic cues (i.e., rotten food, exposed cuts, bodily fluids) paired with their non-pathogenic counterparts. The findings showed no effect of mating prime on visual attention to pathogenic stimuli; however, dispositional mating strategies (SOI-R) were associated with attention to pathogenic stimuli. Individuals with unrestricted sociosexual orientations viewed pathogenic stimuli longer. The findings demonstrate that dispositional mating orientation is associated with greater attention to disgusting images, a link between pathogens and mating orientation that warrants further exploration.

Keywords Attention · Disgust · Eye-tracking · Mating · Pathogens · Sociosexual orientation

Introduction

Emotions serve as coordinating mechanisms that regulate cognition, physiology, and behavior in ways that aid in solving adaptive problems (Al-Shawaf et al., 2015; Al-Shawaf, 2016; Al-Shawaf & Lewis, 2017; Tooby & Cosmides, 2008). The emotion of disgust regulates disease avoidance mechanisms and reduces the likelihood of pathogenic infections (Curtis et al., 2004). Existing evidence suggests that there is a bidirectional relationship between disgust and mating behaviors, where disgust inhibits

Extended author information available on the last page of the article sexual behavior, and sexual arousal inhibits disgust. Sexual behavior increases one's likelihood of pathogenic infections through the transmission of bodily fluids (Gruijters et al., 2016), but sexual behavior is also a key part of reproductive success. Short-term mating orientation may increase one's exposure to pathogenic infections due to the propensity to engage in multiple sexual opportunities with little known information from a sexual partner (Al-Shawaf et al., 2015; O'Shea et al., 2019). Short-term mating can inhibit disgust during a mating opportunity. This may mean that individuals oriented toward short-term mating have lower attention to pathogen related information.

Individuals also vary in their perceived vulnerability to disease and overall levels of disgust. Although some research has suggested that increased trait pathogen disgust sensitivity is associated with higher threat reactivity (Mahkanova & Shepard, 2020; Safra et al., 2021), it is unknown if individual differences in disgust and perceived vulnerability to disease are associated with attention to pathogen cues. The current study investigates the role of short-term mating, individual differences in disgust, and individual differences in perceived vulnerability to disease in attention to pathogen related cues using an eye-tracking paradigm.

Sexual Behaviors and Disgust

Previous research has demonstrated that sexual arousal is negatively associated with disgust. Studies incorporating visual stimuli have shown that when primed with sexually arousing images or videos, people lower their risk assessment for sexually transmitted infections (Blanton & Gerrard, 1997), experience less disgust (Koukounas & McCabe, 1997), and increase their willingness to engage in sexual behavior, including behavior potentially associated with pathogen exposure (Ariely & Loewenstein, 2006; Ditto et al., 2006). Other studies have shown that sexual risk-taking increases after being exposed to a sexually attractive model (Loewenstein et al., 1997). These findings have suggested that temporary states of sexual arousal can affect disgust and distort perceptions of pathogen risk exposure.

Humans have a diverse menu of mating strategies. These are subject to wide individual differences, with some individuals having a stronger orientation toward short-term mating and others having a stronger orientation toward long-term mating (Buss & Schmitt, 1993, 2018). Short-term mating strategies are characterized by the presence of multiple sexual partners, brief intervals of time between sexual encounters, and sexual variety (Buss & Schmitt, 1993). Due to the increased likelihood of engaging in multiple sexual encounters with different people, short-term mating strategies may put individuals at a higher risk of pathogen exposure through sexually transmitted infections. Consequently, implementing a successful short-term mating strategy should be difficult in the presence of high levels of sexual disgust (Al-Shawaf et al., 2015). This suggests that individuals who are oriented toward short-term mating strategies may have lower sexual disgust (Al-Shawaf et al., 2015). Existing evidence does suggest a negative relationship between short-term mating and disgust. Studies using the sociosexual orientation inventory (SOI-R) (Penke & Asendorpf, 2008), a measure of one's propensity to engage in uncommitted sexual activities, have shown that people with an uncommitted sociosexual orientation have lower levels of sexual disgust (Al-Shawaf et al., 2015; Gruijters et al., 2016; Tybur et al., 2009, 2015; O'shea et al., 2019) and pathogen aversion (Murray et al., 2013).

Measuring cognitive processes involved in disgust, such as memory and attention, can provide insight into pathogen detection. Investigating the attentional processes involved in pathogen detection, Fančovičová et al. (2022) showed participants images of disgusting (e.g., spoiled food) and neutral stimuli. Disgusting stimuli were shown to elicit increased attention compared to neutral stimuli, suggesting vigilance about the possibility of contamination. Research investigating the memory processes involved in pathogen detection has shown that individuals display enhanced memory for disgusting images relative to control images (Chapman et al., 2013; Charash & McCay, 2002). Enhanced memory for disgusting images has also been demonstrated in children (Schienle et al., 2021).

Individual differences in disgust and perceived vulnerability to disease have been shown to be linked with heightened responses to threatening situations. Individuals with higher threat detection may be more likely to react to threatening compared to non-threatening situations (Nettle & Bateson, 2012). Further, if individuals are more likely to detect threatening situations, they may have a lower threshold for detecting those threats (Nettle & Bateson, 2012). For instance, individuals who report higher levels of perceived vulnerability to disease engage in more disease preventive behaviors, such as hand washing and mask wearing (Stangier et al., 2021). Research has also shown that individuals with higher perceived vulnerability to disease display a heightened response to threats (Safra et al., 2021). Perceived vulnerability has also been shown to be associated with stronger reactions to pathogen threats, displaying higher levels of overall and pathogen specific vigilance (Mahkanova & Shepard, 2020).

Existing research has also used methods that measure direct attentional processes to disgusting stimuli, such as eye-tracking methods. Eye-tracking measures attention precisely, as it records overt eye movements compared to methods measuring reaction time (Knowles, 2019). Eye-tracking provides rich data that includes where individuals attend to at first view (first fixation duration), looking behavior (fixation count), and overall visual attention (dwell time) (Conklin et al., 2018). In the current context, eye-tracking provides a useful method to understand if individuals display an attentional bias to environmental cues associated with a key adaptive problem: infection.

Only a small number of studies have investigated the attentional processes involved in processing disgust cues. These studies have used eye-tracking to directly measure attention to disgust relevant stimuli. For instance, children with parents who display higher disgust-proneness exhibit greater viewing time of disgusting stimuli (Stevenson et al., 2014). Individuals with high trait anxiety orient more attention to disgust and fearful faces compared to those with low trait anxiety (Fox et al., 2001, 2002; Georgiou et al., 2005; Holas et al., 2014). However, a meta-analytic study on eye tracking did demonstrate that differences in anxiety did not result in more visual attention to threatening cues in adolescents (Lisk et al., 2020). Other studies show that individuals high in contamination fear display increased visual attention to disgust and fearful faces compared to those low in contamination fear (Armstrong et al., 2010). Evidence from the eye-tracking literature bolsters the suggestion that there are individual differences in the cognitive mechanisms involved in processing disgust.

The current study investigated the relationship between individual differences in mating orientation, an experimental mating prime, and attention to pathogenic stimuli. Specifically, we investigated whether a short-term mating prime and individual differences in mating orientation would downregulate attention to disgusting stimuli. We test this prediction based on existing findings showing that short-term mating orientation is associated with lower disgust (Al-Shawaf et al., 2015; O'shea et al., 2019). Previous studies have suggested that experimentally manipulating mating interest is associated with lower disgust proneness (Ariely & Loewenstein, 2006; Ditto et al., 2006) and sexual risk taking (Loewenstein et al., 1997). Furthermore, individuals with a higher propensity to engage in uncommitted sexual encounters (i.e., higher sociosexuality) show lower levels of disgust (Al-Shawaf et al., 2015; Gruijters et al., 2016; O'shea et al., 2019; Tybur et al., 2009, 2015). Although these studies have demonstrated an association between sexual interest and disgust using self-reported measures, researchers have yet to study the relationship between mating and disgust using behavioral measurements that capture interest through eye movements. The inhibitory effect of short-term mating on disgust may be demonstrated by showing less attention to pathogen cues, as this would indicate reduced attention to pathogens after exposure to sexually relevant information. If short-term mating is negatively associated with disgust, we would expect information indicating short-term mating opportunities to play a role in the attentional process involved in detecting pathogens. To test this prediction, we incorporated eye-tracking to measure visual attention to disgust stimuli while manipulating mating context and measuring individual differences in short-term mating strategies.

In addition, we also measured individual differences in perceived vulnerability to disease and trait disgust by having individuals complete the Perceived Vulnerability to Disease Scale (PVD; Duncan et al., 2009) and The Three-Domain Disgust Scale (TDDS; Tybur, Lieberman, & Griskevicius, 2009). Research has demonstrated that individuals with higher levels of trait pathogen avoidance are more reactive, vigilant, and engage in more preventative behaviors during threatening situations. Reactivity and vigilance have been shown to be associated with increased eye movements to threatening stimuli (Nissens et al., 2017). Therefore, we tested if individual differences in disgust and perceived vulnerability would predict visual attention to pathogen related cues. We measured visual attention as indexed by capturing first fixation durations, number of fixations (looking frequency), and dwell time. This study predicted the following: (1) A short-term mating prime would predict less attention to pathogen cues, (2) A stronger orientation toward short-term mating (i.e., higher SOI) would be associated with lower attention to pathogen cues, and (3) Individual differences in disgust and perceived vulnerability would be associated with greater attention to pathogen cues. Our rationale for using a short-term mating prime and dispositional measure of short-term mating (i.e., SOI) was to disentangle if state dependent vs. trait dependent short-term mating would be associated with lower attention to pathogen cues.

Method

Participants

One-hundred and three participants ($M = 19.24$, $SD = 1.47$) from Oklahoma State University participated in this experiment in exchange for course credit (*Women* = 64, *Men* = 39). The sample demographics were, White ($N = 76$), Native-American ($N = 5$), African American ($N = 6$), Hispanic ($N = 9$), Asian-American ($N = 3$), and Other ($N = 4$).

Materials

Short-term Mating Prompt

The short-term mating prompt was borrowed from Griskevicius et al. (2007). The prompt contains a sexually explicit scenario where participants are asked to imagine themselves in a romantic encounter suggestive of a one-night stand with an attractive opposite sex partner. The control prompt included a scenario where participants are asked to imagine themselves with a same-sex friend getting ready to go out for a concert.

Three-domain Disgust Scale

Individual differences in disgust were measured using the Three-Domain Disgust scale (TDDS) (Tybur et al., 2009). This scale measures disgust in three domains: moral, sexual, and pathogen disgust. The 21-item scale measures responses to statements such as "Sitting next to someone who has red sores on their arm", using a 7- point Likert scale from *not at all disgusting* to *extremely disgusting.* The TDDS demonstrated good reliability, *Cronbach's alpha* = 0.85. Since the images used in this study were specific to pathogen cues, we focused on the pathogen disgust subscale in our main analysis.

Perceived Vulnerability to Disease

Individual differences in concern for disease was measured using the Perceived Vulnerability to Disease scale (Duncan et al., 2009). It is a 15-item instrument measuring items on a 7-point Likert scale where higher scores indicate a higher likelihood of perceived risk of disease. The PVD demonstrated good reliability, *Cronbach's alpha* = 0.79.

Short-term Mating Orientation

We measured individual differences in short-term mating orientation using the revised Sociosexual Orientation Inventory (SOI-R). This scale indexes one's propensity to engage in uncommitted sexual encounters. The 9-item scale measures responses to statements, such as "I can imagine myself being comfortable and enjoying "casual" sex with different partners.", using a 9-point Likert scale where "1 = strongly disagree" to "9 = strongly agree". Higher scores represent a stronger orientation toward uncommitted sexual encounters. The SOI-R demonstrated good reliability, *Cronbach's alpha* = 0.85.

Pathogen Cues

We used disgust stimuli from an image set devised by Culpepper et al. (2018). The image set contains a collection of 20 non-pathogenic cues (i.e., man's face, cooked steak) and 20 pathogenic cues (i.e., mucus on a man's face, rotten steak). Each pathogenic image has a matched non-pathogenic counterpart (e.g., a dead squirrel paired with a live squirrel).

Eye Tracking Measures

A Tobii pro X2-60 eye-tracker was used to track eye-movements. We created two regions of interest for each visual presentation using Tobii Pro Studio. One region of interest (ROI) was created for images displaying non-pathogenic cues and one region of interest was created for images displaying pathogenic cues. The eye-tracking metrics that were collected were first fixation duration, number of fixations, and dwell time. First fixation duration was defined as the duration of the first fixation in milliseconds to a region of interest, and it is often used as a measure of early-onset bias (Conklin et al., 2018). Number of fixations was defined as number of fixations made to an interest area, and it is used as a measure of looking behavior. Lastly, dwell time measured the average amount of time in milliseconds spent looking at a ROI. Dwell time is often used as a measure of overall attention (Conklin et al., 2018).

Procedure

The study was approved by the Institutional Review Board (IRB) at Oklahoma State University and was announced on the university's SONA online recruiting system. Upon consent, participants were directed to a computer where they were randomly assigned to either a mating or control condition. In the mating condition, participants were asked to read a short-term mating prompt from Griskevicius et al. (2007) where participants read a story about a romantic encounter, or a control condition which did not include any romantic or sexual information (a prompt about going to concert with a friend). After reading the prompt, participants began the eye-tracking task using a Tobii pro X2-60, which is a non-invasive eye-tracker that does not constrain participants to a chinrest and captures binocular eye movements. They sat approximately 50 cm from the computer screen throughout the experiment. They completed a calibration check which consisted of following a dot across 5 random locations to ensure that eye movements could be recorded accurately. They were given instructions that they would view images presented in pairs and that the images would refresh after 3000ms. The images presented were of a non-pathogenic and pathogenic cue displayed on each side of the computer screen (followed by a fixation cross "X" for 500ms). Image placement (i.e., left or right side of the screen)

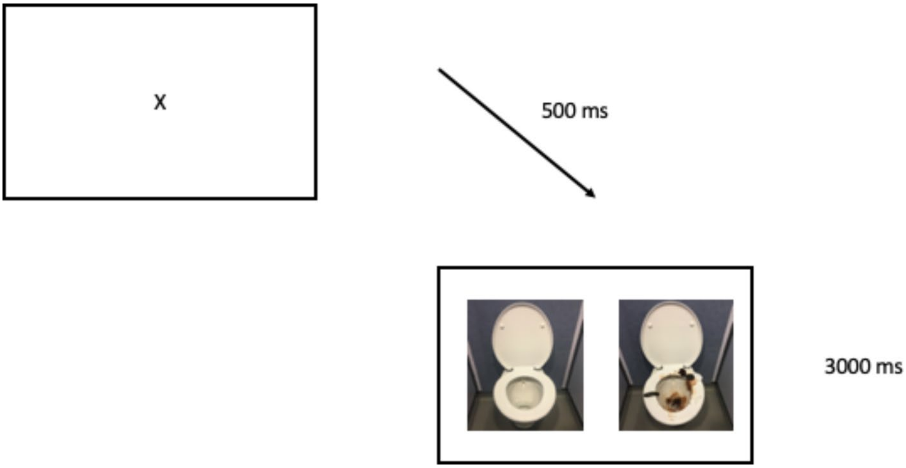

Fig. 1 An example of the presentation sequence for viewing images on the eye-tracker. Presented is a toilet without (left) and with (right) fecal matter on the toilet seat

was counterbalanced. Participants viewed a total of 20 slides (i.e., 40 images total), and the eye-tracking task was completed in approximately 2–3 min. Once they had finished viewing the images, participants were directed to a Qualtrics link and asked to complete a sociodemographic questionnaire, the SOI-R, TDDS, and PVD. In total, the experiment was completed in approximately 20 min.

Results

Statistical Analyses

Linear mixed-effect models (LME) were run to test the role of the mating prime, pathogen cues, individual differences in short-term mating orientation, perceived vulnerability to disease, pathogen disgust, and their interactions on visual attention, as indexed by first fixation durations, dwell time, and number of fixations. Pathogen cues, short-term mating orientation, perceived vulnerability to disease, pathogen disgust, and the interactions between pathogen cues and the individual differences measures were entered as fixed effects, and subject ID was as entered as a random effect. All individual differences measures were mean centered. The inclusion of a random slope for pathogen cues did not improve model fit, therefore, it was not included in the final model. For the LME models, maximum likelihood estimation was used. All significant interactions between the individual differences measures and pathogen cues were probed at -1SD, the mean, and + 1SD from the mean.

Table 1 Correlations between sociosexual orientation (SOI), perceived vulnerability to diseases (PVD), pathogen disgust, three-domain disgust scale (TDDS), and visual time

	SOI	PVD	Pathogen disgust	TDDS
SOI				
PVD	−0.002			
Pathogen disgust	0.009	0.12		
TDDS	−0.34***	0.10	0.74***	
FFD Non-pathogen	−0.02	0.05	−0.17	−0.17
FFD Pathogen	−0.03	−0.07	0.03	0.10
FC Non-Pathogen	−0.23*	0.06	−0.02	0.04
FC Pathogen	0.21*	−0.15	−0.06	−0.23*
Dwell time Non-pathogen	−0.15	0.12	0.02	0.14
Dwell Time Pathogen	0.28**	−0.05	−0.01	−0.20*

Note: *$p<.05$, **$p<.01$, ***$p<.001$. First fixation duration (FFD), Fixation count (FC).

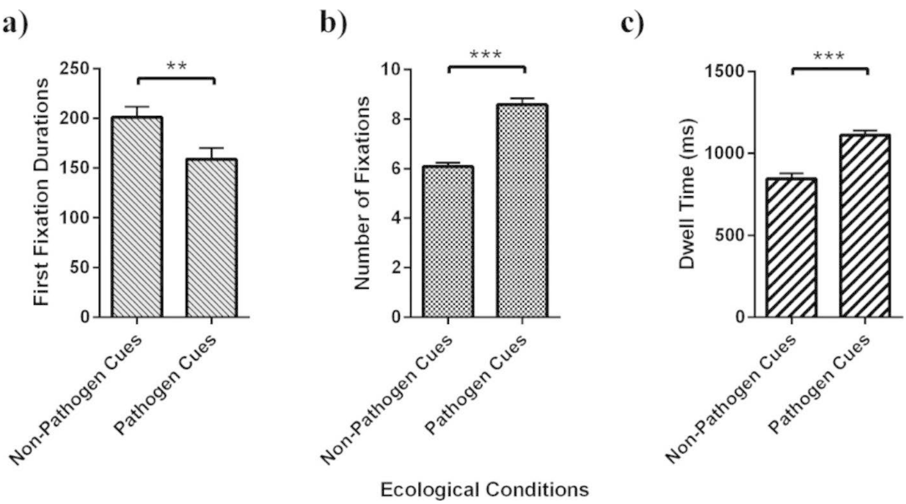

Fig. 2 (a) First fixation duration (in milliseconds), (b) Number of fixations, and (c) Dwell time (in milliseconds) to non-pathogen and pathogen cues

Descriptive Statistics

Table 1 presents the correlations between sociosexual orientation (*M*=2.74, *SD*=1.74), perceived vulnerability to diseases (*M*=3.77, *SD*=0.83), pathogen disgust (*M*=5.04, *SD*=1.00), TDDS (*M*=4.74, *SE*=0.87) and visual attention.

First Fixation Duration

There was a significant main effect for pathogen cues (*b* = -60.84, *SE*=22.03, 95%CI [-104.02, -17.66], *p*=.006). Participants first fixations durations were longer for non-pathogen cues (*M*=200.78, *SE*=10.80) compared to pathogen cues (*M*=158.82, *SE*=10.80), see Fig. 2a. The main effects for mating prime (*b* = -22.00, *SE*=21.82, 95%CI [-64.77, 20.76], *p*=.31) pathogen disgust (*b* = -17.76, *SE*=10.96, 95%CI

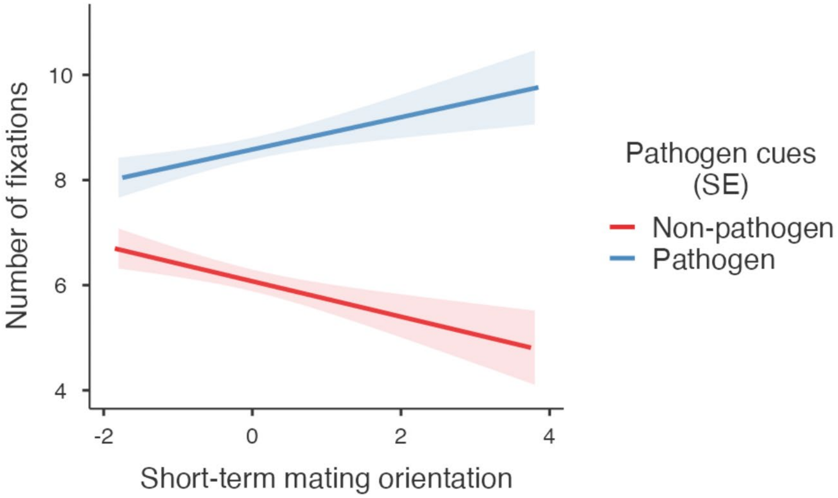

Fig. 3 The moderating role of short-term mating orientation on number of fixations to pathogen cues

[-39.25, 0.372], p=.10), perceived vulnerability to disease (b=0.68, SE=0.87, 95%CI [-1.03, 2.39], p=.43), and short-term mating orientation (b=−0.25, SE=0.96, 95%CI [-2.15, 1.64], p=.79), were not significant. The interactions between the mating prime and pathogen cues (b=37.77, SE=30.86, 95%CI [-27.71, 98.26], p=.22), short-term mating orientation and pathogen cues (b=−0.04, SE=1.37, 95%CI [-2.73, 2.64], p=.97), pathogen disgust and pathogen cues (b=22.16, SE=15.50, 95%CI [-8.22, 52.54], p=.15), and perceived vulnerability and pathogen cues (b = -1.38, SE=1.23, 95%CI [-3.80, 1.03], p=.26), were not significant.

Number of Fixations

There was a significant main effect of pathogen cues on number of fixations (b=2.51, SE=0.29, 95%CI[1.93, 3.07], p<.001). Participants made more visual fixations to pathogen cues (M=8.58, SE=0.25) compared to non-pathogen cues (M=6.09, SE=0.16), see Fig. 2b. There were no significant main effects for mating prime (b=−0.14, SE=0.29, 95%CI [-0.71, 0.42], p=.62), pathogen disgust (b=−0.08, SE=0.14, 95%CI [-0.37, 0.31], p=.59), perceived vulnerability to disease (b=−0.008, SE=0.01, 95%CI [-0.03, 0.01], p=.49), or short-term mating orientation (b=−0.05, SE=0.12, 95%CI [-0.17, 0.28], p=.63). There was a significant interaction between short-term mating orientation and pathogen cues (b=0.74, SE=0.23, 95%CI [0.27, 1.21], p=.002), see Fig. 3. The interaction was significant at -1SD from the mean (b=1.58, SE=0.41, 95%CI [0.75, 2.40], p<.001), the mean (b=2.50, SE=0.29, 95%CI [1.92, 3.08], p<.001), and at +1SD from the mean (b=3.43, SE=0.41, 95%CI [2.60, 4.25], p<.001). Participants' short-term mating orientation was positively associated with visual fixations to pathogen cues. The interactions between mating prime and pathogen cues (b=−0.08, SE=0.58, 95%CI [-1.23, 1.05],

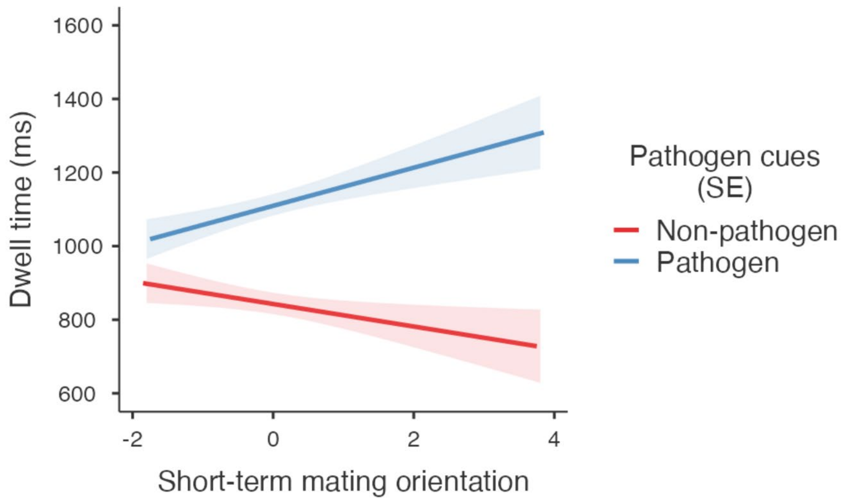

Fig. 4 The moderating role of short-term mating orientation on dwell time to pathogen cues

p=.87), pathogen disgust and pathogen cues (b=−0.05, SE=0.29, 95%CI [-0.64, 0.53], p=.85), and perceived vulnerability and pathogen cues (b=−0.03, SE=0.02, 95%CI [-0.08, 0.007], p=.10) were not significant.

Dwell Time

A significant main effect of pathogen cues on dwell time (b=267.85, SE=41.11, 95%CI [187.26, 348.45], p<.001) revealed that pathogen cues were viewed longer (M=1112.17, SE=26.50) than non-pathogen cues (M=844.17, SE=33.73), see Fig. 2c. The main effects for mating prime (b = -16.30, SE=41.14, 95%CI [-96.95, 64.33], p=.69), pathogen disgust (b=1.74, SE=20.97, 95%CI [-39.35, 42.84], p=.93), perceived vulnerability (b=1.06, SE=1.65, 95%CI [-2.18, 4.31], p=.52, and short-term mating orientation (b=10.19, SE=17.68, 95%CI [-24.06, 45.26], p = .55), were not significant. There was a significant interaction between short-term mating orientation and pathogen cues (b=100.35, SE=33.38, 95%CI [34.91, 166.79], p=.003), see Fig. 4. The interaction was significant at -1SD from the mean (b=143.33, SE=58.33, 95%CI [27.97, 285.73], p=.01), the mean (b=267.84, SE=41.13, 95%CI [187.29, 349.50], p<.001), and at +1SD from the mean (b=390.32, SE=58.49, 95%CI [277.02, 507.66], p<.001). Participants' short-term mating orientation was positively associated with a longer viewing time to pathogen cues. The interactions between mating prime and pathogen cues (b=37.08, SE=82.29, 95%CI[-124.20, 198.37], p=.65), pathogen disgust and pathogen cues (b = -11.65, SE=41.94, 95%CI [-93.86, 70.54], p=.78), and perceived vulnerability and pathogen cues (b = -4.30, SE=3.34, 95%CI [-10.85, 2.24], p=.19) were not significant.

Exploring Possible Sex Differences

Previous research has found that there are sex differences in disgust responses (Al-Shawaf & Lewis, 2013; Al-Shawaf et al., 2016, 2015; Curtis et al., 2004; Tybur et al., 2012). Although we did not have any a priori predictions regarding sex differences and visual attention to pathogen cues as a function short-term mating orientation, we ran separate LME models split by sex in predicting first fixation durations, number of fixations, and dwell time. There were no significant difference in first fixation durations as a function of short-term mating orientation for men (b = -2.15, SE=2.45, 95%CI [-6.97, 2.66], p=.38) and women (b=0.25, SE=1.42, 95%CI [-2.54,, 3.05], p=.85). For number of fixations, there was a significant interaction between short-term mating orientation and pathogen cues in women (b=0.85, SE=0.29, 95%CI[0.28, 1.41], p=.004), whereas for men, the interaction was not significant (b=0.49, SE=0.43, 95%CI [-0.34, 1.34], p=.25). A similar relationship was revealed for dwell time. For women, the interaction between short-term mating orientation and pathogen cues was significant (b=135.17, SE=41.52, 95%CI [53.79, 216.54], p=.002). Women's short-term mating orientation was associated with longer viewing time to pathogen cues. For men, the interaction between short-term mating orientation and pathogen cues was not significant (b=23.35, SE=56.79, 95%CI [-87.96, 134.68], p=.68).

Discussion

In the current study, we examined if a short-term mating prime and individual differences in short term-mating (i.e., SOI) would predict visual attention to pathogen cues. We tested if short-term mating, whether primed or dispositional, would inhibit attention to pathogen related cues resulting in lower viewing time. We found that participants viewed images containing pathogen cues longer than non-pathogen cues. With respect to the role of mating psychology, the short-term mating prime did not have an effect on visual attention to pathogen related cues. However, individual differences in short-term mating orientation were associated viewing time, with a stronger short-term mating orientation predicting greater viewing time for pathogen cues. Individual differences in pathogen disgust and perceived vulnerability did not predict visual attention to pathogen related cues.

These findings demonstrate that individuals attend more to pathogen-salient compared to non-pathogen salient information. This was shown in looking behavior (number of fixations) and overall attention (dwell time). This bolsters the notion that pathogen cues represent a threat and that attending to that threat may provide individuals with a means to prepare or respond to such stimuli. It has been suggested that attending to threatening information is an automatic and mandatory response (Schmidt et al., 2016), which is an evolved mechanism to be able to monitor threating situations (Belopolsky et al., 2011). For instance, individuals display more visual attention when given a signal that indicates a threatening situation (i.e., signaling a shock) (Nissens et al., 2017) or angry facial expressions (Belopolsky et al., 2011). Individuals also orient their eye movements to threatening stimuli even when instructed to attend to other visual stimuli (Schmidt et al., 2015). Although it has often been suggested that attending to threatening stimuli is automatic, we did not find that individuals automatically attended to pathogen cues first compared to non-pathogen cues, as we found that first fixation durations were longer for non-pathogen cues. Visual measurements, such as first fixation durations, are supposed to capture automatic responses to a stimulus at the onset of presentation (Conklin et al., 2018). Perhaps pathogen cues represent a stimulus that requires intentional visual processing to determine whether or not the pathogen represents immediate threat based on our experience with a type of pathogen exposure (i.e., mucus running down a person's face).

The mating prime was not associated with attention to pathogen cues. This finding suggests that experimentally inducing short-term mating through a hypothetical mating prompt does not downregulate one's attention to pathogen cues. There was a positive association between individual differences in short-term mating and visual attention (i.e., number of fixations, dwell time) to pathogen cues. Contrary to our expected predictions, individuals with a propensity to engage in uncommitted sexual encounters did not show reduced attention to viewing pathogen cues. The reasons for this finding are unclear. One possibility is that people with stronger short-term mating orientation, who often have lower disgust, can afford to look at pathogens more closely or for longer without being as strongly affected as their more easily disgusted counterparts. Considering that individuals with a short-term mating orientation prioritize partners with putative indicators of high-quality genes (Buss & Schmitt, 1992), they may be attentive to cues that indicate a higher level of pathogen presence in order to choose the best fit mate and avoid unfit partners. Interestingly, this relationship was seen in the sample of women. Research has shown that women are more easily disgusted than men, on average (Al-Shawaf & Lewis, 2013; Al-Shawaf et al., 2016, 2015; Curtis et al., 2004; Tybur et al., 2012). Since women may suffer greater costs (e.g., the possibility of passing an infection on to dependent offspring) in contracting pathogens, they may be more attentive to pathogen related information when engaging in short-term mating behaviors. Compared to males, females have a greater minimum obligatory parental investment and incur a greater cost in in mating decisions (Trivers, 1972). Therefore, displaying a heightened attentional response to potentially threating cues may be an adaptive response for women who are oriented toward uncommitted sexual behaviors. Conversely, individuals with a lower short-term mating orientation (i.e., more restricted sociosexuality) were less likely to view pathogen cues. This may suggest that individuals who are less likely to engage in uncommitted sexual behaviors or pursue multiple sexual opportunities are more likely to avoid pathogen cues and avoid looking at them. Individuals with a lower propensity for short-term mating are more likely to report higher levels of disgust (Al-Shawaf et al., 2015), and this may result in them looking away from disgusting stimuli. These interpretations should be taken with caution, as they are preliminary and need to be replicated in addition to testing alternative explanations. Finally, individual differences in pathogen disgust and perceived vulnerability were not associated with greater attention to pathogen cues. Previous research has suggested that individuals who report higher disgust and feel more vulnerable to disease have a heightened response system (Safra et al., 2021), making them more vigilant and aware of threat-related stimuli (Mahkanova & Shepard, 2020), such as pathogen cues. However, in the present study, the two measures of trait-level pathogen avoidance were not associated with differences in the amount of attention paid to pathogen cues.

Overall, these findings show that individuals display more attention to pathogen-related cues compared to non-pathogen cues. This finding is in line with the general principle that humans have evolved cognitive mechanisms that are designed to detect recurrent adaptive threats, including avoiding pathogens. Detecting pathogen-related information in an environment would have been beneficial throughout ancestral conditions, and it is still important in modern times. The cognitive mechanisms that are involved, such as attention, help individuals make assessments of the potential threat, and perhaps may influence decision making systems.

There are several limitations to this study. First, The mating prime, which consisted of asking participants to imagine themselves in a hypothetical scenario, may not have been an effective mating prime manipulation. It is possible that a stronger or more ecologically valid mating manipulation may inhibit disgust more effectively – consequently, using other mating manipulations (i.e., images, videos) is warranted. Second, our sample represents another limitation – for this methodologically intensive eye-tracking study, we relied primarily on a sample of WEIRD university students. Curtis et al. (2004) showed that disgust sensitivity declines with age, therefore, it is important to attempt to replicate these findings with older adults and with participants from different cultures. However, Raifee et al. (2022) did not find any evidence for age-related declines in pathogen disgust. Third, in this study we only tested the role of short-term mating and its association with viewing pathogen cues. It is possible that priming pathogen cues may reduce interest in short-term mating opportunities, and this may be dependent on one's dispositional short-term mating orientation. Perhaps an eye-tracking study with separate blocks testing each mechanism (short-term mating – pathogen cues, pathogen cues – short-term mating) can help clarify those relationships. Fourth, this study was conducted at the onset of Covid-19 infections. It is possible that disgust sensitivity was heightened due to rising infections, which may have increased pathogen cue attention. Finally, this study shows that those with a stronger short-term mating orientation attend to pathogens longer, but it remains to be seen whether those with a stronger *long*-term mating orientation display similar or different attentional response systems (STM and LTM orientation appear to be two different constructs and not merely opposite ends of the same continuum; see Jackson & Kirkpatrick, 2007). This represents a useful future direction for researchers interested in the relationship between mating orientation, disgust, and how this connection may manifest itself through attention to visual stimuli.

Conclusion

The findings in this study provide evidence of the visual salience of pathogen related information. By using an eye-tracking paradigm, we found that individuals are more likely to attend and look more frequently at stimuli that included pathogen cues. These findings may provide some insight into the cognitive mechanisms (i.e., attention) involved in processing pathogenic cues.

Authors' Contributions R.G. and L.A.S. contributed to the study conception and design. Material preparation, data collection and analysis were performed by [RG]. The first draft of the manuscript was written by [RG, FP, LAS, and JBC] and all authors commented on previous versions of the manuscript. R.G. and F. P. prepared all figures. All authors read and approved the final manuscript.

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Data Availability Data can be made available upon request to the corresponding author.

Declarations

Ethical Approval All participants provided consent to participate in the study. The study was approved by the institutional review board at Oklahoma State University, Study # IRB-20-94.

Competing Interests The authors declare that there are no competing interests.

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Authors and Affiliations

Ray Garza[1] · Farid Pazhoohi[2] · Laith Al-Shawaf[3] · Jennifer Byrd-Craven[4]

✉ Ray Garza
ray.garza@tamiu.edu

Farid Pazhoohi
pazhoohi@gmail.com

Laith Al-Shawaf
lalshawa@uccs.edu

Jennifer Byrd-Craven
jennifer.byrd.craven@okstate.edu

1 Department of Psychology and Communication, Texas A&M International University, 5201 University Blvd, 78041 Laredo, TX, USA

2 Department of Psychology, University of British Columbia, 2136 West Mall, V6T 1Z4 Vancouver, BC, Canada

3 Department of Psychology, University of Colorado- Colorado Springs, 1420 Austin Bluffs Pkwy, Colorado Springs, 80918 Colorado Springs, CO, USA

4 The Oklahoma Center for Evolutionary Analysis (OCEAN), Oklahoma State University, 116 Psychology Building, 74078 Stillwater, OK, USA