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Pathogen Disgust Sensitivity: More Sensitive Cue Detection or Stronger Cue Avoidance?

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Abstract

Humans differ in their tendency to experience disgust and avoid contact with potential sources of pathogens. Pathogen disgust sensitivity has been used to explain a wide range of social phenomena, such as prejudice, conformity, and trust. Yet, its exact role in the motivational system that regulates avoidance of pathogens, the so-called behavioral immune system, remains unclear. Here, we test how individual differences in pathogen disgust sensitivity relates to the information processing structure underlying pathogen avoidance. Participants (n = 998) rated the perceived health of individuals with or without facial blemishes and indicated how comfortable they would feel about having physical contact with them. Participants with high disgust sensitivity viewed facial blemishes as more indicative of poor health. Moreover, for participants with high disgust sensitivity, perceived health was a stronger determinant of comfort with physical contact. These findings suggest that increased pathogen disgust sensitivity captures tendencies to more readily interpret stimuli as a pathogen threat *and* be more strongly guided by estimated infection risk when deciding who should be approached or avoided. This supports the notion that pathogen disgust sensitivity is a summary of investment in pathogen avoidance, rather than just an increased sensitivity to pathogen cues.

Keywords: disgust sensitivity; pathogen avoidance; individual differences; behavioral immune system; pathogen disgust

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1. Introduction

In addition to a physiological immune system that affords resistance and tolerance to pathogens, humans also have a behavioral immune system that motivates avoidance of pathogens (e.g., Ackerman et al., 2018; Schaller, 2015; Tybur & Lieberman, 2016; Gangestad & Grebe, 2014). How does this system operate? At least three features of the system are fairly well established. First, the system tends to work in a better-safe-than-sorry manner (also referred to as the smoke detector principle; Nesse, 2005). It is biased toward making false-positive errors rather than false-negative errors (i.e., inferring the presence of pathogens when in fact none are present; Miller & Maner, 2012; Ryan et al., 2012), in order to avoid committing the relatively more costly error of coming into contact with potentially lethal pathogens. Second, the emotion disgust, in particular pathogen disgust (Tybur et al., 2009), is the proximate mechanism that motivates individuals to avoid potential sources of pathogens (e.g., Curtis et al., 2004; Lieberman & Patrick, 2014)[1]. Third, there are trait-like individual differences in pathogen avoidance motivations, which are commonly referred to as pathogen disgust sensitivity (e.g., Tybur & Karinen, 2018).

Several scales have been developed to measure individual differences in pathogen disgust sensitivity (e.g., Tybur et al., 2009; Duncan et al., 2009; Olatunji et al., 2007). These measures are widely used and pathogen disgust sensitivity has been evoked as a proximate explanation for various phenomena, such as social trust (Aarøe et al., 2016), social conservatism (Terrizzi et al., 2013), intergroup attitudes (van Leeuwen & Petersen, 2018), and risk taking (Sparks et al., 2019). Yet, the exact role of pathogen disgust sensitivity in the behavioral immune system remains poorly understood. As Tybur and Lieberman (2016, p. 8) concluded: "Trait-level pathogen avoidance could result from more sensitive cue detection, or it could result from strategically favoring Type I errors…relative to Type II errors…or it could result from greater pursuit of benefits of contact with pathogens (e.g., eating, mating)."

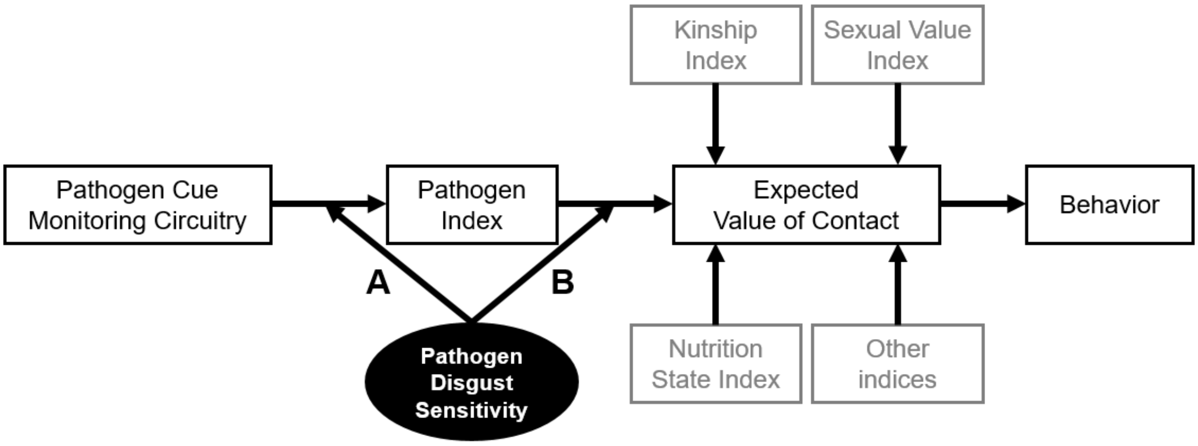
Here, we examine the role of pathogen disgust sensitivity in the information processing system underlying pathogen avoidance motivations. As a theoretical framework, we take the information processing model proposed by Tybur and Lieberman (Tybur &

[1] Disgust is sometimes described as an output of the behavioral immune system. However, when one defines an emotion as a mechanism that coordinates thoughts and behaviors towards a particular goal (Tooby & Cosmides, 1990), rather than the experience of an affective state, then the emotion pathogen disgust is equivalent to the behavioral immune system (Lieberman & Patrick, 2014). We use the term pathogen disgust to refer to the mechanism.

Lieberman; 2016). In short, they proposed that pathogen avoidance mechanisms include (1) perceptual systems that monitor the environment for cues of pathogens; (2) a pathogen presence estimator that integrates these cues and computes a pathogen index (i.e., a representation of the probability that pathogens are present); and (3) a contact value estimator that computes the expected value of contact by integrating the pathogen index with other indices relevant to contact value (e.g., genetic relatedness, potential value as a sexual partner; see Figure 1).

Figure 1

A simplified version of the information processing system underlying pathogen avoidance motivations proposed by Tybur and Lieberman (2016)



Note. The figure illustrates two possibilities for what kind of individual differences in information processing might be captured by pathogen disgust sensitivity. Pathogen disgust sensitivity might involve individual differences in weight given to pathogen cues when computing the pathogen index (arrow A). It is also possible that pathogen disgust sensitivity reflects individual differences in weight given to the pathogen index when computing the contact value index (arrow B).

Although the model proposed by Tybur and Lieberman (2016) succeeds in synthesizing previous findings on pathogen avoidance, it remains unclear how individual differences in pathogen disgust fit into this system. Based on the proposed architecture, one possibility is that pathogen disgust sensitivity reflects people’s sensitivity in detecting pathogen cues (see Figure 1, arrow A). In other words, the probability of a stimulus (e.g., a person with a cough, a banana with brown spots) being classified as a pathogen threat may be higher for people who score high on pathogen disgust sensitivity (Miller & Maner, 2012; De Barra et al., 2013). This may occur because of individual differences in abilities to detect pathogen cues, or because of individual differences in integrating information about cues when computing the pathogen index. If pathogen disgust sensitivity reflects such individual differences, then this leads to the following hypothesis: Pathogen disgust sensitivity is a moderator of the relation between the presence of (potential) pathogen cues and the estimated pathogen index (see Figure 1, arrow A). We refer to this hypothesis as the *pathogen detection hypothesis*.

A second possibility is that pathogen disgust sensitivity captures the weight placed on the pathogen index when computing the estimated value of contact (see Figure 1, arrow B). There may be individual differences in being invested in pathogen avoidance when making trade-offs about nutrition, sex, social contact, and other behaviors that pose infection risk (e.g., Tybur et al., 2017; Tybur & Lieberman, 2016). In other words, pathogen disgust sensitivity may reflect how strongly the pathogen index (compared to other indices) motivates approach-avoidance behavior. If pathogen disgust sensitivity reflects the weight given to the pathogen index, then this leads to the following hypothesis: Pathogen disgust sensitivity is a moderator of the relation between the pathogen index and the contact value index (see Figure 1, arrow B). We refer to this hypothesis as the *contact regulation hypothesis*.

Here, we test the two hypotheses. Specifically, we examine (a) whether people who score high on pathogen disgust sensitivity more readily interpret cues that could potentially indicate the presence of pathogens as an actual pathogen threat (the cue detection hypothesis) and (b) whether people who score high on pathogen disgust sensitivity are more likely to consider potential pathogen threats when deciding with whom they want to have physical contact. These two hypotheses do not reflect the only possible roles of pathogen disgust sensitivity in the information processing underlying pathogen avoidance motivations. Yet given the extant knowledge, these two hypotheses capture the most plausible roles of individual differences in pathogen avoidance. Furthermore, the two hypotheses are not mutually exclusive. It is possible that pathogen disgust sensitivity reflects both the sensitivity of the pathogen detection system *and* the extent to which detected pathogen threats regulate contact.

All data, analysis scripts, and materials are available at the Open Science Framework (https://osf.io/2zunm/).

2. Methods

Using convenience sampling, participants were recruited via three channels: (a) from the student population at a Dutch university and social media websites and participants could complete the study in either English or Dutch (*n* = 539); (b) via social media websites and participants completed the study in English (*n* = 271); and (c) via Russian social media websites and participants completed the survey in Russian (*n* = 188). Our final sample included 998 participants (M_{age} = 24.99 years, SD_{age} = 9.48; 72.95% female, 26.65% male). Participants where provided with information about the study and provided consent at the start of the survey. The study procedures were approved by the Ethics Review Board of the Tilburg School of Social and Behavioral Science.

All participant completed the study online. Participants were randomly assigned to one of two between-subject conditions. In the pathogen cue condition, participants were shown images of eight white male faces with salient pathogen cues. Images were taken from the Center for Vital Longevity Face Database (Minear & Park, 2014) and the pathogen cues were added by superimposing images of acne (Petersen, 2017). While acne is not infectious, it contains cues (inflamed skin, pus) believed to activate pathogen avoidance motivations. Previous work that included a subset of these stimuli showed that faces with these pathogen cues are perceived as less healthy (Van Leeuwen & Petersen, 2018). In the control condition participants were shown images of the same eight white male faces, but without the added pathogen cues.

For each face that was presented, participants were asked to evaluate the person in terms of comfort with contact (e.g., “How would you feel about shaking hands with the person in the picture?” rated on a 5-point scale from *very uncomfortable* to *very comfortable*) and perceived health (e.g., “How healthy does this person look?” rated on a 5-point scale from *very unhealthy* to *very healthy*). The exact wording of the questions and the number of answer options differed slightly across the three samples (see Supplementary Materials).

Later in the survey, after completing items related to other research questions, participants completed the Three-Domain Disgust Scale (TDDS; Tybur et al., 2009). The TDDS asks participants to indicate how disgusted they feel about a particular event or action. The TDDS included a subscale of seven items rated on a scale from *Not at all disgusting* (0) to *Extremely disgusting* (6) that measure pathogen disgust sensitivity (e.g., “Stepping in dog poop”, “Sitting next to a stranger who has sweaty palms”). The number of answer options differed across the three samples (see Supplementary Materials). The reliability of the scale was acceptable (Cronbach’s αs = .71, .70, and .73).

3. Results

All continuous variables were *z*-standardized prior to analysis. All analyses were performed in R (R Core Team, 2021). We used the *lme4* package (Bates et al., 2015) and the *lmerTest* package (Kuznetsova et al., 2016) to estimate multilevel regression models with random intercepts and slopes per target and participant.[2] Before testing our main hypotheses, we examined three basic predictions derived from the pathogen avoidance model by Tybur and Lieberman (2016).

First, we tested whether individuals with pathogen cues were perceived as less healthy than individuals without pathogen cues. Regressing health ratings on pathogen cue presence (-0.5 = facial blemishes absent, 0.5 = facial blemishes present) revealed a significant negative effect, β = -0.917, *SE* = 0.225, 95% CI [-1.320, -0.489], p = .004. Participants perceived individuals with facial blemishes as less healthy.

Second, we tested whether participants were reluctant to have physical contact with individuals with pathogen cues. Regressing participants' comfort with contact on pathogen cue presence (-0.5 = facial blemishes absent, 0.5 = facial blemishes present) revealed a significant negative association, β = -0.431, *SE* = 0.131, 95% CI [-0.708, -0.174], p = .009. Participants were more reluctant to have physical contact with individuals with facial blemishes.

Third, we tested whether people were more averse to physical contact with individuals who they perceived as unhealthy. Regressing participants' comfort with contact on their health ratings of targets revealed a significant positive association, β = 0.474, *SE* = 0.020, 95% CI [0.435, 0.513], $p < .001$. Participants were more comfortable with contact with individuals who were perceived as healthy and more reluctant to have contact with individuals who were perceived as unhealthy. These associations are consistent with several posited relationships in the pathogen avoidance model (Tybur & Lieberman, 2016).

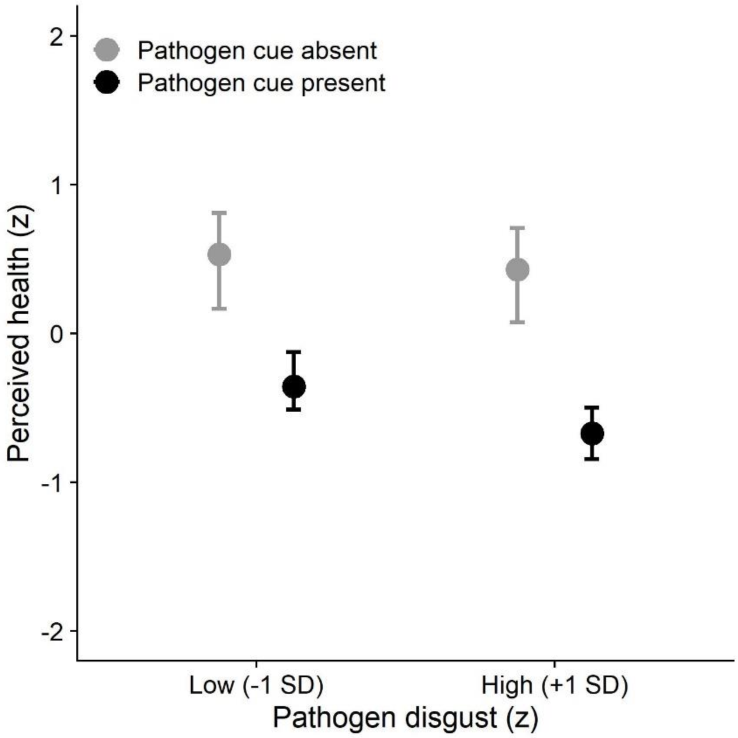
3.1 Primary analyses

Next, we examined the role of individual differences in pathogen disgust. The pathogen detection hypothesis predicts that pathogen disgust sensitivity moderates the relationship between pathogen cues (i.e., whether facial blemishes are present) and perceived health. Above, we showed that individuals with facial blemishes were perceived as less healthy. Here, we tested whether this effect was stronger for participants who score high on pathogen disgust sensitivity. We estimated a model in which we regressed health ratings on pathogen cue presence (-0.5 = facial blemishes absent, 0.5 = facial blemishes present), pathogen disgust sensitivity, and their interaction. This revealed a significant interaction

[2] We first ran all analyses with a maximal random effects structure (Barr et al., 2013) that also included random effects per sample. However, many models failed to converge as the variance that was explained by sample-specific intercepts and slopes was near zero. We therefore omitted sample-specific random effects from our models.

effect, β = -0.103, *SE* = 0.036, 95% CI [-0.183, -0.029], *p* = .005 (see Figure 2). Individuals with facial blemishes were perceived as less healthy and this effect was stronger for participants who scored high (i.e., one standard deviation above the mean) on pathogen disgust sensitivity, β = -1.159, *SE* = 0.224, 95% CI [-1.620, -0.680], *p* < .001, compared to participants who scored low (i.e., one standard deviation below the mean) on pathogen disgust sensitivity, β = -0.826, *SE* = 0.226, 95% CI [-1.252, -0.350], *p* = .004. Thus, the current data support the pathogen detection hypothesis.

Figure 2
The effect of pathogen cues on the perceived health of targets as a function of participants' pathogen disgust sensitivity

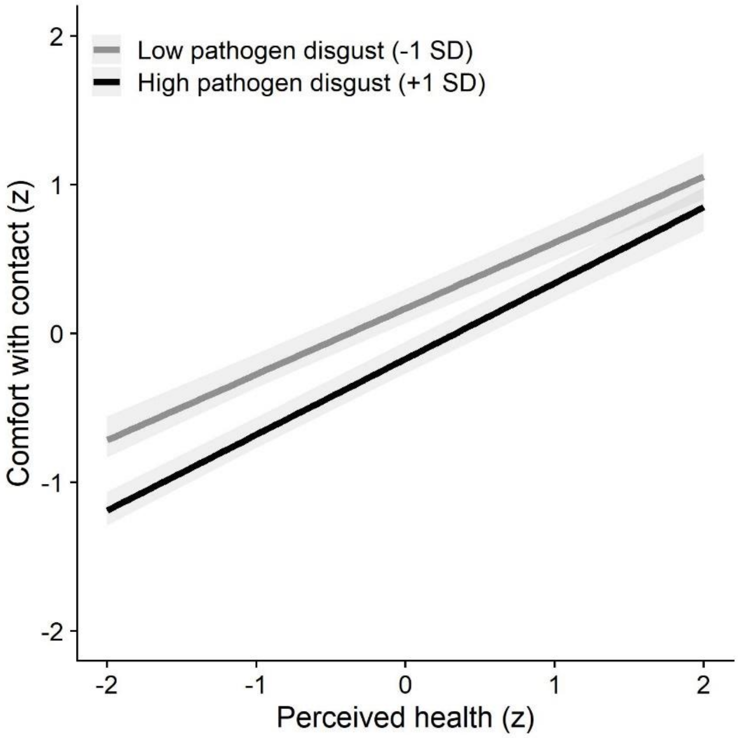


We then tested the contact regulation hypothesis. If pathogen disgust sensitivity reflects an increased weight given to the pathogen index when computing the value of contact, then we should find that pathogen disgust sensitivity moderates the relationship between perceived health and comfort with physical contact. Above we showed that there was a positive association between perceived health and comfort with contact. Here, we tested whether this positive association was stronger for participants who scored high on pathogen disgust sensitivity. We estimated a model in which we regressed comfort with contact ratings on perceived health, pathogen disgust sensitivity, and their interaction. This revealed a significant interaction effect, β = 0.032, *SE* = 0.012, 95% CI [0.007, 0.054], *p* =

.006 (see Figure 3). Participants were more comfortable with having physical contact with individuals that were perceived as more healthy and this association was stronger for participants who scored high (i.e., one standard deviation above the mean) on pathogen disgust sensitivity, $\beta = 0.485$, $SE = 0.022$, 95% CI [0.440, 0.534], $p < .001$, compared to participants who scored low (i.e., one standard deviation below the mean) on pathogen disgust sensitivity, $\beta = 0.413$, $SE = 0.030$, 95% CI [0.356, 0.471], $p < .001$. Thus, the current data also support the contact regulation hypothesis.

Figure 3

The association between perceived health and participants' comfort with contact as a function of participants' pathogen disgust sensitivity



3.2 Robustness checks

To test the robustness of these results, we examined whether our primary findings still emerged when controlling for the sex and age of participants. Two participants did not disclose their sex, six participants did not disclose their age, and two participants did not disclose either, which means that the current analyses were based on a sample of 988 participants. For the pathogen detection hypothesis, we again estimated a model in which we regressed health ratings on pathogen cue, pathogen disgust sensitivity, and their interaction, while also including sex (0 = female, 1 = male) and age in the model. There was a negative effect of sex, $\beta = -0.209$, $SE = 0.041$, 95% CI [-0.285, -0.128], $p < .001$, and a positive effect of age, $\beta = 0.007$, $SE = 0.002$, 95% CI [0.003, 0.010], $p < .001$, showing that female participants and older participants perceived targets as less healthy. Moreover, the interaction effect between pathogen cue presence and pathogen disgust sensitivity remained significant and the effect size was similar, $\beta = -0.102$, $SE = 0.036$, 95% CI [-0.168, -0.033], $p = .004$.

For the contact regulation hypothesis, we again estimated a model in which we regressed comfort with contact ratings on perceived health, pathogen disgust sensitivity, and their interaction, while also including sex (0 = female, 1 = male) and age in the model. There was no significant effect of sex, $\beta = 0.016$, $SE = 0.045$, 95% CI [-0.078, 0.111], $p = .724$, but a positive effect of age, $\beta = 0.006$, $SE = 0.002$, 95% CI [0.002, 0.009], $p = .006$, showing that older participants were less comfortable with having physical contact with targets. More importantly, the interaction effect between perceived health and pathogen disgust sensitivity remained significant and the effect size was similar, $\beta = 0.030$, $SE = 0.012$, 95% CI [0.007, 0.049], $p = .010$. In short, we still found support for both hypotheses when controlling for participant sex and age.

4. Discussion

How do humans avoid pathogens? The pathogen avoidance model proposed by Tybur and Lieberman (2016) synthesizes an extensive literature on this topic to outline the information processing system underlying human pathogen avoidance. In the present study, we aimed to extend this model by examining two plausible (not mutually exclusive) roles of individual differences in pathogen disgust in this system.

First, we tested the *pathogen detection hypothesis*—the idea that people who score high on pathogen disgust are more sensitive in classifying cues as pathogen threats. The current study yielded support for this hypothesis. We found that individuals with facial blemishes were perceived as less healthy. More importantly, this relationship was moderated by the pathogen disgust sensitivity of perceivers. Thus, the same pathogen cues were interpreted as a stronger evidence of infectiousness by participants who scored high on pathogen disgust sensitivity.

Second, we tested the *contact regulation hypothesis*—the idea that people who score high on pathogen disgust put more weight on the pathogen index (i.e., the estimated probability that an individual poses an infection risk) when deciding who should be approached or avoided. The current study also yielded support for this hypothesis. Participants felt more comfortable with having physical contact with individuals when they were perceived as healthier. Again, this relationship was moderated by participants' pathogen disgust sensitivity. Thus, when deciding whether an individual should be approached or avoided, participants who scored high on pathogen disgust sensitivity were more influenced by their perceptions of health.

In the current study, we also replicated several basic assumptions of the pathogen avoidance model by Tybur and Lieberman (2016). Participants perceived individuals with facial blemishes, which could indicate the presence of an infectious disease, as less healthy and were more reluctant to have physical contact with them. We also found a strong positive relationship between perceived health and comfort with contact, showing that participants were more motivated to avoid physical contact with individuals when they perceived them as unhealthy. While the current results confirmed these basic premises, they also extend the pathogen avoidance model by Tybur and Lieberman (2016) by showing how individual differences influence the information processing underlying pathogen avoidance motivations. In short, we found that people who are chronically concerned about pathogens (a) more readily interpret stimuli as a pathogen threat and (b) are more likely to be guided by pathogen concerns when deciding who should be approached or avoided.

4.1 Limitations and Future Directions

Our study was based on several assumptions. First, we measured both the contact value index and the pathogen index with self-report scales. Previous work suggests that self-reports of comfort with physical contact provide a measure of the contact value index (with higher comfort reflecting a higher contact value index) and that self-reports of perceived health provide a measure of the pathogen index (with lower perceived health reflecting a higher value for the pathogen index; Van Leeuwen & Petersen, 2018; Tybur et al., 2020). Second, we assumed that facial blemishes resembling acne are perceived as a pathogen cue, so that faces with such blemishes are on average assigned a higher value on the pathogen index (and hence are evaluated as less healthy by perceivers). Previous work suggests that this assumption is plausible (Curtis et al., 2004; Jaeger et al., 2018; Van Leeuwen & Petersen, 2018).

Our study provides the first evidence on how individual differences shape the information processing underlying pathogen avoidance. We tested our hypotheses in the context of interpersonal contact because many pathogens are transmitted via human-to-human contact and estimating the risk of an individual being infectious is likely one of the primary tasks the human pathogen avoidance system has evolved to perform (Axelsson et al., 2018; Regenbogen et al., 2017). Yet, humans encounter many other potential sources of pathogens (e.g., rotten food, dead animal bodies, bodily fluids) and more work is needed to confirm that pathogen disgust sensitivity regulates avoidance of these hazards in the same way as it regulates avoidance of other humans.

Future studies should also examine how well the current results generalize across different countries and cultures. Our samples included participants from both the Netherlands and Russia and in all our statistical models, the variance explained by sample-specific random effects was close to zero. In other words, we found no evidence that, for example, the effect of pathogen cues on perceived health and comfort with physical contact varied across the samples. Still, the current study was not explicitly designed to test for cultural differences and more systematic work is required.

4.2 Conclusion

In sum, the current study provides insights into how individual differences in pathogen disgust regulate the information processing underlying pathogen avoidance motivations. Our results provide evidence for two complementary roles. Our results suggest that people who score high on pathogen disgust sensitivity more readily interpret cues that could potentially indicate the presence of pathogens as an actual pathogen threat. That is, they are more sensitive in detecting pathogen threats. At the same time, people who score high on pathogen disgust sensitivity place more weight on potential pathogen threats when deciding whether they want to have physical contact. That is, their approach-avoidance tendencies are more informed by pathogen concerns.

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