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RESEARCH ARTICLE

Functional Heuristics of Disease Transmission from Physical Deformities in Food Preferences

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Abstract

Ostensibly serving to restrict contact with disease vectors, humans exhibit aversion toward cues heuristically inferred as pathogenic. This restriction could lead perceivers to downregulate their interest in food consumption, even if such cues may not connote actual disease threats. This proclivity to avoid disease led us to consider how heuristic disease cues inform interest in foods. Participants evaluated a hypothetical food preparer that varied in the presence of heuristic cues to disease transmission (i.e., physical deformities versus healthy control). Individuals with low levels of perceived infectability were more discerning of the social target as a function of disease cues, whereas heightened levels of this trait fostered an overall aversion to targets regardless of health status. Results provide continued evidence for how pathogen avoidance motives compete with other somatic motives.

Keywords Appetite · Behavioral immune system · Stigma · Prejudice · Disgust

Human survival relies on the successful navigation of competing motivational states. These states are frequently in conflict with each other and require vigilance toward threatening social stimuli (Kenrick et al., 2010; Neuberg et al., 2011). One potential stimulus toward which perceivers often exercise extensive judiciousness is food. Many pathogenic threats are visible in food that elicit disgust (e.g., mold, fungus; Hoefling et al., 2009), whereas additional threats are less visible (e.g., microbes). Perceivers could ultimately use visible heuristics of disease transmission to track the potential contamination of food, even if these heuristics are not diagnostic of actual contamination (e.g., Al-Shawaf et al., 2015; Klaczynski, 2008; Rozin & Nemeroff, 2002).

From an error management perspective (Haselton & Nettle, 2006), erroneously engaging actual disease threats would impose considerable fitness costs than erroneously avoiding targets posing no threat. This could result in aversion toward food with the impression that they connote an actual risk of infection despite a lack of more veridical evidence. Heuristic disease cues include anomalous physical features to which perceptual systems calibrate based on cultural information (e.g., Ackerman et al., 2009; Makhanova et al., 2022). Perceivers with heightened concerns of disease threat could view these features as a source of contamination, a widely identified aversion to anomalous features among those with a chronically heightened motivation to avoid disease (e.g., Makhanova et al., 2015; Murray & Schaller, 2012; Young et al., 2011). This study investigates how heuristic cues to disease foster aversion to food, particularly as a function of individual differences in pathogen avoidance.

Disease Avoidance and Social Perceptions

Organisms have sophisticated responses to disease threats. This response contains both innate (e.g., cellular barriers) and adaptive subsystems (e.g., antigenic responses) affording multilayered defenses against infections (Litman et al., 2005; Pancer & Cooper, 2006). However, these physiological responses are metabolically costly and require major caloric expenditure. Humans increase their metabolic activity by 13% to raise their body temperature by 1 °C (Kluger, 1991). These responses divert metabolic resources from physiological systems that promote competing fitness-enhancing behaviors (e.g., eating, mating) to address more immediate physical threats. In complement to physiological

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responses to disease, a behavioral immune system appears to have evolved to facilitate prophylactic responses. This system involves the identification and avoidance of disease vectors preemptively to reduce infection, rendering upregulation of metabolically physiological responses unnecessary (Murray & Schaller, 2016).

Within this behavioral immune system are affective and behavioral responses to disease threats. One well-documented response is disgust toward potentially contaminated food (Al-Shawaf et al., 2015; Hoefling & Strack, 2010; Kupfer & Fessler, 2018). The risk of disease transmission through interpersonal contact suggests this avoidance could mitigate disease transmission (Hoang et al., 2019; Jones et al., 2008). This aversion should be especially apparent when people have affiliative opportunities with others unlikely to transmit the disease (Brown et al., 2021a). Both acute salience of disease and heightened levels of pathogen avoidance motives on a dispositional level foster aversive responses. Responses include interpersonal reticence (Brown & Sacco, 2016; Mortensen et al., 2010; Tybur et al., 2020), aversion to physical contact (Brown & Sacco, 2020, 2022; Brown et al., 2021b; Makhanova & Shepherd, 2020; Murray et al., 2017), and disinterest in socialization (Sacco et al., 2014; Sawada et al., 2018).

Disease Avoidance in Food Domains

As pathogenic threats restrict interpersonal behavior, social groups could benefit from enacting rigid norms to mitigate disease transmission. Within these norms could be dietary customs based on heuristic disease concerns. Cultures in geopolitical regions with historically greater disease prevalence adopt restrictive social norms (Schaller & Murray, 2008), even if norms do not actually reduce disease transmission (e.g., discouraging left-handedness; Murray et al., 2011). Both acute and chronic disease concerns heighten derogation toward nonconforming group members whose behavior appears pathogenic (Lund & Miller, 2014; Murray & Schaller, 2012). Such reticence would function to codify social norms ostensibly necessary for cleanliness (e.g., purity rituals), particularly among those with naturally heightened pathogen concerns (Makhanova et al., 2019). Deviation from food hygiene norms could increase a social group's risk of infection (Wormley & Varnum, 2023).

Reticent dietary norms could be a psychological design feature to reduce foodborne disease transmission (Fessler, 2002). Omnivorous species exhibit neophobia to novel food heuristically associated with disease transmission (e.g., Visalberghi et al., 2002). Humans exhibit a similar aversion as a disgust response (Navarrete & Fessler, 2003), especially considering the pervasiveness of foodborne illnesses through interpersonal contact (Todd et al., 2007; Trestle et al., 2008). Awareness of heuristic cues to disease could present similar functions, including anomalous physical features regarded as pathogenically threatening despite a lack of contagion (Klaczynski, 2008; Park et al., 2007; White et al., 2014). Dispositional pathogen concern is additionally associated with heightened wariness toward these cues (Maner & Miller, 2012). These heuristic associations between contamination and anomalous appearances could lead to disgust toward those with physical contact with food items.

Current Research

We conducted an experiment investigating the interplay between disease avoidance motives and interest in food based on the presence of heuristic cues of disease threat. We predicted that heuristic disease cues would foster aversion to food preparers with physical deformities, given the wariness individuals demonstrate toward such features (Ackerman et al., 2009; van Leeuwen & Petersen, 2018). Given previous research suggesting that chronic activation of pathogen avoidance motives fosters such aversion (e.g., Brown et al., 2019a, b; Makhanova et al., 2015; Murray & Schaller, 2012; Park et al., 2007), chronically heightened pathogen avoidance motives should heighten this response.

Method

Participants

We recruited 335 participants from a large public university in the Southeastern USA. Twenty-two participants were excluded from final analyses for failing a single attention check item, resulting in a final sample of 313 (206 women, 104 men, 3 undisclosed; $M_{Age} = 18.85$, $SD = 1.34$; 85.3% White). A statistical sensitivity analysis in G*Power indicated that we had sufficient power to test for small effects for a basic between-subjects experimental design that includes the two candidate moderators comprising our individual difference measure of disease avoidance (Cohen's $f = 0.16$, $1\text{-}\beta = 0.80$; Faul et al., 2007).

Materials and Procedure

Disease Avoidance Motives

Participants reported dispositional motivations to avoid disease using the perceived vulnerability to disease scale (PVD; Duncan et al., 2009). This 15-item measure consists of two subscales assessing perceived infectability (PI; $M_{Grand} = 3.54$, $SD = 1.15$; $\alpha = 0.87$) and germ aversion (GA;

$M_{Grand} = 3.77$, $SD = 0.92$; $\alpha = 0.69$) along 7-point scales (1, *Strongly Disagree*; 7, *Strongly Agree*). Both subscales correlated with each other, although the degree of correlation suggests that they remain distinct from each other ($r = 0.24$, $p < 0.001$). Much like previous research showing their distinctiveness (e.g., Brown & Sacco, 2016; Makhanova et al., in press), we consider them separately in the resulting model.

Social Targets

We presented an image of a White male face to represent a hypothetical cook at a restaurant named James. Importantly, this target appeared to differ in health status on a between-subjects basis. The target was presented with several notable deformities ($n = 161$) or as a healthy control ($n = 152$). Both versions of the target were presented as a series of slides in a presentation that first introduced the cook with a singular facial image, followed by information on separate slides about where he works and an example of what he cooks. Finally, participants saw an image of the cook's hand to provide a greater context of his physical appearance.

The first and last slides were critically different from each other as cues to disease versus a control condition, whereas the other slides were the same across conditions. For the physical deformity condition, participants viewed a version of the target with deformities that had large facial rashes that would heuristically implicate the target as diseased, although the potential infection risk afforded by this target was relatively ambiguous (Petersen, 2017). In this condition, we presented an image of his hand to have syndactyly, a birth deformity with increased webbing between fingers to conjoin them. Our decision to use both cues to deformity was to amplify the overall signal value of an estimated disease vector in a person despite neither cue being diagnostic of actual disease transmissibility.

The control target appeared physically healthy and had no rashes. We used a similar negatively valanced control image. We presented an image of the target's hand in a brace after spraining his wrist from slipping on ice from the year prior while indicating a full recovery. This methodological decision aligned with previous research using injuries as a control condition to match the negative valence of disease without activating disease concerns that deformities elicit (e.g., Murray et al., 2019; Sacco et al., 2014; White et al., 2013). Participants evaluated the target's perceived health as a manipulation check (1, *Very Unhealthy*; 7, *Very Healthy*; Brown & Sacco, 2018). See Fig. 1.

Evaluations

Participants evaluated the target using eight items assessing the target in relation to his role at a restaurant. Items operated along 7-point scales aggregated into a composite representing favorability, given the high degree of reliability items had (1, *Not at All*; 7, *Very Much*; $\alpha = 0.91$, $M_{Grand} = 5.19$, $SD = 1.16$). Table 1 provides a list of the items.

Results

Perceived Health

We used a one-way custom ANCOVA using condition (deformity vs. control) as a between-subjects factor. GA and PI were entered into the model as moderators to test for interactive effects within the same model. A condition main effect indicated the deformed target appeared less healthy ($M = 4.68$, $SD = 1.27$) than the control target ($M = 5.22$, $SD = 1.03$), $F(1, 307) = 5.32$, $p = 0.022$, $\eta_p^2 = 0.017$.

Effects were most superordinately qualified by a condition × PI interaction, $F(1, 307) = 6.66$, $p = 0.010$, $\eta_p^2 = 0.021$ (Fig. 1). We decomposed the significant interaction with subordinate floodlight analyses at low levels (−1 *SD*) and high levels of PI (+ 1 *SD*) within the omnibus analyses. The deformed target appeared less healthy than the healthy target at low PI, $b = 0.86$, $SE = 0.18$, $t = 4.70$, $p < 0.001$. No difference emerged at high PI, $b = 0.18$, $SE = 0.18$, $t = 1.00$, $p = 0.318$. Viewed another way, PI predicted worse

Fig. 1 Facial image presented of target person for control (left) and deformity conditions

Table 1 Items comprising the evaluation scale for the target

Scale items
I would find a meal cooked by James to be appetizing
I would feel completely comfortable eating something prepared by James
If I knew James was working in the kitchen of a restaurant, I would be a regular customer
I would want to eat a meal prepared by James
I feel like I would lose my appetite if I knew James prepared my meal.*
If I saw James touching my food, I would be upset.*
If I saw James touching my food, I would be disgusted.*
If I owned a restaurant, I would want to hire James

*The item being reverse-scored

evaluations of the control target, $b = -0.18$, $SE = 0.07$, $t = -2.48$, $p = 0.013$. The association for the deformed target was not significant, $b = 0.08$, $SE = 0.07$, $t = 1.17$, $p = 0.241$. No other main effects or interactions emerged ($ps > 0.191$).

Primary Analysis

We employed a similarly dimensioned ANCOVA for our primary analysis addressing favorability toward the target. The GA main effect was significant, $F(1, 307) = 4.79$, $p = 0.029$, $\eta_p^2 = 0.015$. Bivariate correlations indicated GA was associated with marginally less favorability toward the target ($r = -0.10$, $p = 0.059$).

Effects were most superordinately qualified by a condition × PI interaction, $F(1, 307) = 14.87$, $p < 0.001$, $\eta_p^2 = 0.046$ (Fig. 2). At low PI, participants evaluated the control target more favorably than the deformed target, $b = 0.60$, $SE = 0.18$, $t = 3.34$, $p = 0.001$. No difference emerged for high-PI participants, $b = -0.33$, $SE = 0.18$, $t = -1.81$, $p = 0.071$. For the deformed target, PI was unexpectedly associated with greater favorability, $b = 0.19$, $SE = 0.07$, $t = 2.78$, $p = 0.006$. PI was negatively associated with favorability toward the control target, $b = -0.17$, $SE = 0.07$, $t - 2.37$, $p = 0.018$. No other main effects or interactions emerged ($ps > 0.098$) Fig. 3.

Mediation Analyses

The unexpected positive association between PI and evaluations of the target with deformities led us to probe the possibility that these effects could be based on general wariness toward social targets among high-PI individuals. Chronically heightened activation of this motive could foster a general perception of social targets as similarly threatening, which could lead them to derogate social targets without disease cues more readily, whereas chronically low levels of activation would elicit discernment between stimuli based on disease status. To test for that fact, we conducted a moderated mediation model using Model 8 in PROCESS (Hayes, 2013), using the perceived health of the target as the candidate mediator. This model afforded us the opportunity to consider condition and PI as the appropriate predictor and moderator for both the mediator and the outcome (i.e., evaluation) within the same model.

We considered the conditional indirect effects at high PI and low PI for both target conditions. Perceptions of the target as healthy did not predict evaluations of the target at high PI, $b = 0.09$, $SE = 0.10$, 95% [−0.09, 0.29]. However, at low PI, perceptions of health indeed predict more positive evaluations of the target, $b = 0.45$, $SE = 0.11$, 95% CI [0.25, 0.70]. The overall model testing for moderated mediation was significant, with 95% CI [−0.26, −0.03]. This suggests that heightened PI fostered less discernment from perceivers between a target with and without putative cues to disease.

Discussion

Although not supported in the manner predicted, the results were nonetheless aligned with recent research suggesting greater nuance in behavioral immune system effects. High levels of perceived infectability elicited similar levels of vigilance toward both versions of the target, whereas the aversive effects of disease cues appeared specifically for those low in perceived infectability. Chronically heightened pathogen avoidance motives have recently been demonstrated to

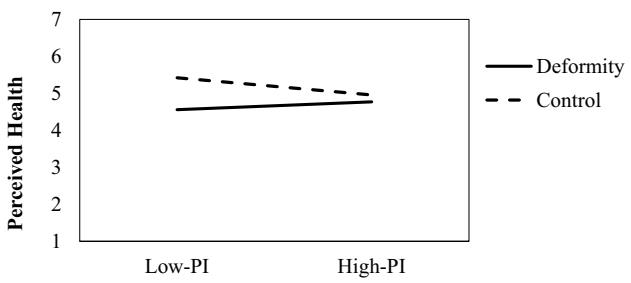

Fig. 2 Perceived health of the target in deformity and control conditions as a function of perceived infectability (PI)

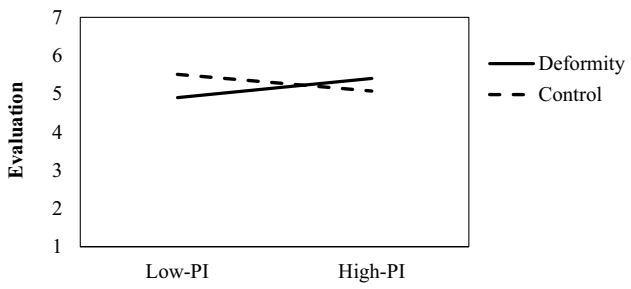

Fig. 3 Favorability of the target in deformity and control conditions as a function of perceived infectability (PI)

foster similar levels of aversion to various social stimuli, whereas the effects of disease cues are most prominent among those with lower chronic activation of these motives (e.g.,Brown & Sacco, 2020; Brown et al., 2019a, b). Acute salience of disease cues could foster aversion among individuals with relatively low chronic salience of disease in specific contexts.

That the effects were driven primarily by perceived infectability tracks previous findings implicating a cognitive component of the behavioral immune system as important in evaluating social value. Previous research indicates that perceived infectability is associated with aversion to heuristic disease cues from bodily features (e.g., Brown & Sacco, 2016; Duncan & Schaller, 2009; Young et al., 2011). This wariness could be rooted in configurally processing information about the likelihood of infection, resulting in calculated behaviors to avoid possible illness (Brown et al., 2021b). These preemptive aversions support an error management framework (Haselton & Nettle, 2006), given the fact that the deformities on the target did not appear to be cutaneous of the chef's actual pathogen load. Rather than risking infection, a cognitive response to cues of physical abnormalities could be sufficient in response to avoid contamination. These effects mirrored how heightened perceived infectability led participants to view the healthy and deformed targets as having similar levels of health.

As evidenced by our mediation model, the unexpected association between perceived infectability and positive evaluations of the deformed target could have been the product of other results. The especially negative evaluation toward the deformed target by individuals low in perceived infectability and greater favorability of the control target could have led to the difference emerging with high perceived infectability who could have simply been warier than all social targets. That is, all features could appear similarly infectious to those perceivers. In fact, the perceived health of the target was not predictive of high-PI individuals' evaluations. Social perceptions among those with chronically heightened activation of this motive could operate with greater reticence toward all stimuli when disease concerns are chronically activated (Mortensen et al., 2010). From an affordance management perspective (Neuberg et al., 2020), a heightened criterion for a perceived disease avoidance opportunity could lead perceivers not to view any stimulus as particularly appetitive.

Limitations and Future Directions

Various limitations emerged in this study necessitating future research. First, our consideration of behavioral immune system responses was based primarily on chronic activation. Future research could use experimental manipulations of disease salience (e.g., priming; Brown & Sacco, 2020; Makhanova, 2022; Murray & Schaller, 2012). Priming procedures would ostensibly activate pathogen avoidance motives in perceivers prior to their evaluations of disease cues, which could afford more causal evidence for these effects given that personality may be chronic activation of a salient motivational state.

It should also be noted that this study was conducted during the fall and winter months in the second year of the COVID-19 pandemic. During this time, individuals reported greater vigilance toward pathogenic threats in their environment, which saw a decrease in social interests and aversion to novel environments that included going to restaurants (Brown et al., 2021b; Gul et al., 2022; Makhanova & Shepherd, 2020). This unique upregulation of various personality traits that influenced interpersonal behavior could lead to future comparisons for when infectious diseases are less salient.

In addition to particularly salient visual heuristics to disease, it could be possible that actual, albeit subtle, cues to infection could foster considerable aversion. Individuals exhibit above-chance accuracy in identifying whether individuals have contracted an infectious disease without obvious visual cues (e.g., lesions, mucus; Axelsson et al., 2018). Such faces further foster aversion from perceivers (Sarolidou et al., 2019). Future studies could task participants with evaluating meals prepared by faces connoting actual infection compared to healthy controls.

Conclusion

Dietary customs are frequently informed by practices that could serve to reduce contamination likelihood. Although these behaviors should ostensibly serve to address explicit cues of infection, the oversensitivity of behavioral immune system responses to potentially anomalous features could lead perceivers to have a more liberal criterion for what features are diagnostic of disease threat despite a lack of actual risk (e.g., Miller & Maner, 2012).

Author Contribution MB and SMB conceived this study in cooperation, with MB programming the study and analyzing the data. MB wrote the initial draft. SMB provided critical commentary on a theoretical level in subsequent drafts. Both authors consented to publication.

Data Availability Data, materials, and pre-registration are provided: https://osf.io/qwkns/?view_only=4967d931fb1e42138842935a5e63653f.

Declarations

Ethical Approval and Consent to Participate This research had IRB approval. Participants provided informed consent.

Conflict of Interest The authors declare no competing interests.

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