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ARTICLE

A meta-analysis of perceived infectability, germ aversion, disgust and outgroup perceptions: Evaluating research on the behavioural immune system

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Abstract

Scholarship on the behavioural immune system suggests that people who perceive themselves as more susceptible to illnesses are more sensitive to disgust, providing an evolutionary advantage to avoid pathogenic stimuli. This sensitivity causes those with greater perceived susceptibility to be biased against outgroup members and avoid those with dissimilar immunological histories. However, the lack of a quantitative review forces researchers to derive arguments from specific empirical observations, rather than holistically drawing from averaged effects across studies. Researchers may over-rely on studies that produced atypical results, causing biases in research on perceived infectability, germ aversion, disgust and outgroup perceptions. To resolve this tension in the literature, we perform a meta-analysis of 74 sources. Our meta-analytic results demonstrate that perceived infectability produces small relations with disgust and non-significant relations with outgroup perceptions, whereas a construct commonly conflated with perceived infectability, germ aversion, produces larger relations with these two outcomes. A meta-analytic structural equation model demonstrates that the indirect effect of perceived infectability on outgroup perceptions via the mediator of disgust is not statistically significant. These findings indicate that, while perceived infectability relates to disgust, the construct does not relate to perceptions of outgroup members, counter to scholarship on the behavioural immune system.

KEYWORDS

behavioral immune system, disgust, germ aversion, outgroup perceptions, perceived infectability

The COVID-19 pandemic ignited an outpouring of studies on perceived infectibility, which has also been labelled perceived vulnerability to illness, subjective likelihood of infection and subjective susceptibility to disease (Delporte et al., 2023; Safra et al., 2021; Troisi et al., 2023). This outgrowth of scholarly attention likely arose due to the role that perceived infectibility plays in psychological processes that garnered widespread attention during the COVID-19 pandemic. In one such research stream, authors widely observed that the cause and spread of COVID-19 were often attributed to outgroups, causing the pandemic to spark social tensions in addition to millions of deaths (Kim et al., 2022; Millar et al., 2023; Peng & Bai, 2024). To probe this observation, authors applied theory on the behavioural immune system.

The behavioural immune system is a set of cognitive and emotional processes that motivate the avoidance of potentially infectious pathogens, with disgust serving as a primary emotional mechanism that causes people to retract from triggering stimuli (Fitzgerald et al., 2022; Schaller & Park, 2011).[1] For instance, people feel disgust and avoid spoiled food, resulting in evolutionary benefits to fitness. People also feel disgust beyond overtly infectious stimuli alone. Historically, people benefitted from avoiding those with differing immunological histories, producing feelings of disgust towards and negative assessments of outgroup members broadly (Fitzgerald et al., 2022; Navarrete & Fessler, 2006; Petersen, 2017). At the same time, certain people have more active behavioural immune systems and experience a greater sensitivity to disgust, particularly those with a greater perceived infectability to disease (Delporte et al., 2023; Troisi et al., 2023). Researchers have argued that those with greater perceived infectability have more negative perceptions of outgroup members due to greater feelings of disgust, resulting in a model leveraged during the COVID-19 pandemic to understand why and how certain people may have more negative perceptions of outgroup members. Given the sizable scholarly attention that this research stream saw even prior to the COVID-19 pandemic (Faulkner et al., 2004; Kam, 2019; Navarrete & Fessler, 2006), a large base of research has been established investigating the validity of these effects (Kam, 2019; Millar et al., 2023; Navarrete & Fessler, 2006).

Despite its popularity, two notable tensions are evident in this literature. First, no quantitative review summarizes studies investigating perceived infectability with disgust and/or outgroup perceptions. While authors point to individual studies to support their assertions, it is unclear whether prior observations are broadly replicable or generalizable across studies and contexts. For instance, authors have produced results that are both supportive (Brady et al., 2021; Fitzgerald et al., 2022; Liuzza et al., 2017) and not supportive (Fan et al., 2022, 2024; van Leeuwen et al., 2023) of the relations studied in the present article. This raises questions about the validity of the research stream, as authors may be citing atypical results to support their arguments. Second, perceived infectibility is often studied as a dimension in the Perceived Vulnerability to Disease Questionnaire (PVDQ) alongside the dimension of germ aversion, which reflects a discomfort with objects and actions that may spread disease (Díaz et al., 2016; Duncan et al., 2009). These two dimensions have significant differences in conceptualization and produce notably divergent relations with correlates and outcomes (Chiesi et al., 2022; Do Bú et al., 2023; Ferreira et al., 2022). Authors often reference results reflecting the two dimensions together (e.g., perceived vulnerability to disease) or even germ aversion alone as representative of the subjective likelihood of illness; however, these results are not representative of perceived infectability, given the stark difference between the two constructs. Germ aversion may be a manifestation of disgust sensitivity rather than the likelihood of illness, leaving significant uncertainties regarding the true relations of perceived infectability and associated theoretical lenses, namely the behavioural immune system.

The current article resolves these tensions in the literature. We perform a meta-analysis on the relations of perceived infectability, germ aversion, disgust and outgroup perceptions, utilizing the behavioural immune system as our guiding theoretical framework. We identify a list of over 10,000

[1]When studying disgust and the behavioural immune system, researchers most often investigate the tendency for people to feel disgust across situations, known as disgust sensitivity. Fewer researchers ask participants to indicate their disgust in specific moments. We consider both operationalizations together when discussing and analysing disgust, as considering them separately does not alter our conceptual arguments or empirical results.

potential sources, which are reduced to 74 sources included in our meta-analysis via a multiple-phase coding process. Our meta-analysis provides overall estimates for the relations of perceived infectability and germ aversion with disgust and outgroup perceptions, determining the average relations of these constructs across contexts. We also perform meta-analytic structural equation modelling to assess whether disgust mediates the relation of perceived infectibility and outgroup perceptions, providing a strong test of this explanatory mechanism. We lastly assess multiple moderating effects, such as the type of disgust (e.g., moral, pathogen) and outgroup (e.g., race, other), to test whether these relations are larger in specific contexts.

Via these efforts, the current article offers significant contributions to scholarship on the behavioural immune system. Our meta-analytic estimates do not pose the same concerns as prior investigations into our studied effects. Namely, our results represent robust relations averaged across many studies rather than relying on the interpretation of individual observations, and we provide separate results for perceived infectability and germ aversion rather than conflating the two together—both characteristics leading to more accurate interpretations. In turn, we provide clarity regarding whether certain questions of the behavioural immune system are warranted.

If our results find that perceived infectability produces significant and sizable relations with disgust and germ aversion, then our results would support present theorizing regarding the behavioural immune system. The associated dynamics could be assumed to occur via automatic processes and implicit cognitions that impact conscious perceptions, wherein perceived infectability can be studied as a conscious perception with associations that strengthen the magnitude of responses from the behavioural immune system. Future researchers could continue the present stream of research, and the placement of constructs could remain consistent across relevant models and theories. Alternatively, if perceived infectability does not produce significant relations with our outcomes, then our results would indicate that the recent questioning of the behavioural immune system is warranted. The associated processes would be considered to operate entirely via automatic processes and implicit cognitions largely independently of conscious perceptions. Perceived infectability, although commonly studied as a representative component of the behavioural immune system, could not be considered an indicator of these implicit cognitions and would need to be recognized as relatively unconnected to the associated autonomic processes. Future researchers would need to realign theoretical rationales regarding the behavioural immune system, and the inclusion of perceived infectability would need to be reconsidered. Therefore, our results provide substantial theoretical insights regardless of whether significant or non-significant effects are produced.

BACKGROUND

Behavioural immune system and disgust

Organisms experience evolutionary benefits from avoiding illness, as it contributes to their reproductive likelihood (Murray et al., 2019; van Leeuwen & Petersen, 2018). These benefits have caused species to evolve a great number of biological processes to combat infectious pathogens, but it has also resulted in humans developing 'an array of affective and cognitive psychological processes that motivate avoidance behavior in order to defend against infectious disease transmission' (Fitzgerald et al., 2022, p. 9039). As a result, humans experience significant evolutionary benefits from possessing their 'psychological mechanisms (adaptations) that are specialized for responding to specific environmental stimuli (such as particular odours) with specific behaviors (such as avoidance) that decreased the likelihood of infectious disease in ancestral environments' (van Leeuwen et al., 2023, p. 679).[2] These cognitive and psychological processes are collectively labelled the behavioural immune system.

[2]As noted by van Leeuwen et al. (2023), "humans do not necessarily strive to maximize pathogen avoidance" (p. 679). People perform cost-benefits analyses to determine whether their enjoyment outweighs their risk of infection.

To repel disease, the behavioural immune system is triggered by any stimuli that pose the threat of illness, such as spoiled food (Faulkner et al., 2004; Fitzgerald et al., 2022). These stimuli then produce cognitive and emotional responses that prompt protective behaviours, with disgust being considered the most central of these emotional responses (Culpepper et al., 2018; Schaller, 2014). Disgust is a basic human emotion with a negative valence and an avoidance orientation, and people naturally retract from stimuli that cause disgust (Oaten et al., 2009). Due to the repellent nature of disgust, it is a powerful mechanism that shields people from infectious agents, as significant emotional regulation is necessary to persist towards disgust-eliciting stimuli (Olatunji et al., 2017; Rohrmann et al., 2009). Further, the compensatory nature of the behavioural immune system operates via automatic processes (Fitzgerald et al., 2022; Petersen, 2017; Schaller & Park, 2011). Infectious stimuli trigger disgust without conscious thought, and the behavioural immune system compensates for the biological immune system largely without recognition.

Disgust is the felt emotion when encountering specific stimuli, but certain people are also more likely to experience this emotion. For instance, one person may remain relatively unphased by any disgusting stimuli (e.g., rotten food), whereas another may feel disgust from relatively innocuous stimuli (e.g., pineapple on pizza). The propensity to experience disgust is labelled disgust sensitivity, and it can be studied as a unidimensional or multidimensional construct (Haidt et al., 1994; Olatunji, Cisler, et al., 2007; Olatunji, Williams, et al., 2007; Van Overveld et al., 2006). When studied as a unidimensional construct, researchers investigate the dynamics of experiencing greater disgust in general. When studied as a multidimensional construct, researchers investigate the dynamics of experiencing greater disgust in more specific domains. For instance, a person may feel greater disgust than average regarding food disgust stimuli, whereas the same person may be relatively unphased by moral disgust stimuli. Researchers have more often studied disgust sensitivity rather than disgust when testing the linkages of the behavioural immune system, and this predominance has occurred due to both theoretical and methodological justifications.

A heightened behavioural immune system causes people to experience both greater disgust across contexts (i.e., disgust sensitivity) and greater momentary disgust (i.e., emotion of disgust), wherein disgust sensitivity causes people to experience greater momentary disgust. In turn, relevant theory suggests that individual differences that cause stronger behavioural immune system reactions relate to disgust via the explanatory mechanism of disgust sensitivity. Studying disgust sensitivity serves as a more proximal linkage to antecedents within these theoretical perspectives. Further, while disgust is the mechanism that causes people to retract when observing certain stimuli, disgust sensitivity causes people to be more or less likely to retract from specific types of stimuli. Because disgust sensitivity reflects systematic tendencies, it is a consistent predictor of behavioural immune system outcomes. That is, disgust sensitivity predicts who is more likely to systematically retract from certain stimuli, whereas felt disgust is the reason why they retract. While disgust and disgust sensitivity play similar roles in relevant theory, the latter is considered a more proximal variable to antecedents and outcomes.[3]

Perceived infectability and its nomological network

Theoretical perspectives on the behavioural immune system argue that individual differences associated with vulnerabilities to disease cause people to possess a more active behavioural immune

[3]Disgust is also more difficult to measure, as it must be gauged immediately after viewing stimuli. While this can be conducted via a survey design, such as including pictures in a survey, it is difficult to ensure that each participant views the pictures in a similar manner (e.g., length of time). For this reason, the measurement of disgust is most often restricted to lab studies. Disgust sensitivity can be included in survey studies via Likert scale format, enabling its inclusion in a wide range of studies. Likewise, the momentary nature of disgust causes it to be influenced certain extraneous factors outside the behavioural immune system, such as object recognition, whereas disgust sensitivity is not impacted by these momentary influences. Assessing antecedents and outcomes of disgust sensitivity provides an accurate assessment of the behavioural immune system, leading to its predominance in empirical research.

system, wherein they experience greater disgust sensitivity to more frequently and strongly retract from infectious stimuli (Fitzgerald et al., 2022; Olatunji et al., 2019; Petersen, 2017; Schaller & Park, 2011). People who possess weaker biological immune systems – and individual differences that relate to weakened immune systems – are more likely to avoid infectious pathogens by experiencing greater disgust, causing an elevated behavioural immune system to compensate for vulnerabilities caused by these individual differences (e.g., compensatory prophylaxis hypothesis) (Fessler et al., 2005; Makhanova et al., 2022; Olatunji et al., 2019). Perceived infectability, the subjective evaluation of one's likelihood to become ill, is one such representative vulnerability. This construct is central to scholarship and theory of the behavioural immune system due to its clear relevance and potential as an indicator for possessing a weakened biological immune system (Delporte et al., 2023; Troisi et al., 2023).

Two primary mechanisms produce perceived infectability (Kam, 2019; Millar et al., 2023; Navarrete & Fessler, 2006). First, people perceive themselves as more susceptible to illness because they possess weaker biological immune systems. People recognize their health and develop subjective evaluations of their own vitality. For this reason, immune system functioning is a primary antecedent of perceived infectability. Second, (sub)conscious processes cause people to systematically under or overestimate their constitution (Delporte et al., 2023; Troisi et al., 2023). For instance, people who score high in neuroticism are known to be more anxious about their well-being, which may cause them to also develop perceptions that they are less healthy than others. These tendencies cause neuroticism to positively relate to perceived infectability, and other individual differences produce similar effects. Thus, constructs associated with biological immune system functioning (e.g., illness history) and biases in self-perceptions (e.g., neuroticism) produce perceived infectability.

Due to its dual emergence, perceived infectability is both a conscious perception and a proxy for implicit cognition. People must evaluate their own vitality when assessing their perceived infectability, causing it to be a conscious perception. This conscious perception, however, emerges from more subtle indicators of health. People continuously evaluate their health via automatic processes, developing implicit cognitions regarding their well-being (Sheeran et al., 2016; Tipura et al., 2025). In turn, these cognitions determine a more conscious evaluation of health, as people draw from their overall perceptions of themselves in assessing their vitality. Because implicit cognitions are a primary determinant of conscious perceptions, the construct of perceived infectability is often utilized to represent both conscious perceptions and implicit cognitions regarding personal health. Researchers have also predominantly assessed perceived infectability due to its benefits relevant to other candidate constructs (e.g., implicit cognitions of health[4] and immune system functioning[5]), producing theoretical and methodological benefits (Delporte et al., 2023; Safra et al., 2021; Troisi et al., 2023).

Further, researchers most often operationalize the subjective evaluation of personal illness propensity via the PVDQ, which includes the dimensions of perceived infectability and germ aversion. Although these two dimensions are often aggregated together in studies, this operational definition only reflects perceived infectability, not germ aversion or both constructs together. Perceived

[4]Implicit cognitions of health are automatic assessments that occur without deliberate awareness. They are closely related to perceived infectability, as both are developed from the same habitual observations and judgements. At the same time, implicit cognitions are less often utilized in research, likely due to the difficulty of measurement. Implicit cognitions are measured via specialized techniques, such as implicit association tests, which prevents inclusion in survey studies (Bartels & Schoenrade, 2022; Schimmack, 2021). Authors have also yet to provide robust psychometric or validity support for these measures. Because implicit cognitions and perceived infectability are closely related, authors have predominantly studied the latter due to associated benefits.

[5]Immune system functioning poses both measurement and theoretical concerns. It is typically measured by indicating experienced illnesses from a selection of options (Hales et al., 2008; Van Thiel et al., 1991). Studies greatly differ regarding the included illnesses, whether including minor versus major ailments, general versus specific conditions, or narrow versus broad lists. Differences in these measures lead to inconsistent results across studies. Also, present vitality determines behavioural immune system functioning. While illness histories are a proxy for immune system functioning, (sub)conscious evaluations represent present vitality. Lastly, immune system functioning alone does not fully account for individual differences in the behavioural immune system, as cognitive biases (and other constructs) also play a role. Perceived infectability provides methodological and theoretical benefits relative to either implicit cognitions or illness histories.

infectability directly represents cognitive evaluations of the perceived likelihood of illness, whereas germ aversion represents responses to threatening stimuli (Díaz et al., 2016; Duncan et al., 2009; Ferreira et al., 2022). For instance, a germ aversion item in the PVDQ is, 'I do not like to write with a pencil someone else has obviously chewed on'. Germ aversion is more accurately a behavioural outcome of disgust – or even an indicator of disgust – because it is a reaction to threatening stimuli. Thus, perceived infectability is an individual difference that reflects personal vulnerabilities that heighten the behavioural immune system, whereas germ aversion is an outcome of the behavioural immune system.

Together, the behavioural immune system causes people to feel disgust and retract from potentially infectious stimuli, and the habitual tendency to feel disgust (i.e., disgust sensitivity) or avoid potentially infectious stimuli (i.e., germ aversion) is the manifestation of this system across contexts. Outgroups serve as overgeneralized stimuli that trigger behavioural immune system responses, which produce negative perceptions of outgroup members. Individual differences associated with weaker biological immune systems, such as perceived infectability, relate to stronger behavioural immune system responses, as the behavioural immune system compensates for weaker biological immune systems. These stronger responses cause those who possess individual differences associated with weaker biological immune systems to experience greater disgust and more negative outgroup perceptions. While commonly studied together, this theoretical perspective indicates that perceived infectability and germ aversion occupy two different functions within the behavioural immune system, and the two constructs should be expected to produce differing relations with disgust, outgroup perceptions, and other outcomes associated with the behavioural immune system—differing relations that are presently unrecognized in the literature. Therefore, it is essential to assess perceived infectability in isolation to test theory of the behavioural immune system, as it is an individual difference believed to impact pathogen responses of the behavioural immune system – not a pathogen response itself.

Perceived infectability and disgust

As detailed above, perceived infectability is central to many theoretical perspectives due to its association with important cognitive, emotional and behavioural outcomes (Faulkner et al., 2004; Kam, 2019; Navarrete & Fessler, 2006). The behavioural immune system compensates for the biological immune system, causing people to avoid infectious stimuli. Perceived infectability is a conscious indicator that reflects the quality of the biological immune system. The behavioural immune system of people with high perceived infectability may compensate for their vulnerabilities, and those with a greater perceived infectability may be more reactive to triggering stimuli (Ding & Luo, 2022; Hlay et al., 2024). These people are expected to experience greater disgust across contexts, as the reactivity of their behavioural immune systems subsequently causes them to more strongly avoid infectious agents – improving their well-being and survivability. Therefore, a positive relation is expected between perceived infectability and disgust, due to the compensation mechanisms of the behavioural immune system.

Hypothesis 1. Perceived infectability positively relates to disgust.

Perceived infectability and outgroup perceptions

People retract from sources perceived as infectious, including objects, animal and even other people (Haidt et al., 1994; Olatunji, Cisler, et al., 2007; Olatunji, Williams, et al., 2007; Van Overveld et al., 2006). Research on the behavioural immune system has observed that people are especially likely to retract from those perceived to be outgroup members (Kam, 2019; Millar et al., 2023; Navarrete & Fessler, 2006), and authors have suggested that this tendency to retract from outgroup members may have served a historical evolutionary advantage (Fitzgerald et al., 2022; Navarrete & Fessler, 2006; Petersen, 2017).

Those who share a common immunological history (e.g., ingroup members) pose less of a disease threat than those who do not (e.g., outgroup members), suggesting that historical ancestors benefitted from reduced contact with outgroup members.

This reactivity towards outgroup members overgeneralizes beyond disease threats alone, known as the smoke detector principle (Park et al., 2003; Petersen, 2017; Schaller & Park, 2011). That is, disgust sensitivity is positively associated with prejudice towards people who are no more likely to be infectious, such as those with physical disabilities (Magallares et al., 2015; Park et al., 2003; Welling et al., 2007). The smoke detector principle argues that this prejudice is due to the evolutionary benefit of over-excluding others rather than under-excluding others, causing the behavioural immune system to activate for a broader set of stimuli than infectious pathogens alone. Similarly, the divergence from prototypes principle argues that people perceive any divergence from prototypical appearances as indicators of potentially infectious stimuli (Schaller et al., 2003; van Leeuwen et al., 2023). While some differences may indeed indicate infectious stimuli (e.g., sores), the behavioural immune system may overgeneralize its effects to divergences from prototypes that are not infectious (e.g., amputated limbs). The divergence from prototypes principle explains why people may possess negative perceptions of others via the behavioural immune system, but recent authors have not supported this theoretical perspective (Fan et al., 2022, 2024; van Leeuwen et al., 2023).

Further, empirical distinctions have been observed between different types of disgust, including disgust arising from infectious stimuli (e.g., pathogen) and ethical transgressions (e.g., moral) (Olatunji et al., 2012; Tybur et al., 2009). Moral disgust is particularly relevant to social interactions. Authors have suggested that humans are particularly sensitive to moral disgust because it historically indicated whether conflicts may arise between ingroup and outgroup members, potentially avoiding unnecessary aggression and enhancing survivability (Chapman & Anderson, 2013; Tybur et al., 2013). This triggering effect of potentially harmful social sources impacts interactions with others. Not only do people feel disgust towards outgroup members, but this emotional underpinning may cause general negative perceptions of outgroup members.

As argued above, people with greater perceived infectability possess more reactive behavioural immune systems, and people who perceive themselves as more susceptible to illness are more likely to avoid infectious stimuli (Ding & Luo, 2022; Hlay et al., 2024; Makhanova et al., 2021). We suggest that these people are more likely to hold negative opinions of outgroup members because their behavioural immune system is more sensitive towards triggering stimuli. That is, as these individuals have greater tendencies to retreat from pathogenic stimuli, those with greater perceived infectability are more likely to hold negative perceptions of outgroup members. We suggest that this bias is consistent across all types of outgroups, including those unassociated with pathogenic threats, due to the overgeneralization of threatening stimuli (e.g., smoke detector principle) (Schaller & Park, 2011). Thus, we hypothesize that perceived infectability produces a positive relation with negative perceptions of outgroup members.

Hypothesis 2. Perceived infectability positively relates to negative perceptions about outgroup members.

We further propose that the relations in our hypotheses produce a mediating effect, such that people with greater perceived infectability are more likely to hold negative perceptions of outgroup members because they experience greater disgust. As outlined above, people with a greater perceived infectability are more likely to experience disgust towards triggering stimuli, and these people are more likely to hold negative opinions of outgroup members because they habitually feel disgust towards them. We hypothesize that perceived infectability produces an indirect effect on negative perceptions of outgroup members via disgust.

Hypothesis 3. Perceived infectability produces an indirect effect on negative perceptions about outgroup members via disgust.

Before continuing, we emphasize the importance of potentially not supporting our hypotheses. Researchers have both supported (Brady et al., 2021; Fitzgerald et al., 2022; Liuzza et al., 2017) and failed to support (Fan et al., 2022, 2024; van Leeuwen et al., 2023) the relations of perceived infectability, disgust and outgroup perceptions. While our arguments followed predominant theorizations in the current literature (Ackerman et al., 2018; Schaller & Park, 2011), our studied relations are not as certain as commonly assumed. For this reason alone, the current meta-analysis represents a sizable contribution to the current literature, as we provide robust evidence regarding the existence of – or lack thereof – these effects. If supported, future researchers can continue utilizing currently applied theoretical lenses, and future research can progress upon its current stream in a more confident manner. If not supported, our meta-analysis would provide robust evidence that our understanding of the behavioural immune system is misaligned, and the interrelations between its primary constructs do not function as presently assumed. Future researchers would then need to revise extant theoretical perspectives or create new theoretical perspectives to more accurately detail the nature of these relations. For instance, the behavioural immune system may need to be reconceptualized as an entirely automatic process with few impacts on conscious recognition if perceived infectability is found to produce non-significant effects. Therefore, our investigation provides substantial insights into the modern literature regardless of whether significant or non-significant results are found.

Germ aversion

Research on subjective evaluations of one's propensity for illness is biased because researchers have operationalized this construct as both perceived infectability and germ aversion together – or even germ aversion alone. By providing meta-analytic results that reflect the relation of perceived infectability alone, we provide insights into the nature of subjective evaluations regarding one's propensity for illness within the behavioural immune system. At the same time, we also provide meta-analytic effects regarding the relations of germ aversion, such that we can compare observed effects between the two constructs. If germ aversion produces substantially larger effects than perceived infectability, then our results would indicate that prior research has significantly overestimated the relations of perceived infectability within the behavioural immune system. In turn, future researchers would need to realign their expectations.

We further argue that the relations of germ aversion with disgust and outgroup perceptions are larger than those of perceived infectability. Germ aversion is a manifestation of the behavioural immune system, as it is a tendency to avoid infectious stimuli. Disgust and outgroup perceptions are also manifestations of the behavioural immune system. Disgust is a reactive trigger to avoid pathogenic stimuli, whereas negative outgroup perceptions are a conditioned perception to avoid overgeneralized stimuli. These constructs are more tightly conceptually associated relative to perceived infectability, as they each represent a similar portion of the behavioural immune system. Constructs that share a similar criterion space are known to produce stronger interrelations, and we therefore hypothesize that germ aversion produces stronger relations with disgust and outgroup perceptions than perceived infectability.

> **Hypothesis 4.** Germ aversion produces stronger relations with (a) disgust and (b) outgroup perceptions than perceived infectability.

Moderating effects

We treated disgust and outgroup perceptions as holistic constructs in our hypothesizing; however, disgust and outgroup perceptions are typically differentiated by their foci, and the differing types may produce divergent associations with perceived infectability (Olatunji, Cisler, et al., 2007; Olatunji, Williams,

et al., 2007; Tybur et al., 2009). Two scales are most commonly applied to assess the tendency to experience disgust: the Disgust Scale – Revised (Olatunji, Cisler, et al., 2007; Olatunji, Williams, et al., 2007) and the Three Domains of Disgust Scale (Tybur et al., 2009). The Disgust Scale – Revised includes three dimensions: core, reflecting a broad sensitivity to potentially infectious stimuli (e.g., eating unusual meat, seeing rats and cockroaches); animal reminder, reflecting a sensitivity to signals of the animal origins of humans (e.g., touching a dead body); and contamination, reflecting a sensitivity to objects potentially infected with germs (Olatunji, Cisler, et al., 2007; Olatunji, Williams, et al., 2007). The Three Domains of Disgust Scale also includes three different dimensions: pathogen, reflecting a sensitivity to infectious agents; sexual, reflecting a sensitivity to undesirable reproductive partners; and moral, reflecting a sensitivity to those who do not abide by social norms (and may thereby cause conflict) (Tybur et al., 2009).

While experiences of disgust arising from any target are expected to systematically relate to both perceived infectability and outgroup perceptions, certain types of disgust may produce heightened relations with either perceived infectability or outgroup perceptions. People with heightened perceived infectability may be more sensitive to stimuli that could cause illness. It could be expected that perceived infectability has stronger relations with the disgust types of core, contamination and pathogen, as these three types are associated with the possibility of illness; however, perceived infectability may produce weaker relations with animal reminder, sexual and moral disgust, because these three types produce disgust independent of infectious pathogens. Likewise, outgroup perceptions may produce stronger relations with types of disgust associated with interpersonal interactions, namely the moral dimension of the Three Domains of Disgust Scale. The other types of disgust in popular measures may produce weaker relations, as they are less associated with interpersonal interactions (and avoiding social conflict).

Alternatively, no widespread scale assesses perceptions regarding multiple types of outgroups. Instead, authors often study different outgroups of interest in their investigations (Kam, 2019; Millar et al., 2023; Navarrete & Fessler, 2006), which has broadly ranged to include those defined by gender, sexual orientation, nationality, racial categories, ethnic categories, weight, and other characteristics (Magallares et al., 2015; Park et al., 2003; Welling et al., 2007). Across these studies, authors have provided consistent justifications and expectations for the relation of outgroup perceptions with perceived infectability and disgust, suggesting that these relations arise from historical evolutionary advantages in excluding outgroup members. Due to these consistent justifications, it is expected that the relations of outgroup perceptions with perceived infectability and disgust are largely consistent, regardless of the type of outgroup.

We expect that the relations of perceived infectability differ based on the type of disgust, whereas we do not expect that these relations differ based on the type of outgroup. At the same time, we test these relations in an exploratory manner. That is, we do not propose specific hypotheses regarding which types of disgust produce stronger relations, and we instead broadly test whether differences are observed in our meta-analytic estimates. For this reason, we propose the potential of moderating effects as a testable inquiry rather than specific hypotheses, which more appropriately reflects the partially exploratory nature of our moderation investigation.

> **Testable Inquiry 1**. Does the target of disgust and perceptions about outgroup members moderate their relations with perceived infectability?

METHOD

To conduct our meta-analysis, we adhered to the recommendations of prior guides, reviews and prominent sources (Borenstein et al., 2021; Cheung, 2015a, 2015b; Harrer et al., 2021; Hedges & Olkin, 2014; Hunter & Schmidt, 2004; Jak, 2015; Migliavaca et al., 2022; Wiernik & Dahlke, 2020). Appendix S1: A includes our meta-analytic database.

Searches

We conducted 61 searches across two meta-databases between April and June of 2025. Fifty-six of these searches included three portions. The first word was either 'perceived' or 'subjective'. The second portion was either 'likelihood of', 'threat of', 'risk of', 'probability of', 'vulnerability to', 'invulnerability to' or 'susceptibility to'. The final word was either 'disease', 'infection', 'illness' or 'pathogen'. The combination of the two first words, seven middle portions and four final words resulted in 56 searches ($2 \times 7 \times 4$). These searches were supplemented by five additional searches: 'Perceived Infectability', 'Contamination Cognitions Scale', 'Health Cognitions Questionnaire', 'Perceived Vulnerability to Disease Questionnaire' and 'Germ Aversion'.[6] For each search, the entire text string was enclosed within parentheses.

The two utilized databases were Google Scholar and EBSCO. These two databases were selected because they each catalogue a large scope of literature, and using these two databases can ensure that most studies on our relations of interest would be discovered. For instance, EBSCO search results return the aggregate results of 47 separate databases, including APA PsycInfo, MEDLINE and Health Source Complete. Likewise, Google Scholar is known to produce more results than even EBSCO, suggesting that the two databases together can ensure that our meta-analytic database is representative of extant research on our studied relations.

When conducting our searches, all results from EBSCO were recorded, but only the first 1000 results from Google Scholar were recorded. Google Scholar produces more results than could reasonably be reviewed for most searches, even for relatively specific queries. For example, the search, 'perceived vulnerability to disease', alone produced 2470 results. Due to this property of the database, restricting results to the initial 1000 was necessary to code our sources. This decision was also supported because sources in the latter portion of the search results were less relevant to our studied topic, often including the terms in reference sections alone. The waning relevance of sources suggests that additional relevant sources would not be discovered after the initial 1000 sources. Lastly, we performed forwards-and-backwards searches of our results, but the comprehensiveness of our search procedures was supported because no additional sources were added to our database via this process.

Coding

Our coding process is represented in Figure 1. The initial database of search results included 11,234 sources, which is much larger than initial databases of similar topics (Broadbent et al., 2015; Dempster et al., 2015; Howard & Murry, 2025). The breadth of our initial database is likely due to the large number of conducted searches. After removing duplicate articles, 8159 sources remained in our database, which were then coded in a multi-phase process.

For each phase of the coding process, two coders coded 20 sources at a time until their interrater agreement met the designated cutoff (Cohen's $\kappa \geq .80$). The two coders then proceeded to code sources independently, conferring on any unclear coding decisions. In the first phase of the process, the coders coded whether the sources reported an empirical study that measured perceived infectability, regardless of its label (e.g., subjective likelihood of illness). This phase reduced our database from 8159 sources to 708 sources, and this reduced list of sources is provided in Appendix S1: A. In the second phase of the process, the coders coded all relations of perceived infectability reported in the article. These relations were reviewed to determine whether they represented a studied effect represented by our hypotheses, and articles that did not report an effect of interest were removed. This reduced our database from 708 sources to 71 sources. Lastly, we emailed contact authors of all sources in our meta-analytic database for any undiscovered results regarding the relations of perceived infectability. Two authors provided three additional sources, bringing our final meta-analytic database to 74 sources, which is also provided in Appendix S1: A. Our final

[6]The search for, "Germ Aversion", was conducted in February 2026 during the review process.

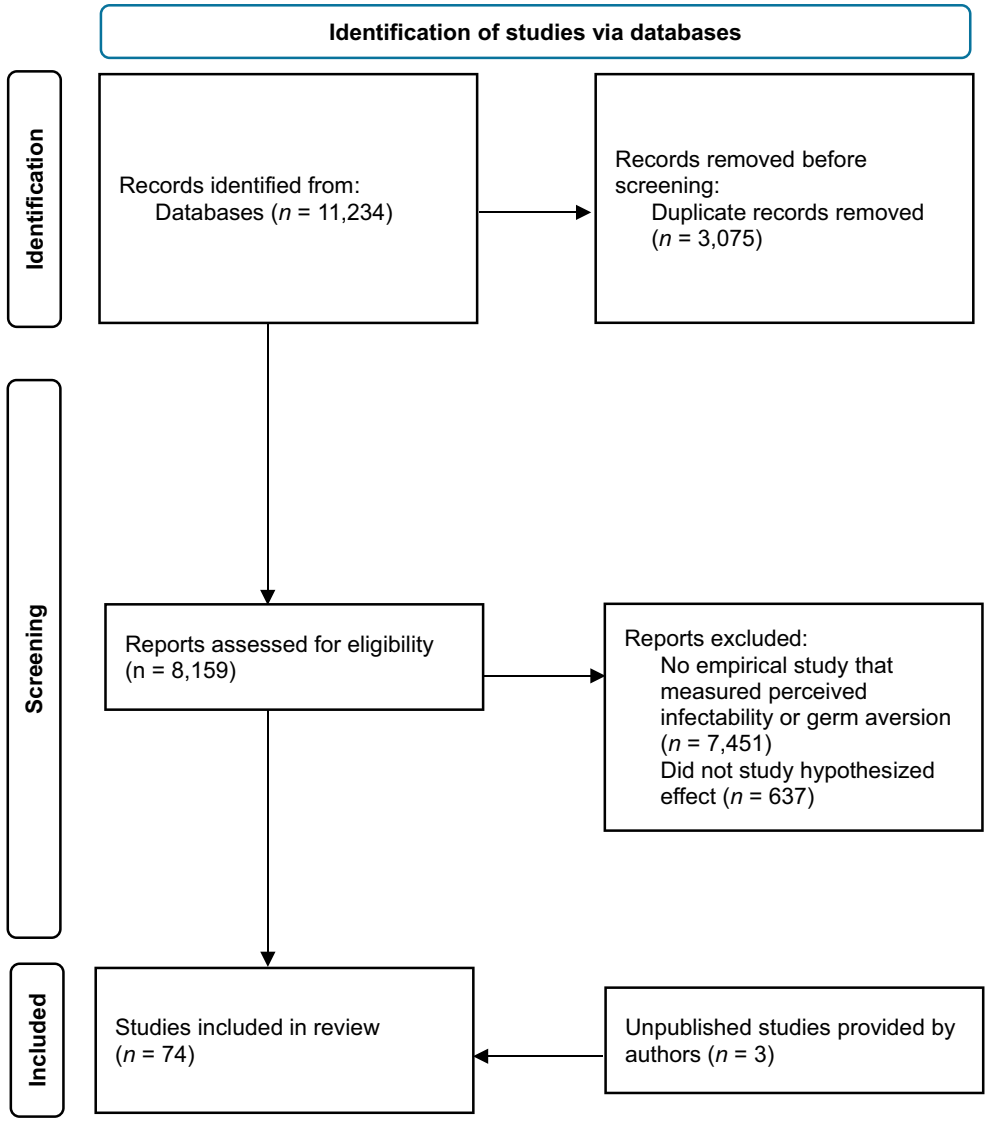

FIGURE 1 Modified PRISMA statement.

meta-analytic database is again larger than many meta-analyses on similar topics (Broadbent et al., 2015; Dempster et al., 2015; Howard & Murry, 2025), further supporting the robustness of our procedures.

Analyses

We began our meta-analysis by identifying potential outliers and influential cases. This is an essential first step as these observations would otherwise unduly sway subsequent analyses, substantially biasing our interpretations. We calculated eight different indicators of outliers and influential cases, but we primarily focused on studentized deleted residuals to identify candidate effects to be removed from our meta-analytic database due to prior support for their accuracy (Viechtbauer & Cheung, 2010). As some readers may prefer the interpretation of results with outliers and influential cases included, we include analyses with these cases included within in Appendix S1: B, whereas our primary text includes analyses with these cases excluded.

Comprehensive Meta-Analysis V4 was utilized to calculate publication bias analyses, univariate meta-analytic estimates, and assessments of moderating effects. We report four publication bias analyses: Begg and Mazumdar's rank correlation analysis using Kendall's τ with continuity correction, Egger's test, the trim-and-fill method and fail-safe k. Both Begg and Mazumdar's (1994) and Egger's (Egger et al., 1997) tests assess the relation between the magnitude of effects and their standard errors, and publication biases are indicated to be present if this relation is statistically significant. The trim-and-fill method assesses the distribution of effect sizes and standard errors to determine whether any undiscovered studies are implied to be missing (Duval, 2005). The fail-safe k estimates the number of missing studies that would need to be included in analyses to alter the statistical significance of results (Carson et al., 1990). By calculating multiple indicators of publication bias, we assess the robustness of our estimates and indicate whether readers should interpret our findings with certain caveats in mind.

Regarding our univariate meta-analytic estimates, we report our effects as sample-size weighted random effects correlation coefficients ($\bar{r}$) because all primary sources likewise reported the studied relations as correlation coefficients. We utilized the sample-size weighted random effects approach because studies have supported that this analysis better models between-study variance, causing it to be the recommended approach of many guides (Borenstein et al., 2021; Harrer et al., 2021; Hedges & Olkin, 2014; Hunter & Schmidt, 2004). Further, we tested potential moderating effects via a sample-size weighted random effects meta-regression, wherein study characteristics were included as predictors of the relations of interest. As recommended by authors (Borenstein et al., 2021; Harrer et al., 2021; Hedges & Olkin, 2014; Hunter & Schmidt, 2004), this approach determines whether the study characteristics significantly relate to the effect sizes, thereby indicating the presence of moderating effects. We treated each effect as a separate datapoint in our moderation analyses, as some studies reported the relations of multiple types of disgust or outgroups that could be included in this analysis.

We corrected for unreliability using the artefact distribution method, as recommended by many authors to address potential measurement issues (Hunter & Schmidt, 2004; Wiernik & Dahlke, 2020). For each source that reported a relation of interest, we recorded the Cronbach's alphas of the applied scales, and we calculated the average Cronbach's alpha for our constructs of interest. These average Cronbach's alphas were then utilized with the formula provided by Wiernik and Dahlke (2020) to correct for unreliability, producing corrected meta-analytic correlation coefficients ($\bar{\rho}$). The average reported Cronbach's alphas are provided in Tables 1 and 2. The average Cronbach's alpha for the measures of perceived infectability was .85, and the average Cronbach's alpha for the measures of germ aversion was .73.

The MetaSEM package in R 4.4.1 was used to calculate our multivariate meta-analytic estimates, specifically our assessments of mediation. We utilized the approach outlined by Harrer et al. (2021) and calculated meta-analytic structural equation models. This approach assesses the indirect effect of perceived infectability on outgroup perceptions via disgust while simultaneously accounting for all potential relations, resulting in the proper modelling of variance between our studied variables when testing these effects.

Lastly, we performed sensitivity analyses to ensure that our meta-analytic observations were not driven by our analytical decisions. In our primary analyses, we utilized the average study correlation for sources that reported multiple effects of interest within a single study. For instance, some sources may have investigated the relation of perceived infectability with perceptions of multiple different outgroups, which would have been included in our meta-analytic database as a single averaged correlation in our overall estimates of effects. While the typical approach of meta-analyses, some authors have argued that this approach does not account for the non-independence of effects (Cheung, 2015a, 2015b; Jak, 2015). To address this limitation, Appendix S1: B provides sensitivity analyses using a three-level meta-analytic approach, which accounts for the non-independence of observations by not requiring effects to be averaged together prior to analyses. All inferences were consistent between our primary and sensitivity analyses, supporting the robustness of our findings. We report the traditional sample-size weighted random effects in our primary text due to the familiarity of interpretation for most readers, but we also report these three-level meta-analytic estimates in our Supporting Information to ensure that our results were not driven by our analytical decisions.

TABLE 1 Publication bias analyses for the relations of perceived infectibility and disgust.

Type of disgust	No. of sources	*k*	*n*	$\overline{\alpha}$	Fail-safe *k*	B&M	Egger's test		Trim-and-fill	
							β_0	*t*	Left of mean	Right of mean
All Disgust	49	57	18,243	.79	3554	−.06	−0.44	1.08	0	10
Animal	10	11	1887	.75	83	−.25	−2.23	1.13	0	0
Body Odour	1	1	159	.92	–	–	–	–	–	–
Contamination	12	13	2202	.61	106	.50	3.17	2.15	0	0
Core	11	13	2943	.77	188	.04	0.13	0.15	0	0
Death	1	1	983	–	–	–	–	–	–	–
Food	3	4	630	.84	2	−.50	−5.43	3.86	0	2
General	24	29	8805	.81	1573	−.04	0.38	0.55	0	0
Interpersonal	2	3	1325	.71	11	−.67	−1.76	1.96	0	2
Moral	19	20	5950	.86	15	−.15	−0.66	0.84	0	4
Pathogen	24	26	9771	.78	784	−.19	−1.20	2.05	0	1
Sexual	19	19	6735	.83	263	−.11	−0.91	1.00	0	0

Note: *k*=Number of studies, *n*=Total sample size, $\overline{\alpha}$ = Average Cronbach's alpha, B&M=Kendall's τ with continuity correction from Begg and Mazumdar's rank correlation analysis, Egger's Test β_0=Intercept from Egger's Test, Egger's Test *t*=*T*-statistic of slope from Egger's Test, Trim-and-Fill Left of Mean=Implied studies missing from left of mean, Trim-and-Fill Right of Mean=Implied studies missing from right of mean.

TABLE 2 Publication bias analyses for the relations of perceived infectibility and attitude towards outgroups.

Type of outgroup	No. of sources	*k*	*n*	$\overline{\alpha}$	Fail-safe *k*	B&M	Egger's test		Trim-and-fill	
							β_0	*t*	Left of mean	Right of mean
All	21	25	9936	.85	0	−.12	−1.47	1.05	0	0
Elderly	1	1	649	.76	–	–	–	–	–	–
Overweight	3	4	939	.78	5	0	0.88	0.65	1	0
Sexual	2	2	1898	.94	–	–	–	–	–	–
Outgroup	3	4	1088	.92	0	0	−1.81	0.40	0	0
Other	5	5	1883	.88	2	−.30	−1.47	0.91	0	0
Race	8	9	3473	.89	5	−.19	−3.42	1.24	0	0
Sex	2	2	610	.87	–	–	–	–	–	–

Note: *k*=Number of studies, *n*=Total sample size, $\overline{\alpha}$ = Average Cronbach's alpha, B&M=Kendall's τ with continuity correction from Begg and Mazumdar's rank correlation analysis, Egger's Test β_0=Intercept from Egger's Test, Egger's Test *t*=*T*-statistic of slope from Egger's Test, Trim-and-Fill Left of Mean=Implied studies missing from left of mean, Trim-and-Fill Right of Mean=Implied studies missing from right of mean.

RESULTS

Outliers and influential cases results

Appendix S1: B includes a visual representation of our outlier and influential case results. For all relations, almost all studies produced studentized deleted residuals below two, indicating that most studies were in the expected range of observations. For the outcome of disgust, its relations with both perceived infectability and germ aversion each included a study with a studentized deleted residual outside the standard cutoff of two. Both of these studies were removed from our meta-analytic databases. For the outcome of outgroup perceptions, its relation with perceived infectability

alone included a study with a studentized deleted residual outside the standard cutoff of two. This study was removed from our respective meta-analytic database. No outlier was identified for the relation of germ aversion and outgroup perceptions. While we believe removing these studies benefited the interpretation of our primary results, readers can refer to Appendix S1: B for results including these studies.

Publication bias results

Tables 1 and 2 provide the results of our publication bias analyses. For the relations of perceived infectability and disgust, no effect indicated that publication biases were present for either Egger's or Begg and Mazumdar's test. The overall relation of perceived infectability and all indicators of disgust produced a trim-and-fill method result indicating that 10 studies were implied missing, but no other relation indicated that five or more studies were implied missing. When inspecting the implied missing studies, the relation of perceived infectability and disgust may be underestimated in our primary analyses. As reported below, the magnitude of this meta-analytic effect is estimated to be .13, whereas the trim-and-fill adjusted value is .15. Together, only one of three analyses identified potential publication biases for the relations of perceived infectability and disgust, and this analysis indicated that our observed effects only slightly deviated from the predicted actual effects. While this difference is minor, readers should interpret this effect with this consideration in mind.

For the relations of perceived infectability and outgroup perceptions, no effect indicated that publication biases were present for any publication bias analysis, suggesting that no studies are implied to be missing. This indicates that systematic publication biases did not produce a detectable influence on our results, and the presently reported relations of perceived infectability and outgroup perceptions in the present meta-analysis can be readily interpreted without additional considerations for the potential systematic inflation or deflation of effects.

Our fail-safe *k* values notably varied in magnitude. For the relations of perceived infectability and disgust, all fail-safe *k* values of statistically significant effects were 10 or above, with most producing a value of 80 or above. This finding indicates that a very large number of undiscovered studies would need to exist to notably sway our interpretations for the relation of perceived infectability and disgust, supporting the robustness of our findings for this relation. For the relations of perceived infectability and outgroup perceptions, no effect was larger than small in magnitude (presented in detail below). The magnitude of these effects caused each of the respective fail-safe *k* values to also be small in magnitude, as the effects were already either not statistically significant or approached non-statistical significance. This finding indicates that undiscovered studies would be unlikely to sway our interpretations of these effects, as they are already small in magnitude. Thus, our fail-safe *k* values are supportive of our interpretations.

Primary results

Tables 3 and 4 provide our results. In interpreting the magnitude of the correlations, we apply the guidelines of Bosco et al. (2015), which suggest that small correlations are below .20, moderate correlations are between .20 and .36, and large correlations are above .36.

Disgust

Perceived infectability produced a significant, positive, and small relation with all indicators of disgust together ($\overline{r}$ = .13, 95% CI [0.11, 15], $p < .001$, $\overline{\rho}$ = .16, $k = 57$, $n = 18{,}243$). When separated by the targets of disgust, the coefficients ranged from very small (moral disgust sensitivity; $\overline{r}$ = .04,

TABLE 3 Relations of perceived infectibility and disgust.

Construct	No. of sources	*k*	*n*	$\bar{r}$	$\bar{\rho}$	95% CI	*z*-Value	*p*-Value	I^2
All Disgust	49	57	18,243	.13	.16	0.11, 0.15	12.25	<.001	38.62
Animal	10	11	1887	.14	.18	0.07, 0.20	3.75	<.001	56.27
Body Odour	1	1	159	.26	.29	0.11, 0.40	3.32	.001	0
Contamination	12	13	2202	.13	.18	0.07, 0.19	4.02	<.001	52.30
Core	11	13	2943	.15	.19	0.11, 0.20	6.50	<.001	25.66
Death	1	1	983	.20	.20	0.14, 0.26	6.35	<.001	0
Food	3	4	630	.09	.11	−0.01, 0.20	1.74	.08	40.84
General	24	29	8805	.17	.20	0.14, 0.20	9.75	<.001	54.91
Interpersonal	2	3	1325	.14	.18	0.09, 0.20	5.01	<.001	2.30
Moral	19	20	5950	.04	.05	0.01, 0.07	2.64	.01	13.85
Pathogen	24	26	9771	.12	.15	0.10, 0.15	8.78	<.001	37.44
Sexual	19	19	6735	.10	.12	0.07, 0.13	6.12	<.001	35.18

Note: *k*=Number of studies, *n*=Total sample size, $\bar{r}$ = Sample-size weighted random effect average correlation coefficient, $\bar{\rho}$ = Sample-size weighted random effect average correlation coefficient corrected for unreliability, 95% CI=95% Confidence interval of the sample-size weighted random effect average correlation coefficient, *z*-value=*Z*-value of the sample-size weighted random effect average correlation coefficient, *p*-value=*p*-value of the ample-size weighted random effect average correlation coefficient.

TABLE 4 Relations of perceived infectibility and attitude towards outgroups.

Construct	No. of sources	*k*	*n*	$\bar{r}$	$\bar{\rho}$	95% CI	*z*-Value	*p*-Value	I^2
All	21	25	9936	.03	.04	−0.01, 0.07	1.39	.16	70.16
Elderly	1	1	649	.00	.00	−0.07, 0.08	0.10	.92	0
Overweight	3	4	939	.09	.11	0.03, 0.16	2.82	.005	0
Sexual	2	2	1898	−.05	−.06	−0.22, 0.13	−0.51	.61	91.34
Outgroup	3	4	1088	−.00	−.00	−0.18, 0.17	−0.04	.97	85.60
Other	5	5	1883	.06	.07	0.01, 0.11	2.14	.03	23.17
Race	8	9	3473	.04	.05	−0.04, 0.11	0.95	.34	78.69
Sex	2	2	610	−.03	−.03	−0.11, 0.05	−0.77	.44	0

Note: *k*=Number of studies, *n*=Total sample size, $\bar{r}$ = Sample-size weighted random effect average correlation coefficient, $\bar{\rho}$ = Sample-size weighted random effect average correlation coefficient corrected for unreliability, 95% CI=95% Confidence interval of the sample-size weighted random effect average correlation coefficient, *z*-value=*Z*-value of the sample-size weighted random effect average correlation coefficient, *p*-value=*p*-value of the ample-size weighted random effect average correlation coefficient.

95% CI [0.01, 0.07], $p=.01$, $\bar{\rho}=.05$, $k=20$, $n=5950$) to moderate (body odour disgust sensitivity; $\bar{r}=.26$, 95% CI [0.11, 40], $p<.001$, $\bar{\rho}=.29$, $k=1$, $n=159$); however, any moderate correlations were estimated with only a single study, and cannot be considered meta-analytic effects. Instead, the largest of these meta-analytic effects (i.e., estimated with multiple studies) was the relation of perceived infectability and general disgust ($\bar{r}=.17$, 95% CI [0.14, 20], $p<.001$, $\bar{\rho}=.20$, $k=29$, $n=8805$), which was still a significant, positive, and small relation. Therefore, the relation of perceived infectability was consistently statistically significant but small with the various indicators of disgust, including the overall effect.

We next assessed whether the focus of disgust altered the magnitude of our observed relations. To do so, we performed a meta-regression, wherein dummy codes representing the focus of disgust were entered as the sole predictors of the relation of perceived infectability and disgust. We created dummy codes for each focus represented by more than three sources, and all other foci were included within an

'other' category. This resulted in dummy codes for animal, contamination, core, general, moral, pathogen, sexual and other. In the analysis, core was chosen as the referent, and we treated each recorded effect as independent to ensure a sufficient number of observations. The dummy codes explained a significant amount of variance in the relation of perceived infectability and disgust (Q=49.64, df=7, p<.001), but the only significant dummy code was moral (β=−0.12, SE = .03, Z=−3.82, p<.001). This finding indicates that the relation of perceived infectability with moral disgust was significantly smaller than its relation with core disgust. While the foci of disgust together explained significant variance in the relation, all other specific comparisons regarding the focus of disgust did not produce significant differences regarding their relation with perceived infectability.

Outgroup perceptions

Perceived infectability produced a non-significant relation with outgroup perceptions ($\overline{r}$ = .03, 95% CI [−0.01, 07], p=.16, $\overline{\rho}$ = .04, k=25, n=9936). When separated by target, all correlations remained small, and the only two statistically significant relations were between perceived infectability and negative perceptions of overweight individuals ($\overline{r}$ = .09, 95% CI [0.03, 16], p=.005, $\overline{\rho}$ = .11, k=4, n=939) and the other category ($\overline{r}$ = .06, 95% CI [0.01, 11], p=.03, $\overline{\rho}$ = .07, k=5, n=1883). The relation of perceived infectability was consistently non-significant and small with the various indicators of outgroup perceptions, including the overall effect.

We utilized the approach described above to test for the moderating effect of the outgroup target. Because studies varied regarding their outgroup target, the only two categories for our dummy codes were: race and other. The results indicated that the dummy code did not explain a significant amount of variance in the relation of perceived infectability and disgust (Q=1.41, df=1, p=.24), and the effect of the specific dummy code was not statistically significant (β=−0.05, SE = .04, Z=−1.19, p=.24). Therefore, the chosen outgroup target did not significantly alter the relation of perceived infectability and perceptions of outgroup members.

Mediation results

Five studies were included in our test of mediation, as they reported all interrelations of perceived infectability, disgust, and outgroup perceptions. The total sample size of this analysis was 2023. Our test of mediation indicated that perceived infectability produced a significant effect on disgust (β=0.08, SE = .02, z=3.81, p<.001), disgust produced a significant effect on outgroup perceptions (β=0.05, SE = .02, z=2.32, p=.02), and perceived infectability did not produce a significant relation on outgroup perceptions when accounting for disgust (β=−0.02, SE = .02, z=−1.10, p=.27); however, the indirect effect of perceived infectability on outgroup perceptions via disgust was not statistically significant (ab=−.01, 95% CI [−0.00, 0.00]).

Germ aversion

We meta-analytically tested the direct effects of germ aversion on both disgust and outgroup perceptions. Tables 5 and 6 present our publication bias results. For the relations of germ aversion and disgust, no effect indicated that publication biases were present for Begg and Mazumdar's test, whereas Egger's test was significant only for the relation of germ aversion and general disgust. The overall relation of germ aversion and all indicators of disgust produced a trim-and-fill method result indicating that five studies were implied missing, but no other relation implied that five or more studies were missing. The relation of germ aversion and disgust may be underestimated in our analyses. The magnitude of this meta-analytic effect is estimated to be .35, whereas the trim-and-fill adjusted value is .40. While minor,

TABLE 5 Publication bias analyses for the relations of germ aversion and disgust.

Type of disgust	No. of sources	*k*	*n*	$\overline{\alpha}$	Fail-safe *k*	B&M	Egger's test β_0	Egger's test *t*	Trim-and-fill Left of mean	Trim-and-fill Right of mean
All Disgust	49	56	20,928	.79	37,554	−.04	−2.76	3.43	0	5
Animal	11	13	2797	.75	768	−.04	−0.90	0.45	0	0
Body Odour	1	1	159	.92	–	–	–	–	–	–
Contamination	14	16	4612	.61	3257	−.18	−1.93	1.40	0	0
Core	12	15	3853	.77	1745	−.13	−2.23	1.30	0	2
Death	1	1	983	–	–	–	–	–	–	–
Food	3	3	926	.84	76	−.67	−3.18	2.29	0	0
General	27	33	12,712	.81	6948	−.05	−2.16	2.16*	0	0
Interpersonal	1	1	984	.71	–	–	–	–	–	–
Moral	17	19	6097	.86	550	−.02	−0.01	0.01	0	0
Pathogen	24	26	10,417	.78	1447	−.02	−0.07	0.06	0	0
Sexual	17	18	6882	.83	2029	−.09	−1.81	1.37	0	2

Note: *k*=Number of studies, *n*=Total sample size, $\overline{\alpha}$ = Average Cronbach's alpha, B&M=Kendall's τ with continuity correction from Begg and Mazumdar's rank correlation analysis, Egger's Test β_0=Intercept from Egger's Test, Egger's Test *t*=*T*-statistic of slope from Egger's Test, Trim-and-Fill Left of Mean=Implied studies missing from left of mean, Trim-and-Fill Right of Mean=Implied studies missing from right of mean. * $p < .05$.

TABLE 6 Publication bias analyses for the relations of germ aversion and attitude towards outgroups.

Type of outgroup	No. of sources	*k*	*n*	$\overline{\alpha}$	Fail-safe *k*	B&M	Egger's test β_0	Egger's test *t*	Trim-and-fill Left of mean	Trim-and-fill Right of mean
All	24	32	11,004	.85	1836	.13	1.04	1.05	5	0
Elderly	3	4	1981	.76	94	.50	22.15	2.45	1	0
Overweight	4	10	1225	.78	166	.09	0.26	0.25	2	0
Sexual	2	2	1898	.94	–	–	–	–	–	–
Outgroup	2	2	648	.92	–	–	–	–	–	–
Other	5	5	1755	.88	118	−.30	−3.13	0.82	0	2
Race	9	9	3533	.89	48	0	0.04	0.01	2	0
Sex	1	2	568	.87	–	–	–	–	–	–

Note: *k*=number of studies, *n*=total sample size, $\overline{\alpha}$ = average Cronbach's alpha, B&M=Kendall's τ with continuity correction from Begg and Mazumdar's rank correlation analysis, Egger's Test β_0=Intercept from Egger's Test, Egger's Test *t*=*T*-statistic of slope from Egger's Test, Trim-and-Fill Left of Mean=implied studies missing from left of mean, Trim-and-Fill Right of Mean=implied studies missing from right of mean.

readers should interpret this effect with this consideration in mind. Alternatively, for the relation of germ aversion and outgroup perceptions, no effect indicated that publication biases were present for either Egger's or Begg and Mazumdar's tests. The relation of germ aversion and all indicators of outgroup perceptions produced a trim-and-fill method result indicating that five studies were implied missing, but no other relation implied that five or more studies were missing. The relation of germ aversion and outgroup perceptions may be overestimated in our analyses. The magnitude of this meta-analytic effect is estimated to be .16, whereas the trim-and-fill adjusted value is .13. While again minor, readers should interpret this effect with this consideration in mind.

Our fail-safe *k* values were large. For the relations of germ aversion and disgust, all fail-safe *k* values were above 70. For the relations of germ aversion and outgroup perceptions, all fail-safe *k* values were above 45. These findings indicate that a very large number of undiscovered studies would need to exist to notably sway our interpretations, supporting the robustness of our findings. Thus, our fail-safe *k* values support our interpretations.

Tables 7 and 8 present our findings on the relations of germ aversion with disgust and outgroup perceptions, respectively. Germ aversion produced a significant, positive, and moderate relation with all indicators of disgust together ($\bar{r}$ = .35, 95% CI [0.32, 39], p<.001, $\bar{\rho}$ = .46, k=56, n=20,928). When separated by the targets of disgust, the coefficients ranged from small (moral disgust sensitivity; $\bar{r}$ = .14, 95% CI [0.11, 18], p<.001, $\bar{\rho}$ = .18, k=19, n=6097) to very large (interpersonal disgust sensitivity; $\bar{r}$ = .68, 95% CI [0.65, 0.71], p<.001, $\bar{\rho}$ = .94, k=1, n=984); however, this very large correlation was estimated with only a single study. The largest of these meta-analytic effects (i.e., estimated with multiple studies) was the relation of germ aversion and contamination disgust ($\bar{r}$ = .42, 95% CI [0.35, 0.48], p<.001, $\bar{\rho}$ = .63, k=16, n=4612). The relation of perceived infectability was consistently significant and moderate to large with the indicators of disgust, including the overall effect. Furthermore, germ aversion produced a significant and small relation with outgroup perceptions ($\bar{r}$ = .16, 95% CI [0.12, 21], p<.001, $\bar{\rho}$ = .20, k=32, n=11,004). When separated by target, all conditions except for one remained statistically significant, and the magnitude of effect sizes ranged from small (race; $\bar{r}$ = .09, 95% CI [0.04, 20], p=.02, $\bar{\rho}$ = .11, k=9, n=3533) to moderate (overweight; $\bar{r}$ = .25, 95% CI [0.17, 0.33], p<.001, $\bar{\rho}$ = .33, k=10, n=1225). The relation of germ aversion was consistently significant and small to moderate with the indicators of outgroup perceptions.

Lastly, we tested whether the overall relations of germ aversion with disgust and outgroup perceptions were larger than those of perceived infectability. The correlation of germ aversion ($\bar{r}$ = .35, 95% CI [0.32, 39], p<.001, $\bar{\rho}$ = .46, k=56, n=20,928) was significantly larger (Z=23.17, p<.001) than the correlation of perceived infectability ($\bar{r}$ = .13, 95% CI [0.11, 15], p<.001, $\bar{\rho}$ = .16, k=57, n=18,243) with disgust, and the correlation of germ aversion ($\bar{r}$ = .16, 95% CI [0.12, 21], p<.001, $\bar{\rho}$ = .20, k=32, n=11,004) was significantly larger (Z=9.49, p<.001) than the correlation of perceived infectability ($\bar{r}$ = .03, 95% CI [−0.01, 07], p=.16, $\bar{\rho}$ = .04, k=25, n=9936) with outgroup perceptions.

TABLE 7 Relations of germ aversion and disgust.

Construct	No. of sources	*k*	*n*	$\bar{r}$	$\bar{\rho}$	95% CI	*z*-Value	*p*-Value	I^2
All Disgust	49	56	20,928	.35	.46	0.32, 0.39	18.78	<.001	86.14
Animal	11	13	2797	.29	.39	0.22, 0.36	7.73	<.001	73.55
Body Odour	1	1	159	.24	.29	0.09, 0.38	3.06	.002	0
Contamination	14	16	4612	.42	.63	0.35, 0.48	11.32	<.001	83.16
Core	12	15	3853	.34	.45	0.26, 0.42	8.05	<.001	84.67
Death	1	1	983	.29	.29	0.23, 0.35	9.35	<.001	0
Food	3	3	926	.34	.43	0.27, 0.41	8.74	<.001	25.44
General	27	33	12,712	.40	.52	0.36, 0.45	15.90	<.001	87.14
Interpersonal	1	1	984	.68	.94	0.65, 0.71	25.97	<.001	0
Moral	17	19	6097	.14	.18	0.11, 0.18	7.24	<.001	53.78
Pathogen	24	26	10,417	.41	.54	0.37, 0.44	20.46	<.001	75.65
Sexual	17	18	6882	.26	.33	0.22, 0.30	12.12	<.001	65.30

Note: *k*=number of studies, *n*=total sample size, $\bar{r}$ = sample-size weighted random effect average correlation coefficient, $\bar{\rho}$ = sample-size weighted random effect average correlation coefficient corrected for unreliability, 95% CI=95% confidence interval of the sample-size weighted random effect average correlation coefficient, *z*-value=*Z*-value of the sample-size weighted random effect average correlation coefficient, *p*-value=*p*-value of the ample-size weighted random effect average correlation coefficient.

TABLE 8 Relations of germ aversion and attitude towards outgroups.

Construct	No. of sources	*k*	*n*	$\bar{r}$	$\bar{\rho}$	95% CI	*z*-value	*p*-value	I^2
All	24	32	11,004	.16	.20	0.12, 0.21	6.76	<.001	81.22
Elderly	3	4	1981	.23	.31	0.08, 0.37	2.95	.003	91.52
Overweight	4	10	1225	.25	.33	0.17, 0.33	5.77	<.001	45.57
Sexual	2	2	1898	.11	.13	0.00, 0.22	2.01	.04	77.99
Outgroup	2	2	648	.08	.10	−0.19, 0.34	0.60	.55	75.88
Other	5	5	1755	.23	.29	0.10, 0.35	3.45	.001	84.89
Race	9	9	3533	.09	.11	0.02, 0.15	2.43	.02	75.09
Sex	1	2	568	.12	.15	0.04, 0.20	2.79	.005	0

Note: *k*=number of studies, *n*=total sample size, $\bar{r}$ = sample-size weighted random effect average correlation coefficient, $\bar{\rho}$ = sample-size weighted random effect average correlation coefficient corrected for unreliability, 95% CI=95% confidence interval of the sample-size weighted random effect average correlation coefficient, *z*-value=*Z*-value of the sample-size weighted random effect average correlation coefficient, *p*-value=*p*-value of the ample-size weighted random effect average correlation coefficient.

Supplemental analyses

A possible moderating effect on our results is the year of each source. The COVID-19 pandemic altered the extent and manner in which people perceived their health, as the possibility of illness became significantly more salient to all people (Kim et al., 2022; Millar et al., 2023; Peng & Bai, 2024). The powerful effects of the COVID-19 pandemic may have altered the relations of perceived infectability. To test this possibility, we performed several analyses to inspect the effect of year on the relation of perceived infectability, disgust and outgroup perceptions, wherein we tested a variety of dummy-coded schemes in our analyses. For instance, we tested whether our relations differed when comparing sources produced prior to 2020 against sources produced in 2020 and after, but we also tested whether our relations differed when comparing sources produced between 2020 and 2023 against all other sources. None of these analyses found that the publication year produced systematic differences in our tested relations, indicating that the COVID-19 pandemic did not change the nature of our relations. For example, meta-regressions comparing relations of perceived infectability in sources produced prior to 2020 against sources produced in 2020 and after were not significant for disgust (Q=1.89, df=1, p=.17) or outgroup perceptions (Q=−.04, df=1, p=.33). Additional analyses found that publication year, when treated as a continuous variable, did not significantly influence any of our tested relations, as the meta-regressions did not produce significant effects for the relations of perceived infectability with either disgust (Q=1.67, df=1, p=.20) or outgroup perceptions (Q=.71, df=1, p=.40). Therefore, publication year did not influence the nature of our relations.

The operationalization of perceived infectability may influence our results. For this reason, we coded the applied measure of perceived infectability in each of our sources. We found that all sources reporting effects that could be included in our meta-analytic database applied the perceived infectability subscale of the Perceived Vulnerability to Disease Questionnaire (PVDQ). Because most studies utilized the PVDQ, a multitude of authors have provided significant psychometric and validity information regarding the measure, supporting its applicability as a measure of perceived infectability. Because no authors both applied alternative measures and reported statistical results that could be included, we could not determine whether the operationalization of perceived infectability influenced our results.

Likewise, operationalizing disgust as either a felt emotion or disgust sensitivity may influence our results. We coded whether each source studied felt disgust or disgust sensitivity. We found that 50 studies investigated the relation of perceived infectability with disgust sensitivity, whereas only 6 investigated the relation of perceived infectability with felt disgust. This finding supports our arguments that the extant literature has primarily investigated the role of disgust in the behavioural immune system as disgust sensitivity. The relation of perceived infectability and disgust sensitivity was small ($\bar{r}$ = .13, 95% CI

[0.11, 15], $p < .001$, $\overline{\rho} = .16$, $k = 52$, $n = 17{,}183$), as was the relation of perceived infectability and felt disgust ($\overline{r} = .09$, 95% CI [0.02, 16], $p < .01$, $\overline{\rho} = .11$, $k = 6$, $n = 1463$). A meta-regression comparing the effect sizes between disgust sensitivity and disgust was not statistically significant ($Q = .80$, $df = 1$, $p = .37$), indicating that the operationalization of disgust as either sensitivity or felt did not significantly influence its magnitude of relation with perceived infectability.

DISCUSSION

The relations of perceived infectability with disgust and outgroup perceptions are central to the behavioural immune system and theories focused on both emotions and intergroup relations (Faulkner et al., 2004; Kam, 2019; Millar et al., 2023). Despite its popularity, a quantitative review of the relations between perceived infectability with disgust and outgroup perceptions has yet to be produced, causing significant tensions in the present literature. Authors are forced to reference individual study results throughout their theorizing, perhaps placing too large a reliance on potentially unreliable findings. They also often conflate perceived infectability and germ aversion in research, obfuscating the true nature of relations associated with the behavioural immune system. As highlighted by van Leeuwen et al. (2023), among others, the extant literature on these effects is often viewed as overall supportive but also incomplete.

The current article resolves this tension in the literature by performing a meta-analysis investigating these relations. From an initial database of 11,234 sources, our multiple-phase coding process identified a final list of 74 sources that were included in our meta-analysis. Our results demonstrated that perceived infectability consistently produced small and significant relations with disgust, and the magnitude of these relations largely did not differ based on the foci of disgust (e.g., pathogen). Our results also showed that perceived infectability consistently produced very small and non-statistically significant relations with outgroup perceptions, and the magnitude of these relations did not differ based on the foci of the perceptions (e.g., race). Each of these effects was also significantly smaller than the relations of gem aversion with disgust and outgroup perceptions. Lastly, the indirect effect of perceived infectability on outgroup perceptions via disgust was not statistically significant. Together, these results indicate that these relations are not strong or particularly robust, producing a contrast with assumptions in the present literature. These findings provide several implications for research and practice.

Theoretical implications and future research directions

Perceived infectability and disgust

Authors have argued that the behavioural immune system compensates for weak biological immune systems, such that people who are temporarily or permanently vulnerable to illness experience greater sensitivities to disgust to avoid potentially pathogenic threats (Fessler et al., 2005; Makhanova et al., 2022; Olatunji et al., 2019). Our results support this notion, but they also indicate that the relation of perceived infectability with disgust is small. Researchers should continue developing theory regarding the compensatory effect of the behavioural immune system for the biological immune system, but they should also recognize the nuance in this relation and understand that the effect is weak. Given this finding, it should be questioned why prior research assumed this relation is robust and the associated implications. In our meta-analytic database, some studies produced moderate effects between perceived infectability and disgust. While these studies were outnumbered by much smaller findings, prior researchers likely over-relied on these moderate results when developing their arguments and theories. Future researchers should realign their perspectives regarding the magnitude of this relation in two manners.

First, researchers need to ensure that their studies are sufficiently powered. Many studies utilized samples of less than 100 participants in our meta-analytic database, which is much too small to reliably detect small effect sizes for most statistical analyses (Cohen, 1992). These authors rely on sampling variation to detect their effects, suggesting a significant concern in the literature. While our meta-analysis overcomes this limitation by aggregating the effects of these studies to produce robust estimates, future researchers must ensure that their studies are sufficiently powered. Second, researchers must acknowledge that alternative effects explain the vast majority of variance in disgust, as perceived infectability only explains a fraction of variance. Specifically, creating and testing broad omnibus models that account for multiple predictors of disgust is necessary to understand the differential variance explained by multiple predictors. The variance of multiple predictors may be relatively partitioned, such that each still produces a significant effect when studied together; however, the variance may also be overlapping, such that some effects are no longer statistically significant when tested together (Nimon & Oswald, 2013; Tonidandel et al., 2009). Given its small effect, this finding is possible for perceived infectability, suggesting a particularly important avenue for research.

It should be recognized that authors have predominantly investigated the relations of perceived infectability with disgust sensitivity rather than felt disgust. While our observed results did not differ whether researchers investigated felt disgust or disgust sensitivity, future researchers should investigate the role of felt disgust in the behavioural immune system. Relevant theory on the behavioural immune system proposes that certain people are more likely to experience disgust, which has led to the greater study of perceived infectability with disgust sensitivity (Fitzgerald et al., 2022; Schaller & Park, 2011); however, these prior authors have fallen short of investigating the entirety of these theoretical perspectives by not including investigations on felt disgust. Therefore, investigating this understudied linkage of perceived infectability could provide a more complete depiction of the behavioural immune system, although this relation was still observed to be small in the current meta-analysis.

Perceived infectability and outgroup perceptions

Researchers have suggested that people who perceived themselves as more vulnerable to illness are more likely to stigmatize outgroup members, as their active behavioural immune systems would be more likely to protect themselves from those with differing immunological histories (Magallares et al., 2015; Park et al., 2003; Welling et al., 2007). Our results challenge this notion. Perceived infectability produced a weak and non-significant relation with outgroup perceptions, and it also produced a non-significant mediating effect on outgroup perceptions via disgust. One's subjective assessment of their susceptibility has little effect on how they perceive outgroup members, which alters how relevant theory should be approached.

Perceived infectability did not produce a significant indirect effect on outgroup perceptions via disgust, and its non-significant direct effect suggests that an alternative mediator does not explain a sizable relation between perceived infectability and disgust. Like the relation of perceived infectability and disgust, researchers have overinterpreted prior results utilizing the PVDQ in assessing the relation of the subjective evaluation of one's propensity to illness and outgroup perceptions, as germ aversion produces stronger relations with outgroup perceptions than perceived infectability (Do Bú et al., 2023; Faulkner et al., 2004; Klavina et al., 2011). A person's sensitivity to disgust may influence both their germ aversion and outgroup perceptions, while perceived infectability plays a much smaller role in developing outgroup perceptions as an antecedent effect. This observation indicates that models and theories of outgroup perceptions may still incorporate the behavioural immune system, but the impact of individual differences associated with fitness may play a smaller role than previously assumed.

A benefit of our work should also be emphasized in this regard. It is difficult to perform a single experiment that compares the magnitude of effects regarding many different types of disgust and/or outgroup targets while maintaining a sufficient sample size; however, our meta-analysis was able to

compare these effects with an aggregated sample size in the tens-of-thousands. By doing so, we provide direct insights into whether certain outgroups are more closely associated with the behavioural immune system, testing effects proposed by recent authors. Because testing these effects in single studies is difficult, future researchers should seek other effects that could be meta-analytically tested in a similar manner. For instance, researchers could assess effects regarding specific outgroups across contexts, assessing the potential of cultural impacts on these relations. Thus, our meta-analysis can serve as a guide for these studies.

Perceived infectability and germ aversion

Many studies operationalize perceptions of one's propensity for illness via the PVDQ, which includes the dimensions of perceived illness and germ aversion. These authors regularly observe moderate relations with disgust (Garza et al., 2023; Olatunji et al., 2025). Our meta-analysis demonstrated that perceived infectability produces small relations with disgust, whereas germ aversion produces significantly larger relations (Chiesi et al., 2022; Do Bú et al., 2023; Ferreira et al., 2022). Researchers have interpreted the PVDQ as representing the subjective evaluation of one's propensity for illness, which would be an inappropriate assertion given the differences between perceived infectability and germ aversion. Perceived infectability is an indicator of a weakened immune system and cognitive biases that produce a (relatively modest) greater sensitivity to disgust; however, germ aversion is an outcome of a greater sensitivity to disgust, as people are more likely to avoid pathogen risks because they feel greater disgust from them (Chiesi et al., 2022; Do Bú et al., 2023; Ferreira et al., 2022). Perceived infectability is an antecedent of disgust, whereas germ aversion is an outcome. Models of the behavioural immune system should be revised to account for this differing placement of perceived infectability and germ aversion, necessitating the reinspection of prior results through new theoretical lenses.

Specifically, researchers should study the separation of perceived infectability and germ aversion, especially by testing whether the latter possesses a novel function in the behavioural immune system. The current meta-analysis can only provide inferences regarding the existence of relations rather than the nature of any causal effects, which should be an endeavour for future researchers. Namely, we suggest that germ aversion is an outcome of a greater disgust sensitivity, but it may also be an antecedent to outgroup perceptions. That is, greater sensitivity to disgust causes people to habitually avoid contexts with perceived infectious pathogens (i.e., germ aversion), and their tendency to avoid these contexts may cause them to subsequently hold more negative perceptions of outgroup members with different immunological histories (and trigger pathogen cues). Germ aversion may therefore serve as a valuable – but presently unrecognized – explanatory mechanism for this portion of the behavioural immune system. If found to mediate these relations, future research would need to integrate theory more directly associated with germ aversion when studying outgroup biases produced by the behavioural immune system.

Alternative amplifiers of the behavioural immune system

Researchers should probe alternative amplifiers of the behavioural immune system, as perceived infectability produced small effects on disgust responses. We suggest two candidate mechanisms. First, conscious evaluations and implicit cognitions are related to a large extent (Bartels & Schoenrade, 2022; Schimmack, 2021). If one produces weak effects, it can be generally expected that the other would too. Despite this likelihood, future researchers should explore the extent that implicit perceptions of infectability relate to disgust, as the behavioural immune system operates implicitly. Perceived infectability

reflects cognitive self-assessments of health, whereas disgust corresponds to an affective-motivational system that may not map neatly onto self-judgements. Implicit cognitions may be a predictor of both perceived infectability and disgust, despite the two outcomes producing a modest relation between each other.

Second, conscious evaluations and implicit cognitions regarding the potential of illness may be only common byproducts of the behavioural immune system, wherein immune system functioning triggers both. The brain may be inherently intertwined with the behavioural immune system, such that actual susceptibility to illness may influence the behavioural immune system independent from any conscious evaluations or implicit cognitions. That is, specific areas of the brain may initiate feelings of disgust that largely operate outside of conscious evaluations of well-being. While studies have demonstrated that these emotion regulation aspects of the brain are associated with evaluations (Wiens, 2006; Winkielman & Berridge, 2004), it cannot be guaranteed that the same effects operate for the behavioural immune system. This process may be largely biological in nature, requiring substantial revisions to extant theory. Future researchers should assess the extent to which immune system functioning relates to disgust, utilising more advanced measurement approaches than illness histories, such as obtaining biological indicators of immune system functioning in the present moment.

Researchers should also consider integrating novel theory into the behavioural immune system framework. The behavioural immune system framework excludes the potential impact of pathways that can be explained via observational learning and other social cognitive characteristics or processes (e.g., cultural background), which may contribute to heightened perceived infectibility and disgust. Social cognitive theory asserts that individual learning and behaviour result from the reciprocal interaction among personal characteristics, environmental influences, and behaviour (Bandura, 2013). This theory also posits that individual learning and behaviour are a result of modelling behaviours, attitudes and emotions observed in others (e.g., caregivers). For example, children raised by a caregiver with a biologically weakened immune system (e.g., a primary immunodeficiency; Picard et al., 2015) may themselves possess a heightened perceived likelihood of infectibility. In these cases, social learning and social cognitive effects may be at play, where children observe, learn and develop a heightened perceived infectibility through consistent social modelling of practices such as meticulous hygiene routines or maintaining increased social distance. In turn, these children may be more likely to experience disgust as a result of the perceived infectibility. Thus, integrating the behavioural immune system framework with a social cognitive framework may contribute to a more holistic understanding of enhancing global health promotion and disease prevention (Bandura, 2013), which may also be true for other novel theoretical frameworks.

Practical implications

Public health campaigns are often approached through emotionally driven messages, and different emotions can be strategically triggered to facilitate different persuasive goals (Nabi, 2015). When emotions are intentionally generated via health communication, they can facilitate message acceptance, intention to engage in desired behavioural change, and actual behavioural change (Bleakley et al., 2015; Dillard et al., 1996). For example, public health campaigns often use disgust to promote hygiene (e.g., handwashing posters in restrooms), and similar campaigns, using disgust as a trigger, may resonate more with people who already feel vulnerable to illness. However, as the indirect effect of perceived infectability on outgroup perceptions via disgust was not statistically significant, health campaigns that only focus on preventive behaviours to reduce contamination risks may need to be reconsidered. Policymakers and media professionals should instead focus on other emotional or cognitive factors that show stronger associations. A multi-pronged advertising strategy that prioritizes clarity and scientific accuracy is likely to be more effective.

Limitations and future research directions

Meta-analytic methodology

Our searches were more comprehensive than many meta-analyses on similar topics, resulting in a large initial and final meta-analytic database. We followed best practices in coding our articles to ensure that errors did not impact our interpretations, and we provided sensitivity analyses to show that our interpretations did not differ based on the applied analytical approach. At the same time, researchers differ regarding their approaches to meta-analyses, and other researchers may have produced differing results when testing the same relations. For this reason, future researchers should replicate the current results using alternative search, coding and analytical procedures. While we expect their results to replicate our findings and support the robustness of our interpretations, such efforts are necessary to ensure the validity of findings.

We performed searches to obtain all sources that reported relations of perceived infectability and/or germ aversion with disgust and/or outgroup perceptions. These relations were necessary to test our desired univariate and multivariate relations. Due to our approach, we did not obtain all sources that reported the relation of disgust and outgroup perceptions, as they were not necessary for our univariate hypotheses and could not be included in our multivariate analysis. Future researchers should perform a focused analysis on the relation of disgust and outgroup perceptions to obtain robust meta-analytic estimates for this relation, which could provide more complete perspectives on developing outgroup perceptions.

Models of mediation inherently involve causal relations (Harrer et al., 2021; Jak, 2015). Not enough prior studies investigated our relations of interest using methodological designs that could assess causal effects to perform meta-analyses that could likewise assess causal effects. An immediate next step in this domain of research should be the application of advanced methodological designs, such as panel studies, to assess causal effects (Shamsollahi et al., 2022). Researchers could provide greater assurance for their proposed mechanisms, rather than assuming that cross-sectional observations support the directionality of their proposals.

Similarly, we performed extensive searches to identify all relevant prior sources, but certain effects were tested with a relatively small number of sources. For instance, our meta-analytic structural equation model was calculated with five sources. While the interpretation of our results is unlikely to change with a substantial number of additional studies (as evidenced by our fail-safe k values), there are more interpretative risks when interpreting results with a small number of studies. Authors have suggested that meta-analytic effects calculated with more than 10 studies are particularly robust (IntHout et al., 2015), and future researchers should reassess our meta-analytic estimates when more studies have been conducted on these relations. We expect our results to replicate, providing further support for the robustness of our findings.

A benefit of the meta-analytic methodology is the capability to aggregate prior results across a wide variety of contexts to produce averaged results, causing the analysis to reflect the present literature. Extant studies have not focused on the relation of perceived infectability and disgust with one single outgroup. Instead, significant heterogeneity is evident in outgroup measures, emphasizing that current research on the relation of perceived infectability and outgroup perceptions has utilized a wide variety of outgroup targets. Given this feature of the present literature, our meta-analysis aggregated prior results across a number of outgroups to produce our observed effects. In unreported analyses, we tested whether any subgroup analyses produced differing results. None of these effects could be distinguished from expected variability in results, suggesting that no one outgroup was notably different from the other. This finding also indicates that our decision to aggregate the outgroups together was appropriate. Nevertheless, future researchers should replicate these results once more studies have been conducted, such that they can perform more subgroup analyses that focus on specific outgroup targets. These results could support the robustness of our interpretations even further.

Lastly, we intended to assess whether the applied measures within our meta-analytic database influenced our observed results. Too few authors applied measures of perceived infectability other than the PVDQ subscale and/or measures of felt disgust to perform these comparative analyses. The reliance on specific measures provides significant evidence for the psychometric properties and validity of these measures, and prior authors have repeatedly supported that these measures likely gauge their intended constructs as intended. Future researchers should periodically reassess the proliferation of these measures throughout the literature to determine whether authors are indeed using supported scales.

Unstudied effects

We did not investigate whether our studied relations differed across contexts. The present literature has not identified a justification for our studied effects differing across contexts (e.g., cultural differences), and too few studies investigated our studied relations in differing contexts to perform these comparative assessments via the meta-analytic methodology. Future researchers should consider performing these investigations, once relevant theory has been developed. It should also be recognized that we did perform a multitude of analyses comparing our studied effects across different time ranges, particularly those associated with before and after the COVID-19 pandemic. We demonstrated that these tested relations did not differ across these time periods, suggesting that extant theoretical perspectives may be broadly applicable across contexts. Therefore, our results provide justification for researchers to apply prior theory in future studies, as the COVID-19 pandemic did not alter the nature of our studied relations.

We chose to study perceived infectability due to its prominence in prior research on the behavioural immune system, but other constructs could also provide notable insights in future research. Implicit cognitions of infectability may be more proximal to the behavioural immune system (Delporte et al., 2023; Safra et al., 2021; Troisi et al., 2023). Extant authors may not have studied this construct as regularly as perceived infectability due to its difficulty of measurement, but future researchers should perform meta-analytic investigations on this construct once additional studies have been conducted. It is expected that these implicit cognitions may serve as antecedent effects to perceived infectability, and a meta-analysis could provide robust estimates of this important link in the behavioural immune system.

Likewise, immune system functioning, often operationalized as illness histories, is distinct from perceived infectability. This distinctness is not a limitation of either construct, but instead indicates that the two constructs are unique and play separate roles in the behavioural immune system. While less commonly studied as a representative aspect of the behavioural immune system, immune system functioning is nevertheless included in relevant theories and models (Delporte et al., 2023; Safra et al., 2021; Troisi et al., 2023). A future investigation should perform a similar meta-analysis, wherein authors should assess both the potential antecedent effect of immune system functioning on perceived infectability and the influence of measurement on this relation. Immune system functioning is most often measured by asking respondents to indicate the frequency that they have experienced certain symptoms in the past year (Wilod Versprille et al., 2019). These measures vary based on the exact symptoms, causing the construct to differ across studies. These differences in measurement could produce notably differing results, such that certain checklists produce stronger relations than others. Testing this impact could significantly advance our understanding regarding the antecedent effect of immune system function on perceived infectability—and the behavioural immune system.

CONCLUSION

When studying perceived infectability, researchers were previously forced to leverage specific prior observations to guide their theorization, and they also often referenced prior results on perceived infectability and germ aversion together—or the latter alone—in developing their arguments for the effects of the subjective assessment of one's likelihood of illness. The current article provides

overall assessments for the relations of perceived infectability with disgust and outgroup perceptions, demonstrating that these effects are weak, do not produce a significant mediating effect, and do not vary based on the type of disgust or outgroup perceptions. Based on these results, future researchers should reconsider the role of perceived infectability in the behavioural immune system, as the subjective assessment of one's likelihood of illness does not appear to impact sensitivities to disgust or outgroup perceptions. A promising direction for future research is the replication of prior investigations, applying measures that are specifically aligned with proposed theoretical perspectives. The results of these studies could produce the revision of theory associated with the behavioural immune system, refining our knowledge of how people avoid triggering stimuli in their environment—and who is more sensitive to triggers.

AUTHOR CONTRIBUTIONS

Matt C. Howard: Conceptualization; methodology; software; data curation; investigation; validation; formal analysis; supervision; visualization; project administration; resources; writing – original draft; writing – review and editing. **Maggie Davis:** Writing – original draft; writing – review and editing; methodology; data curation; investigation; project administration. **Emory Serviss:** Writing – original draft; writing – review and editing; methodology; data curation; investigation; project administration.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the Supporting Information of this article.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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