RESEARCH PAPER

# I GOT IT. PERCEIVED INFECTABILITY AND GERM AVERSION AFTER COVID-19 INFECTION

Alfonso Troisi, Valeria Carola, Roberta Croce Nanni


## Abstract

*Objective*: The COVID-19 pandemic has offered a unique opportunity to test evolutionary hypotheses on the functionality of the behavioral immune system. The aim of the present study was to ascertain if a previous infection with COVID-19 was associated with increased levels of perceived infectability and germ aversion. Based on the calibration hypothesis, we predicted that the activation of the behavioral immune system was greater in those participants who had been infected compared to those who reported no previous COVID-19 infection.

*Method*: The sample included 2072 participants who completed an online survey between March 1 and April 10, 2022 when the Italian population was facing the third wave of the COVID-19 pandemic. To measure the activation of the behavioral immune system, we used the Perceived Vulnerability to Disease (PVD) scale.

Results and Conclusions: Perceived infectability was significantly greater in those participants who had been infected compared to those who reported no previous COVID-19 infection but there was no significant difference between the two groups in terms of germ aversion. Overall, our findings suggest that individual differences in the activation of the behavioral immune system were marginally affected by a personal history of COVID-19 infection. A possible explanation is that the environmental sensitivity of the behavioral immune system is tuned more on chronic disease threat (i.e., ecologies with higher pathogen load) than on situational disease threat (e.g., a pandemic or disease outbreak like the COVID-19 pandemic).


**Key words:** COVID-19, infection, behavioral immune system, perceived infectability, germ aversion, calibration hypothesis

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## Introduction

Before the COVID-19 pandemic it was difficult to imagine that the worldwide spreading of a respiratory infectious disease could have so many implications for the study of human psychology and behavior. The challenge of facing a global infectious threat has confirmed the importance of behavioral sciences for the rest of medicine and the necessity of considering the relationship between physical and mental health in terms of bidirectional pathways (Troisi, 2023). Specifically, the COVID-19 pandemic has revealed how evolutionary rooted psychological reactions to the risk of being infected by a potentially severe contagious disease can impact individual adherence to prevention and treatment programs (Troisi et al., 2023).

There is a substantial difference between fear of infection and fear of degenerative diseases that rank at the top of the morbidity statistics in affluent countries. Our ancestors living in the natural environment were not exposed to those risk factors that are typical of modern environments (e.g., extended longevity, high calories diet, sedentary lifestyle, obesity, smoking, drinking alcohol, pollution, etc.) and, therefore, they had an infinitesimal likelihood of getting cancer or developing senile dementia. Yet, they had a very high likelihood of dying from an infection. From an evolutionary perspective, this means that infectious diseases have exerted strong selective pressures on human psychology and behavior (Troisi, 2020).

Selection pressures have reinforced our defenses against infections by causing the evolution of a behavioral immune system that is separate from, and complementary to, the physiological immune system. The behavioral immune system includes a set of proactive mechanisms that inhibit contact with pathogens in the first place. These mechanisms offer a sort of psychological and behavioral prophylaxis against infection (Schaller et al., 2015; Iwasa et al, 2021). Like the physiological immune system, the behavioral immune system includes both detection and response mechanisms. When an external cue connoting infection risk (e.g., seeing another person with symptoms of infectious disease) is detected, it triggers a cascade of emotional and cognitive responses that minimize the infection risk (e.g., through social avoidance of people who appear to pose an infection risk). There are two distinct mechanisms serving the adaptive function of the behavioral immune system. Perceived infectability reflects personal beliefs about the likelihood of being infected by pathogens. Higher levels of perceived infectability are associated with greater fear of infection and increased compliance with preventive behaviors. Germ aversion reflects disgust-driven responses to situations of high risk of disease transmission. Higher levels of germ aversion are associated with greater disease avoidance behaviors (Safra et al., 2021; Church et al., 2022).

From an evolutionary perspective, human variation in many traits and behaviors exists because these characteristics have been calibrated to fit different environments. This theoretical perspective posits that the activation of the behavioral immune system should be adaptively calibrated according to an individual's likelihood of contracting disease. The calibration hypothesis predicts that individuals in environmental settings that are riskier in disease threat should exhibit greater activation of the emotional and cognitive responses that represent the first line of defense against infectious contagion. Thus, individual differences in perceived infectability and germ aversion should reflect environmental differences in chronic disease threat (i.e., ecologies with higher pathogen load) and/or situational disease threat (e.g., a pandemic or disease outbreak) (Boggs et al., 2022).

The COVID-19 pandemic has offered a unique opportunity to test evolutionary hypotheses on the functionality of the behavioral immune system. The aim of the present study was to ascertain if a previous infection with COVID-19 was associated with increased levels of perceived infectability and germ aversion. Based on the calibration hypothesis, we predicted that the activation of the behavioral immune system was greater in those participants who had been infected compared to those who reported no previous COVID-19 infection.

## Materials and Methods

### *Participants*

The sample included 2072 participants (mean age ± SD: 38.00 ± 13.62 years; mean education ± SD: 15.33 ± 3.26 years) who completed an online survey between March 1 and April 10, 2022 when the Italian population was facing the third wave of the COVID-19 pandemic (**figure 1**).

Data collection was made by implementing an anonymous online survey based on a customized Jotform questionnaire (https://www.jotform.com). The survey could be completed using a personal computer/laptop, tablets, or smartphone, in approximately 30 minutes. Participants identified themselves by providing an alphanumeric code or a nickname. The unique ID widget was used to prevent multiple compilations of the online questionnaire. Participants were recruited through virtual snowball sampling. A small pool of initial informants nominated, through their real or virtual social networks, other participants who expressed their interest to contribute to the study. Eligibility criteria were minimum age of 18 years and residence in Italy.

To access the online questionnaire, participants were requested to sign an informed consent that explained the procedure of data collection and the aims of the study. No payment was given for participation. The study was approved by the Ethical Committee of the Department of Dynamic and Clinical Psychology, Sapienza, University of Rome (Prot. n. 0000453 and Prot. n. 0000112).

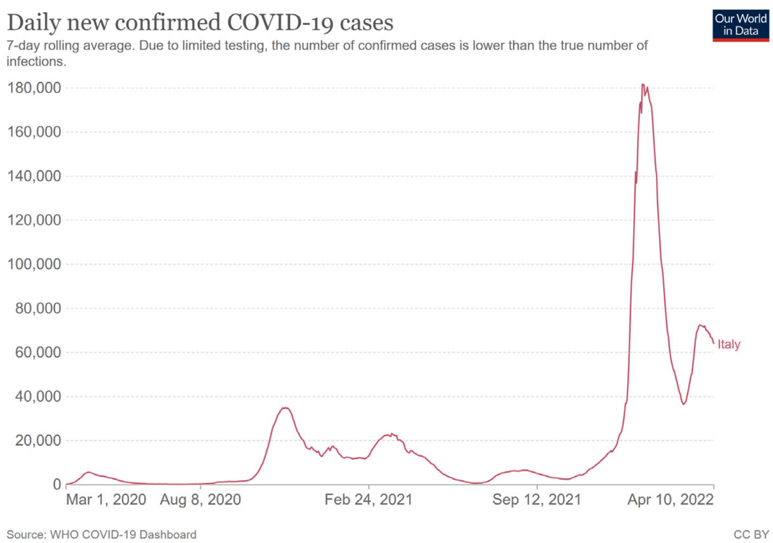
After electronically agreeing to be part of the study, participants completed the primary study measures and other questionnaires in a random order, except for demographics and COVID-19 infection status (Have you ever gotten a confirmed diagnosis of COVID-19?) which appeared last (response options were "yes" coded as 1 or "no" coded as 0).

### *Measures*

#### The Perceived Vulnerability to Disease (PVD) scale

To measure the activation of the behavioral immune

**Figure 1.** *Daily new confirmed cases of COVID-19 in Italy including the period of data collection. Source: https://ourworldindata.org/*coronavirus/country/italy



system, we used the PVD scale. The PVD scale is a measure assessing participants perceived susceptibility to catching infectious disease and their aversion to pathogens (Duncan et al., 2009). The PVD consists of 15-items divided into two subscales. The Perceived Infectability subscale (PI; 7 items) measures perceived susceptibility to infectious diseases in general (e.g., "I am more likely than the people around me to catch an infectious disease"). The Germ Aversion subscale (GA; 8 items) measures aversive response in relation to potential pathogen transmission (e.g., "I prefer to wash my hands pretty soon after shaking someone's hand"). GA predicts responses rooted in intuitive emotional appraisals of risk, whereas PI predicts responses informed by more rational cognitive appraisals. All ratings of items were made on a scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). A total score for each subscale was created by adding up each item score. Higher scores reflect greater perceived infectability or germ aversion. The version used in this study was the Italian version (Troisi et al., 2022). The internal consistency of the two subscales was adequate and acceptable in the present sample: Cronbach's α 0.82 for PI and 0.78 for GA.

**The Disgust Propensity and Sensitivity Scale-Revised (DPSS-R)**

Pathogen disgust sensitivity is elicited by specific stimuli and should be distinguished by general disgust propensity and sensitivity. For this reason, we included among the psychometric measures the Italian version of the DPSS-R (Martoni et al., 2017). The revised version of the DPSS (van Overveld et al., 2006) consists of 16 items aiming at assessing disgust propensity (e.g., "I find something disgusting"; "I worry that I might swallow a disgusting thing") and disgust sensitivity (e.g., "When I feel disgusted, I worry that I might pass out"; "I think feeling disgust is bad for me") irrespective of disgust elicitors. Each statement is rated on a 5-point Likert scale (from 1 "never" to 5 "always"). In our study, the DPSS-R total score showed good internal consistency (Cronbach's α 0.81).

### *Statistical Analysis*

Two-way Analysis of Covariance (ANCOVA) was used to compare PVD and DPSS-R scores of participants with and without previous COVID-19 infection. Effect size was calculated by using partial eta-squared. Gender distribution across the two groups was calculated by using the chi-square statistic. Analysis was performed on a personal computer using SPSS for Windows, version 25.0 (SPSS, Chicago, IL).

## Results

Among the 2072 participants, 821 (39.6%) reported that they had received a confirmed diagnosis of COVID-19 infection. The relative percentage of confirmed cases was slightly higher among women (40.7%) than among men (35.2%) (chi-square = 4.07, $p < 0.05$). Participants with a past diagnosis of COVID-19 infection were younger ($F = 9.54$, $p < 0.005$) and less educated ($F = 6.00$, $p = 0.01$) than participants who had not contracted the infection.

To ascertain if the scores on the two PVD scales were higher in participants with a past diagnosis of COVID-19 infection, we built two-way ANCOVA models with COVID infection and gender as factors, age and education as covariates, and the PVD scales as dependent variables. The first ANCOVA model with the PI scale as the dependent variable showed a significant effect of COVID infection ($F = 10.54$, $p < 0.001$, partial eta-squared = 0.005) and a significant effect of gender ($F = 4.74$, $p < 0.05$, partial eta-squared = 0.002). The interaction effect (COVID-19 infection x gender) ($F = 0.53$, NS) was not significant. Compared to their counterparts, female participants and participants with a past diagnosis of COVID-19 infection scored higher on the measure of perceived infectability (**figure 2**).

The second ANCOVA model with the GA scale as the dependent variable showed a significant effect of gender ($F = 41.79$, $p < 0.001$, partial eta-squared = 0.02). The effect of COVID infection ($F = 1.15$, NS) and the interaction effect (COVID-19 infection x gender) ($F = 0.15$, NS) were not significant. Regardless of a past diagnosis of COVID-19 infection, women scored higher than men on the measure of germ aversion. Germ aversion did not increase after COVID-19 infection (**figure 3**).

**Figure 2.** *Mean scores (± 2 SEM) of the PI-PVD scale in the two cohorts of participants (infected versus noninfected). See text for statistical comparison*

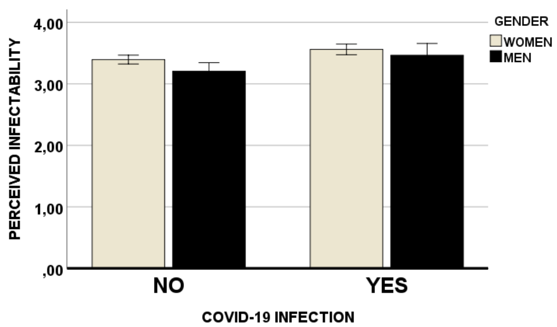



**Figure 3.** *Mean scores (± 2 SEM) of the GA-PVD scale in the two cohorts of participants (infected versus noninfected). See text for statistical comparison*

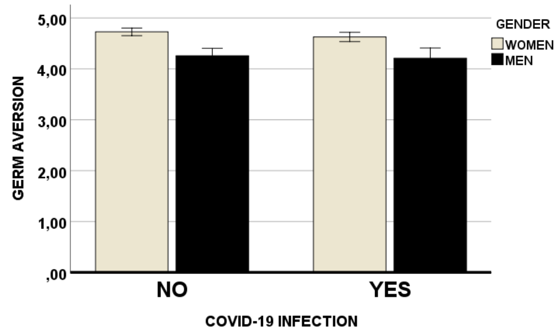
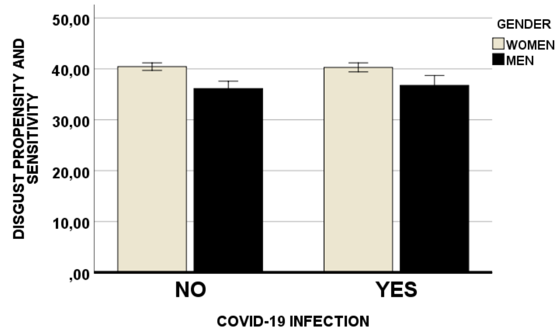



**Figure 4.** *Mean scores (± 2 SEM) of the DPSS-R scale in the two cohorts of participants (infected versus noninfected). See text for statistical comparison*



We repeated the ANCOVA analysis using the DPSS-R score as the dependent variable. We found a significant effect of gender ($F = 34.05$, $p < 0.001$, partial eta-squared = 0.02). The effect of COVID infection ($F = 0.12$, NS) and the interaction effect (COVID-19 infection x gender) ($F = 0.32$, NS) were not significant. Regardless of a past diagnosis of COVID-19 infection, women scored higher than men on the measure of disgust propensity and sensitivity. Disgust propensity and sensitivity did not increase after COVID-19 infection (**figure 4**).

## Discussion

Our prediction that a personal history of COVID-19 infection was associated with higher levels of perceived infectability and germ aversion was only partially confirmed. Perceived infectability was significantly greater in those participants who had been infected compared to those who reported no previous COVID-19 infection but there was no significant difference between the two groups in terms of germ aversion. In addition, it is worth noting that, although the between-groups statistical difference in perceived infectability was highly significant due to the large sample size, the difference in terms of mean scores and the corresponding effect size (i.e., partial eta-squared) were small. Overall, our findings suggest that individual differences in the activation of the behavioral immune system were marginally affected by a personal history of COVID-19 infection. It is likely that individual variation in perceived infectability and germ aversion reflect more trait-like personal characteristics than state-like reactions to contingent environmental stimuli.

The validity of our findings should be assessed in the light of one important methodological limitation. Our data were cross-sectional and we did not measure the activation of the behavioral immune system before and after COVID-19 infection in the same subjects. Thus, even if age, gender and education were included into statistical models to control their confounding effects, it remains possible that the differences (or the lack of) between the infected and noninfected participants were a result of mismatch between individuals in the two cohorts rather than a result of the COVID-19 infection.

Despite this methodological limitation, this is the first study that compared participants who had been infected with those who reported no previous COVID-19 infection. To our knowledge, all previous studies used data collected before the COVID-19 pandemic with data collected during the COVID-19 pandemic, without distinguishing participants on the basis of a confirmed diagnosis of COVID-19 infection. In addition, major differences in the measures used to assess psychological reactions to threat of infection make it furtherly difficult to compare our findings with those of previous studies. Many studies used measures of a general propensity to disgust as the DPSS-R used in the present study. Although we found that a personal history of COVID-19 infection did not exert a significant effect on either the DPSS-R or the GA-PVD, there are important distinctions between germ aversion (defined as a specific reaction to potential disease exposure) and general disgust (defined as a broader emotional response to an array of stimuli) (Duncan et al., 2009). Also, the distinction between perceived infectability and germ aversion should be taken into consideration when interpreting the results of previous studies. Perceived infectability reflects "cold" cognitive beliefs about health risks in contrast to the "hot" emotional processes indexed by germ aversion (Church et al., 2022).

These methodological considerations inform the following discussion of previous studies and may explain the inconsistency of their findings. One study that adopted a within-subjects design compared pathogen disgust sensitivity during the COVID-19 pandemic to baseline pathogen disgust sensitivity, determined prior to the COVID-19 pandemic, in the same sample of UK adults (Carr et al., 2022). In line with our results, the authors found that the pandemic did not alter overall pathogen disgust sensitivity and concluded that disgust sensitivity is stable despite an increased threat of infection. Studies adopting a between-subjects design reported different findings. Milkowska et al. (2021) and Stevenson et al. (2021), who both used matched populations to compare disgust sensitivity pre- and post-pandemic, found that disgust sensitivity was increased during the early stages of the COVID-19 pandemic. Using both cross-sectional and longitudinal methodologies, Boggs et al. (2022) found that disgust sensitivity increased following the outbreak of the pandemic.

Overall, the data collected during the COVID-19 pandemic do not definitively confirm or disconfirm the calibration hypothesis of the behavioral immune system. This is puzzling considering that studies conducted in geographical regions with a high risk of infection have clearly demonstrated how the flexibility of the behavioral immune system is strictly regulated by local pathogen burden (Skolnik and Dzokoto, 2013; Cepon-Robins et al., 2021). A possible explanation is that the environmental sensitivity of the behavioral immune system is tuned more on chronic disease threat (i.e., ecologies with higher pathogen load) than on situational disease threat (e.g., a pandemic or disease outbreak like the COVID-19 pandemic).

Regardless of the validity of the calibration hypothesis, data collected during the COVID-19 pandemic have shown the preventive utility of the behavioral immune system for decreasing the risk of infection. Shook et al. (2020) found that germ aversion correlated with the frequency of preventive health behaviors such as social distancing, avoid touching face, wearing facemask, hand washing and disinfecting objects. Cox et al. (2020) reported that heightened disgust proneness before the pandemic resulted in an increased use of protective behaviors amid the pandemic. Makhanova and Shepherd (2020) found that germ aversion was negatively associated with the number of face-to-face interactions and positively associated with anxiety about social proximity. Troisi et al. (2023) found a significant and positive correlation between pathogen disgust sensitivity and COVID-19 vaccine uptake. For any additional score unit on the GA-PVD scale, the odds of being vaccinated were approximately 1.68 times higher. Thus, the likelihood of being vaccinated for a participant with the highest possible score on the GA-PVD scale was approximately 12 times higher than the likelihood for a participant with the lowest possible score.

In conclusion, irrespective of the specific focus of research, studies of the activation of the behavioral immune system during the COVID-19 pandemic and the analysis of its impact on prevention and treatment programs have much improved our understanding of the importance of evolutionary rooted psychological defenses against the risk of infection.

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