

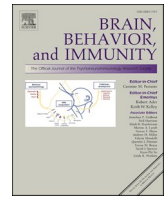


Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

# Brain Behavior and Immunity

journal homepage: [www.elsevier.com/locate/ybrbi](http://www.elsevier.com/locate/ybrbi)

## Viewpoint

# Sorry, I am sneezing and coughing but I do not have COVID-19

Jaouad Bouayed

Université de Lorraine, LCOMS/Neurotoxicologie Alimentaire et Bioactivité, 57000 Metz, France



## ARTICLE INFO

### Keywords:

COVID-19  
Sneezing  
Coughing  
Behavioral immune system  
Stigmatization  
Social rejection

Sneezing and coughing are important defensive reflex responses to expel noxious xenobiotics including infectious agents or irritants, and are also common symptoms of many allergies. However, they further permit the transmission of pathogens in the case of respiratory infectious diseases. Droplets of variable size can be propelled by these airway reflexes (Dhand and Li, 2020; Prather et al., 2020). A sneeze expels around 40,000 droplets whereas a cough releases around 3,000 ones (Dhand and Li, 2020). Large droplets containing influenza like viruses can move approximately 6 feet (2 m) when an ill individual sneezes or coughs (Dhand and Li, 2020). However, it is estimated that intense sneezes and coughs can propel large droplets more than 20 feet (6 m) (Prather et al., 2020). Wearing a face mask, and covering mouth and nose with flexed elbow or tissue when coughing or sneezing are largely adopted means, among other protective behavior, proposed by the government and used by people to control the spread of the novel coronavirus disease 2019 (COVID-19). Droplets ( $>5$  to  $10\ \mu\text{m}$ ) and aerosols ( $\leq 5\ \mu\text{m}$ ) constitute the main mean of the transmission of COVID-19 (Prather et al., 2020), which appears as a flu-like illness. Thus, protective personal measures could significantly reduce the dispersion distance and virus load from sneezing and coughing by asymptomatic and symptomatic persons (Dhand and Li, 2020). Flu-like symptoms include sneezing, a less common symptom of COVID-19, and coughing, a common symptom that is present in up to 70 % of symptomatic COVID-19 patients (Song et al., 2021), constitute the main reasons for COVID-19-related stigma. For example, it has been reported that coughing has constituted a significant stigma-related factor for COVID-19 patients with cough, leading to their social isolation (Song et al., 2021). However, coughing can persist even for months in the case of post-COVID syndrome. It has been demonstrated that in the time of a flu pandemic, public sneezing increases the

perception of contracting serious diseases (e.g. flu) as well as the perception of unrelated risks (e.g. heart attack and dying from accident) (Lee et al., 2010). It has been highlighted that humans do not distinguish between sneezing and coughing sounds from infectious and non-infectious origins (Michalak et al., 2020). This suggests that benign as well as infectious sneezing and coughing sounds could be confounded, and thus individuals may rather perceive benign ones or the protective reflex responses from uninfected individuals for infectious threats that have to be avoided.

Sneezing and coughing may act as sensory cues, indicative of potential contamination by the new coronavirus, activating the behavioral immune system (BIS), the first line of defense against infection threat. The BIS triggers adaptive responses that encourages pathogen-avoidance behaviors, decreasing the risk of infection and spread, and conserving the physiological immune system that is reactive, metabolically costly and risks collateral damage (Schaller, 2011; Murray et al., 2019; Miller and Maner, 2011; Williams and Dienes, 2020). When the threat of infection is imminent, it is thought that the BIS may proactively induce the responses of the physiological immune system, e.g. to produce more pro-inflammatory cytokines (Schaller, 2011; Murray et al., 2019; Miller and Maner, 2011). However, the BIS has evolved to be hypersensible, as humans may also proactively respond to erroneous cues that pose no actual infection threat (Schaller, 2011). Thus, sneezing and coughing from both infected and uninfected persons could promote COVID-avoidant attitudes, including proactive and social distancing behaviors.

Nevertheless, the BIS is characterized by a significant variability in reactivity or sensitivity across individuals, and the threat level may also influence its response (Schaller, 2011; Miller and Maner, 2011). For

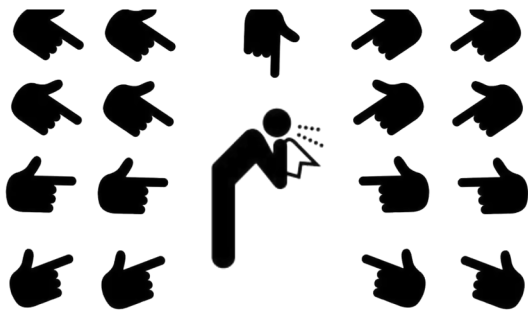
E-mail address: [jaouad.bouayed@univ-lorraine.fr](mailto:jaouad.bouayed@univ-lorraine.fr).

<https://doi.org/10.1016/j.bbi.2021.12.018>

Received 1 November 2021; Received in revised form 11 December 2021; Accepted 18 December 2021

Available online 27 December 2021

0889-1591/© 2021 Elsevier Inc. All rights reserved.



**Fig. 1.** Public sneezing or coughing during COVID-19 pandemic could become a source of embarrassment or stigmatization for uninfected individuals, as they could be perceived by members of the community as sensory signals indicative of potential infection threat by the causative virus, the severe acute respiratory syndrome coronavirus (SARS-CoV-2). The behavioral immune system (BIS) is a proactive system that detects a broad range of sensory cues indicating a real but also a potential threat of infection, and thus it could make errors of detection, judging e.g. a sneezing or coughing of uninfected person to be infectious. Depending on its sensibility that is variable among individuals and also the level of the threat, BIS triggers adaptive prophylactic behavior to avoid the source of infection in the goal to conserve the physiological immune system that is reactive, metabolically costly and risks to cause collateral damages. When the level of threat is perceived as imminent, BIS may also proactively activate the physiological immune system. Excessive BIS activation may lead to adverse behavioral outcomes including stigma-related behaviors such as social rejection and discrimination.

instance, people with a profile indicative of strong physiological immunity such as men with low cortisol and high testosterone levels exhibited weaker behavioral immune responses (Murray et al., 2019). In contrast, people with higher traits of contamination fear or with a higher pathogen disgust sensitivity, or those who have recently been ill are expected to engage in a more prophylactic behavior or even exhibiting negative attitudes (Murray et al., 2019; Miller and Maner, 2011). Thus, they might erroneously perceive a healthy person sneezing or coughing as being infectious. Disgust is an important component of the BIS (Schaller, 2011; Murray et al., 2019). Interestingly, it has been shown that the more disgusting sneezing and coughing sounds from uninfected individuals have been erroneously judged as auditory cues, indicative of infection threat similarly to those originating from infected individuals (Michalak et al., 2020). Nowadays, it has been reported that many healthy people, smokers or individuals suffering from non-infectious diseases such as allergies try to inhibit coughing or sneezing or even do it discreetly to avoid being embarrassed or stigmatized in public (Fig. 1) (Williams and Dienes, 2020). In fact, although the BIS functions to minimize the likelihood of infection, its hyperactivation could rather promote prejudicial attitudes including stigmatization, discrimination, xenophobia, and social rejection (Schaller, 2011).

Some of these negative social behaviors have emerged during the beginning of the COVID-19 pandemic towards people of Asian descent. Stigma, an attribute that is deeply discreditable or undesirable,

constitutes a common adverse social consequence of infectious diseases, including COVID-19 (Yuan et al., 2021). It has been argued that fear and anxiety of contracting COVID-19 that is spreading rapidly, are the main drivers of stigma towards vulnerable populations (Yuan et al., 2021). Social stigma is often associated with devaluation, exclusion and discrimination, as stigmatized individuals may suffer e.g. from avoidance, social rejection, denials of employments, and physical and psychological violence. In a meta-analysis, it has been found that COVID-19-related stigma affected more than third of vulnerable populations including infected patients, community populations and healthcare workers (Yuan et al., 2021). For example, during the early stage of this pandemic, it has been reported that some individuals who recovered from COVID-19 and also some frontline medical workers did suffer from stigma related-behavior, including prohibition of access to public transportation, assaults on the street or during the course of work and were imposed to move out of their rented houses (Yuan et al., 2021).

During this unprecedented global health crisis, the perception of humans towards sneezing and coughing has been undoubtedly significantly altered, owing to the fear and anxiety in healthy people to become contaminated, which raises the question whether these airway reflexes are still accepted in public when compared to the pre-COVID period. It should not be forgotten that sneezing and coughing are very frequent signs of allergy and common colds, and this should be also stressed by health professionals and medical stakeholders in order to avoid a social gap for concerned individuals.

## References

- Dhand, R., Li, J., 2020. Coughs and sneezes: their role in transmission of respiratory viral infections, including SARS-CoV-2. *Am. J. Respir. Crit. Care Med.* 202 (5), 651–659.
- Lee, S.W.S., Schwarz, N., Taubman, D., Hou, M., 2010. Sneezing in times of a flu pandemic: public sneezing increases perception of unrelated risks and shifts preferences for federal spending. *Psychol. Sci.* 21 (3), 375–377.
- Michalak, N.M., Sng, O., Wang, I.M., Ackerman, J., 2020. Sounds of sickness: can people identify infectious disease using sounds of coughs and sneezes? *Proc Biol Sci.* 287 (1928), 20200944.
- Miller, S.L., Maner, J.K., 2011. Sick body, vigilant mind: the biological immune system activates the behavioral immune system. *Psychol. Sci.* 22, 1467–1471.
- Murray, D.R., Prokosch, M.L., Airington, Z., 2019. Psychobehavioroimmunology: connecting the behavioral immune system to its physiological foundations. *Front. Psychol.* 7 (10), 200.
- Prather, K.A., Wang, C.C., Schooley, R.T., 2020. Reducing transmission of SARS-CoV-2. *Science* 368, 1422–1424.
- Schaller, M., 2011. The behavioural immune system and the psychology of human sociality. *Phil. Trans. R. Soc. B* 366, 3418–3426.
- Song, W.J., Hui, C.K.M., Hull, J.H., Birring, S.S., McGarvey, L., Mazzone, S.B., Chung, K.F., 2021. Confronting COVID-19-associated cough and the post-COVID syndrome: role of viral neurotropism, neuroinflammation, and neuroimmune responses. *Lancet Respir. Med.* 9 (5), 533–544.
- Williams, S.N., Dienes, K. Coronavirus: new social rules are leading to new types of stigma 2020. *The Conversation*. <https://theconversation.com/coronavirus-new-social-rules-are-leading-to-new-types-of-stigma-142885>.
- Yuan, K., Huang, X.L., Yan, W., Zhang, Y.X., Gong, Y.M., Su, S.Z., Huang, Y.T., Zhong, Y., Wang, Y.J., Yuan, Z., Tian, S.S., Zheng, Y.B., Fan, T.T., Zhang, Y.J., Meng, S.Q., Sun, Y.K., Lin, X., Zhang, T.M., Ran, M.S., Wong, S.Y., Rüsich, N., Shi, L., Bao, Y.P., Lu, L., 2021. A systematic review and meta-analysis on the prevalence of stigma in infectious diseases, including COVID-19: a call to action. *Mol. Psychiatry* 27, 1–15.