Addendum: Neural anticipation of virtual infection triggers an immune response

Addendum to: *Nature Neuroscience* https://doi.org/10.1038/s41593-025-02008-y, published online 28 July 2025.

https://doi.org/10.1038/s41593-026-02284-2

Published online: 24 April 2026

Check for updates

Sara Trabanelli, Michel Akselrod, Julia Fellrath, Giulia Vanoni, Tommaso Bertoni, Silvia Serino, Georgia Papadopoulou, Maren Born, Matteo Girondini, Giuseppe Ercolano, Giulia Ellena, Anthony Cornu, Giulio Mastria, Hector Gallart-Ayala, Julijana Ivanisevic, Petr Grivaz, Maria Paola Paladino, Camilla Jandus & Andrea Serino

The authors wish to acknowledge previous research that has provided evidence for links between perceptual processing of disease-related cues and biological immune responses. A seminal study reported that viewing images depicting symptoms of infectious disease enhanced the IL-6 response in blood samples exposed to a subsequent immune challenge[1]. Further studies reported changes in salivary immune markers (including cytokines, TNF-α and secretory immunoglobulin A, sIgA) upon exposure to disease-related cues such as images, videos or virtual reality interactions with individuals displaying symptoms of illness (for example, sneezing or coughing)[2–8]. However, in some of these studies, comparable changes in immune markers were observed following exposure to both potentially contagious and control cues[3,6–8]. In addition, salivary immune monitoring presents methodological challenges, so that more than one quarter of the collected saliva samples were excluded from analysis because of insufficient sample quality or reliability. As a result, findings based solely on salivary immune markers should be interpreted with caution and should be considered as preliminary indicators of immune modulation. More robust immuno-monitoring analyses should rather focus on soluble markers, immune cell frequency and activation measurements, and bulk RNA profiling in the blood samples of participants exposed to infection-related cues.

Another line of research has investigated the neural processing of disease cues using functional magnetic resonance imaging[8–10]. These studies examined responses to visual and even olfactory signs of illness and reported activation in regions including middle frontal and orbitofrontal cortex (associated with salience evaluation and decision making), higher-order sensory regions, such as inferior temporal and occipital cortices, multisensory areas, processing exteroceptive, e.g., intraparietal sulcus, or interoceptive, i.e., insula - body-related stimuli. Together, these findings demonstrate neural sensitivity to sickness cues, but not whether such neural responses translate into anticipatory activation of the immune system, nor through which neuro-immune pathways such interactions might occur.

The findings from Trabanelli et al. extend the framework of anticipatory neuro-immune activation in humans, demonstrating that predictive neural processes may engage immune pathways in preparation for potential infection.

References

1. Schaller, M., Miller, G. E., Gervais, W. M., Yager, S. & Chen, E. Mere visual perception of other people's disease symptoms facilitates a more aggressive immune response. *Psychol. Sci.* **21**, 649–652 (2010).
2. Stevenson, R. J. et al. Disgust elevates core body temperature and up-regulates certain oral immune markers. *Brain. Behav. Immun.* **26**, 1160–1168 (2012).
3. Stevenson, R. J., Hodgson, D., Oaten, M. J., Barouei, J. & Case, T. I. The effect of disgust on oral immune function. *Psychophysiology* **48**, 900–907 (2011).
4. Keller, J. K., Wülfing, C., Wahl, J. & Diekhof, E. K. Disease-related disgust promotes antibody release in human saliva. *Brain, Behav. Immun. Health* **24**, 100489 (2022).
5. Keller, J. K. et al. SARS-CoV-2 specific sIgA in saliva increases after disease-related video stimulation. *Sci. Rep.* **13**, 22631 (2023).
6. Keller, J. K. et al. ACHOO - Bless you! Sense of presence can provoke proactive mucosal immune responses in immersive human-agent interactions. *Proc. - 2024 IEEE Conf. Virtual Real. 3D User Interfaces* **VR 2024**, 557–567, https://doi.org/10.1109/VR58804.2024.00076 (2024).

7. Brown, S. G., Ikeuchi, R. K. M. & Lucas, D. R. Collectivism/individualism and its relationship to behavioral and physiological immunity. *Heal. Psychol. Behav. Med.* **2**, 653–664 (2014).
8. Keller, J. K. & Diekhof, E. K. Visual cues of respiratory contagion: their impact on neuroimmune activation and mucosal immune responses in humans. *Brain. Behav. Immun.* **125**, 398–409 (2025).
9. Regenbogen, C. et al. Behavioral and neural correlates to multisensory detection of sick humans. *Proc. Nat. Acad. Sci. USA* **114**, 6400–6405 (2017).
10. Leschak, C. J. et al. Ventromedial prefrontal cortex activity differentiates sick from healthy faces: Associations with inflammatory responses and disease avoidance motivation. *Brain. Behav. Immun.* **100**, 48–54 (2022).