

# Functional connectome of vicarious traumatization: detecting and helping individuals vulnerable to mental illness

Xiao-Ya Wei<sup>1,2</sup>, Xu Wang<sup>1,\*</sup> and Cun-Zhi Liu<sup>2,\*</sup>

<sup>1</sup>School of Life Sciences, Beijing University of Chinese Medicine, Beijing 100029, China

<sup>2</sup>International Acupuncture and Moxibustion Innovation Institute, School of Acupuncture-Moxibustion and Tuina, Beijing University of Chinese Medicine, Beijing 100029, China

\*Correspondence: Cun-Zhi Liu, [lcz623780@126.com](mailto:lcz623780@126.com); Xu Wang, [wangx@bucm.edu.cn](mailto:wangx@bucm.edu.cn)

COVID-19 has spread globally for more than 2 years, having a tremendous impact on both the physical health of the infected cases and the mental health of the general population (Wu et al., 2021; Shanahan et al., 2022). In addition to psychiatric symptoms such as depression and anxiety, vicarious traumatization (stress resulting from empathic engagement with the trauma of others) is a generic psychological condition during the pandemic, increasing the risk of mental illness (Liu & Liu, 2020; Serafim et al., 2020). Certain populations may be more susceptible to vicarious trauma than others, and it is increasingly important to identify factors that may affect individual susceptibility (de Figueiredo et al., 2021). There is evidence that the prepandemic brain functional connectome can predict individual anxiety induced by the pandemic (He et al., 2021). However, the whole relationship map of the general distress (e.g. depression and anxiety), vicarious traumatization, and functional connectome is unclear.

Suo and colleagues (Suo et al., 2022) evaluated the relationships of these variables in 105 college students from Chengdu, China. The authors used the timeline of the COVID-19 pandemic as a natural and ingenious manipulation. The prepandemic multimodal magnetic resonance imaging (MRI) and questionnaire data were collected from October 2019 to January 2020. Then, the Vicarious Traumatization Questionnaire (VTQ) was evaluated during the outbreak of the COVID-19 (February to April 2020), and the Depression Anxiety Stress Scale (general distress, DASS) was measured after the peak of the pandemic from March to April 2021. A connectome-based predictive modeling method was applied to reveal the resting-state functional connectivity (RSFC) contributing to subsequent vicarious traumatization. Then, mediation analysis was used to investigate the role of vicarious traumatization in associating RSFC and DASS.

The authors found that only the RSFC of the negative prediction network can predict VTQ scores by connectome-based predictive modeling analysis using a leave-one-out cross-validation procedure ( $q^2 = -0.18$ ,  $r_{[\text{observed}, \text{predicted}]} = 0.18$ ,  $P = 0.024$ ). Specifically, the negative and positive prediction networks were determined by RSFC-VTQ correlations. RSFC strength of each edge in the negative prediction network was negatively associated with VTQ scores. The contributing RSFC was located in the frontoparietal, medial frontal, default mode, motor, and salience networks.

The stability of these results was also demonstrated in the new model after 5- or 10-fold cross-validation. Notably, the negative  $q^2$  (also known as prediction or cross-validation  $R^2$ ) in the linear predicting model suggests that the model performance needs further improvement. The combination of the multimodal brain metrics and artificial intelligence algorithms (Li et al., 2021) in the future may facilitate the predicting and understanding of vicarious traumatization and mental illness.

In addition, the authors fully examined the associations among vicarious traumatization, general distress, and functional connectome. There were significant positive VTQ-DASS ( $r = 0.59$ ,  $P < 0.001$ ) and DASS-RSFC ( $r = 0.33$ ,  $P < 0.001$ ) correlations, showing that these variables are interconnected. Mediation analysis showed a full and significant indirect effect (0.28,  $P < 0.05$ ) of VTQ scores in the DASS-RSFC link. All results remained when controlling for age, gender, and mean head motion. Therefore, the functional connectome may affect general distress through vicarious traumatization.

These findings provide valuable insight into the neural functional mechanism of the vicarious traumatization and present a “functional connectome → vicarious traumatization → general distress” neuropsychological pathway. A strength of this study is the extensive control analyses of confounding variables (e.g. age, sex, head motion, family socioeconomic status, overall psychological health conditions), global signal, cross-validation, and brain parcellation strategies, which increases the validity and stability of the results. In addition, if the established brain connectome measures can predispose individuals to vicarious traumatization, they could be used as neural markers to identify high-risk populations for depression or anxiety. However, given the financial costs and calculation complexity involved in MRI scanning, it is hard to scan every person in the general population before the occurrence of stressful life events. The authors also provide an accessible and cheaper opportunity (i.e. VTQ) for recognizing and helping susceptible individuals at an earlier stage. Complementary to the expensive MRI, other imaging types, such as facial (Wang et al., 2020; Xie et al., 2021) and tongue (Song et al., 2019) imaging, may also offer chances to monitor mental health conveniently.

Although promising, such findings are exploratory and still without a direct clinical translation. It is important to exploit

Received: 16 June 2022; Revised: 22 June 2022; Accepted: 23 June 2022

© The Author(s) 2022. Published by Oxford University Press on behalf of West China School of Medicine/West China Hospital (WCSM/WCH) of Sichuan University. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

preventive or health care measures accordingly. Growing evidence has supported the potential benefits of early intervention with nonpharmacological therapies (e.g. exercise) (Mizzi et al., 2022; Silva et al., 2022). In addition, acupuncture, as a complementary therapy, is commonly recommended for the treatment of psychiatric disorders (e.g. depression) (Smith et al., 2018), and may also play an important role in reducing the risk of psychiatric disorders. Recently, using the UK Biobank database, a *Nature* study (Douaud et al., 2022) has revealed the effects of SARS-CoV-2 on brain structure, such as greater reduction in cortical thickness and whole brain size. In the future, a longitudinal cohort with large sample size is essential for clarifying how intervention, infection, and aging influence the brain-behavior links identified here. Since a larger sample size may include both infected and uninfected individuals, it will also help to distinguish the underlying neuropsychological basis from the perspective of both stresses from the trauma of self- and empathic engagement with the trauma of others.

In summary, Suo and colleagues used resting-state functional MRI, VTQ, and general distress data obtained in a sample of young adults to show that prepandemic brain functional connectome measures were predictive of vicarious traumatization in response to a stressful life event. The findings highlight the neural underpinning of vicarious traumatization and also remind medical experts to not only pay attention to the physical health of the infected individuals, but also to the mental health of medical staff and the general public during the spreading of a pandemic, all in line with the goals of psychoradiology (Pan et al., 2021).

## References

- de Figueiredo CS, Sandre PC, Portugal LCL, et al. (2021) COVID-19 pandemic impact on children and adolescents' mental health: biological, environmental, and social factors. *Prog Neuropsychopharmacol Biol Psychiatry* **106**:110171.
- Douaud G, Lee S, Alfaro-Almagro F, et al. (2022) SARS-CoV-2 is associated with changes in brain structure in UK Biobank. *Nature* **604**:697–707.
- He L, Wei D, Yang F, et al. (2021) Functional connectome prediction of anxiety related to the COVID-19 pandemic. *Am J Psychiatry* **178**:530–40.
- Li F, Sun H, Biswal BB, et al. (2021) Artificial intelligence applications in psychoradiology. *Psychoradiology* **1**:94–107.
- Liu C, Liu Y. (2020) Media exposure and anxiety during COVID-19: the mediation effect of media vicarious traumatization. *Int J Environ Res Public Health* **17**:4720.
- Mizzi AL, McKinnon MC, Becker S. (2022) The impact of aerobic exercise on mood symptoms in trauma-exposed young adults: a pilot study. *Front Behav Neurosci* **16**:829571.
- Pan N, Wang S, Zhao Y, et al. (2021) Brain gray matter structures associated with trait impulsivity: a systematic review and voxel-based meta analysis. *Hum Brain Mapp* **42**:2214–35.
- Serafim AP, Gonçalves PD, Rocca CC, et al. (2020) The impact of COVID-19 on Brazilian mental health through vicarious traumatization. *Braz J Psychiatry* **42**:450.
- Shanahan L, Steinhoff A, Bechtiger L, et al. (2022) Emotional distress in young adults during the COVID-19 pandemic: evidence of risk and resilience from a longitudinal cohort study. *Psychol Med* **52**:824–33.
- Silva DTC, Prado WL, Cucato GG, et al. (2022) Impact of COVID-19 pandemic on physical activity level and screen time is associated with decreased mental health in Brazilian adults: a cross-sectional epidemiological study. *Psychiatry Res* **314**:114657.
- Smith CA, Armour M, Lee MS, et al. (2018) Acupuncture for depression. *Cochrane Database Syst Rev* **3**:Cd004046.
- Song J, Wang Q, Xu X, et al. (2019) Predictive value of fissured tongue in functional dyspepsia combined with depression. *Gastroenterol Res Pract* **2019**:4596560.
- Suo X, Zuo C, Lan H, et al. (2022) COVID-19 vicarious traumatization links functional connectome to general distress. *Neuroimage* **255**:119185.
- Wang X, Wang Y, Zhou M, et al. (2020) Identifying psychological symptoms based on facial movements. *Front Psychiatry* **11**:607890.
- Wu T, Jia X, Shi H, et al. (2021) Prevalence of mental health problems during the COVID-19 pandemic: a systematic review and meta-analysis. *J Affect Disord* **281**:91–8.
- Xie W, Liang L, Lu Y, et al. (2021) Deep 3D-CNN for depression diagnosis with facial video recording of self-rating depression scale questionnaire. *Annu Int Conf IEEE Eng Med Biol Soc* **2021**:2007–2010.