



## How climate-change awareness can provoke physical symptoms

The Intergovernmental Panel on Climate Change has described the risks to humans from a changing climate. Although difficult to specify precisely, health outcomes of climate changes are potentially enormous (Rising *et al.* 2022). They include the risks associated with excessive temperatures, extreme weather events, biodiversity loss, air pollution, and so forth, which threaten both physical and mental health. Climate experts emphasize the need for rapid and fundamental changes in behaviors, lifestyles, and social organizations to minimize and adapt to global warming, but effective responses are often inhibited by false information and denial in social media as well as by political resistance. Information campaigns are important to induce accurate risk perception, awareness of the necessity of lifestyle changes, and beliefs that these changes will be effective in order to motivate pro-environmental behaviors. However, such awareness has also been associated with anxiety and depression and may impact mental health (Clayton 2020). In this letter, our goal is to describe how greater awareness of climate change may also provoke physical symptoms.

Recent models of physical symptom formation show how cognitive and emotional factors such as health beliefs and symptom expectations can outweigh sensory information in the process of developing symptoms (Henningsen *et al.* 2018). Given that the human brain is hardwired to reduce uncertainty (Anderson *et al.* 2019) and ensure bodily protection (Van den Bergh *et al.* 2021), physical symptoms can arise in response to health information that is perceived as alarming even if the body is not affected. These nocebo-based symptoms, the evil twins of placebo effects, are routinely observed in medicine (Colloca and Barsky 2020). Negative expectations promote the development of symptoms in the same way that positive expectations

increase the benefit of treatments. Nocebo-based symptoms are as real as externally caused symptoms, and neurobiological studies have described the underlying processes explaining how the brain translates negative expectations into physical symptoms (Wager and Atlas 2015).

Health worries about modern environmental changes have already been shown to provoke nocebo-based physical symptoms. For example, symptoms that sufferers attribute to electromagnetic fields result from worries about mobile phones and Wi-Fi networks: when affected individuals were convinced that electromagnetic radiation was present, they experienced symptoms (eg fatigue, headache) regardless of whether real radiation was present or absent (Rubin *et al.* 2010). These conditions are not anecdotal. In laboratory experiments, the induction of negative expectations regarding Wi-Fi radiation can provoke somatic sensory experiences in healthy volunteers exposed to sham-Wi-Fi (Bräscher *et al.* 2017).

Climate-change awareness could provoke nocebo-based symptoms in several ways. Excessive worries about climate change, potentially aggravated by inadequate governmental response (Hickman *et al.* 2021), can lead to increasing concerns about environmental health and produce physical symptoms associated with environmental factors. For instance, individuals worried about temperature rise may experience airways discomfort and breathlessness even with moderate temperatures. Nocebo-based symptoms could also result from excessive health worries about new technologies trying to mitigate climate-change impacts (eg tinnitus [sound perception with no external causes] attributed to wind turbines) or helping to endure them (eg brain fog attributed to air-conditioning) (Dömötör *et al.* 2019). If not properly attended to in climate-change communication, these nocebo-based symptoms may add on to climate change's physiological-based symptoms.

Probable risk factors of nocebo-based physical symptoms associated with environmental worries include individual

attributes such as negative affectivity, health anxiety, and catastrophism (the tendency to expect the worst) (Van den Bergh *et al.* 2017). Furthermore, although media coverage that informs about climate change is necessary, it may describe health hazards in a rather sensationalist way that may elicit adverse effects. For example, the incidence of symptoms associated with electromagnetic fields correlates with the spread of alarming information about electromagnetic fields in newspaper articles (Huang *et al.* 2018). Conversely, nocebo-based physical symptoms can be prevented by the promotion of balanced and scientifically sound information about health hazards and appropriate explanations about underlying mechanisms of the nocebo effect (Crichton and Petrie 2015).

Greater awareness of climate change and its impacts on health is necessary; so too is attention to the possible physical and psychological health impacts and consequences of such awareness. We propose that: (1) policy makers should promote climate-change awareness in collaboration with expert researchers and health practitioners to develop and evaluate specific collective prevention strategies using dedicated toolkits, such as the Yale Program of Climate Change Communication (Campbell *et al.* 2023); (2) health practitioners can impact beliefs and behaviors about climate change (Maibach *et al.* 2021) and, therefore, should be educated also about the risk of growing climate-change awareness for mental disorders and physical symptoms, and the ways to prevent them; medical education and clinical settings should incorporate concepts drawn from health psychology and biopsychosocial health to reduce these risks; (3) journalists and weather forecasters can be trained to report more efficiently about climate change (Yagatich *et al.* 2022) and encouraged to: (i) disseminate scientifically grounded and tailored information, and (ii) inform the public about effective ways to minimize the risks associated with climate-change awareness; and (4) researchers should investigate the moderators and mediators of impacts of climate-change

awareness on both mental and physical health.

Insights about the potential for unintended consequences are necessary to promote climate-change awareness in a safe, constructive, and effective way.

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