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Can explicit suggestions about the harmfulness of EMF exposure exacerbate a nocebo response in healthy controls?

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ABSTRACT

While there has been consistent evidence that symptoms reported by individuals who suffer from Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) are not caused by EMF and are more closely associated with a nocebo effect, whether this response is specific to IEI-EMF sufferers and what triggers it, remains unclear. The present experiment tested whether perceived EMF exposure could elicit symptoms in healthy participants, and whether viewing an 'alarmist' video could exacerbate a nocebo response. Participants were randomly assigned to watch either an alarmist ($N = 22$) or control video ($N = 22$) before completing a series of sham and active radiofrequency (RF) EMF exposure provocation trials (2 open-label, followed by 12 randomized, double-blind, counterbalanced trials). Pre- and post-video state anxiety and risk perception, as well as belief of exposure and symptom ratings during the open-label and double-blind provocation trials, were assessed. Symptoms were higher in the open-label RF-ON than RF-OFF trial ($p < .001$). No difference in either symptoms ($p = .183$) or belief of exposure ($p = .144$) was observed in the double-blind trials. Participants who viewed the alarmist video had a significant increase in symptoms ($p = .041$), state anxiety ($p < .01$) and risk perception ($p < .001$) relative to the control group. These results reveal the crucial role of awareness and belief in the presentation of symptoms during perceived exposure to EMF, showing that healthy participants exhibit a nocebo response, and that alarmist media reports emphasizing adverse effects of EMF also contribute to a nocebo response.

1. Introduction

The public's perception of the potential health implications associated with the use of modern technologies has been steadily changing in recent years (Petrie and Wessely, 2002; Petrie et al., 2001). This is often reflected in the mainstream media, where news reports consistently suggest that there are dangers of various aspects of modern life while often neglecting more mundane causes of illness (Petrie and Wessely, 2002; Frost et al., 1997). Generally, these stories do not reflect the current state of science (Eldridge-Thomas and Rubin, 2013; Claassen et al., 2012), but instead focus on reports of members of the community who claim to experience conditions characterized by a variety of adverse symptoms which they ascribe to their use of, or proximity to, various environmental stimuli, including vaccinations, genetically modified food, infrasound from wind turbines and electromagnetic fields (EMF) emitted by mobile phone and wireless technologies (Petrie and Wessely, 2002).

One particularly prominent condition is Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF). People who suffer from this condition typically report experiencing a diverse range of non-specific symptoms which they attribute to their exposure to the EMF emitted by everyday electrical and wireless technologies and infrastructure (Röösli et al., 2004; Baliatsas et al., 2012). Yet, while a considerable proportion of the population report experiencing IEI-EMF (estimated to be between 1.5% and 13.5% (Hillert et al., 2002; Levallois et al., 2002; Schröttner and Leitgeb, 2008; Baliatsas et al., 2015; Eltiti et al., 2007a; Schreier et al., 2006; Blettner et al., 2009; Tseng et al., 2011)), there has been no robust evidence to implicate a bioelectromagnetic mechanism in producing the reported symptoms (Rubin et al., 2005, 2010; Röösli et al., 2010; Health Council of the

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Netherlands, 2009; Health Canada, 2015; Scientific Committee on Emerging and Newly Idenified Health Risks, 2015; Staudenmayer et al., 2003). For instance, when tested under double-blind protocols, IEI-EMF participants do not report an increase in symptoms to EMF and are unable to perceive the difference between active and sham exposures (Rubin et al., 2010; Röösli et al., 2010). Instead, the evidence suggests that the condition is more closely associated with a nocebo response, as awareness of the exposure and a belief of being exposed have been shown to play an important role in the presentation of the condition. For example, a number of studies have found that participants experience an increase in symptoms when they are aware of the active exposure condition in an initial non-blinded trial compared to sham, but do not exhibit more symptoms in active than sham exposures in subsequent double-blind trials (Eltiti et al., 2007b; van Moorselaar et al., 2017; Verrender et al., 2018). Furthermore, sham exposures (ie. with no EMF) have been shown to be sufficient to trigger symptoms in IEI-EMF participants (Verrender et al., 2018; Oftedal et al., 2007; Wilén et al., 2006; Nam et al., 2009). The exact role of the nocebo response in the development of IEI-EMF, however, is not fully understood. For instance, recent findings from a qualitative study suggest that instead of the condition originating from a nocebo response, IEI-EMF individuals may be using the notion of sensitivity to EMF to provide a narrative to explain their pre-existing medically unexplained symptoms, in an effort to make their condition more practically and emotionally manageable Dieudonné (2016). Yet, it is important to note that Dieudonné (2016) did not test the cause of the participants symptoms, but rather, retrospectively asked participants about their beliefs regarding the cause of their symptoms. As retrospective self-reports are known to suffer from recall bias (Baliatsas et al., 2015; Vrijheid et al., 2009), these methods are not able to determine symptom etiology.

Given the prevalence of distressing and debilitating IEI-EMF symptoms, and in light of the evidence suggesting that such symptoms may be the result of a nocebo response, there is a great need to better understand the triggers that elicit such responses. Generally, a nocebo response occurs when conscious or subconscious negative expectations trigger or exacerbate adverse symptoms in response to an exposure that is not known to cause those effects (Hahn, 1997; Bräscher et al., 2017a). These expectations may be induced by explicit suggestions about the potential effects of an exposure (Webster et al., 2016; Benedetti et al., 2007) or by learning through classical conditioning (Bräscher et al., 2017a).

The communication of information about potential adverse health effects associated with EMF exposure constitutes an explicit suggestion which may be responsible for the formation of negative expectations and consequent nocebo response seen in IEI-EMF individuals (Webster et al., 2016). For example, there has been consistent evidence that precautionary information can negatively influence beliefs about EMF exposure, despite this information originally being intended to reassure the public (Wiedemann et al., 2014, 2013, 2006; Wiedemann and Schütz, 2005; Barnett et al., 2007; Nielsen et al., 2010). Similarly, viewing mainstream media reports which either promote the view that EMF exposure is hazardous, or focus on individuals with IEI-EMF, have been shown to increase worries about EMF exposure (Witthöft et al., 2017), while viewing an advertisement claiming to protect against the 'harmful effects of everyday EMF exposure' has been shown to increase both heart rate and concern about EMF (Köteles et al., 2016). Further, recent content analyses have shown that mainstream media reports about EMF exposure often misrepresent the current state of scientific evidence by focusing on an electromagnetic cause for IEI-EMF, or suggesting a relationship between EMF exposure and ill-health (Eldridge-Thomas and Rubin, 2013; Claassen et al., 2012). If such misinformation is being distributed on a wide scale and is negatively influencing people's beliefs about EMF exposure, it is possible that this may be a contributing factor to the prevalence of IEI-EMF.

Yet, it remains unclear whether the negative beliefs induced by such communications can result in greater symptom formation following a perceived exposure to EMF. Although Szemerszky et al. (2010) demonstrated that suggestions about the strength of EMF exposure can lead to increased symptom scores and an increase in the belief that a sham magnetic field was active, that study did not assess the effect of explicit suggestions of risk from EMF exposure (which may induce negative expectations) and was limited by a lack of counterbalancing. Furthermore, while Witthöft and Rubin (2013) reported that viewing a sensationalist media report about the adverse effects of Wi-Fi can increase the likelihood of a person experiencing symptoms following a sham exposure and developing an apparent sensitivity to EMF, the effect was only found for those with high pre-existing levels of state anxiety. This may be because the study lacked a verified non-exposure condition, potentially resulting in insufficient statistical power to detect effects in non-anxious individuals. In support of this notion, a similar study which included a cued non-exposure condition found that those who watched a film focusing on 'adverse effects of Wi-Fi' perceived tactile electrical stimuli as more intense during a cued Wi-Fi exposure (which was actually a sham exposure) compared to a cued no Wi-Fi condition, and that the effect was not mediated by anxiety (Bräscher et al., 2017b). This suggests that manipulating a participant's belief of exposure via cues may be important for influencing symptom perception irrespective of pre-existing state anxiety levels. The latter study, however, assessed somatosensory perception rather than symptom perception, and so it remains uncertain as to whether negative beliefs induced by information about EMF exposure can result in greater symptom formation or belief regarding exposure status following a perceived exposure to EMF.

To address these limitations, the present study was designed to determine whether perceived EMF exposure could elicit symptoms in a healthy population, and additionally, whether messages emphasizing 'adverse health effects of EMF exposure' can exacerbate a nocebo response. The study was also designed to explore, within-subjects, whether there is a relationship between a person's belief of exposure and symptoms, and whether there is a difference in symptom response between participants with low, medium and high pre-existing levels of state anxiety. To this end, an initial non-blinded open-label trial was employed, where the status of exposures emanating from the device (during an active and sham condition) were visually demonstrated to each participant using an EMF meter.

2. Materials and methods

2.1. Participants

Forty-four participants aged 18–30 years (M = 21.92, SD = 4.88; 50% male) were recruited through advertisements placed online and around the University of Wollongong campus. A power calculation conducted in G*Power 3.0 (Faul et al., 2007) for an independent samples t-test based on an effect size of 0.8, an alpha level of 0.05 and a power of 0.80 recommended a total sample size of 42.

All participants were first screened via a telephone interview to confirm eligibility for the study. To be included in the study, participants were required to be over the age of 18 and report being of good health. Participants were excluded from the study if they reported having a current illness or medical condition, or having used illicit substances within the 7-day period prior to the study. Suitable participants were required to attend the Illawarra Health and Medical Research Institute for one mutually convenient testing session. The study was approved by the Human Research Ethics Committee (HE: 2016/981). All participants were instructed to abstain from alcohol for at least 8 h, caffeine for at least 1 h, and mobile phone use for at least 2 h before the beginning of the testing session. Participants were compensated with a monetary gift card for their involvement in the study.