Journal of Psychosomatic Research 74 (2013) 206–212

Contents lists available at SciVerse ScienceDirect

Journal of Psychosomatic Research

Are media warnings about the adverse health effects of modern life self-fulfilling? An experimental study on idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF)

Michael Witthöft [a,b,*,1], G. James Rubin [a]

[a] King's College London, Department of Psychological Medicine, Weston Education Centre, United Kingdom
[b] Division of Clinical Psychology and Psychotherapy, Johannes Gutenberg University of Mainz, Germany

ARTICLE INFO

Article history:
Received 10 October 2012
Received in revised form 1 December 2012
Accepted 3 December 2012

Keywords:
Electromagnetic hypersensitivity
Functional somatic syndromes
Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF)
Media reports
Medically unexplained symptoms
Somatization

ABSTRACT

Objective: Medically unsubstantiated 'intolerances' to foods, chemicals and environmental toxins are common and are frequently discussed in the media. Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) is one such condition and is characterized by symptoms that are attributed to exposure to electromagnetic fields (EMF). In this experiment, we tested whether media reports promote the development of this condition.

Methods: Participants ($N = 147$) were randomly assigned to watch a television report about the adverse health effects of WiFi ($n = 76$) or a control film ($n = 71$). After watching their film, participants received a sham exposure to a WiFi signal (15 min). The principal outcome measure was symptom reports following the sham exposure. Secondary outcomes included worries about the health effects of EMF, attributing symptoms to the sham exposure and increases in perceived sensitivity to EMF.

Results: 82 (54%) of the 147 participants reported symptoms which they attributed to the sham exposure. The experimental film increased: EMF related worries ($\beta = 0.19$; $P = .019$); post sham exposure symptoms among participants with high pre-existing anxiety ($\beta = 0.22$; $P = .008$); the likelihood of symptoms being attributed to the sham exposure among people with high anxiety ($\beta = .31$; $P = .001$); and the likelihood of people who attributed their symptoms to the sham exposure believing themselves to be sensitive to EMF ($\beta = 0.16$; $P = .049$).

Conclusion: Media reports about the adverse effects of supposedly hazardous substances can increase the likelihood of experiencing symptoms following sham exposure and developing an apparent sensitivity to it. Greater engagement between journalists and scientists is required to counter these negative effects.

Introduction

Mass media reports concerning the possible health effects of weak electromagnetic fields (EMF) often focus on the issue of 'idiopathic environmental intolerance attributed to electromagnetic fields' (IEI-EMF). People with IEI-EMF typically suffer from a diverse range of nonspecific physical symptoms (e.g., headache, dizziness, burning skin, tingling; [1]) that they attribute to their exposure to the EMF emitted by, for example, mobile phones, mobile phone base stations, power lines and WiFi [2,3]. IEI-EMF is often associated with occupational and social impairments [4,5]. In its more extreme form, IEI-EMF can result in people withdrawing almost entirely from modern society in order to avoid electrical devices. People with severe forms of IEI-EMF are regularly featured in news reports on the issue [6].

Less commonly featured is the strong body of evidence from experimental studies which have tested whether exposure to EMF triggers symptoms [7]. Double-blind provocation studies have shown that people with IEI-EMF are unable to detect the presence of EMF and that their symptoms are as likely to be triggered by sham exposure to EMF as by real exposure [8–10]. A number of studies have demonstrated that these symptoms can be related to the so-called nocebo effect [11–13]. Given this, it has been suggested that psychological mechanisms play an important role in the etiology of the condition [14]. According to this theory, anxiety about EMF coupled with an expectation that symptoms will develop following exposure to an electromagnetic stimulus might initially cause people's symptoms to occur via a nocebo effect. Expectations and worry may also increase the likelihood of symptoms being attributed to the electromagnetic stimulus and of a person deciding that they are sensitive to EMF. There is some evidence that these effects may be more likely among people with pre-existing negative affect or somatization, and among

* Corresponding author at: Division of Clinical Psychology and Psychotherapy, Johannes Gutenberg University of Mainz, Wallstrasse 3, D-55099 Mainz, Germany. Tel.: +49 6131 3939202; fax: +49 61313939102.
E-mail address: witthoef@uni-mainz.de (M. Witthöft).
[1] MW was a visiting researcher at King's College London, United Kingdom.

0022-3999/$ – see front matter
http://dx.doi.org/10.1016/j.jpsychores.2012.12.002

people who are prone to somatosensory amplification [13–15]. The frequent reports carried by the mass media presumably also contribute to the development of IEI-EMF [16], although this supposition has yet to be experimentally tested. In line with this hypothesis is the finding from epidemiological studies that media reports in the aftermath of disasters (e.g., nuclear accidents, terrorist attacks) have significantly increased symptom reports and health care utilization [17–19]. Therefore, it is timely to test such associations for IEI-EMF as well, in an experimental setting.

In this study, we tested whether watching a real television report from the UK which promoted a link between exposure to WiFi and symptoms would increase: concern about EMF; the likelihood of participants developing symptoms following a sham exposure to a "new type of WiFi signal;" the likelihood of symptoms being attributed to the exposure; and the likelihood of a participant believing themselves to be sensitive to EMF as a result. We also tested whether effects on worry, symptoms or attributions were strongest in people with pre-existing anxiety or somatization, or who were predisposed to somatosensory amplification. Finally, we tested whether increases in perceived sensitivity to EMF were most evident among people who attributed symptoms to the sham exposure.

Method

Study design

We used a between-groups experiment. Participants were randomly assigned after enrollment into the study to watch either a television report about the adverse health effects of WiFi or a control condition involving a report of the same length but relating to the security of mobile phone data transmission. Randomization was performed by using a computerized random number generator. After watching the report, all participants received the same 15 minute sham exposure to a WiFi signal. Testing took place between January and June 2012 at King's College London.

Participants

We recruited participants by sending a circular email to people registered on a university database of potential research volunteers and to students and staff of King's College London. Participants were required to be 18 or over and speak English. A power calculation for linear regression analyses was based on an alpha level of 0.05, a power of 0.80 with up to 9 independent variables, and a minimum R^2 of 0.10. For this analysis, a sample size of 150 is recommended [20]. Ethical approval of the current study was provided by the King's College London Psychiatry, Nursing and Midwifery Research Ethics Committee (research ethics reference number: PNM/11/12-18).

Questionnaires

We assessed symptoms with a modified state version of the checklist for symptoms in daily life (CSD) [21]. This comprised 34 items with a 5-point Likert scale ranging from "not at all" to "extremely." Factor analyses of our data revealed 3 factors of anxiety related symptoms, head and concentration symptoms, and tingling sensations. As well as using the total CSD score in our analyses, we calculated the mean scores for those symptoms loading on each factor for use as subscales.

We assessed symptom attributions by asking "Please indicate how much the sensations and symptoms you may have experienced are attributable to the electromagnetic field." Response options were "not at all", "somewhat", "quite a bit", and "a great deal."

We used the EMF version of the Sensitive Soma Assessment Scale (SSAS) [22] to assess perceived sensitivity to EMF. This consists of five statements such as "my body is very sensitive to the effects of electromagnetic fields," rated on 5-point scales from "1 = strongly agree" to "5 = strongly disagree."

We assessed worries about the health effects of EMF by using the three-item radiation subscale of the Modern Health Worries Scale (MHW-R) [23]. This assesses the degree to which people are concerned about health risks associated with mobile phones, mobile phone base stations and powerlines by using three 5-point scales ranging from "no concern" to "extreme concern."

We assessed state anxiety with a 6-item short version of the State Trait Anxiety Inventory (STAI-6) [24], somatization by using the 15-item Patient Health Questionnaire (PHQ-15) [25] and somatosensory amplification by using the Somatosensory Amplification Scale (SSA) [26].

Procedure

We sent an information sheet to people who responded to our recruitment email. This informed participants that "This project will assess whether a new type of electromagnetic field, which will be used in future mobile phone and WiFi systems, can cause short term physical symptoms such as fatigue or headaches." We asked people willing to participate to make an appointment to come to our laboratory.

The experimental session lasted 60 min. Prior to watching the television report, participants provided informed written consent, answered demographic questions and provided baseline (Time 1 (T1)) measures of the MHW-R, SSAS, PHQ-15, SSA and STAI-6. We then randomly assigned participants to one of two television reports. In the experimental group, people viewed a 9 minute section from a television documentary screened in the UK by BBC One in 2007 concerning the potential health effects of WiFi [27]. This included statements from concerned scientists and members of parliament about the potential health risks of mobile phone and WiFi signals and included interviews with people suffering from IEI-EMF. In the control group, participants viewed a 9 minute BBC News report discussing the security of internet and mobile phone data [28]. This contained no health related content. We told participants that we wanted them to watch the film as part of a memory test and that we would ask questions about the film at the end of the experiment.

After watching the film (T2), participants completed the CSD, MHW-R and STAI-6. We then attached our exposure equipment to the participant's head. This consisted of an antenna mounted on a headband which was "meant to bring the signal as close to your body as possible." The antenna was seemingly connected to a WiFi router which in turn was connected to a laptop. Participants were asked to monitor for possible symptoms that might develop during the exposure and were told that they could ask to terminate the exposure if any symptoms became too strong. Following this instruction, the experimenter left the room for the duration of the exposure. We instructed participants to activate the exposure by pressing a button on the laptop as soon as the experimenter left the room. After pressing the button, a flashing WiFi symbol appeared on the laptop screen in front of the participants for 15 min. After this period, the experimenter removed the equipment and asked the participants to complete the CSD, symptom attribution, SSAS, STAI-6 and MHW-R (T3).

After the final measure was taken, we used a funnel debriefing procedure [29] for a subsample of our participants ($n = 133$) to assess whether they had believed our cover story. We then told all participants the true nature of the study and provided them with monetary compensation.

Data analysis

Positively skewed symptom reports and questionnaire data were log-transformed where necessary.

To test the effects of the television report on concerns about EMF, we used a linear regression analysis with the difference score of the

MHW-R (T2 minus T1) as the dependent variable and the television report condition as the main independent variable. We also included STAI-6, SSA and PHQ-15 scores together with their two-way interactions with the television report condition as predictors.

We used T-tests to test the difference in symptom scores before and after our sham exposure, and used Cohen's *d* as a measure of effect size ($d = 0.20$: small effect; $d = 0.50$: medium effect; $d = 0.80$: large effect). We also used differences in log-transformed total symptom scores from T2 to T3 as the dependent variable in a linear regression, which included the television report as the main predictor, together with scores for the STAI-6 (at T2), SSA (T1), PHQ-15 (T1), MHW-R (T1) and their corresponding two-way interaction effects with the film condition. Because head and concentration symptoms were particularly common following our exposure, we repeated this regression by using the head and concentration subscales of the CSD. Identical regressions were also used to predict symptom attribution as a dependent variable.

We analyzed increases in self-reported sensitivity to EMF by subtracting log-transformed mean scores of the sensitive soma assessment scale (SSAS) at T3 from those at T1. We used a linear regression to test whether increases in SSAS scores would be predicted by the attribution of symptoms to WiFi in our exposure, by the television report condition, or by the interaction between these variables. The interaction analysis within the multiple linear regression analysis was based on the approach described by Aiken and West [30]. Multicolinearity was assessed but was unproblematic throughout the analyses.

Data were analyzed by using IBM SPSS Statistics (Version 20.0.01).

Results

We enrolled 150 participants. Two were excluded from our final analysis due to equipment failure and one was excluded due to implausibly rapid responses to our questionnaire. Tables 1 and 2 show the personal characteristics for the 147 participants included in the analyses and their mean scores on our questionnaires.

Effect of the television film on worries about EMF

Watching the WiFi film significantly increased MHW-R scores (Fig. 1, part A; main effect of WiFi film: $\beta = 0.19$; $P = .019$) and this effect was strongest in people with higher levels of state anxiety at T2 (Fig. 1, part B: interaction between WiFi film and STAI-6: $\beta = 0.22$; $P = .012$). Additionally, higher state anxiety (main effect of STAI-6T2: $\beta = 0.17$; $P = .051$) and higher scores on somatosensory amplification (main effect of SSA T1: $\beta = 0.18$; $P = .056$) were marginally significantly related to increases in MHW-R scores. Repeating the analysis by including age, sex, and level of education as additional predictor variables revealed equivalent results for the reported effects. In addition, age was negatively associated with increases in MHW-R scores ($\beta = -0.17$; $P = .043$) suggesting that lower age was associated with stronger increases in worries about EMF. No significant effect was observed for the other demographic variables.

Table 1
Personal characteristics for the two experimental groups watching a film on health related dangers of WiFi or a film on mobile phone data transmission security (control film)

	Experimental film conditions		Test statistic for differences between groups
	WiFi film ($n = 76$)	Control film ($n = 71$)	
Number of female participants (%)	51 (67.1%)	48 (67.6%)	$\chi^2 < 0.01$ ($P = .95$)
Mean age (standard deviation)	31.25 (11.44)	28.30 (8.83)	$T(145) = 1.74$ ($P = .08$)
Education			
O level (or lower)	4 (5.2%)	5 (7.0%)	$\chi^2 = 0.21$ ($P = .98$)
A levels	19 (25.0%)	17 (23.9%)	
Degree	27 (35.5%)	25 (35.2%)	
Postgraduate	26 (34.2%)	24 (33.8%)	

Effect of the television film on symptoms after sham exposure

In comparison to baseline scores at T2, scores at T3 (both scores log-transformed) were significantly higher for total CSD ($T(146) = 7.75$; $P < .001$; $d = 0.53$), and for anxiety ($T(146) = 4.46$; $P < .001$; $d = 0.30$), head/concentration ($T(146) = 8.54$; $P < .001$; $d = 0.62$) and tingling ($T(146) = 4.46$; $P < .001$; $d = 0.53$) subscales (Fig. 2, part A). Our linear regression with total CSD score as the outcome suggested a significant interaction between the film condition and STAI-6 scores ($\beta = 0.22$; $P = .008$), with symptom reports increasing most in people with higher levels of anxiety who watched the WiFi film. Concerns about EMF also contributed significantly to the prediction of symptom scores (main effect MHW-R at T1: $\beta = 0.33$; $P < .001$). We found no significant main effect of the film condition ($\beta = 0.05$; $P = .47$) or of any other predictor. Head and concentration symptoms following exposure increased as a function of watching the WiFi film (main effect: $\beta = 0.14$; $P = .054$), especially in people with higher anxiety (interaction between film condition and STAI-6: $\beta = 0.31$; $P < .001$; see Fig. 2, part B). A greater tendency towards somatosensory amplification (main effect SSAS: $\beta = 0.18$; $P = .046$) and more concerns about EMF (main effect MHW-R at T1: $\beta = 0.34$; $P < .001$) were also positively related to increases in head and concentration symptoms. Repeating the analyses by including age, sex, and level of education as additional predictor variables revealed equivalent effects and none of these demographic variables had a significant effect on the total symptom reports or the head and concentration related symptom reports after the sham exposure.

Effect of the television film on symptom attribution

Data regarding symptom attribution following the WiFi exposure were available for 124 participants. Five participants did not receive this question and 18 reported no symptoms following the exposure. 82 participants (55.8%) attributed symptoms to our sham exposure "somewhat," "quite a bit" or "to a great deal." Attributions of symptoms to the WiFi exposure were strongest in people who watched the WiFi film and who also had higher levels of state anxiety (interaction between WiFi film and STAI-6: $\beta = .31$; $P = .001$; Fig. 3) and among people with high levels of somatization (main effect of PHQ-15: $\beta = .19$; $P = .056$), higher state anxiety at T2 (main effect of STAI-6: $\beta = .18$; $P = .039$), and more concerns about EMF at T1 (main effect of MHW-R: $\beta = .24$; $P = .003$). We observed no significant main effect of the WiFi film on symptom attribution ($\beta = .06$; $P = .485$) or of any other predictor. Repeating the analysis by including age, sex, and level of education as additional predictor variables revealed equivalent effects, but in addition, being female was significantly associated with stronger symptom attributions to the sham exposure ($\beta = .17$; $P = .029$).

Effect of the television film on perceived sensitivity to EMF

We detected no main effect of the WiFi film on increases in SSAS scores ($\beta = .04$; $P = .629$). However, the attribution of symptoms to WiFi did significantly predict increases in SSAS scores ($\beta = 0.29$; $P < .001$), an effect which showed a significant interaction with the television film ($\beta = 0.16$; $P = .049$; Fig. 4) with people who watched the WiFi film and who attributed symptoms to WiFi showing the largest increases in self-reported sensitivity. Repeating the analysis by including age, sex, and level of education as additional predictor variables revealed equivalent results. In addition, being female was marginally associated with higher perceived sensitivity to EMF ($\beta = .15$; $P = .070$).

Participant acceptance of our sham exposure

Our funnel debriefing suggested that 115 of the 133 participants asked (86.4%) believed they had indeed been exposed to a WiFi signal during the experiment. This included two participants who asked to terminate their exposure early because of the high level of symptoms they had experienced. 14 participants (10.5%) thought they might have been taking part in a randomized controlled trial with a 50% chance of being exposed to a signal. Four participants (3.0%) did not believe that they had been exposed to any signal.

Discussion

Mass media reports concerning the possible adverse health effects of modern technologies are common [16]. Our study demonstrated that these reports not only elevate levels of concern among the public, they can also increase the likelihood of someone reporting symptoms following exposure to an innocuous substance and increase the likelihood of them attributing their symptoms to that substance. In line with previous reports [13,31], these effects were strongest in people with higher pre-existing levels of anxiety, greater tendency towards somatosensory amplification and more worries about the health effects of EMF. While these data demonstrate that media stories about novel health threats can have a short-term negative impact on well-being, our study also suggested that longer-term effects are possible: participants who attributed their symptoms to the sham

Table 2
Questionnaire data (mean (standard deviation)) for the two experimental groups

	Experimental film conditions						Group differences WiFi vs. Control
	WiFi film ($n=76$)			Control film ($n=71$)			
	T1	T2	T3	T1	T2	T3	
Somatic symptoms (CSD)	–	1.18 (0.24)	1.36 (0.49)	–	1.14 (0.19)	1.30 (0.44)	T2: $P=.23$; T3: $P=.35$
Head/concentration symptoms (CSD subscale)	–	1.36 (0.41)	1.79 (0.83)	–	1.33 (0.38)	1.60 (0.63)	T2: $P=.59$; T3: $P=.16$
Anxiety related symptoms (CSD subscale)	–	1.11 (0.22)	1.20 (0.45)	–	1.06 (0.14)	1.16 (0.42)	T2: $P=.10$; T3: $P=.39$
Tingling sensations (CSD subscale)	–	1.16 (0.30)	1.29 (0.47)	–	1.12 (0.22)	1.34 (0.57)	T2: $P=.55$; T3: $P=.68$
Sensitive Soma Assessment Scale (SSAS)	1.91 (0.75)	–	2.06 (1.08)	1.95 (0.78)	–	1.98 (0.86)	T1: $P=.77$; T3: $P=.93$
Radiation worries (MHWS)	1.88 (0.77)	2.18 (0.93)	2.36 (1.14)	1.94 (0.78)	2.00 (0.84)	2.20 (1.04)	Ps(T1, T2, T3) > 0.22
State anxiety (STAI-6)	1.42 (0.38)	1.55 (0.58)	1.57 (0.65)	1.55 (0.47)	1.51 (0.46)	1.50 (0.48)	Ps(T1, T2, T3) > 0.08
Somatization (PHQ-15)	1.35 (0.28)	–	–	1.40 (0.28)	–	–	$P=.28$
Somatosensory amplification (SSA)	2.43 (0.65)	–	–	2.59 (0.67)	–	–	$P=.13$

T1 = Assessment before watching the film; T2 = Assessment after the film and before the EMF sham exposure; T3 = Assessment after the EMF sham exposure.

WiFi exposure in our experiment were more likely to believe themselves to be sensitive to EMF if they had watched the WiFi film. Had we not debriefed participants at this stage, it is possible that this belief would have made future symptomatic reactions to electromagnetic stimuli more likely.

Several previous studies have demonstrated that sham exposures can elicit symptoms in healthy participants [7,9,32] and people with various forms of IEI [12,33], and that this process might be facilitated by leaflets produced by an IEI support group [31]. However, another study failed to find, probably due to the small sample size and the lack of statistical power, a significant effect of written positive or negative information on expectations, cognitive performance, and symptom reports after a real or sham exposure to an EMF [34]. Compared to these previous studies, ours is the first experimental study to directly test the impact of media reporting on this process. A strength is that our experimental condition used a genuine television report originally watched by 4.6 million people in the UK [35]. While the program was later censured for giving "a misleading impression of the state of scientific opinion" [36], subsequent media reports concerning the health effects of EMF have continued to present EMF as likely to cause symptoms and IEI-EMF [37]. We believe that due to the high ecological validity of the chosen television report our findings are generalizable to a real-world context and consequently, people with predisposing characteristics that served as a significant moderator in our analysis (e.g., higher levels of somatosensory amplification and negative state affect) are likely to develop symptoms in response to similar television reports.

Conceptually, our findings are in line with cognitive–psychological and cognitive–behavioral models of symptom formation that have been proposed for medically unexplained symptoms and somatoform disorders [38,39]. Based on these models, we have previously proposed a cognitive–behavioral approach to IEI [40,41], in which certain information (e.g., media reports, information from physicians or relatives) trigger and amplify symptom focused attention, catastrophizing cognitions (e.g., "EMF are dangerous/harmful and must be strictly avoided"), and result in safety-seeking and avoidance behavior regarding suspected

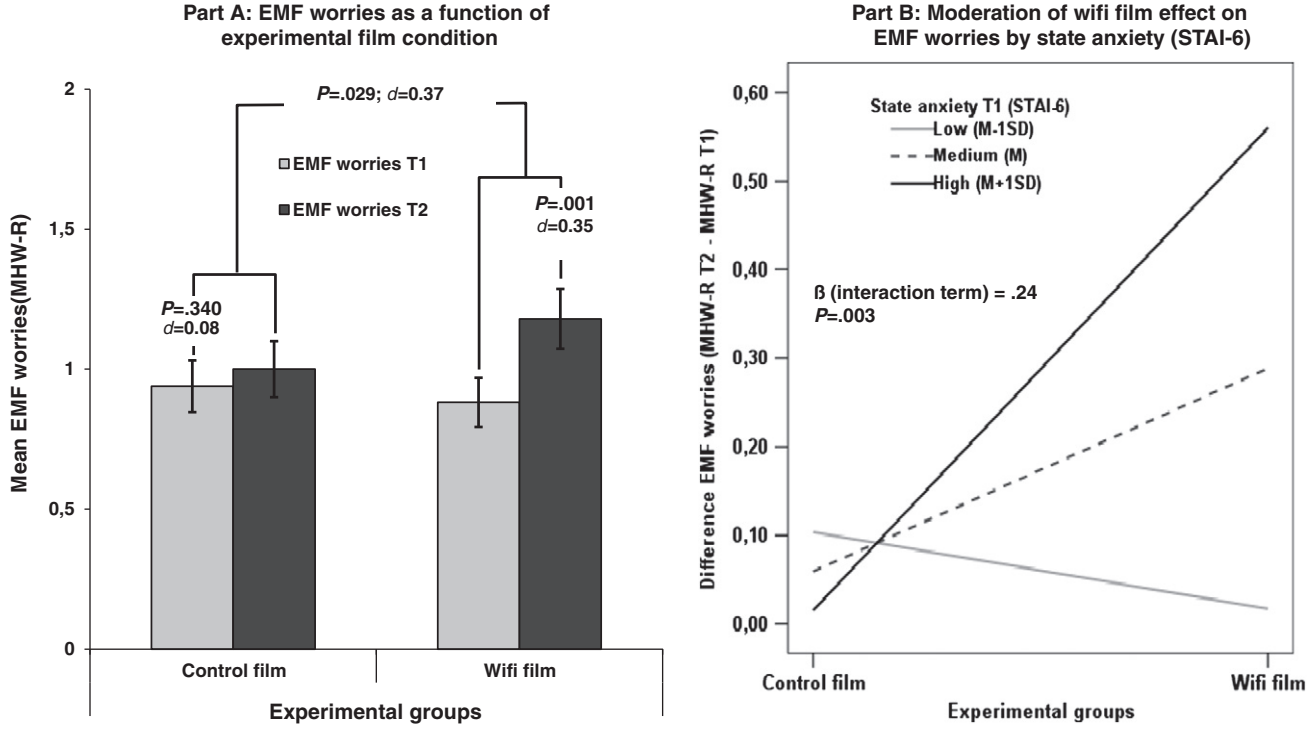

Fig. 1. Part A (left): mean values of modern health worries related to electromagnetic fields (EMF worries) before (T1) and after (T2) watching a film on health related dangers of WiFi or a control film on mobile phone data transmission safety. Error bars represent standard errors of the mean. Part B (right): moderation of the WiFi film effect on modern health worries by state anxiety. The three lines represent regression lines for mean levels of state anxiety, as well as high (mean plus one standard deviation) and low (mean minus one standard deviation) levels of state anxiety.

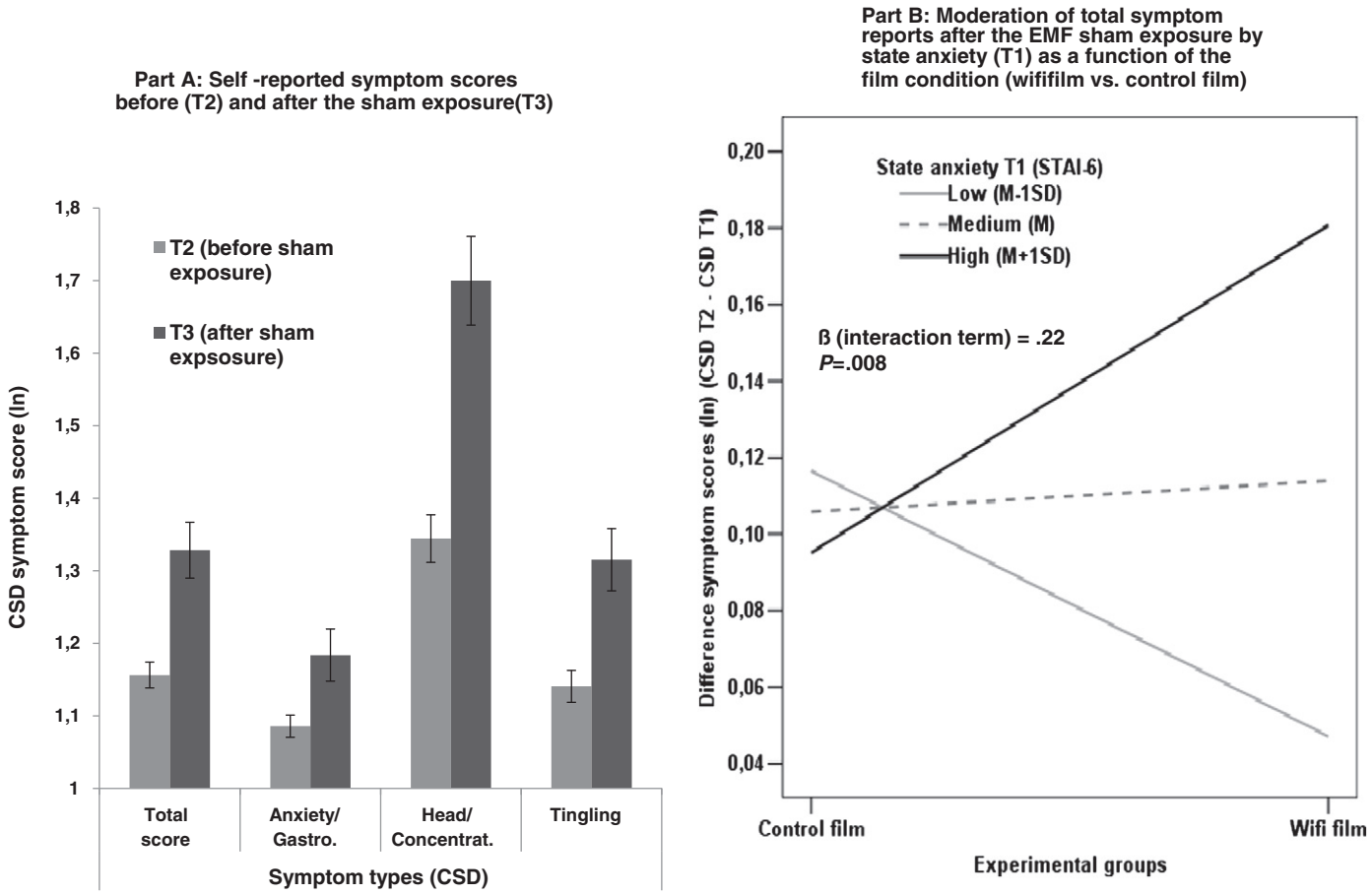

Fig. 2. Part A (left): symptom reports before and after sham WiFi exposure (symptom total score and subscales of anxiety, head-related, and tingling symptoms). Error bars represent standard errors of the mean. Part B (right): moderation of the association between the WiFi film condition and the symptoms reported after the sham WiFi exposure according to levels of state anxiety. The three lines represent regression lines for mean levels of state anxiety, as well as high (mean plus one standard devation) and low (mean minus one standard deviation) levels of anxiety.

IEI trigger substances that maintain this vicious circle via negative reinforcement. According to this model, IEI and other functional somatic syndromes are the result of both, more general (e.g., negative affectivity, somatosensory amplification) and rather specific (e.g., specific media reports related to IEI) factors. We believe that such a cognitive–behavioral approach is applicable not only to the etiology and pathogenesis of IEI but also to the more specific condition of IEI-EMF. This model may stimulate the development of promising treatment options that go beyond telling people to simply avoid EMF or other potential triggers thereby fostering social isolation and further symptom focused attention.

In terms of limitations, because we did not use a 'no exposure' control condition we cannot definitively say that the increase in symptoms observed in our study was the result of a nocebo effect caused by our sham exposure. However, given that symptom increases were relatively large and showed expected associations with somatosensory amplification, modern health worries and our experimental condition, it seems unlikely that the mere passage of time during the testing session was responsible. To rule out this possibility, future studies should include a no-exposure control condition in which participants are instructed to focus attention on their body and to carefully monitor any kind of symptom. An alternative possibility is that some symptom reports were influenced by the demand characteristics of the study rather than reflecting actual symptom experience. Future studies could therefore try to assess symptom experiences more objectively, for example, by using video monitoring of possible expressions of symptoms (e.g., scratching; [42]). Additionally, because we did not systematically assess the current and previous medical and psychiatric conditions of our participants, we cannot rule out the possibility that these factors might have influenced our results, e.g., in terms of the symptom reports. However, the fact that the participants were randomly assigned to the two film conditions and the pre-post-test design we applied renders a strong causal influence of any preexisting medical or mental condition as primary explanation for our findings is unlikely.

For economical reasons, state symptom reports were only assessed twice, directly before and after the WiFi sham exposure. Due to the lack of a baseline measure of state symptom reports before the film condition, it is impossible to exactly quantify any possible influence of the WiFi film on the state symptom reports (although the participants of the two film conditions did not differ significantly in their first assessment of symptom reports that took place after watching the film and before conducting the sham exposure; Table 2).

If inaccurate media portrayals of novel technologies or substances can produce adverse effects on the wellbeing of vulnerable members of the public, one obvious implication is that journalists should endeavor to provide more accurate reporting. Calls from scientists for better science and health reporting are nothing new, however [7,43] and any change is likely to come slowly. In the meantime, we can only urge scientists working in these areas to stay engaged with the media to ensure that stories about the potential health impact of new technologies are adequately informed by the best available evidence.

Conflict of interest statement

G. James Rubin (GJR) has received payment from the Church of England for expert testimony relating to the installation of WiFi

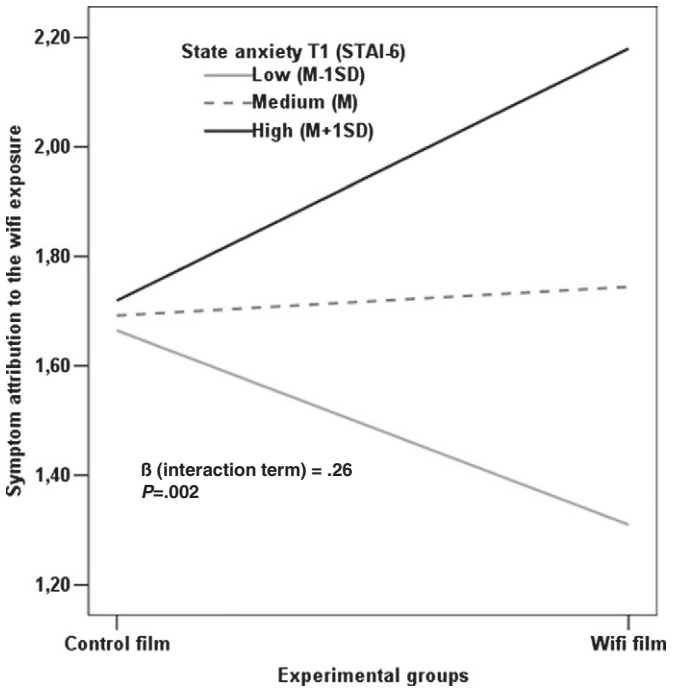

Fig. 3. Moderation of the association between the WiFi film condition and the symptom attribution to the WiFi exposure by levels of state anxiety for participants who reported symptoms after the sham exposure ($n = 124$). The three lines represent regression lines for mean levels of state anxiety, as well as high (mean plus one standard deviation) and low (mean minus one standard deviation) levels of state anxiety.

equipment on Church property. Other than this all authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that (1) GJR and Michael Witthöft (MW) had no support from any that might have an interest in the submitted work for the submitted work; (2) GJR and MW have had no financial relationships with any companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) GJR and MW have no non-financial interests that may be relevant to the submitted work.

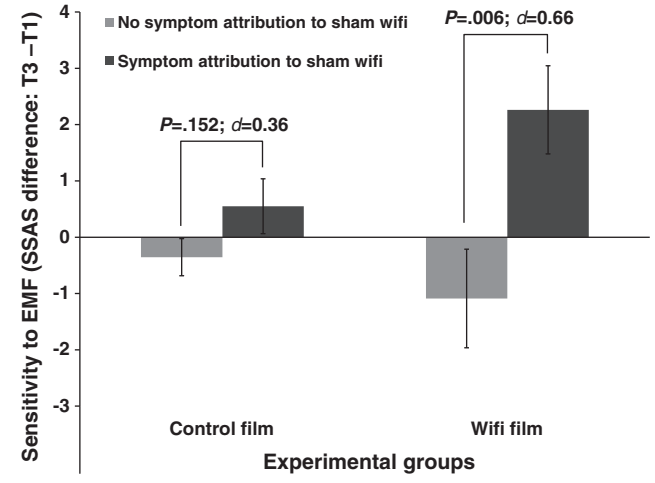

Fig. 4. Changes in self-reported sensitivity to electromagnetic fields (EMF; assessed with the Sensitive Soma Assessment Scale; SSAS) over the course of the experiment as a function of television report condition (WiFi film vs. control film) and the attribution of symptoms to the sham WiFi exposure. Error bars represent standard errors of the mean.

Acknowledgments

This study was supported by a fellowship within the Postdoctoral Programme of the German Academic Exchange Service (DAAD) awarded to MW and by a grant of the German Research Foundation (DFG, WI 3666/2-1). The funders played no role in study design; the collection, analysis or interpretation of data; writing the report; or in the decision to publish. The authors are fully independent of the funders.

References

[1] Oftedal G, Wilen J, Sandstrom M, Mild KH. Symptoms experienced in connection with mobile phone use. Occup Med 2000;50:237–45.
[2] Schuz J, Petters C, Egle UT, Jansen B, Kimbel R, Letzel S, et al. The "Mainzer EMF-Wachhund": results from a watchdog project on self-reported health complaints attributed to exposure to electromagnetic fields. Bioelectromagnetics 2006;27:280–7.
[3] Baliatsas C, Van Kamp I, Lebret E, Rubin GJ. Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF): a systematic review of identifying criteria. BMC Public Health 2012;12:643.
[4] Roosli M, Moser M, Baldinini Y, Meier M, Braun-Fahrlander C. Symptoms of ill health ascribed to electromagnetic field exposure — a questionnaire survey. Int J Hyg Environ Health 2004;207:141–50.
[5] Carlsson F, Karlson B, Orbaek P, Osterberg K, Ostergren PO. Prevalence of annoyance attributed to electrical equipment and smells in a Swedish population, and relationship with subjective health and daily functioning. Public Health 2005;119:568–77.
[6] Boyd I, Rubin GJ, Wessely S. Taking refuge from modernity: 21st Century hermits. J R Soc Med in press.
[7] Goldacre B. Why don't journalists mention the data? BMJ 2007;334:1249.
[8] Rubin GJ, Nieto-Hernandez R, Wessely S. Idiopathic environmental intolerance attributed to electromagnetic fields (formerly 'electromagnetic hypersensitivity'): an updated systematic review of provocation studies. Bioelectromagnetics 2010;31:1–11.
[9] Rubin GJ, Das Munshi J, Wessely S. Electromagnetic hypersensitivity: a systematic review of provocation studies. Psychosom Med 2005;67:224–32.
[10] Rubin GJ, Hahn G, Everitt BS, Cleare AJ, Wessely S. Are some people sensitive to mobile phone signals? Within participants double-blind randomized provocation study. BMJ 2006;332:886–91.
[11] Schweiger A, Parducci A. Nocebo: the psychologic induction of pain. Pavlov J Biol Sci 1981;16:140–3.
[12] Landgrebe M, Barta W, Rosengarth K, Frick U, Hauser S, Langguth B, et al. Neuronal correlates of symptom formation in functional somatic syndromes: a fMRI study. Neuroimage 2008;41:1336–44.
[13] Szemersky R, Koteles F, Lihi R, Bardos G. Polluted places or polluted minds? An experimental sham-exposure study on background psychological factors of symptom formation in 'idiopathic environmental intolerance attributed to electromagnetic fields'. Int J Hyg Environ Health 2010;213:387–94.
[14] Rubin GJ, Cleare AJ, Wessely S. Psychological factors associated with self-reported sensitivity to mobile phones. J Psychosom Res 2008;64:1–9.
[15] Van den Bergh O, Winters W, Van Diest I. Learning subjective health complaints. Scand J Psychol 2002;43:147–52.
[16] Petrie KJ, Wessely S. Modern worries, new technology, and medicine: new technologies mean new health complaints. BMJ 2002;324:690–1.
[17] Ten Veen PMH, Morren M, Yzermans CJ. The influence of news events on health after disaster: a longitudinal study in general practice. J Trauma Stress 2009;22:505–15.
[18] Vasterman P, Yzermans CJ, Dirkzwager AJE. The role of the media and media hypes in the aftermath of disasters. Epidemiol Rev 2005;27:107–14.
[19] Young ME, Norman GR, Humphreys KR. Medicine in the popular press: the influence of the media on perceptions of disease. PLoS One 2008;3:e3552.
[20] Cohen J. Statistical power analysis for the behavioral scientist. 2nd ed.New York: Academic Press; 1988.
[21] Wientjes CJ, Grossman P. Overreactivity of the psyche or the soma? Interindividual associations between psychosomatic symptoms, anxiety, heart rate, and end-tidal partial carbon dioxide pressure. Psychosom Med 1994;56:533–40.
[22] Nieto-Hernandez R, Rubin GJ, Cleare AJ, Weinman JA, Wessely S. Can evidence change belief? Reported mobile phone sensitivity following individual feedback of an inability to discriminate active from sham signals. J Psychosom Res 2008;65(5):453–60.
[23] Petrie KJ, Sivertsen B, Hysing M, Broadbent E, Moss-Morris R, Eriksen HR, et al. Thoroughly modern worries. The relationship of worries about modernity to reported symptoms, health and medical care utilization. J Psychosom Res 2001;51:395–401.
[24] Marteau TM, Becker H. The development of a six-item short-form of the state scale of the Speilberger state–trait anxiety inventory (STAI). Br J Clin Psychol 1992;31:301–6.
[25] Kroenke K, Spitzer RL, Williams JBW. The PHQ-15. Validity of a new measure for evaluating the severity of somatic symptoms. Psychosom Res 2002;68:258–66.
[26] Barskey AJ, Wyshak G, Klerman GL. The somatosensory amplification scale and its relationship to hypochondriasis. J Psychiatr Res 1990;24:323–34.

[27] BBC Panorama. WiFi: a warning signal. http://news.bbc.co.uk/1/hi/programmes/panorama/6683969.stm; 2007.
[28] BBC Click Report. Technology and mobile phone hacking. http://www.youtube.com/watch?v=BxFkHii2K_w; 2011.
[29] Chartrand TL, Bargh JA, van Baaren RB. Linking automatic evaluation to mood and information processing style: consequences for experienced affect, impression formation, and stereotyping. J Exp Psychol Gen 2006;135:70–7.
[30] Aiken LS, West SG. Multiple regression: testing and interpreting interactions. Newbury Park: Sage; 1991.
[31] Winters W, Devriese S, Diest IV, Nemery B, Veulemans H, Eelen P, et al. Media warnings about environmental pollution facilitate the acquisition of symptoms in response to chemical substances. Psychosom Med 2003;65:332–8.
[32] Cinel C, Russo R, Boldini A, Fox E. Exposure to mobile phone electromagnetic fields and subjective symptoms: a double-blind study. Psychosom Med 2008;70(3):345–8.
[33] Das Munshi J, Rubin GJ, Wessely S. Multiple chemical sensitivities: review. Curr Opin Otolaryngol Head Neck Surg 2007;15:274–80.
[34] Nevelsteen S, Legros JJ, Crasson M. Effects on information and 50 Hz magnetic fields on cognitive performance and reported symptoms. Bioelectromagnetics 2007;28:53–63.
[35] Broadcaster's Audience Research Board. Weekly top 30 programmes, May 14–20 2007. http://www.barb.co.uk/report/weekly-top-programmes-overview?.
[36] BBC News. Panorama Wi-Fi complaints upheld. http://news.bbc.co.uk/1/hi/uk/7122230.stm; 2007.
[37] Page L. The man living in the woods to escape Wi-Fi and mobile phones. The Guardian, 20 July 2012.
[38] Brown RJ. Psychological mechanisms of medically unexplained symptoms: an integrative conceptual model. Psychol Bull 2004;130:793–812.
[39] Witthöft M, Hiller W. Psychological approaches to origins and treatments of somatoform disorders. Annu Rev Clin Psychol 2010;6:257–83.
[40] Bailer J, Witthöft M, Bayerl C, Rist F. Syndrome stability and psychological predictors of symptom severity in idiopathic environmental intolerance and somatoform disorders. Psychol Med 2007;37:271–81.
[41] Witthöft M, Gerlach AL, Bailer J. Selective attention, memory bias, and symptom perception in idiopathic environmental intolerance and somatoform disorders. J Abnorm Psychol 2006;115:397–407.
[42] Lorber W, Mazzoni G, Kirsch I. Illness by suggestion: expectancy, modeling, and gender in the production of psychosomatic symptoms. Ann Behav Med 2007;33:112–6.
[43] Iaboli L, Caselli L, Filice A, Russi G, Belletti E. The unbearable lightness of health science reporting: a week examining Italian print media. PLoS One 2010;5:e9829.