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Health complaints and wind turbines: The efficacy of explaining the nocebo response to reduce symptom reporting

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ABSTRACT

Background: A number of people are reporting an environmental sensitivity to sub-audible windfarm sound (infrasound), characterised by the experience of recurrent non-specific symptoms. A causal link between exposure and symptoms is not indicated by empirical evidence. Research indicates symptoms may be explained by the nocebo response, whereby health concerns and negative expectations, created from social discourse and media reports, trigger symptom reporting.
Objective: The experimental aim was to test whether providing a nocebo explanation for symptoms, to individuals reporting symptomatic experiences during infrasound exposure, would ameliorate symptoms during further exposure.
Method: Sixty-six volunteers were randomly assigned to nocebo explanation or biological explanation groups. Participants were concurrently exposed to infrasound and audible windfarm sound, while reporting on current symptoms and mood, during two exposure sessions. Preceding session one, participants watched a presentation integrating media warnings about purported health risks posed by windfarm infrasound. Before session two, nocebo explanation participants viewed material outlining how nocebo responding could explain symptom reporting. Instead biological explanation participants watched material presenting pathophysiological theories for symptoms.
Results: During session one, participants reported increased symptoms and mood deterioration from baseline assessment. During session two symptom reporting and mood deterioration was maintained by biological explanation participants, while mood and symptoms reported by nocebo explanation participants returned to baseline levels.
Conclusion: Results indicate that providing an explanation of the nocebo response, followed by exposure to infrasound, has the potential to operate as an intervention to reduce symptomatic experiences in people reporting symptoms attributed to windfarm generated infrasound.

1. Introduction

While harnessing wind power is widely considered to be a vital component of global energy policies designed to address climate change, the construction of wind farms has become increasingly contentious in many local communities (Knopper et al., 2014). This is often because of assertions that sensitive individuals, living in the environs of a wind farm, risk developing an environmental illness (Knopper and Ollson, 2011). This environmental illness, often referred to as wind turbine syndrome, is said to be characterised by the experience of recurrent non-specific symptoms triggered by exposure to the low frequency sub-audible sound (infrasound) generated by wind turbines (Pierpont, 2009). That some individuals report a sensitivity to infrasound has public health implications given associations between perceived environmental sensitivities and poorer subjective health (Baliatsas et al., 2014); increased health care utilisation (Rubin et al., 2008); decreased occupational performance (Peachey-Hill and Law, 2000); reduced quality of life (Nordin et al., 2013); psychological distress (Skovbjerg et al., 2012); and social withdrawal (Boyd et al., 2012).

Treating individuals reporting symptoms attributed to wind turbine generated infrasound exposure is complicated by the fact the evidence does not support a direct pathophysiological relationship between infrasound and the symptoms experienced (Bolin et al., 2011; Ellenbogen et al., 2012; Merlin et al., 2014). Infrasound is consistently present in the external environment created by natural phenomena, such as air turbulence and ocean waves, and machinery, such as traffic and air-conditioning units (Leventhall, 2006). Further, comprehensive assessment of levels of infrasound at residences close to wind farms has shown

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equivalence with measured levels found in other rural and urban environments and, importantly, that wind turbine generated infrasound does not significantly contribute to background levels of environmental infrasound (Evans et al., 2013).

Understanding what might be causing symptom reports is critical to inform successful interventions to alleviate distress and symptom reporting in communities in which wind farms are proposed and operating. It is noteworthy that experiencing symptoms is a common phenomenon, and is not in and of itself indicative of illness. A recent general population study found that over the course of a week respondents experienced a median number of 5 symptoms, 23% of the population reported 10 or more symptoms, and only 10.6% of respondents were completely symptom free (Petrie et al., 2014). In the case of wind turbine syndrome the collection of symptoms reported, such as headache, tinnitus, fatigue, dizziness, sleep problems, anxiety, irritability, depressed mood, and an inability to concentrate, are commonly experienced in the community (e.g. McAteer et al., 2011; Shargorodosky et al., 2010).

Interestingly, symptomatic experiences attributed to wind turbines substantially occurred after a self-published book (Pierpont, 2009) put forward the theory that wind turbine generated infrasound was causing a constellation of common symptoms in people living close to wind farms, and also outlined a proposed biological mechanism for symptoms (Chapman et al., 2013). Although the established science does not support such assertions, claims that wind farm infrasound is hazardous to health have since proliferated through social discourse and the media, particularly via the internet (Leventhall, 2013). The dissemination of information which creates a perception that an environmental exposure is hazardous to health can itself trigger symptom reporting, even when the environmental exposure is completely innocuous, though the nocebo effect (Crichton et al., 2014a; Faasse and Petrie, 2013). The nocebo effect may be conceptualised as the flip side of the placebo effect and, in a medical context, occurs when side effects are reported follow the administration of an inert medication or procedure (Barsky et al., 2002). The nocebo response to a benign environmental exposure occurs when individuals expect symptoms from exposure so they are more likely to notice and report symptoms consistent with health concerns (Pennebaker, 1994; Petrie et al., 2005). Epidemiological and experimental evidence indicates that, rather than any adverse physiological impact of infrasound, negative expectations and symptom misattribution are driving symptom reporting in the vicinity of wind farms (Chapman et al., 2013; Crichton et al., 2014b).

Given mounting evidence that anxiety and negative expectations may help explain symptom reports attributed to infrasound generated by wind farms, a simple intervention to reverse such symptom reporting might be to provide an explanation of the nocebo effect to those reporting symptoms, to reduce anxiety and change expectations. Evidence suggests that simply telling affected individuals that symptoms do not have an organic basis, and that wind turbine produced infrasound exposure would not cause symptoms, is unlikely to be sufficient to reduce anxiety and symptom reports (Petrie and Sherriff, 2014). However, the provision of a more coherent alternative explanation for the experience of symptoms, such as an account of how nocebo responding could explain symptom reporting, might reduce concern, provide reassurance, and alleviate symptoms.

Accordingly, in this study, we tested the potential for the provision of a nocebo explanation for symptomatic experiences to reverse symptom reporting triggered by negative expectations created from media information about a purported environmental health threat. A community sample was chosen to participate in the study because affected individuals most often identify as a previously healthy member of the community, who now have an environmental illness having experienced a rapid, intense and/or persistent onset of symptoms which coincided with exposure to wind turbine sound (Chapman, 2011). The study builds on a sham controlled experiment which demonstrated that negative information disseminated by the media about the purported health risks posed by infrasound produced by wind farms creates negative expectations triggering symptomatic responses during exposure to both genuine and sham infrasound (Crichton et al., 2014c). This experiment also revealed that individuals not given negative expectations about the health effects of infrasound, experienced no increase in symptoms during infrasound exposure, further confirming the involvement of nocebo responding in creating symptomatic experiences.

In this study we hypothesised that participants viewing media information about the health risk posed by infrasound generated by wind turbines would exhibit a nocebo response, reflected in increased symptoms and mood deterioration, during simultaneous exposure to audible and sub-audible wind farm sound. We further hypothesised that participants provided information explaining the nocebo effect, following their initial exposure to infrasound, would experience a return to baseline in reported symptoms and mood during a second exposure period. In contrast, we hypothesised that participants provided information about a proposed biological mechanism for symptoms, would maintain elevations in symptoms and deterioration in mood during a second exposure period.

2. Materials and method

2.1. Study design

This single blind study incorporated a within and between subjects design in which participants took part in two fourteen minute listening sessions, throughout which they were concurrently exposed to infrasound (9 Hz, 50.4 dB) and audible wind turbine sound (43 dB), while reporting on their current symptoms and mood. Participants were randomly assigned to either a nocebo explanation group or biological explanation group, according to a computer generated random number sequence.

Immediately preceding the first listening session participants, in both groups, viewed the same audio-visual presentation featuring material from the internet about the purported health risks posed by infrasound produced by wind farm. During a fifteen minute interval between listening session one and listening session two, participants in the nocebo explanation group viewed audio-visual material which explained that the scientific evidence did not support a direct link between symptoms reported and infrasound, and then described how the nocebo effect could provide a pathway for symptom reporting. In contrast, before the second exposure period, participants in the biological explanation group watched audio-visual material which presented pathophysiological theories for symptom reporting.

Experimental procedures were conducted at the acoustic research facility of the University of Auckland, in a listening room built for experiments assessing subjective responses to sound, to the standard set by the International Electrotechnical Commission (IEC268-13). The study was reviewed by and received ethics approval from the University of Auckland Human Participants Ethics Committee: reference number: 010607.

2.2. Participants

A community sample consisting of 66 volunteers, 43 female and 23 male, aged between 17 and 70 years ($M=27.56$, $SD=12.69$), completed experimental procedures. Participants were recruited

by a local community newspaper advertisement and flyer, placed on the University of Auckland website, asking for volunteers interested in participating in research investigating symptom and mood experiences during exposure to infrasound, sound below the threshold of human hearing. Participants were informed they would be exposed to infrasound during two 14 min exposure periods and were reassured they could stop the experiment at any time. At the end of the experiment volunteers were fully debriefed, and received a NZ $20 shopping voucher. The optimal sample size was calculated using G-Power (Faul et al., 2007), on the basis of main analysis involving a 2 (nocebo explanation versus biological explanation) × 3 (measurements at baseline, session one, and session two) mixed analyses of variance to determine within-between interactions in relation to symptom reports and mood. Assessment showed that with a minimum of 44 participants, setting power at 0.95 and alpha at 0.05, it would be possible to detect a medium effect (f=0.25) (Cohen, 1990).

2.3. Materials

2.3.1. Audible and sub-audible wind farm sound

Sound files were constructed using a combination of the Adobe® Audition software package with a Presonus® Firepod audio interface, and a Mackie® HR 150 active studio woofer, to produce infrasound at 9 Hz, which was transmitted throughout exposure sessions at 50.4 dB. Audible wind farm sound, which had been recorded 1 km from a wind farm, was simultaneously played at 43 dB. It has been established that that the audible and sub-audible sound played would not generate adverse health effects (Crichton et al., 2014b).

2.3.2. Audio-visual materials

Audio-visual materials consisting of Digital Video Display (DVD) presentations were each of 5 min 40 s duration (video scripts are available from the authors on request). The negative expectation DVD, played to all participants before the first listening session, set negative expectations by incorporating information sourced from the internet about the alleged risk posed by infrasound produced by wind farms, which included television footage of people discussing their adverse symptomatic experiences attributed to wind turbine sound exposure. The nocebo explanation DVD put forward the scientific evidence that, despite information found on the internet about the health risk posed by infrasound, infrasound exposure was an everyday experience, and exposure to infrasound at the level produced by wind farm would not produce adverse health effects. Further, the DVD provided an explanation of the nocebo effect, and peer reviewed scientific evidence supporting the involvement of the nocebo response in symptom reporting around wind farms was outlined (e.g. Chapman et al., 2013; Crichton et al., 2014c).

The biological explanation DVD put forward proposed pathophysiological mechanisms for symptom reporting found online: (1) that the outer hair cells of the auditory portion of the inner ear, the cochlear, are stimulated by infrasound (Salt and Hullar, 2010) and; (2) infrasound interferes with auditory and visual signals received by the brain, because of a sensitivity of the sensory system primarily responsible for movement, balance, and spatial orientation (the vestibular system), to low frequency vibration (Pierpont, 2009).

2.4. Measures

2.4.1. Demographic data

All participants completed a demographic information questionnaire, in which participants indicated their sex, ethnicity, age, employment status, and level of education.

2.4.2. Concern about the health effects of windfarm sound

As a manipulation check participants were asked to indicate the extent to which they agreed with the statement “I am concerned about the health effects of sound produced by wind turbines”. Assessment was made on a 100 mm visual analogue scale from 0 disagree strongly to 100 agree strongly at three different time points; at baseline, after viewing the negative expectation DVD, and at the end of the experiment.

2.4.3. Coherence and plausibility of explanations for health effects

After viewing either the nocebo or biological explanation DVD participants evaluated four questions about the coherence and plausibility of the explanations on a 100 mm visual analogue scale from 0 disagree strongly to 100 agree strongly. Participants were asked four questions about the extent to which they found the explanation provided to them: (1) easy to understand; (2) made sense; (3) was convincing; and (4) was correct. Participants were also asked a further two questions using the same VAS scale, repeated at the end of the experiment. Nocebo explanation participants were asked about the extent to which they believed: (1) accessing information on the internet, or being provided with information, that infrasound causes poor health and physical symptoms, such as headache, might cause people to experience these symptoms, and (2) whether nocebo response, where expectations lead to the experience of symptoms, might explain why people report symptoms from infrasound produced by wind farms. Biological explanation participants were asked about the extent to which they believed: (1) infrasound affects sensory hair cells which would explain why people report symptoms from infrasound produced by wind farms, and (2) symptoms were triggered as a result of infrasound interfering with auditory and visual signals received by the brain.

2.4.4. Symptoms and mood

At baseline and during exposure sessions, participants assessed their experience of 24 physical symptoms (e.g. dizziness, ear pressure, and nausea), 12 positive mood items (e.g. calm, relaxed, and cheerful) and 12 negative mood items (e.g. worried, anxious, distressed) on a seven point Likert scale ranging from 0 (*not at all*) to 6 (*extreme* or *extremely).* Symptom and mood questionnaires were completed during each exposure period, prompted by a 2-second audible tone (middle C–262Hz) played 2 min into each session.

For each assessment period a total symptom score was evaluated as the number of symptoms reported with a rating ≥ 1, and a total symptom intensity score was calculated as the sum of the ratings made for all symptoms reported. In relation to mood, for each period of assessment, a total positive mood score was evaluated as the cumulative total of the ratings given for all positive mood items, and a total negative mood score as a sum of the ratings made for all negative mood items.

The questionnaires were developed by the authors to include mood experiences and symptoms said to arise as a result of exposure to wind farm sound (e.g. Pierpont, 2009). Reliability has been established in previous studies assessing subjective responses to infrasound exposure (Crichton et al., 2014b, 2014c). The questionnaires were demonstrated to have good internal reliability over the course of the current study, with Cronbach's α coefficients between 0.82 and .95 for the symptom questionnaire; between 0.87 and 0.93 for the negative mood scale; and 0.89 and 0.93 for the positive mood scale.

2.5. Data analysis

Statistical analysis was conducted using SPSS version 22 statistical software. As a randomisation check a comparison of groups

was carried out to determine whether the groups differed significantly on any demographic variable. This analysis was undertaken using independent *t* tests for parametric data, and chi-square tests for categorical data. Further, a mixed design analysis of variance (ANOVA) was conducted to test within and between group differences in health concerns at baseline, after viewing the expectation video, and at the end of the experiment. To evaluate differences in symptom and mood reporting over the course of experiment mixed design analyses of covariance (ANCOVA), controlling for baseline scores, were undertaken to assess any within and between group differences at baseline and during exposure sessions. All *p* values in multiple comparisons were adjusted using Bonferroni corrections.

3. Results

3.1. Randomisation check

There were no significant differences between the groups in relation to any of the demographic variables assessed.

3.2. Concern about health effects of sound produced by wind farms

In relation to concern about the health effects of sound produced by wind farms, results showed a significant group by time interaction $F(2, 128)=38.90$, $p<0.001$, $\eta_p^2=0.38$. Analysis showed concern significant increased from baseline in both groups when assessed immediately after viewing the negative expectation DVD ($ps<0.001$). This concern increased over the course of the experiment in the biological explanation group, with a further significant increase in concern from viewing the negative expectation DVD to assessment at the end of the experiment ($p=0.006$). This indicated that the experience of biological explanation participants was consistent with the provision of negative expectations, and that a biological explanation for adverse health effects increased concern over and above the provision of information that infrasound was causing symptoms in people living close to wind farms. In relation to nocebo explanation participants, by the end of the experiment, there was a significant decrease in concern from assessment after watching the negative expectation DVD ($p<0.001$), and there was a further reduction in concern from baseline which approached significance ($p=0.057$). Thus results indicated that the nocebo explanation given was reassuring to those in the nocebo explanation group. The influence of the different explanations provided to each group was also highlighted by differences in concern, as assessed at the end of the experiment, with biological explanation participants being significantly more concerned than nocebo explanation participants about the health effects of sound produced by wind farms ($p<0.001$). Results are depicted in Fig. 1.

3.3. Coherence and plausibility of explanations for health effects

There were no differences between the groups in relation to assessment of the coherence and plausibility of the explanation for the experience of health effects provided. Participants in both groups found the explanation provided easy to understand (biological explanation group: $M=83.09$, $SD=18.23$; nocebo explanation group: $M=90.79$, $SD=16.91$); made sense (biological explanation group: $M=83.55$, $SD=15.60$; nocebo explanation group: $M=88.76$. $SD=18.33$); was convincing (biological explanation group $M=83.15$, $SD=14.40$; nocebo explanation group: $M=82.42$, $SD=20.24$); and was correct (biological explanation group: 77.52,

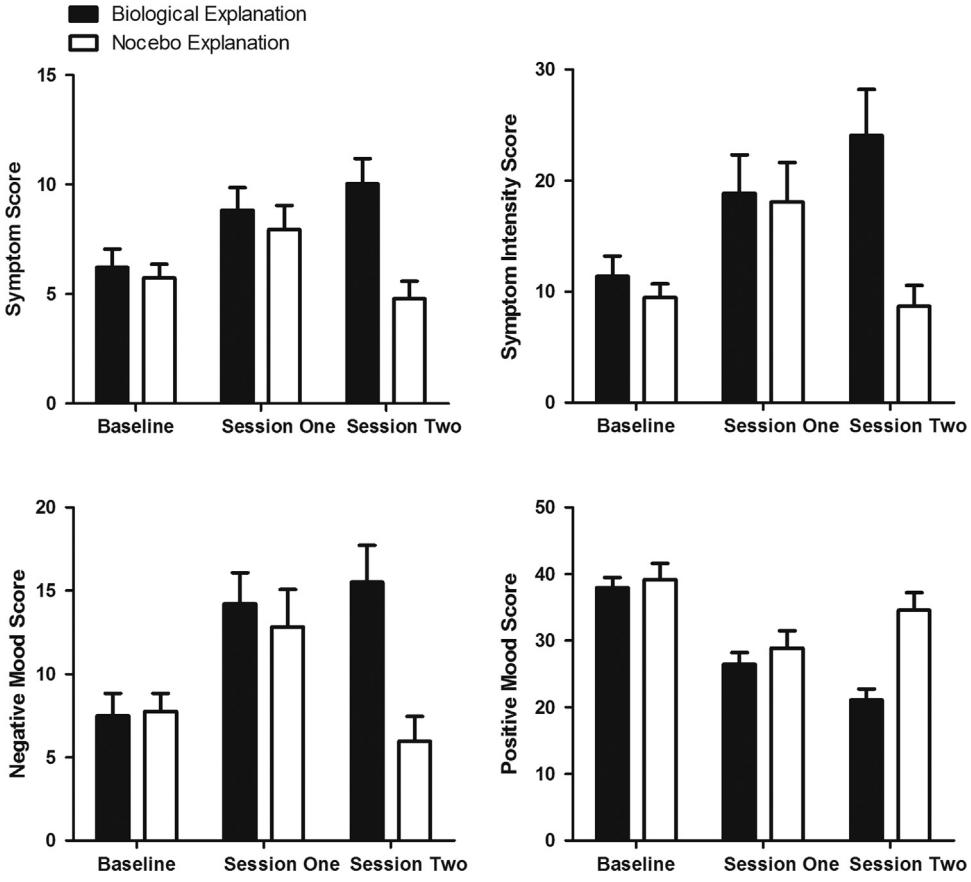

Fig. 1. Concern about the health effects of sound produced by windfarms assessed at baseline, after viewing the negative expectation DVD, and at the end of the experiment.

$SD=18.58$; nocebo explanation group: $M=75.58$, $SD=20$).

Immediately following the explanation DVD biological explanation participants indicated they believed that infrasound affects sensory hair cells within the inner ear, which would explain why people report symptoms from infrasound produced by wind farms ($M=80.59$, $SD=14.52$). This belief was maintained throughout the experiment, as indicated when measured at the conclusion of the experiment ($M=82.53$, $SD=11.94$). Biological explanation participants also believed the explanation that symptoms were triggered as a result of infrasound interfering with auditory and visual signals received by the brain after the video presentation ($M=81.16$, $SD=15.47$) and at the end of the experiment ($M=81.94$, $SD=12.34$). Results suggest that experiences within the experiment were consistent with beliefs created by the explanation for the health effects provided in the explanation DVD.

Results also showed that, after watching the explanation DVD, nocebo explanation participants believed that accessing information on the internet or being provided with information that infrasound causes poor health and physical symptoms, such as headache, might cause people to experience these symptoms ($M=85.61$, $SD=15.52$). This belief was maintained throughout the experiment, as measured at the end of the experiment ($M=85.91$, $SD=14.1$). Following the DVD explanation nocebo explanation participants also believed that the nocebo response, where expectations lead to the experience of symptoms, may explain why people report symptoms from infrasound produced by wind farms ($M=82.61$, $SD=16.49$), a belief still held at the end of the experiment ($M=85.36$, $SD=15.45$).

3.4. Symptoms and symptom intensity

Mixed ANCOVA analysis, controlling for baseline scores, showed significant group by time interactions in relation to symptoms $F(2, 126)=15.56$, $p<0.001$, $\eta_p^2=0.20$, and to symptom intensity $F(2, 126)=9.51$, $p<0.001$, $\eta_p^2=0.13$. In relation to the biological explanation group there was a significant increase from baseline to session one in both the number of symptoms experienced ($p=0.002$) and reported symptom intensity ($p=0.046$), and that increase from baseline was sustained during session two ($ps<0.001$). In contrast the nocebo explanation group reported an increase from baseline to session one in symptoms and symptom intensity ($ps=0.008$), but a decrease in symptomatic experiences from session one to session two, with symptoms and symptom intensity returning to baseline levels during session two ($ps<.001$). As expected, biological explanation participants reported significantly more symptoms and greater symptom intensity than nocebo explanation participants during session two ($ps<0.001$). There were no between group differences at any other time of assessment. Symptom results are depicted in Fig. 2.

3.5. Mood

In relation to mood, analysis using a mixed ANCOVA, controlling for baseline scores, revealed significant group by time interactions in terms of both negative mood $F(2, 126)=9.74$, $p<0.001$, $\eta_p^2=0.13$, and positive mood $F(2, 126)=13.13$, $p<0.001$, $\eta_p^2=0.17$. Post hoc analysis showed a pattern consistent with symptom results. In the biological explanation group there was a significant increase from baseline in negative mood during session one ($p=0.002$) and session two ($p<0.001$), and also significant decreases from baseline in positive mood during both sessions ($ps<0.001$). In terms of the nocebo explanation group there was a significant increase in negative mood ($p=0.026$) and a significant decrease in positive mood ($p<0.001$) from baseline to session one, with mood returning to baseline levels during session two. As predicted biological explanation participants had significantly greater negative mood and lower positive mood than nocebo explanation participants during session two ($p<0.001$). There were no between group differences in mood at any other time of assessment. Mood results are also depicted in Fig. 2.

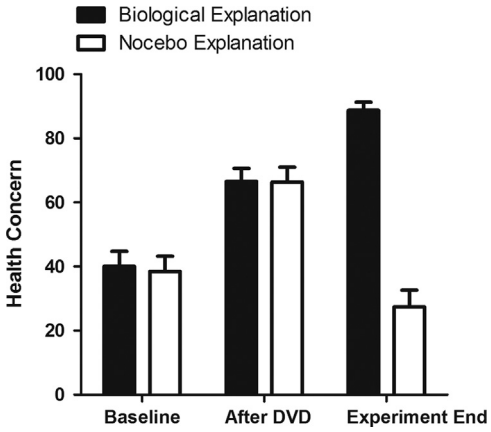

Fig. 2. Symptom and mood reporting by each group at baseline and during exposure sessions.

4. Discussion

The central finding from this study is that symptoms, reported by individuals during a perceived exposure to an environmental hazard, were alleviated during further exposure if they were provided with an account of how the nocebo effect could explain health effects. As predicted we found that providing people with material on the internet suggesting that infrasound produced by wind farms is causing symptoms in people living close to wind farms increased concerns about the health effects of wind farm sound and resulted in increased symptoms and mood deterioration, during exposure to wind farm sound. That health concern increased and symptomatic experiences were maintained by participants who viewed further internet material putting forward pathophysiological mechanisms for symptom reporting indicates that biological explanations, available through the media to people living in the vicinity of wind farms, may be perpetuating both health concerns and symptom reports. Our results accord with experimental research indicating that nocebo responses to media health warnings about perceived environmental hazards may be providing a pathway for medically unexplained symptom presentations attributed to environmental agents (Winters et al., 2003; Witthoft and Rubin, 2013; Crichton et al., 2014c). Findings are also consistent with epidemiological evidence showing that complaints about the health effects of wind farm sound cluster in areas where residents are exposed to local negative news stories and targeted anti-wind farm publicity (Chapman et al., 2013).

Analyses of media stories about purported links between negative health and environmental agents have revealed such reporting often reflects an alarming incongruence with the current state of the scientific evidence, by emphasising an unsubstantiated or exaggerated risk of harm (Eldridge-Thomas and Rubin, 2013; Claassen et al. 2012; Chapman et al., 2014). Given that such stories abound on the internet, and that the web is increasingly being used by individuals to find health related information (Macario et al., 2011), there is unprecedented potential for such reports to trigger anxiety and increase symptom reporting in the community. This is highlighted by the fact that increased symptom reporting occurred in this experiment in a healthy community sample

provided with health warnings about wind turbines, also found on the internet.

The experiment is the first to explore whether providing individuals with a nocebo explanation for symptoms experienced during a perceived noxious environmental exposure could reduce symptoms during further exposure. The literature indicates that simply revealing that symptoms do not have a pathogenic cause is not reassuring and is unlikely to alleviate symptoms (Rief et al., 2006). Therefore simply telling participants that infrasound exposure would not cause the adverse effects experienced is unlikely, on its own, to be responsible for the symptomatic improvement reported in the nocebo explanation group. Given evidence that people reporting symptoms around wind farms are not convinced by statements that infrasound exposure would not cause health effects (e.g. Pierpont, 2009), the explanation given to participants provided a clear mechanism for symptoms. Evidence suggests that patients experiencing medically unexplained symptoms are most reassured by explanations about symptoms that are empowering, make sense, and eliminate blame (Hatcher and Arroll, 2008; Salmon et al., 1999). The explanation provided in the experiment was designed to normalise the nocebo response and avoid any connotation that such responding should be viewed pejoratively or as being imaginary. To this end evidence was outlined which demonstrated that experiencing symptoms by suggestion is a typical human response to health warnings, with the potential to explain symptom reporting thought to be a direct response to infrasound exposure. Importantly, results showed participants found the nocebo explanation easy to understand, made sense, and was convincing.

That the nocebo explanation was followed closely by exposure to infrasound so that participants could assess, in a concrete way, whether prior experiences could be explained by the nocebo effect was likely to have enhanced reassurance. Providing individuals with reported sensitivity to mobile phones with feedback that they had been unable to discriminate between an active mobile -phone signal from a sham signal was shown to have no influence on subsequent symptom levels or perceived sensitivity to mobile phones (Nieto-Hernandez et al., 2008). However, as the authors of this study noted, evidence indicates that reassurance might have improved and symptom reporting might have been reduced if the patients had been provided with pre-test information about psychological explanations for symptom reporting prior to exposure (Donkin et al., 2006). Reassurance in the current study was reflected in the shift in health concern seen in the nocebo explanation group. Unlike participants given a biological explanation for symptoms, by the end of the experiment, nocebo explanation participants were no longer concerned about the health effects of wind farm sound.

Results indicate that providing an explanation of the nocebo effect, followed by exposure to an environmental agent previously thought to have directly caused symptoms, has the potential to operate as an intervention to reduce symptomatic experiences in people reporting symptoms attributed to innocuous environmental agents. The next step would be to investigate whether such an approach would also be effective to ameliorate symptoms in individuals holding long term beliefs that their experience of symptoms is related to hazardous exposure to wind farm generated infrasound. Given that there is evidence a nocebo response to an environmental exposure may become a conditioned response, over time (Rubin et al., 2010; Van den Bergh et al., 2002), the intervention may have to be modified for long term symptom reporters to include an explanation of conditioned responses. Thus research with patients with longstanding health complaints is required to investigate whether nocebo explanations and explanations about conditioning would be enough to shift the processes implicated in longer-term conditioned responses.

Given that the current study relied on self-report of symptoms, future research should also encompass physiological measures that more objectively assess the influence of expectations and explanations about symptoms on symptomatic experiences. Further research should also investigate whether nocebo explanations, provided by clinicians as part of the patient doctor interaction, could reduce nocebo responding seen in patients (Tan et al., 2014). It is crucial that caution is exercised when explaining to individuals about the possible involvement of psychological mechanisms in the aetiology of their environmental illness. When clarifying to individuals that psychological processes are implicated in their symptomatic experiences there is a risk that individuals will feel offended and discredited, which may be counterproductive to symptom improvement (Stone et al., 2002). However, evidence has shown that many patients with perceived environmental intolerances are open to the idea that psychological factors may be playing a role in their symptom experience (Nieto-Hernandez et al., 2008).

While it is important that a possible biological basis for symptom reporting is not erroneously overlooked, and that audible wind farm sound continues to be properly regulated, worldwide there have been over 60 studies investigating the link between wind turbines and human health, and the weight of the scientific evidence is that there is no direct connection between wind turbines and symptom reporting (Knopper et al., 2014). Therefore interventions designed to alleviate distress and symptom reporting are more likely to be successful if they address alternative psychological mechanisms for symptom reports, such as nocebo responding and symptom misattribution (Rubin et al., 2014).

In summary, providing a nocebo explanation for symptoms experienced during exposure to an environmental agent, perceived to be hazardous as a result of accessing negative media health warnings, reversed symptom reporting during a further period of exposure. This study provides encouraging indications that providing an explanation that normalises the nocebo response and eliminates blame, closely followed by exposure to an environmental agent, previously thought to pose a health threat, may operate to reduce health concern and ameliorate symptom reporting in individuals with perceived sensitivities to innocuous environmental agents.

Conflict of interest

The authors declare they have no actual or potential competing financial interests and have not received funding for this study.

Ethical approval

This study was reviewed and received ethical approval by the University of Auckland Human Participants Ethics Committee; reference number: 010607.

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