Effect of listening to breathing recordings on self-reported breathlessness: a public experiment

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To the Editor:

Breathlessness is a common and persistent symptom for those living with chronic lung conditions and advanced disease [1]. It can be distressing for those who experience it, and often results in anxiety, physical inactivity and a poorer quality of life [2, 3]. Additionally, it impacts significantly on those who are close, including friends and family, and is associated with a considerable care burden [4].

Breathlessness can occur physiologically, *e.g.* during exercise, but can also be experienced in many scenarios, including respiratory pathology or psychological distress. Complex interactions between neural networks in the brain are now thought to underpin the perception of breathlessness, and a growing body of research has identified consistent areas of the brain that are associated with breathlessness, including the insula, cingulate and sensory cortices, the amygdala, and the periaqueductal grey matter [5–7]. A recent body of research proposes that the perception of breathlessness is influenced by "priors" generated based on expectations learned from past experiences, which determine the importance assigned to sensory inputs [8, 9]. These priors are compared against incoming sensory signal to generate the symptom experience. This could explain why simply observing breathlessness in others can elicit breathlessness and negative affects in the absence of physiological changes [10]. Additionally, a nocebo effect has been demonstrated, where expectation of breathlessness resulted in increased neural processing and subsequent intensity of symptom experience [11].

It is not currently known 1) whether breathlessness is induced when people are exposed to audio recordings of breathlessness; or 2) whether people listening to breathlessness precipitated by different scenarios will experience breathlessness to different degrees. We aimed to explore these questions in healthy volunteers.

Our hypotheses were: 1) listening to brief audio recordings of breathlessness precipitated by different scenarios will induce breathlessness in healthy volunteers; and 2) the degree of breathlessness that is induced will be affected by the scenario of breathlessness that is being listened to.

To collect preliminary data to test these hypotheses, we conducted a live public experiment in collaboration with Science Gallery, King's College London. We ran the experiment on three dates between 12 October and 16 November 2019 as part of the "On Edge" exhibition at Science Gallery, King's College London. Participants were members of the public aged 16 years and above who attended the exhibition and opted to participate. Data were collected *via* an online interface using a touchscreen tablet. Written consent was obtained prior to taking part. Participants listened to audio recordings of breathlessness, which we defined as breathing patterns elicited by one of four scenarios: 1) a healthy person post-exercise, 2) an anxious person, 3) a person with chronic lung disease and 4) a person approaching the end of life. They were asked to correctly identify the breathlessness scenario, and were asked to report how breathless they felt at baseline and after each recording using the Numerical Rating Scale (NRS) "now" which is a validated measure of how breathless a person is feeling at the current time on a scale of 0–10 (high scores represent worse breathlessness) [12]. We estimated that a minimum sample size of 200 participants would be sufficient based on experience of the 2018 experiment conducted by Herzog *et al.* [10].

Shareable abstract (@ERSpublications)
This public experiment – a collaboration between the Cicely Saunders Institute and Science Gallery London – found that listening to audio recordings of breathlessness resulted in a noticeable increase in self-reported breathlessness. https://bit.ly/3o8py2Q

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Recordings were sourced from consenting patients and using an online audio bank. They were edited to create a 6 s looped clip. The order that recordings were presented to participants was randomised as follows: for each participant, an automated computer program allocated each of the four recordings a random position (between 1 and 4) in the experimental sequence.

To test hypothesis 1, we compared mean±SD NRS scores at baseline to scores after listening to any of the breathlessness recordings. To test hypothesis 2, we compared mean±SD NRS scores at baseline to scores after each breathlessness scenario. We used a one-way ANOVA with repeated measures and *post hoc* pairwise comparisons, and applied a Bonferroni adjustment for multiple comparisons. Results were confirmed using a Friedman test. Due to randomisation of the recording order, we did not adjust for order of recordings during analysis. Ethical approval was obtained from King's College London (reference HR-18/19-12676).

268 people participated in the live experiment. 63% were female (n=169) and most were aged 18–35 years (67%; n=180). 87% (n=232) reported a previous experience of anxiety, and 70.5% (n=189) reported a previous experience of breathlessness. The breathlessness scenario was correctly identified as anxiety by 69% of participants, exercise by 59%, chronic lung disease by 39%, and approaching the end of life by 33%.

Hypothesis 1: participants' self-reported breathlessness was greater after listening to any of the recordings than at baseline. Mean±SD NRS was 1.29±1.82 at baseline, 1.42±1.85 after recording 1, 1.50±1.82 after recording 2, 1.51±1.84 after recording 3, and 1.56±1.98 after recording 4.

Hypothesis 2: self-reported breathlessness increased after listening to any of the four recordings, and the increase was largest after listening to the anxiety scenario (figure 1). The increase in NRS score from baseline was statistically significant at $p<0.05$ after listening to the recordings of anxiety, end of life or exercise, but there was no statistically significant change after listening to the recording of lung disease (figure 1).

In this public experiment, listening to audio recordings of breathlessness increased participants' self-reported breathlessness. Listening to the audio recording of breathlessness caused by anxiety increased self-reported breathlessness the most.

The sound of breathlessness caused by anxiety or exercise were correctly identified more often than the breathlessness recordings precipitated by the other scenarios. It may be that these sounds are more familiar than the sound of someone approaching the end-of-life or of chronic lung disease, which participants may have been less likely to have experienced prior to taking part in the experiment. We were unable to explore the relationship between prior experience of breathlessness/anxiety and the effect of the breathlessness recordings on NRS score in this preliminary dataset, and this is an important question for future research.

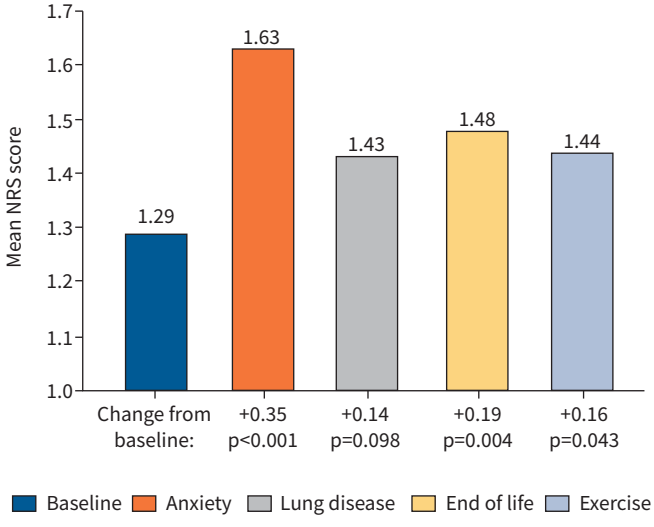

FIGURE 1 Numerical Rating Scale (NRS) scores prior to listening to any recordings of breathlessness, and after listening to four randomly ordered recordings of breathlessness.

These findings, whilst preliminary, raise the question of how exposure to audible breathlessness may affect informal carers and health professionals involved in the care of those living with chronic breathlessness. The findings of Herzog *et al.* [10] indicate that observation of breathlessness can induce vicarious breathlessness, and our findings suggest this may be the case even when the breathless person is not visible. The impact for caregivers who may be exposed to constant breathlessness could be important, and therefore education and training for caregivers to better understand breathlessness is essential [13]. It may also be interesting to further consider the effects of listening to breathlessness outside of the healthcare setting, for example when induced by exercise.

This study demonstrates that, in the right circumstances, a public experiment can enable efficient recruitment; this approach could be usefully applied to appropriate research questions in future. For this study we were able to exceed the planned sample size in three afternoons. We were able to conduct a rigorous study, with randomisation of recordings to eliminate the impact of recording order on the findings.

The limitations of this methodology were that it required a very brief experimental protocol and meant we were unable to collect sufficient data on prior experience of breathlessness/anxiety to investigate the impact of past experience on induced breathlessness. We were also unable to apply a control group or washout period between recordings. This has limited the inferences that can be drawn from our data and we cannot rule out that the findings from hypothesis 1, which suggest a dose–response effect of listening to breathlessness recordings, relate to the lack of washout period rather than true experience. Furthermore, participants were mostly aged 18–35 years and were attending an exhibition focused on anxiety. Therefore, results are unlikely to be representative of the general population or of those caring for people with chronic breathlessness who are likely to have regular exposure to the sound of breathlessness. Further work with more extensive data collection in more targeted populations could help to understand the clinical implications of our findings, for example how high levels of exposure to breathlessness among carers of people living with chronic breathlessness or anxiety could impact their own experience.

There were no clinically significant changes in participants' breathlessness based on a threshold of 0.5 on the NRS [14]; however, we used very short recordings to keep the total study duration down and this may have limited the impact on participants. A future study with longer exposure time might identify greater effects on breathlessness and would more closely reflect real life experience of those with breathlessness.

In conclusion, this public experiment generated initial data showing that listening to breathlessness recordings increased participants' self-reported breathlessness. The cause of breathlessness appeared to mediate this effect. Further investigation is needed to determine the mechanisms behind these findings, and the impact of prior experience of breathlessness. The clinical implications deserve further consideration.

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