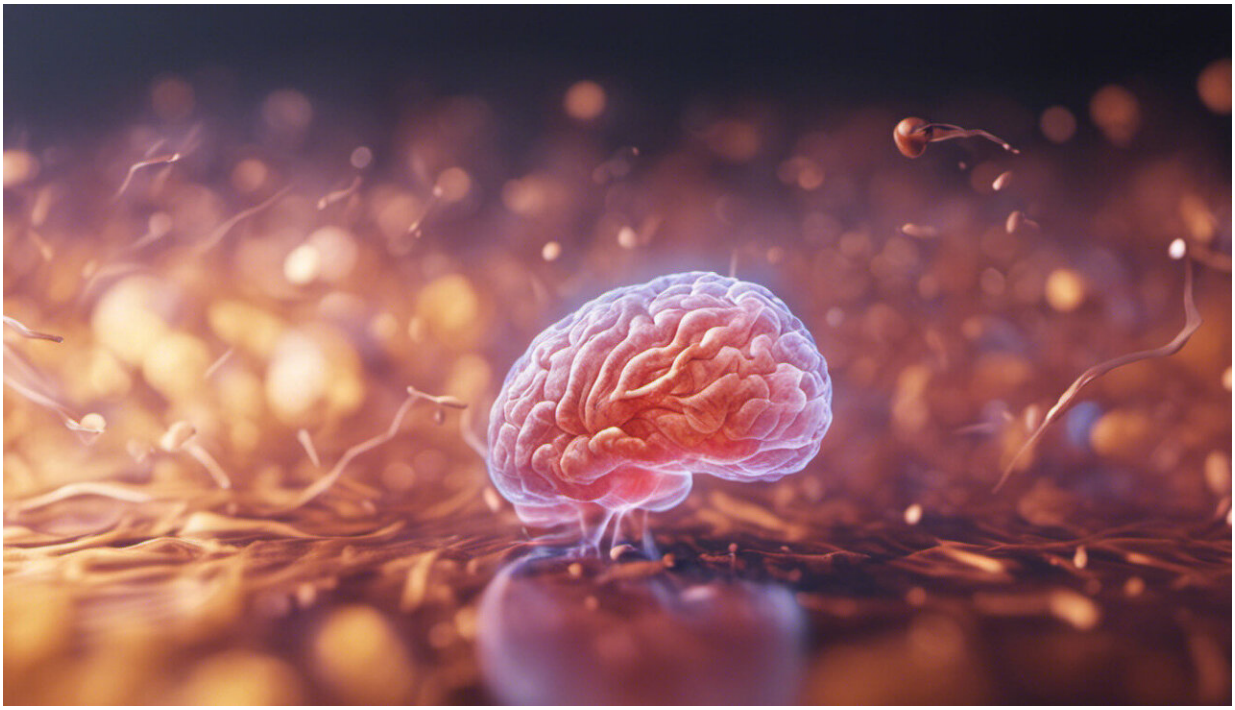
Personalised treatment for people with chronic breathing disorders

September 20 2017, by Kyle Pattinson, Oxford Science Blog



Credit: AI-generated image (disclaimer)

Ever realised you've forgotten your inhaler and immediately felt your breathing become more difficult? Ever wanted to walk upstairs to get something, but the thought of becoming breathless has stopped you? You're not alone! Our brains store a phenomenal amount of information about the world, based on our past experiences. This helps us to assess

situations quickly and anticipate how our bodies will respond, such as when we will become breathless. These ideas are learned and updated constantly throughout our life, and quickly adapt if we develop something like a chronic breathing disorder.

These learned ideas, or 'priors', are thought to not only influence our actions (such as avoiding the stairs), but can materially alter the way we perceive a symptom like breathlessness. This theory is termed the 'Bayesian brain hypothesis', and it explains how our priors are compared to incoming sensory information in the brain, and both pieces of information are used to create our conscious perception.

Breathlessness can be experienced by people with a wide range of conditions: those with respiratory, cardiovascular or neuromuscular diseases, as well as some people with cancer or conditions such as panic disorder. Symptoms vary, but can include hunger for air, increased breathing effort, rapid breathing and chest tightness. These breathing symptoms have been known for a long time to be influenced by psychological states such as anxiety, but also by low mood, hormone status, gender, obesity and level of fitness. However, the influence of our previous experiences and learned associations has only more recently entered into the equation.

When we have repeated or frightening exposures to breathlessness, such as an asthma attack or severe breathlessness, our brain can quickly learn and update our priors. This system is designed to help us to avoid threats and keep us safe, but generating very strong expectations (priors) about breathlessness can then exacerbate our symptoms on future occasions. What's more, certain personailty traits such as higher anxiety, or greater body awareness may also influence this system, making some people more susceptible to developing strong expectations about their breathlessness. Once these expectations are embedded, they can be difficult to 'un-learn' – the brain can easily catastrophise about the

potential worst case scenario, such as having another asthma attack.

Scientists at the University of Oxford are at the cutting-edge of a continually improving brain imaging technology that is being used to shed some light on what exactly is happening when we anticipate and experience breathlessness (see some examples here and here). Over the last eight years our research team has been steadily chipping away at these brain mysteries, in the hope that their findings will lead to more carefully targeted and personalised treatments for people with chronic breathlessness.

In the Nuffield Department of Clinical Neurosciences, we are using high-field functional magnetic resonance imaging to look at the brain's workings in incredible detail. This has enabled us to start uncovering the complex neural mechanisms involved in dealing with breathlessness.

The team have been exploring brain networks of breathlessness perception in people with chronic obstructive pulmonary disease (sometimes known as emphysema or bronchitis). The most successful currently available treatment for this condition is pulmonary rehabilitation: a programme of exercise, education, and support to help people with chronic breathing problems learn to breathe more easily again. This type of rehabilitation does not influence physical lung function. That means that it must instead work by helping people to change their learned priors, which make them overestimate the threat of breathlessness (we're back to those stairs again).

Using functional magnetic resonance imaging, we have confirmed that the people who had benefitted from this rehabilitation programme had both higher initial brain activity and greater rehabilitation-induced changes in parts of the brain linked to body symptom evaluation and emotion – the insula and anterior cingulate cortex. They are now working towards studies that can help to increase these changes in

breathlessness expectations, and to identify which people in particular are most amenable to the benefits of pulmonary rehabilitation. This was the focus of our recently published study, and will help to better understand how personalised therapy may be designed for each individual.

Treating the lungs AND the brain

Clearly there can't be a 'one size fits all' approach to treating debilitating perceptions of breathlessness. Current attempts to treat the complexity of chronic breathing problems have been somewhat scattered, and we must now work towards understanding the individual 'lived experience of breathlessness' to lead us to more carefully nuanced interventions. The different factors at play in breathlessness all need to be targeted as part of a comprehensive treatment programme: What are the brain mechanisms at work in learned expectations? How do anxiety, stress and low mood impact on breathlessness? How closely are the observable physical symptoms actually linked to lung function? Imagine the discomfort that could be reduced and quality of life that could be improved, not to mention the money that could be saved (breathlessness due to COPD costs the NHS more than £4 billion per year), if breathlessness were approached in a more holistic way.

Pulmonary rehabilitation is just one in a raft of potential behavioural and drug therapies that could be used to ease the often crippling fear of breathlessness. Only 35% of people who are prescribed pulmonary rehabilitation actually take it up (for a variety of reasons, including not being able to get out to the venues where it is run); and only 60% of those who take it up actually benefit. Therefore, more research is needed to understand the specific mechanisms of breathlessness perception, and develop different treatments that would be suitable for different people. It is the details we are gleaning about the incredibly complex brain mechanisms of symptom perception that will equip us to design more

successful treatment options for those whose symptoms do not match their lung function, to bring breathlessness back under control.

More information: Olivia K. Faull et al. Breathlessness and the body: Neuroimaging clues for the inferential leap, *Cortex* (2017). DOI: 10.1016/j.cortex.2017.07.019

Anja Hayen et al. Understanding dyspnea as a complex individual experience, *Maturitas* (2013). DOI: 10.1016/j.maturitas.2013.06.005

Provided by University of Oxford