

The effects of transcutaneous vagus nerve stimulation combined with slow breathing on pain as well as affective and autonomic responses to noxious stimuli.

Popular science summary

The vagus nerve is part of the autonomic nervous system, which controls the activity of the internal organs (e.g., the activity of the heart or digestive system). In recent decades, vagus nerve stimulation has been increasingly used as a therapeutic method – initially in the treatment of epilepsy and then in the treatment of drug-resistant depression. During studies on the therapeutic use of vagus nerve stimulation, it has been observed that it can reduce pain. These observations inspired studies on the use of vagus nerve stimulation as a method for managing various types of chronic pain (i.e., pain that persists or relapses for a period longer than three months, such as migraines or low back pain). Currently, this research is in a preliminary phase and, despite some inconsistencies in results, the results are promising and justify further research.

Initially, vagus nerve stimulation was performed using an implanted stimulator device that directly stimulates the vagal nerve bundle in the neck. Recently, non-invasive methods of vagus nerve stimulation have been developed, in which nerve endings of the auricular branch of the vagus are stimulated; this is known as transcutaneous auricular vagus nerve stimulation. Because this method doesn't require patients to undergo a surgical procedure, it has a wider scope of potential applications. Research investigating transcutaneous auricular vagus nerve stimulation has suggested that this method also may influence the perception of pain.

Recently, some researchers have proposed that transcutaneous vagus nerve stimulation may be combined with slow breathing to increase its effectiveness. Slow controlled breathing (i.e., breathing that is consciously slowed down) is widely used, for example to help people cope with stressful situations. Much research has suggested that slow breathing exercises can help manage pain, including chronic pain and pain induced in the laboratory as a part of an experiment. Slow breathing produces changes in the activity of the vagus nerve, because its nerve endings monitor various physiological processes related to breathing. For this reason, simultaneous stimulation of the vagus nerve by slow breathing and transcutaneous auricular vagus nerve stimulation may produce stronger effects than each of those methods separately.

The main goal of this research project is to investigate the effects of transcutaneous auricular vagus nerve stimulation combined with slow breathing on pain, emotional state, and autonomic activity when experiencing pain. Emotional state will be investigated because improvement of emotional state is believed to be one of the mechanisms that mediates the effects on pain of both slow breathing and vagus nerve stimulation. Previous research has shown that both slow breathing and vagus nerve stimulation influence our emotional state and that our emotional state affects how intense and unpleasant that the pain we experience is (pain is perceived as more intense when we are anxious). This project will help us to understand how important changes in emotional state are for the pain-reducing effects of slow breathing and vagus nerve stimulation.

This research project will also measure the activity of the autonomic system. Pain increases arousal, including increasing heart rate. In many situations, this increase of arousal is adaptive (e.g., when it helps you escape an attacking predator). Unfortunately, when arousal is persistently increased over a long period of time (as in chronic pain), it can have negative consequences for your health (for example, by increasing the risk of cardiovascular diseases). The present research project will allow us to figure out whether vagus nerve stimulation and slow breathing dampen this increased physiological arousal elicited by pain.

In the future, the results of this research project may help design interventions for people suffering from chronic pain. It is possible that such interventions would not only decrease the perception of pain but also limit the negative effects of pain on mood.