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Attentional Modulation of Reflex Cough

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OBJECTIVE: Reflex cough is a defensive response generated in the brainstem in response to chemical and mechanical stimulation of the airways. However, converging evidence shows that reflex cough is also influenced by central neural control processes. In this study, we investigate whether reflex cough can be modulated by attentional focus on either external stimuli or internal cough-related stimuli.

METHODS: Healthy volunteers (N = 24; seven men; age range, 18-25 years) completed four blocks of citric acid-induced cough challenges while, simultaneously, auditory stimuli were presented. Within each block, four concentrations were administered (30, 100, 300 and 1,000 mM, randomized). During two subsequent blocks, participants focused their attention externally (counting tones). During the other two blocks, participants focused their attention internally (counting coughs). The order of attentional focus was counterbalanced across participants. Ratings of the urge to cough were collected after each challenge. Cough frequency was determined by audio recording.

RESULTS: Cough frequency was higher when participants focused their attention internally vs externally ($P < .05$). Also urge to cough was greater during internal vs external focus ($P < .05$), but the effect was smaller in later blocks of trials.

CONCLUSIONS: Reflex cough can be modulated by attentional focus. Internally focused attention may be a mechanism involved in excessive (idiopathic) cough, while an external focus may be introduced as part of treatments targeting excessive cough.

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Cough is the most common symptom for which individuals consult their general practitioner.[1] It is a key symptom of a variety of medical conditions: Acute cough is often the consequence of an upper respiratory tract infection,[1] whereas chronic cough may be indicative of postnasal drip syndrome, asthma, or gastroesophageal reflux disease.[2] However, in 20% to 42% of patients presenting with chronic cough, cough can persist even after extensive investigation or treatment trials.[3] These patients with refractory cough invariably have an enhanced cough reflex, and it has been suggested to label this condition as cough hypersensitivity syndrome.[3,4]

Cough is, typically, conceived as reflexive behavior wherein afferent activity from mechanical or chemical stimulation of the airways results in changes in the respiratory motor neural pattern generated by the brainstem.[5] Evidence from decerebrated and anesthetized animals shows that cough reflexes can occur without the involvement of cortical processes.[6,7] However, recent models of cough also emphasize the role of higher brain center neural control processes. Evidence is amassing that higher-order brain mechanisms are involved in the sensory processing of cough stimuli. The afferents that elicit cough relay information from peripheral stimulation to centers of the brain that are involved in the perception of stimulus intensity[8] and produce a respiratory sensation, an urge to cough, which, typically, precedes cough motor activity.[9] Furthermore, urge-to-cough activation is not limited to brain centers involved in stimulus intensity, but consists of additional brain centers, organized in a "cough network," suggesting higher brain (cortical) control of urge to cough.[5,8] In a similar fashion, descending pathways allow for behavioral modulation of cough behavior by cortical processes.[5,8,10,11]

One of the behavioral candidates for this higher brain control of cough behavior is attentional focus. Because information processing is resource limited, attentional focus serves as a mechanism determining the processing priority allocated to any given stimulus. Both bottom-up and top-down mechanisms influence attentional focus. For example, stimulus attributes such as intensity, novelty, salience, and suddenness of stimuli (bottom-up) may alter the processing priorities, but also concurrent emotions, expectancy, deliberate strategic orienting, and meaning attributed to stimuli (top-down) may reorganize priorities.[12,13] It has been shown that attentional focus on respiratory sensations modulates the perception and magnitude of respiratory-related evoked potentials.[14] These findings suggest that any variable altering the processing priority of cough-related stimuli of equal intensity may actually increase or decrease the urge to cough and cough behavior.

To our knowledge, only a few studies have investigated the effects of attentional focus on cough. A series of observational studies in naturalistic settings[15] showed that cough frequency was lower when the external environment (eg, a portion of a film clip, a lecture) was rated as more interesting. Another study[16] showed that participants with asthma coughed more frequently and rated the urge to cough higher when a citric acid inhalation test was framed as an asthma test vs a taste test. The findings were interpreted as the effects of beliefs on selective attention to respiratory vs taste sensations. However, neither of these studies experimentally manipulated attentional focus. In the current study, we manipulated attentional focus inward (focus on cough sensations) or outward (focus on auditory stimuli) and hypothesized that cough frequency and urge to cough would be greater during internal vs external attentional focus.

Materials and Methods

Participants

Undergraduate students (N = 28, eight men) were invited to participate in an investigation of cough reflex sensitivity in response to different, harmless, airborne substances. Participants were reached through e-mail and flyers. Based on self-report, individuals diagnosed with a medical condition associated with cough (eg, asthma, allergy, rhinitis) were excluded, as were participants reporting a respiratory infection in the 3 weeks preceding the experiment. The experiment was approved by the medical ethical committee of University Hospitals Leuven (S52118). All participants gave written informed consent. Four participants were excluded because of a self-reported cold, bringing the total number of participants to 24 (seven men; age range, 18-25 years). At the end of the experiment, participants were debriefed, thanked, and given a compensation of €7.

Self-Report Measures

Perceived urge to cough was measured by a 0 to 10 Borg-type scale labeled from "not at all" to "extremely strong."[9] The degree of attentional focus on the tone or cough-counting task was also measured immediately after the single breath inhalation of citric acid with a 0 to 10 Likert-type scale labeled from "not at all" to "extremely focused."

Apparatus

Cough provocation was carried out using a single-breath, dosimeter-controlled inhalation (Jaeger Aerosol Provocation System dosimeter; Carefusion Corp) of citric acid (2 s). Citric acid was dissolved in a physiologic saline solution by the hospital pharmacy. Different concentrations of citric acid were used: 30 mM or 5.8 mg/mL, 100 mM or 19.2 mg/mL, 300 mM or 58 mg/mL, and 1,000 mM or 192 mg/mL. Participants wore a nose clip when breathing through the dosimeter.