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Review

Why do we yawn?

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ABSTRACT

Yawning is a phylogenetically old behaviour that can be observed in most vertebrate species from foetal stages to old age. The origin and function of this conspicuous phenomenon have been subject to speculations for centuries. Here, we review the experimental evidence for each of these hypotheses. It is found that theories ascribing a physiological role to yawning (such as the respiratory, arousal, or thermoregulation hypotheses) lack evidence. Conversely, the notion that yawning has a communicative function involved in the transmission of drowsiness, boredom, or mild psychological stress receives increasing support from research in different fields. In humans and some other mammals, yawning is part of the action repertoire of advanced empathic and social skills.

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1. Introduction

Yawning can be observed in most vertebrate species from foetal stages to old age. In mammals, it consists of an involuntary sequence of mouth opening, deep inspiration, brief apnea, and slow expiration (Walusinski and Deputte, 2004). It can be accompanied by other facultative motor acts such as stretching (Provine et al., 1987a). In humans, yawns last on average about 6 s, and the individual yawn duration and frequency remains remarkably stable over weeks (Provine, 1986). In birds and fish species, a mouth gaping similar to yawning can be observed, and yawning as opposed to other forms of mouth openings has been defined as a slow opening of the mouth, maintenance of the open position for more than 3 s, followed by a more rapid closure of the mouth (Baenninger, 1987). The homology of yawning between different species is controversial, but at least similar movement sequences and similar conditions of occurrence can be observed (Baenninger, 1987; Deputte, 1994).

Since yawning seems to be a phylogenically old and frequent phenomenon, one would expect that it provides some evolutionary advantage, i.e., that is has a certain useful function. Indeed, numerous hypotheses on the function of yawing have been posited throughout the centuries. They were usually derived from behavioural observations of yawns.

In mammals, it has been observed that more than 90% of yawns occur at rest whereas the remaining yawns seem to be triggered by social or emotional stimuli. These contextual differences have motivated a classification of yawning into “physiological” and “social” yawns, although the phenomenology of yawns does not depend on the context (Deputte, 1994; Walusinski and Deputte, 2004). In accordance with the distinction of physiological and social yawn contexts, the hypotheses on the function of yawning have emphasised either a physiological or a social role of yawning.

In contrast to the abundance of theoretical considerations, experimental data is relatively scarce. Yet, in the last few decades, an increasing number of studies have shed some light on its conditions and effects. Although the available data is still far from providing a complete or generally accepted account of the mechanisms and consequences of yawning, it does allow confronting some of the theoretical models with empirical observations. In this review, we will try to classify existing hypotheses according to their current experimental evidence.

All hypotheses postulating a physiological role of yawning share the common assumption that yawning regulates a particular body function, e.g., the blood oxygen level or the brain arousal level. Thus, the mechanisms of yawning are characterised as a homeostatic system with negative feedback regulation. Accordingly, physiological models necessarily make at least two different predictions that can be empirically tested: (i) yawning is triggered by up- or downturns of a given body state and, (ii) yawning acts on the corresponding body function. We will therefore review the evidence of each physiological hypothesis based on its predictions with regards to triggers and effects of yawning. In the case of social models of yawning, the postulated regulating function of yawning would not concern body functions of individuals but rather the communication within social groups. The predictions of this model as well as the corresponding evidence will also be reviewed.

This article will focus on normal yawning; a recent review on pathological yawns can be found elsewhere (Walusinski, 2009).

2. Anatomy and pharmacology

Numerous neurotransmitters, neuropeptides, and hormones have been found to be implicated in the control of yawning. Neuroendocrine substances as diverse as, among others, dopamine, acetylcholine, glutamate, serotonin, nitric oxide, adrenocorticotropic hormone (ACTH) related peptides, oxytocin, and steroid hormones facilitate yawning whereas opioid peptides have an inhibitory effect. Some of these mediators (e.g., dopamine, glutamate, oxytocin) interact in the paraventricular nucleus of the hypothalamus (PVN) and induce yawning via oxytoninergic projections to the hippocampus, the pons, and the medulla oblongata. Other pathways seem to be effective for serotonin, acetylcholine, and ACTH related peptides (Argiolas et al., 1987; Argiolas and Melis, 1998; Sato-Suzuki et al., 1998).

It would be crucial in our search for a purpose of yawning to understand the interaction of these pharmacological pathways with vigilance and respiration centres or with the mechanisms of communication and empathy. However, studies using an interdisciplinary approach of this kind are currently lacking.

3. Physiological hypotheses

3.1. Respiratory and circulatory hypotheses

For several centuries, at least since Hippocrates in the 4th century BC, scholars have thought that yawning might remove “bad air” from the lungs and increase oxygen circulation in the brain (Trautmann, 1901; Schiller, 2002; Matikainen and Elo, 2008).

3.1.1. Oxygen need and hypercapnia do not induce yawning

This hypothesis predicts that yawning is triggered when blood or brain oxygenation is insufficient, i.e., when oxygen (O_2) levels drop and the CO_2 concentration rises.

However, from self-observation most people will confirm that they do not yawn more frequently when they do exercise and need more oxygen than when they are at rest (Provine et al., 1987b). In accordance with this notion, experiments by Provine et al. (1987b) demonstrated that healthy subjects who are exposed to gas mixtures with high levels of CO_2 or physical exercise, do not yawn more frequently. Similarly, high levels of O_2 had no influence on the yawning rate. The study has some limitations, since the subjects had to use hand-held masks prone to leakage and had to count their yawns themselves by pressing a button to activate an event recorder. A potential effect of blood gas concentration might therefore have been hidden by confounding effects. Moreover, the effect of breathing low oxygen concentrations on the yawning rate has not been evaluated due to safety concerns. Nevertheless, the study clearly found significant effects of blood gases and exercise on breathing rates, which demonstrates that breathing and not yawning is the primary – if not only – physiological mechanism used