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Brief report

CHEWING ON GUM ALLEVIATES CHRONIC BOUTS OF EXCESSIVE YAWNING: TWO CASE STUDIES

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ABSTRACT

Spontaneous yawning is an involuntary reflex that occurs across mammals and other vertebrate classes, but the complete neurological basis of this response remains unknown. Recent studies examining the variables that alter contagious yawning in humans have provided critical insights into the mechanisms controlling spontaneous yawning, which in turn have the potential to generate applied therapeutic benefits to individuals experiencing abnormal yawning. This report details the case histories of two individuals with chronic and debilitating bouts of excessive yawning in the absence of sleep problems or any underlying medical condition to explain their symptoms. Although neither individual has received treatment to reduce their yawning, both report that chewing on gum, which has previously been shown to diminish yawn contagion in the laboratory, is effective at immediately alleviating their symptoms. In addition, one of the individuals reports that chewing on gum regularly throughout the day has diminished the overall frequency of these excessive yawning episodes. These findings are discussed in relation to research indicating that yawns function to promote neurovascular circulation and brain cooling.

Keywords: *behavioral medicine, contagious behavior , thermoregulatory dysfunction*

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INTRODUCTION

Yawning is characterized by an involuntary and extended gaping of the jaw with deep inspiration, followed by a brief period of peak muscle contraction and then a passive closure of the jaw with shorter expiration (Barbizet, 1958). Yawns are widespread across mammals and other vertebrate classes (Baenninger, 1987), and have long garnered interest in human ethology as a stereotyped action pattern and releasing stimulus (Provine, 1986).

Nonetheless, yawning remains poorly understood and misconceptions about sleep and oxygen are common (Walusinski, 2010a). While yawn frequency is highest just after waking and prior to sleep onset (Provine, Hamernik, & Curchack, 1987a; Zilli, Giganti, & Salzarulo, 2007), and is therefore correlated with subjective ratings of sleepiness (Giganti, Zilli, Aboudan, & Salzarulo, 2010), the number of times a person yawns each day is not related to sleep duration (Baenninger, Binkley, & Baenninger, 1996). In addition, experiments have confirmed that the function of yawning is not to increase blood oxygenation, and that breathing and yawning are controlled by separate mechanisms (Provine, Tate, & Geldmacher, 1987b). Instead, yawning is a complex reflex involved in behavioral and neurological transitions.

To date, comparative and neurological research suggests that spontaneous yawning plays a role in promoting cortical arousal (Baenninger, 1997) and state change (Provine, 2005). Mechanistically, this is thought to occur through the changes in neurophysiology that result from the motor action pattern. In particular, the extending gaping the jaw and deep inhalation of air that characterizes yawning facilitates intracranial circulation (Walusinski, 2014) and cooling of the brain (e.g., Gallup, Miller, & Clark, 2011; Shoup-Knox, Gallup, Gallup, & McNay, 2010). From an evolutionary perspective, these physiological processes are thought to represent the primitive function of this response, while yawns that are released through contagion are a more recently derived feature among highly social species (Gallup, 2011).

Studies examining the variables that alter the expression of contagious yawning, which is often used as a proxy for spontaneous yawning since it can be reliability induced with yawn stimuli (Provine, 1986), provide support for these physiologic interpretations. For example, methods of behavioral brain cooling, such as nasal breathing and forehead cooling, practically eliminate yawn contagion in the laboratory (Gallup & Gallup, 2007). An extension of this work also showed that cooling of the carotid blood supply, which is sufficient to decrease temperature at the superiomedial orbital area (i.e., the brain temperature tunnel; Abreu, Haddidan, Hott, Assis, & Silverman, 2010), significantly diminishes both the urge to yawn and overall contagious yawning frequency (Ramirez, Ryan, Eldakar, & Gallup, 2019). Moreover, Gallup & Engert (2019) recently demonstrated that chewing on gum significantly decreases the rate, frequency, and duration of contagious yawning among college students. Given that the mandibular contractions of gum chewing increase cerebral blood flow (Hasegawa, Ono, Hori, & Nokubi, 2007), these results further support the hypothesized brain cooling and neurovascular circulatory functions of spontaneous yawning.

Clinical findings are also in line with these interpretations. Collectively, modified patterns of spontaneous yawning are consistently linked with medical conditions that

alter brain temperature and/or intracranial circulation (Gallup & Gallup, 2008; Gallup, Feo, & Gallup, 2010). In particular, excessive or abnormal yawning, which can be defined by ≥3 yawns/15 min, has been associated with various pathologies that have these outcomes, including stroke, traumatic brain injury, and neurodegenerative disease (Daquin, Micallef, & Blin, 2001; Gallup, 2014; Krestel, Bissetti, & Walusinski, 2018).

Although rare, cases of chronic and debilitating bouts of excessive yawning have been documented in the absence acute medical changes, sleep problems, or evidence for any underlying disease. Specifically, Gallup & Gallup (2010) reported on two individuals with analogous symptoms, each regularly experiencing bouts of uncontrollable yawning that lasted anywhere from 5 to 45 minutes in length and could occur up to 15 times a day. Despite each person seeing multiple doctors about their problem, neither had been accurately diagnosed or treated effectively. Through an evaluation of their medical histories, it was evident that changes in brain and body temperature were tied to the onset and severity of their abnormal yawning. Moreover, both individuals reported relief from their symptoms when implementing methods previously shown to reduce contagious yawning in the laboratory, e.g., nasal breathing and forehead cooling (Gallup & Gallup, 2007).

Here, the case histories of two new individuals with similar symptoms of chronic and uncontrollable bouts of excessive yawning are reported. Just like the earlier cases, neither individual has trouble sleeping, nor have they received a medical diagnosis to explain their abnormal yawning. In an attempt to offer therapeutic benefits, both were provided with a list of variables known to inhibit yawning in the laboratory through temperature regulation and neurovascular circulation.

METHODS

Two individuals independently contacted the author by email seeking more information about their longstanding and recurring experiences with bouts of excessive yawning. Both were born in the United States, are college educated, married, and have children. Each individual was asked to describe their symptoms and to provide their medical histories regarding their condition. The local university institutional review board approved this research and both individuals gave consent to participate in this study.

Case 1

The first person to contact the author was a 75-year-old woman. She is 1.55 m tall and weighs 46 kg. She reports that her bouts of excessive yawning started roughly 10 years ago, and that her symptoms have not changed in severity. She describes herself as healthy and her previous medical history only includes osteopenia. She has no sleep problems, and typically sleeps 6-7 hours each night. She indicates that her yawning episodes do not typically occur just before or after sleep, and the amount of sleep she gets is not related to the frequency or severity of her symptoms. She has not sought direct medical advice for

her yawning, nor is she aware of any drugs or medications she has taken that alter her yawning.

Case 2

The second person to contact the author was a 68-year-old man. He is 1.70 m tall and weighs 78 kg. He reports that his bouts of excessive yawning began 17 years ago, and since then there have been no changes in the severity of his symptoms. His previous medical history includes appendicitis when he was a young child, three kidney stones, a minor ischemic stroke that occurred seven years ago, and anxiety and depression 3-4 years ago. He has been taking medications for high blood pressure and high cholesterol for ten years. He has no trouble sleeping, and typically sleeps for 7 hours each night. He indicates that his yawning episodes do not typically occur just before or after sleep, and that the amount of sleep he gets the night before is not related to the frequency or severity of his symptoms the next day.

He has never sought medical assistance for his symptoms, though he has discussed his yawning with a neurologist following his stroke, and with his general practitioner on different occasions. He has not been prescribed any medications or treatment, nor is he aware of any drugs of medications he has taken that affect his symptoms. His general practitioner suggested he might have sleep apnea, which he was tested for and diagnosed with five years ago. He states that he no longer uses a CPAP device, but instead sleeps in a recliner, which has attenuated the heavy snoring and wake-up drowsiness he previously experienced. No changes in yawning were reported alongside the introduction or discontinuation of the CPAP.

RESULTS

Both individuals experience analogous symptoms. The woman reports that each bout lasts between 10-15 minutes in length and can include 25 or more yawns. The man states that his bouts range from 8 to 13.5 minutes in length and typically consist of 12-20 consecutive yawns. Both report that the yawns during these episodes are considerably longer and more intense than isolated spontaneous yawns, and the woman states that these episodes are accompanied by significant tearing from her eyes. The man indicates that he begins to feel extremely tired during the episodes and needs to stop what he is doing until the bout ends. The woman reports experiencing these yawning bouts roughly five times each week, while the man experiences these bouts one to five times daily. Neither individual is able to predict the onset of their yawning, though the woman reports that the episodes are most frequent for her when sitting while the man indicates that his occur predominately in the late afternoon and early evening.

Upon contacting the author, both individuals were informed of the following variables that have been documented to reduce contagious yawning among healthy participants in the laboratory: repeated nasal breathing, cooling of the forehead and/or

neck, and chewing on gum. Prior to even receiving this information, the woman independently reported that chewing on gum was the only thing she was aware of that alleviated her yawning. She reports routinely chewing gum roughly five minutes after a bout begins, which immediately stops the yawning. Similarly, she also indicates that sometimes eating can halt a bout of yawning. The man was not aware of any behavioral methods to reduce his symptoms, but stated that he began chewing on gum after receiving this information. Similar to the woman, he reports that once he begins chewing on gum during a bout his yawning immediately stops. As a result, he has started chewing on gum regularly throughout the day, and since doing so has noticed that the frequency of these newly abbreviated bouts has even diminished. Instead of experiencing one to five distinct bouts of excessive yawning per day, he now experiences only one or two episodes daily. Neither patient reported implementing other behavioral measures.

DISCUSSION

Most people yawn between 5 and 10 times per day (Baenninger et al., 1996; Walusinski, 2010b), with these events clustered during transitional periods of sleeping and waking (Provine et al., 1987a). However, more frequent yawning is known to be a common side-effect of certain pharmaceutical drugs (Beale & Murphee, 2000; Gallup & Gallup, 2009), and abnormal forms of yawning have been associated with various medical conditions and neurological pathologies (Daquin et al. 2001; Gallup & Gallup, 2008; Krestel et al., 2018; Walusinski, 2010).

The current report documents two new cases of chronic bouts of excessive yawning that have not been linked to changes in health status, an underlying medical condition, or drug use. Both individuals report that their abnormal yawning originated ten or more years ago. The bouts they experience include 12-25+ consecutive yawns, which are described as more intense and longer in duration than typical yawns, and span 8-15 minutes in length. The woman typically experiences these bouts five times per week, while they are triggered between one to five times daily for the man.

Previously, chronic cases of excessive yawning similar to this were found to be associated with temperature changes and thermoregulatory dysfunction (Gallup & Gallup, 2010). However, the information acquired from the current study does not show a direct connection with temperature regulation. Unlike in Gallup & Gallup (2010), neither individual here reported feeling cold during or after a long bout of yawning, identified pharmaceutical drugs that exacerbated the condition, or had documented changes in body temperature surrounding these events. In addition, neither individual in the current report indicated attempting nasal breathing or forehead/neck cooling as a means of alleviating their yawns, which were effective at reducing or postponing bouts of yawning in the previous cases. Instead, both individuals here reported being able to completely halt a bout of yawning by chewing on gum. The man also indicated that chewing on gum throughout the day reduced the overall frequency of these episodes.

These findings provide converging evidence that gum chewing inhibits the expression of yawning. Recently, Gallup & Engert (2019) found that chewing on gum

reduced the rate, frequency, and duration of contagious yawning among college students in the laboratory. Similar to the extended gaping of the jaw during yawning, the mandibular contractions of chewing on gum are known to increase cerebral blood flow (Hasegawa et al., 2007), and therefore this behavior may act to stifle the mechanism(s) driving the abnormal yawning. Previous research has pointed to the mandibular gaping of the yawn reflex as being essential for the proper functioning of this response. For example, patients with tetraplegia, who cannot open their mouth voluntarily, are known to extensively gape their jaw while yawning (Bauer, Gerstenbrand, & Hengl, 1980; Geschwend 1977). In addition, people instructed to clench their teeth while yawning report feeling left in mid-yawn and indicate the experience as unpleasant (Provine, 1986).

The neuroanatomical center and complete neurochemistry controlling yawning remain unknown (Krestel et al., 2018), and therefore further studies in neuroscience and medicine are needed to fully uncover the mechanism(s) governing this response. However, as this work shows, non-invasive studies examining the variables that alter yawn contagion can also be valuable in improving our understanding of this stereotyped action pattern. Although the etiology of the chronic yawning experienced by the two individuals here cannot be determined, this report was able to draw on findings from basic research in psychology to demonstrate unique therapeutic benefits of chewing on gum. Given that similar forms of chronic and debilitating bouts of excessive yawning have been reported elsewhere, this condition may be more common than previously recognized. Hopefully this work will help spur further examination of these symptoms and help clear up common misconceptions about excessive yawning. To this point, neither individual has received a diagnosis to explain their abnormal yawning or been effectively treated by a physician to reduce their symptoms; however, both have been notified of the possible connection to brain thermoregulation.

ETHICAL STATEMENT

These studies were approved by the Institutional Review Board of SUNY Polytechnic Institute [IRB-2017-10-12-(1), IRB-2018-03-21-(1)].

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