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ON THE CONTEXT OF YAWNING: WHEN, WHERE, AND WHY?

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ABTRACT

From personal logs kept by 28 subjects of their yawning during 1 week we found that yawns occurred during the hours of transitions between sleeping and waking. During the day yawns were associated with attending class, driving, studying or reading, and watching television. A survey of a much larger sample of subjects disclosed some agreement, but several discrepancies between what respondents believed about their yawning and the actual behavior of those subjects who kept logs.

ARTICLE

Yawning is a very obvious act in humans and other animals, yet it has not received much attention in either science or daily life. In a recent review of "evolution and facial action in reflex, social motive and paralanguage" yawning received no mention (Fridlund, 1991). To some extent, this lack of interest may be because yawning is rarely life-threatening; in fact, frequent or excessive yawning does accompany a wide range of pathological conditions, including frontal lobe tumors, epidemic encephalitis, supranuclear palsy, certain gastric diseases, brain stem lesions, some forms of epilepsy, motion sickness, narcotic withdrawal, and chorea (Barbizet, 1958; Comroe, 1974; Graybiel & Knepton, 1976; Heusner, 1946; O'Brien, 1976; Rudolph, Barnett, & Einhorn, 1977).

Yawning has been observed in individuals belonging to all classes of vertebrates (Baenninger, 1987; Craemer, 1924) and is one of the very earliest acts that human infants perform (Blanton, 1917). It has been observed in rat fetuses at 20 days (Smotherman & Robinson, 1987). In 1955 Ferrari, Floris, and Paulesu discovered that a yawning-stretching syndrome was elicited in laboratory dogs 30 min after intracerebroventricular injection of ACTH. Subsequent research on pharmacological induction of yawning has suggested that yawning elicitation results from an interaction between inhibitory dopaminergic and excitatory cholinergic influences on a specific motor program, possibly in the brain stem (Urba-Holmgren et al., 1990).

Androgenic influences on yawning have been found. Goy and Resko (1972) showed that testosterone injections produce both yawning and penile erections in male rhesus monkeys; Phoenix and Chambers (1982) found that testosterone propionate, but not estradiol, produced yawning in females and pseudohermaphrodites, as well as in males. In nonhuman primates males yawn significantly more than females; this is not true in humans (Schino & Aureli, 1989).

Yawning thus appears widespread phylogenetically, very early ontogenetically, and is subject to a variety of peptide and steroid influences. All of this suggests that it must be an important act, but its functions in our species have remained elusive.

One approach to inferring the functions of a behavioral act is to determine the context in which it

occurs, including its antecedents and consequences (Baenninger & Greco, 1991). One of the practical difficulties in studying low-frequency behavioral acts such as yawning is that observers must be very patient; long periods of time may elapse between performances of the act by an individual. Observing groups of people in different situations gives some information; for example, Baenninger (1987) reported data on rates of yawning in lecture classes, subway cars, cafeterias, and so forth. But information on antecedents and consequences of yawning for individuals is not available in such a procedure.

Asking individuals to keep tallies of their own yawning is one approach to solving this problem. Despite our initial reservations about the subjective nature of such personal data, the procedure has been shown to be a valid measure in the laboratory, at least for short time periods (Greco & Baenninger, 1989). Keeping a log specifically for any behavioral act may artificially increase the frequency with which that act is reported, because the attention of log-keepers is more than usually focused on the act. At present we can offer no solution for this potential artifact. In the first part of this report we present data from "yawn logs" kept by volunteer subjects over the course of 1 week.

Another solution to the problem of gathering data is to survey individuals about when they yawn. Whether respondents can report accurately the situations and times of day at which they actually do yawn is, of course, an empirical question. In such a survey, people may report when they think their yawning occurs, but the data may reflect beliefs and common sense" rather than actual fact. In the second part of this report we present results of a survey of yawning that we carried out. By comparing such survey data with personal logs kept by individuals we may reach more valid conclusions about the circumstances under which yawning occurs.

STUDY 1: PERSONAL LOGS

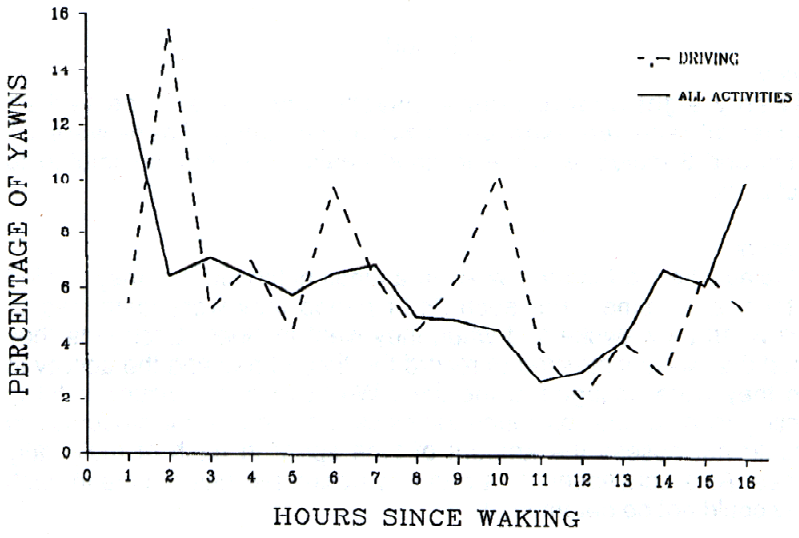
Subjects : Twenty-eight undergraduate psychology students served as subjects; all received extra credit for participating. There were 25 females and 3 males, all were in good health, and they commuted to school by car.

Procedure : Subjects kept a log for 1 week in a small notebook that they carried with them at all times. For each 24-hr period they were instructed to record when they awoke and when they went to sleep. Each time they yawned they were instructed to record the time of day and the activity in which they were engaged at the time. We have been unsuccessful in collecting reliable data on round-the-clock activities of our students, so we could not assess the amount of time spent in each of their daily activities. As a consequence, a rate of yawning per unit of time in each activity could not be determined.

Results : During 1 week the subjects emitted a total of 2044 yawns. The mean was 10.43 yawns/ person/24 hr, with a range from 0 to 70. Overall, there was virtually no relationship between the number of yawns emitted each day and the number of hours sleep that subjects had the previous night ($r = -0.059$, based on 192 observations). This lack of association strongly suggests that amount of sleep is not an important determinant of yawning frequency.

The most frequent activities in which subjects were engaged when they yawned were sitting in class (21.4%), driving a car (16.2%), watching television (12.6%), and studying or reading (10.5%). During 61% of the yawns reported, subjects were engaged in one of these four activities, all of which are of relatively long duration and entail little social interaction. Other activities that were episodic, occurred regularly, and were of short duration (e.g., dressing, showering, cleaning, cooking and eating) were associated with 8.4% of yawns, and conversations (face-to-face, by telephone, or at a party) were associated with 6.0%. Only 3 yawns (0.1%) were reported while thinking, an activity that is difficult to record objectively because it does not include overt behavioral signs. Subjects were awake for an average of 16 hr each day, but yawning was not distributed equally across this time period. The solid line in

Figure 1 shows the percentages of total daily yawns that were performed during each hour of the day. Yawns were most frequent during the first hour after waking and during the hour immediately before sleeping. The lowest frequency of yawning occurred during the 11th and 12th hr after awakening, that is, during the early evening for most of our subjects.



Also shown in Figure 1 (dotted line) are the percentages of yawns in each hour that occurred while driving or sitting in traffic. Yawning appears to be strongly associated with driving a car, 16.2% of daily yawns were reported while driving (second only to yawning in class, and ahead of yawning at the TV set). At those periods in the middle of the day when commuting by car occurred there were clear peaks of yawning.

STUDY 2: SURVEY OF YAWNING

A 14-item questionnaire was given to 157 students at Temple University. In the first 10 questions specific situations were identified and respondents were asked whether they would be "likely" or "unlikely" to yawn in them or whether they "don't know." Question 11 asked whether they were more likely to yawn in the morning, afternoon, or evening, and Item 12 asked them whether they could identify any particular time or situation when they yawned more often and to describe it briefly. Question 13 asked whether they were currently subject to any particular conflicts or problems, and whether they were taking any medications. The last question asked for any additional comments, and whether they had yawned (or felt like yawning) while responding to the questionnaire. Studeb-nts were all volonteers, and the questionnaires were administered to them in small groups. They were encouraged to take as much time as they needed in responding.

Results

None of the respondents reported any unusual medical or psychological problems for which they were taking drugs. Five students failed to respond to all the questions, but the responses they gave are included. Thirty students (19%) reported yawning or feeling like yawning while taking the questionnaire; in earlier studies we found that reading about yawning significantly increased yawning by laboratory

subjects (Baenninger & Greco, 1991). The questionnaire results are shown in Table 1. Particular situations reported by some as conducive to yawning included lectures (750/o), being tired or lacking sleep (32%), being under stress, or seeing other people yawn. To us it is noteworthy that there is no real concensus about situations or stimuli associated with yawning.

Table 1 Yawning Questionnaire

Situation	Likely	Unlikely	Unknown
Listening to speech or lecture	118	27	12
Sitting in a traff ic jam	60	82	15
Waiting for a train or bus	66	60	26
Driving at night on lonely highway	90	47	15
Driving on sunny day (no traffic)	19	113	20
While giving a speech or lecture	4	140	8
Waiting to begin a competitive event	18	120	14
Being interviewed for a job	4	136	12
Lying in bed before falling asleep	83	57	12
Getting out of bed in the morning	121	29	2

Yawn more in: morning 38(25%) afternoon 64(42%) evening 40(26%) noresponse 10

Yawn more while:

tired	25
lecture/class	29
lack of sleep	15
stress	9
after a meal	8
see others yawn	8
working	7
study at night	4
in church	4

GENERAL DISCUSSION

Although there were areas of agreement between the two studies some discrepancies emerged that may reflect differences between keeping a log and responding to a survey: The former represents what subjects actually do, and the latter represents what they believe they do. For example, the log data indicated no relationship between sleep duration and yawning frequency during the following day; survey results indicated that respondents believe that there is a relationship.

Survey respondents believed that they yawn more in the afternoon than in either the morning or evening, but the log results flatly contradict this belief because afternoon hours were when the percentages of daily yawns fell to their lowest levels. Survey respondents believed that lying in bed at night and arising in the morning were both situations where yawning was frequent. Partly supporting this finding, the logs in Study 1 showed that the first hour after waking and the last hour before bed were the times when most yawns occurred, although the logs indicated that it is the activities that accompany retiring to bed and arising in the morning that are associated with yawning. In any event, this temporal variation supports findings of Provine, Hamernik, and Curchak (1987) in humans and of Anias, Holmgren, Urba-Holmgren, and Eguibar (1984) in rats. In rats of a strain selectively bred for a high frequency of yawning (Urba-

Holmgren et al., 1990) a clear circadian variation of yawns existed, with a peak frequency in late light and early dark hours (Anias et al., 1984).

Frequent yawning thus appeared to be associated with the transition between different levels of arousal; the log data on actual yawning show that the first hour and the last hour of the waking day are the peaks of yawning frequency. Except for these peaks, mornings and evenings were not periods during which yawning frequency was unusually high however. Relatively few yawns are actually performed during the afternoon, a period when adults do not normally shift from activity to inactivity or vice versa. Apparently the yawns that were emitted in the early and late afternoon were primarily associated with driving.

If yawning is somehow related to level of arousal (Askenasy, 1989; Greco & Baenninger, 1991) one would expect yawns to occur frequently when transitions between different levels of arousal are required, as when people are first getting up in the morning, when they are retiring for the night. A less obvious prediction from this arousal hypothesis is that people should yawn frequently while attending lectures, and when driving a car (both activities in which keen attention and easy relaxation are likely to alternate). This was what we found.

For experienced drivers driving is a relaxed activity for which a certain level of arousal (or at least attention) is needed occasionally. Our log data indicated that driving a car late at night was associated with yawning; survey respondents agreed, and also believed that they were unlikely to yawn while driving on a sunny day with no traffic, or while

sitting in traffic. The driving conditions under which logs showed yawning were unfortunately not specified exactly; the majority were commuting to school, but whether they were mainly at speed or stopped in traff ic could not be determined.

Like driving, listening to lectures is an activity in which arousal levels may frequently shift between alert attention and a relaxed state that may border on sleeping. In both studies listening to lectures was the most frequent situation associated with yawning. Over 21% of the yawns were reported in the logs during this activity; informally, college students reported to us that they spend about 3 hr (18% of the day) in lecture classes. Survey respondents overwhelmingly (75%) believed that they were likely to yawn during lectures. This result agrees with an earlier finding that the rate of yawning was higher during lecture classes than while eating, talking, watching TV, riding in the subway, or virtually any other activity observed (Baenninger, 1987). The belief by survey respondents that they yawn most frequently in lectures appears to be correct.

Data on yawning of other vertebrate species have rarely been reported systematically (Baenninger, 1987), but the few studies where yawning has been mentioned support the hypothesis that transitions in arousal level may be associated with frequent yawning. Myrberg (1972) found that damselfish Eupomacentrus partitus yawned when making transitions between various social behaviors such as agonistic responses and nest entrances/exits, a finding confirmed by Baenninger (Il 987) in Siamese fighting fish, Betta spiendens. Among members of the Felidae (Baenninger, 1987), Canidae (Bekoff, 1974), and nonhuman primates (Baenninger, 1987; Hall, 1962; Hinde & Rowell, 1962), transitions between behavioral states (such as anticipation of feeding or play) also appear to be accompanied by yawns. In laboratory rats Holmgren et al. (1991) have reported a food-anticipatory yawning rythmn.

Survey respondents reported that they were likely to yawn when tired or sleep-deprived. Our data from the yawning logs did not support this belief; the lack of any correlation between yawn frequency and hours of sleep during the previous night suggests that this widely held belief is incorrect, at least for our college student subjects (whose sleeping patterns may not be typical of the general population).

Performance of activities that were observed or judged by others was believed by the survey respondents to make yawning unlikely (e.g., being interviewed, giving a speech, or waiting for a competition to begin). The subjects who kept logs did not report any of these public or competitive activities, so we cannot make any clear comparisons. In a general way the log data do confirm these survey results, because relatively few yawns occurred while the log-keepers were working and talking.

Uniess they actually keep track of the circumstances under which they yawn, most people probably are not normally aware of their own yawns and are unlikely to recall much about them. When asked, as in our survey, to recall anything about their own yawning they are likely to rely on widely held beliefs or "common sense" rather than on empirical observations of themselves. These beliefs may bear only a marginal relationship to the actual distribution of yawning frequency assessed by keeping logs. This suggests that people may not normally pay much attention to yawning; like breathing, blinking, sighing, and other biologically important acts, yawning is taken for granted and ignored unless it is disrupted or abnormal in some way. Until fairly recently, this lack of attention has also characterized scientific interest in yawning.

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