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Chewing over physiology integration

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Abdulkader, Fernando, Anna Karenina Azevedo-Martins, Manoel de Arcisio Miranda, and Kellen Brunaldi. Chewing over physiology integration. *Adv Physiol Educ* 29: 51–53, 2005; doi:10.1152/advan.00042.2004.—An important challenge for both students and teachers of physiology is to integrate the different areas in which physiological knowledge is didactically divided. In developing countries, such an issue is even more demanding, because budget restrictions often affect the physiology program with laboratory classes being the first on the list when it comes to cuts in expenses. With the aim of addressing this kind of problem, the graduate students of our department organized a physiology summer course offered to undergraduate students. The objective was to present the different physiological systems in an integrated fashion. The strategy pursued was to plan laboratory classes whose experimental results were the basis for the relevant theoretical discussions. The subject we developed to illustrate physiology integration was the study of factors influencing salivary secretion.

PROCEDURES

The laboratory activities consisted of recruiting two groups of students, Chewing-Gum and Exercise, with four students per group. All groups were first asked to collect the salivary flow from one of its members in 15-ml graded tubes for 10 min. The saliva so collected was named Control and the salivary flow in ml/min was calculated. After control measurements, the Chewing-Gum students were asked to chew a chewing gum for 10 min and simultaneously collect their saliva (Chewing-Gum Test Saliva). At the same time, the Exercise students performed an aerobic exercise (such as bicycle ergometer, jumping jack or climbing up and down the stairs) for 10 min while collecting their saliva (Exercise Test Saliva). Salivary flow was also calculated for both test groups.

Salivary amylase activity was also estimated by a simple turbidimetric analysis with a spectrophotometer. Briefly, control and test saliva were diluted 1:50 with tap water. Aliquots of 0.5 ml of each dilution were added to 5 ml of corn starch suspension (absorbance ~0.5) and immediately placed in a cuvette. The absorbance decay was monitored for 2 min (sampled each 30 s) and plotted as a function of time in a graph. Each group produced a graph showing data from control and test saliva and amylase activity compared by inclination of control and test curves.

RESULTS

Results from Chewing-Gum students showed a marked increase in salivary flow, whereas the Exercise students had a trend to decrease saliva output. However, in both cases the

amylase activity increased. Representative examples of the results obtained are shown in Fig. 1 and Table 1. These results allow the discussion of several points related to different themes in physiology (Fig. 2).

Sensory-motor integration. In gum chewing, there is an activation of both mechanoreceptors and taste receptors that are afferent sensory pathways to the central nervous system. As a result of this sensory input, there is an efferent motor response directly to the salivary glands through parasympathetic fibers, increasing blood flow to salivary glands (mainly parotid glands) and hence salivary flow. Such motor activity feeds back the sensory input, because saliva enhances contact between tasting molecules and taste buds as well as changes the texture of the bolus. Also with gum chewing, another interesting point that can be brought out is classical (Pavlovian) conditioning in learning, because other sensory inputs, such as visual and auditory, can be associated with an increase in salivary flow.

Exercise physiology. As a consequence of exercise, the sympathetic tone is increased, thus causing a deviation of blood flow from several organs, such as salivary glands, to skeletal muscle. As a result of this sympathetic stimulation, usually salivary volume output is decreased.

Functions of the gastrointestinal tract. Results show a basic feature of the digestive system, mainly that parasympathetic stimuli trigger secretory activity, whereas sympathetic stimuli decrease secretion. One would also expect that parasympathetic stimulation would dilute saliva, decreasing amylase activity. This is the opposite of what is actually observed. This is explained by the fact that the contribution of amylase-rich parotid secretion to the overall salivary flow is increased, showing also that there are functional differences among salivary glands.

Autonomic nervous system. Sympathetic and parasympathetic branches have antagonistic effects if one considers only the salivary flow, but these two branches of the autonomic nervous system act in the same direction to increase amylase activity. This shows that although the sympathetic and the parasympathetic are in most cases antagonistic, this is not always true.

Enzyme biochemistry. Integration between biochemical and physiological knowledge can be explored, such as the chemical structure of starch, the action of amylase, and the importance of carbohydrates as energetic substrates.

Table 1. Salivary flow in rest (control), exercise, and chewing

Group	Control	Test
Gum chewing	0.1 0.37	0.35 1.62
Exercise	0.15 0.35	0.18 0.25

Values are in milliliters per minute.

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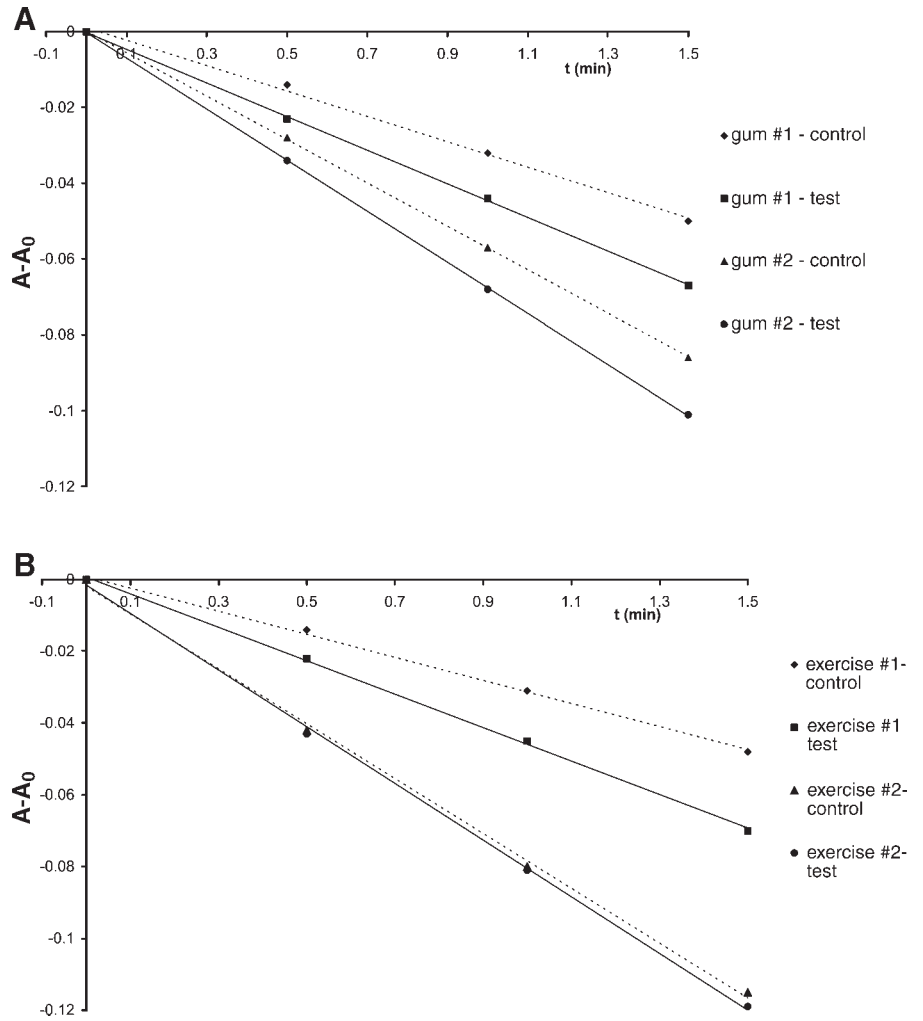


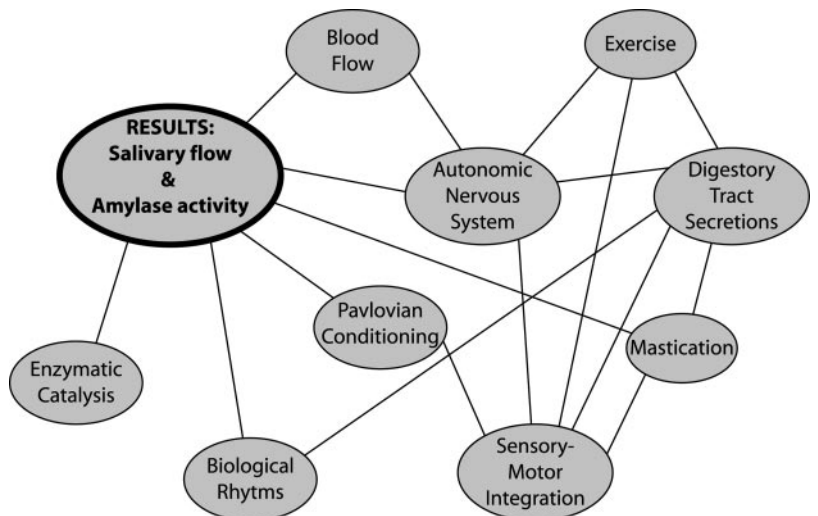
Fig. 1. Decay of absorbance (A) in relation to the initial absorbance (A_0) of a corn starch suspension with the addition of saliva. Data for 2 individuals are presented in each graph. A: in the Chewing-Gum group, test saliva (solid lines) caused a faster decay of absorbance than in the control condition (broken lines). B: same illustration showing results of the Exercise group.

Circadian rhythms. After the experiment, students can be asked whether they expect to observe any changes in salivary flow during the day. As such, salivary flow can also be used to introduce to the students the topic of biological rhythms, because it presents an easily identifiable circadian pattern, with

higher salivary outputs during wakefulness, mainly near meal hours.

In summary, this proposal allows for an interdisciplinary overview of physiology, on the basis of a simple, low-cost laboratory experiment. Moreover, the approach here presented

Fig. 2. A conceptual map of the physiological themes and their interrelations that can be addressed when discussing the results obtained.



illustrates some of the basic features and concerns of in vivo physiological research. Obtained results, shown in Fig. 1 and Table 1, exemplify the importance of controlled experiments, as well as the possible differences among individuals and the necessary use of a sample with more than one individual to establish population values.

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