

Undergraduate Designed Investigations in the Human Physiology Laboratory

Karen A. McMahon

Biological Science, The University of Tulsa, Tulsa OK 74104

karen-mcmahon@utulsa.edu

Introduction

During the spring 2013 semester, Biol. 2151: *Human Physiology Laboratory* was introduced as a required course for majors in nursing, athletic training, and exercise & sports science at the University of Tulsa. Biol 2151 replaced the one-semester Biol 1021 *Human Anatomy & Physiology Laboratory* in which experimentation in physiology was limited due to the anatomical component of the course.

With a lab completely dedicated to the study of human physiology, I was able to incorporate many of the human physiology lessons from BIOPAC® Student Lab, a data acquisition system in which students themselves are the test subjects. There is also flexibility in Biopac Systems for students to design their own investigations; the human physiology experiments designed by the students included:

- examining differences in motor unit recruitment and clench strength between athletes and non-athletes;
- examining the effectiveness of chemical hand warmers or soothing music as relaxation techniques in biofeedback;
- observing differences in reaction times between gamers vs. non-gamers and musicians vs. non-musicians;
- observing the pulmonary volumes post-exercise and
- studying the effect of temperature on the diving reflex.

Materials

General

Biopac MP-35 & 36 Units
Standard Lead Set (SS2L)

Disposable Electrodes
Conductive Electrode Gel

Abrasive Pads
Exercise Mats

Per Lesson

Biofeedback - EDA Lead (SS3L), Heat Therapy Patches, Music CDs

Reaction Time - Handswitch(SS10L)

Pulmonary Volumes Post-Exercise - Airflow Transducer(SS14LA), Calibration

Syringe (AFT6/A), Bacteriological Filters (AFT1)

Diving Reflex - Plastic Basins, Thermometers (°C), Ice, Wash Cloths

Discussion

Students thoroughly embraced designing their own investigations. They learned how to formulate a hypothesis, design a controlled experiment, analyze the results, and determine a conclusion - the scientific method - which they only fully understood when they put the science into practice.

References

Biopac Student Laboratory Manual, 1998-2010. Biopac Systems, Inc. Goleta CA

Lessons:

1 EMG I, 14 Biofeedback, 11 Reaction Time I, 12 Pulmonary Function I, & BSL PRO H08 Diving Reflex <http://www.biopac.com/h08-dive-reflex>

Acknowledgments

The fantastic students in Biol 2151: Human Physiology Laboratory, Sections 1 & 2, Sp' 2013

Results

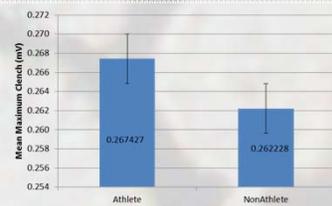


Fig. 1. Mean maximum clench in athletes vs. non-athletes.

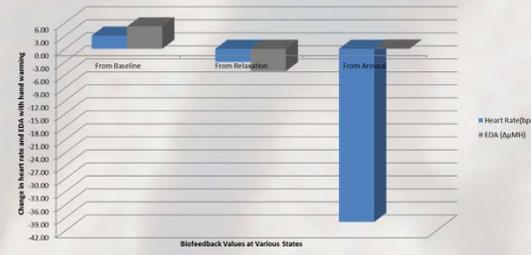


Fig. 2. Effectiveness of hand warmer pads as a relaxation technique in biofeedback.

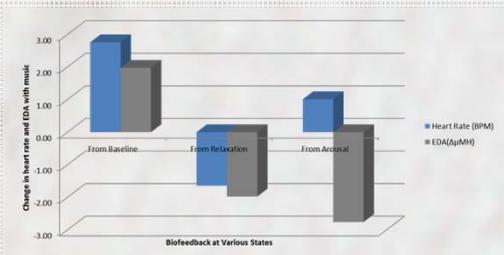


Fig. 3. Effectiveness of music as a relaxation technique in biofeedback.

The first designed experiment (Fig. 1) followed a lesson on EMG and motor unit recruitment and examined whether the maximum clench strength of athletes would be greater than that of non-athletes. An athlete was defined as a member in a TU Golden Hurricane team. After a lesson using calming thoughts as a technique in biofeedback to control autonomic function, students suggested and tested other methods to stimulate the parasympathetic division and reduce sympathetic activity: hand warmer pads and soothing music. Results indicated that hand warmer pads (Fig. 2) had a slightly greater effect on reducing heart rate and EDA (electrodermal activity -- galvanic skin response) than calming thoughts. Soothing music (Norah Jones's CD *Come Away with Me*) significantly reduced both heart rate and EDA compared to calming thoughts alone.

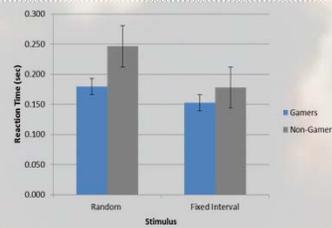


Fig. 4. Reaction times of gamers vs. non-gamers.

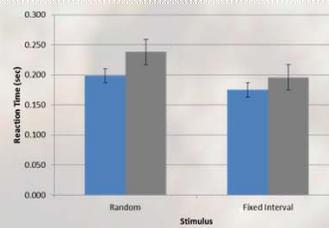


Fig. 5. Reaction times of musicians vs. non-musicians.

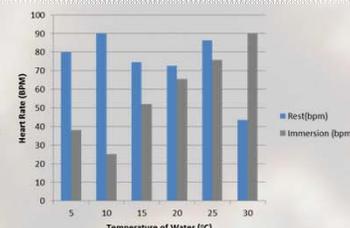


Fig. 6. Effect at different temperatures on the diving reflex.

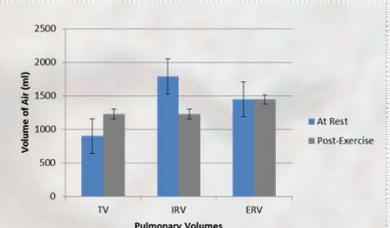


Fig. 7. Effect of exercise on TV, IRV, and ERV.

Students first investigated reaction times with a handswitch to random and fixed stimuli (beeping sounds); test subjects responded more quickly to stimuli set at fixed intervals. Each lab section then designated two populations to test reaction times. In section 1, students hypothesized that "gamers" (frequent players of video games) would respond more quickly to both random and fixed interval stimuli (Fig. 4). In the second section, students hypothesized that musicians would have greater finger dexterity and keener hearing and thus faster reaction times compared to non-musicians (Fig. 5). After a presentation on the mammalian diving reflex (significant decrease in heart rate in response to exposure of the facial trigeminal nerve to cold water), an experiment was designed to identify which cold water temperatures were most effective in inducing bradycardia. As shown in Fig. 6, bradycardia was most pronounced at 10°C, but was also present at 5 and 15°C. Students first recorded pulmonary volumes (tidal volume, inspiratory reserve volume, and expiratory reserve volume) at rest. After aerobic exercise (running up stairs, push-ups, or jumping jacks for 1 minute), students recorded pulmonary volumes after exercise and noted that TV increased, but IRV and ERV did not (Fig. 7), a result not anticipated by most students.



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