

Processing Load and Biopotentials: An Evaluation of a Consumer Electroencephalogram (EEG).

Kristen M. Bishop

Behavioral Sciences Department & Behavioral Neurosciences Program, Andrews University

bishopk@andrews.edu

Abstract

The general public is extremely interested in mental training and the use of brain imaging to study the mind. One device that combines the two and is currently on the market for consumers is a single channel EEG band produced by NeuroSky which claims to measure concentration. However, the claims that they have developed a single channel measure of concentration and meditation have not been tested. EEG power is related to cognitive memory and performance, which both contribute to concentration. In addition to EEG waves, pupil size is a reliable physiological index of processing load and concentration. The first purpose of this study is to replicate the finding of pupil diameter size and concentration. The second purpose is to see if the results of the replication correlate with the proprietary concentration reading from the NeuroSky single channel EEG as a first step towards understanding what, if anything, consumer EEG equipment measures.

Introduction

In this current age of technology, popular psychology, supposedly based on research, is quickly becoming more available to the layperson. This is especially true with regard to the use of brain imaging to study the mind (Racine, Bar-Ilan & Illes 2006).

One device that is currently on the market for consumers is a new single-channel electrode (EEG) product produced by NeuroSky which claims to measure concentration and meditation; however, these claims have not been measured.

I propose to use the pupillometric response as a means of verifying claims about “concentration” and “meditation” computed by the NeuroSky EEG unit. The purpose of this study to replicate the relationship between pupil diameter size and concentration and to examine if the single-channel EEG yields the same pattern.

Pupil diameter is a good index of processing and has been used to measure processing load, concentration, and task difficulty (e.g. Bijleveld, Custers & Aarts, 2009).

Methods: Pupil Dilation

Subjects were verbally asked to add 0, 1 or 3 to each of four randomly selected numbers (see diagram at right). After a brief pause subjects were asked to respond with their answers. During this process each participants' (N=29) left eye was tracked using a 60 Hz dark pupil infra-red eye tracker which measured pupil dilation. Three subjects were removed from data analysis due to eye tracking loss.

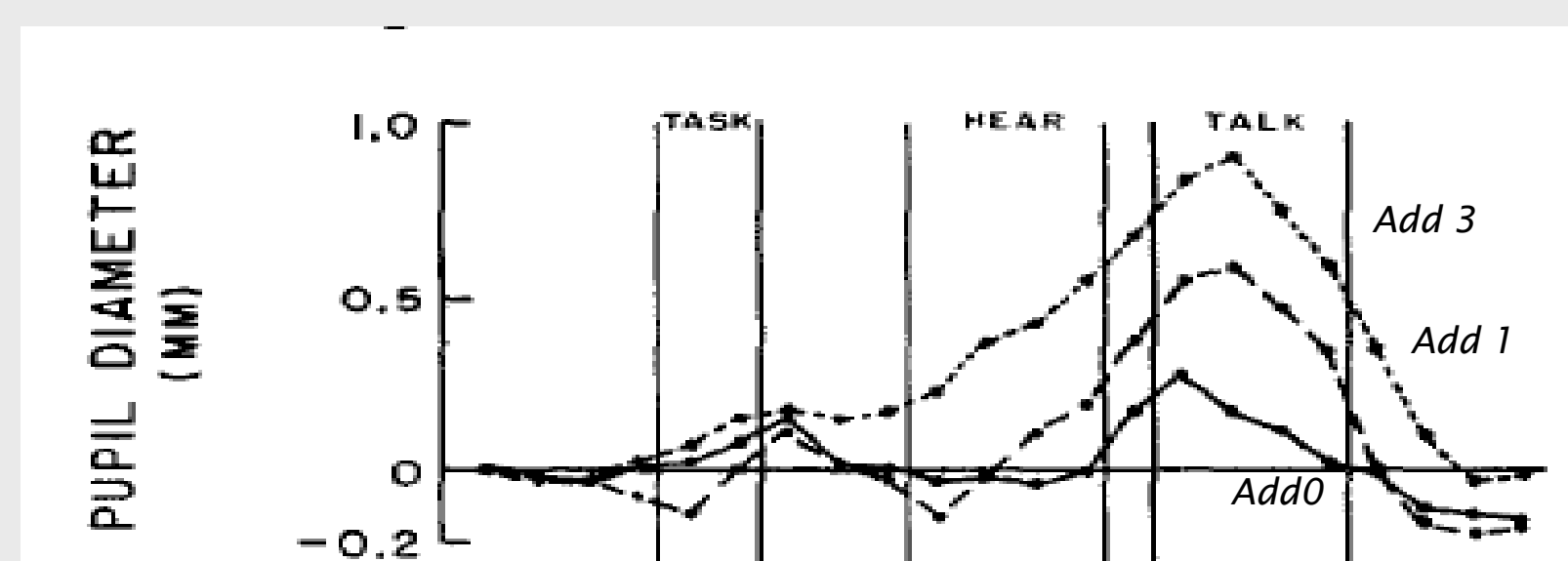
Analysis

Using R, four one-way repeated measures ANOVAs were done to analyze the following segments: 0-200 frames since list onset, 200-400 frames since list onset, and 400-600 frames since list onset full 600 frame window (10 seconds).

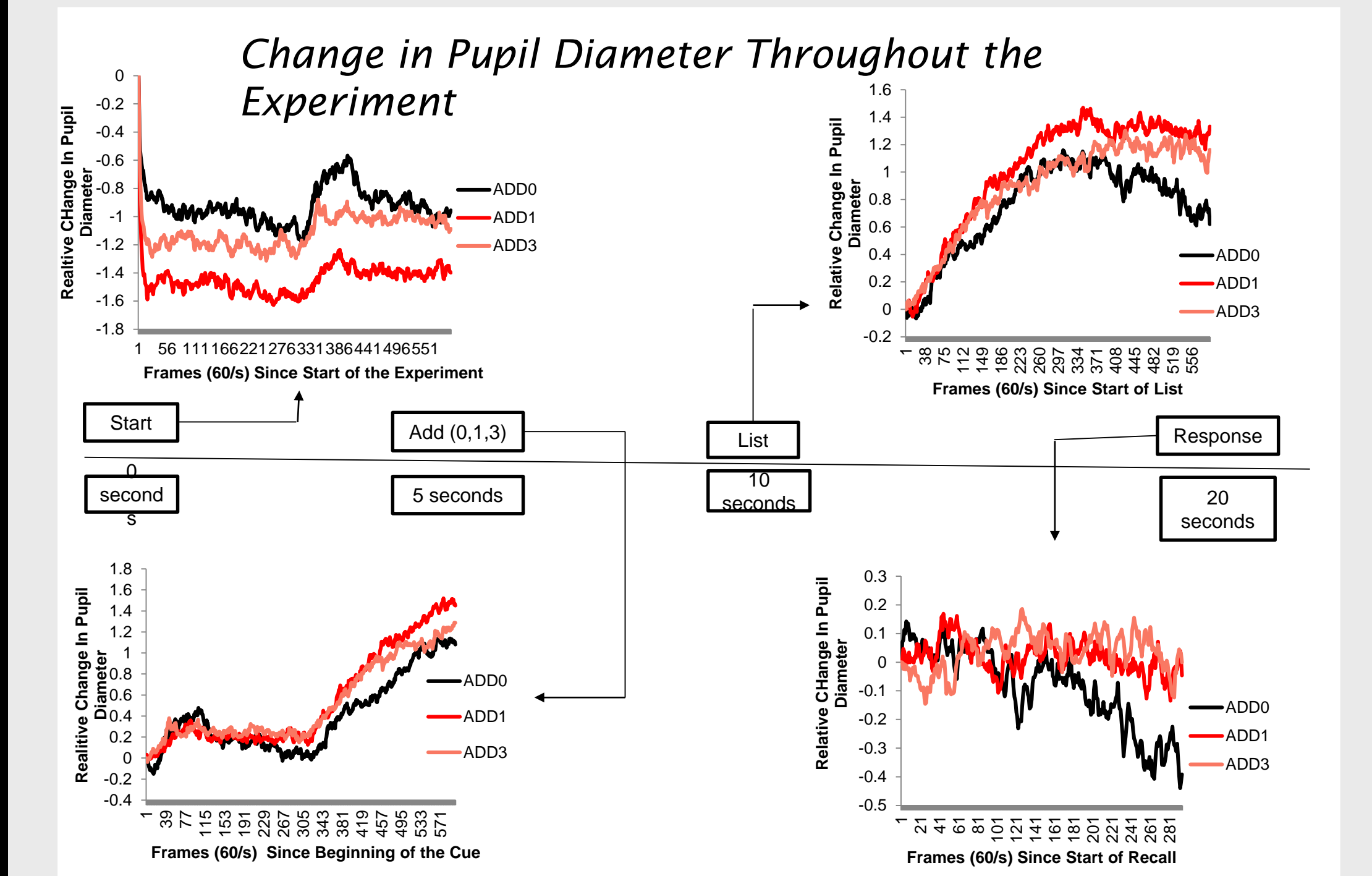
Results

Frames	F(2,50)	P
0-200	2.16	.13
200-400	2.92	.06
400-600	5.59	*.01
0-600	4.02	*.02

*significant values



Original 1969 Kahneman graph of pupil diameter changes and task load.



Discussion

As seen in the 1969 experiment done by Kahneman and colleagues, subjects' pupils dilated in response to increased cognitive load with similar diameter curves. However compared to the original study the biggest difference was found between the baseline and the add 1 condition instead of the baseline and add 3 condition. This could be because participants gave up at the add 3 condition. The increase in pupil dilation was greatest at the end of the list likely because the capacity of working memory is being heavily strained. For our future research, if the NeuroSky device works as it states we should see these same patterns as well.

Selected References

- Bijleveld, E., Custers, R., & Aarts (2009). The unconscious eye opener: Pupil dilation reveals strategic recruitment of resources upon presentation of subliminal reward cues. *Psychological Sciences*, 20(11), 1313-1351. Doi 10.1111/j.1467-9280.2009.02443.x
- Kahneman, D., Tversky, R., Shapiro, D. & Crider, A. (1969). Pupillary, heart rate, and skin resistance changes during a mental task. *Journal of Experimental Psychology*, 79(1), 614-167.
- Klimesch, W. (1999). EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. *Brain Research Review* 29, 169-195.
- Racine, E., Bar-Ilan, O., & Illes, J. (2006). Brain imaging: A decade of coverage in print media. *Science Communications*, 28(1), 122-143. Doi: 10.1177/1075547006291990