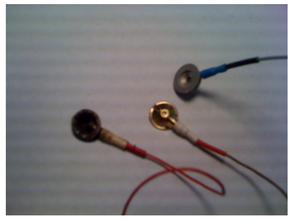

DIY ERPs

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INTRODUCTION

Providing early independent research opportunities to undergraduates is an important goal for many colleges and universities, since it allows students the chance to explore and become prepared for careers in their field of study. The entry cost of giving undergraduates experience in neuroscience research, however, becomes increasingly steep as technologies required for neuroscience research are required. This is a problem especially for liberal arts colleges whose research budgets may not have room for expensive, brand new equipment.

While many brain imaging methods are important, electroencephalography (EEG) is a relatively inexpensive and useful method to measure brain activity. However, electrophysiology research often requires equipment and lab set-ups (noise-proof recording rooms) that may not be available at small colleges. Our goal was to demonstrate that these problems can be overcome by refurbishing an outdated Grass 79D amplifier and, using a relatively inexpensive USB analog to digital converter, record and analyze ERPs using a standard PC running MATLAB. We hope that our project might be useful to other small colleges with minimal equipment budgets and might increase the amount of undergraduate-level cognitive neuroscience research at Wittenberg University and beyond.

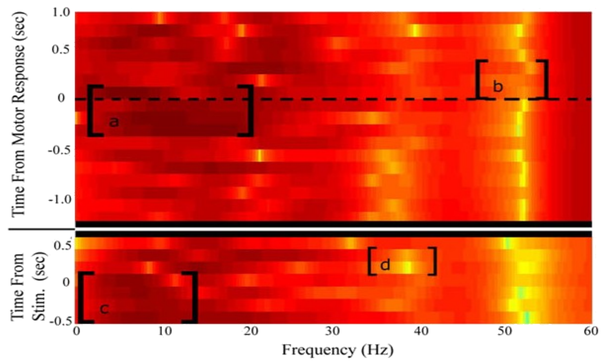
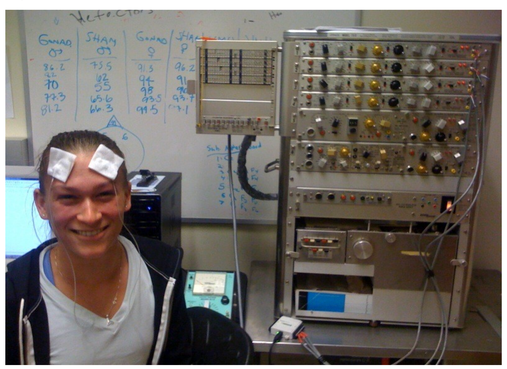


Figure 1: Our first cognitive EEG experiment demonstrated the capabilities of our rig to measure cortical attention-based changes before and during motor tasks. While we found alpha- and beta– wave changes for both stimulus attention and motor responses, the high level of high-frequency noise kept ERP studies from being yet possible at this time.



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ABSTRACT

We detail the use of several off-the-shelf hardware and software components to create an inexpensive "homemade" ERP device. We used this machine to try to find the N170 to faces relative to other object classes and to faces relative to inverted faces. We took hardware bandpass filtered (1-100 Hz) analog outputs of a common polygraph (Grass Instruments model 79D; used models were available at the time of abstract submission for well under $700) which normally provides output to pens, and instead sent the signal through a National Instruments USB data acquisition card. MATLAB was used to present stimuli and to analyze signal output. We have thus far used single electrodes placed via the 10-10 system and with regard to published coordinates. Electrodes were placed over the left and right FFA and we used the ear as reference. Despite the paucity of electrodes, initial results are promising and show strong negative deflections to faces in the range of 100-200 ms post-stimulus. The goal of our poster presentation is to present our hardware and software methods in detail to the vision community and to gather feedback that might be helpful to us and to other small colleges with minimal cognitive neuroscientific equipment budgets.

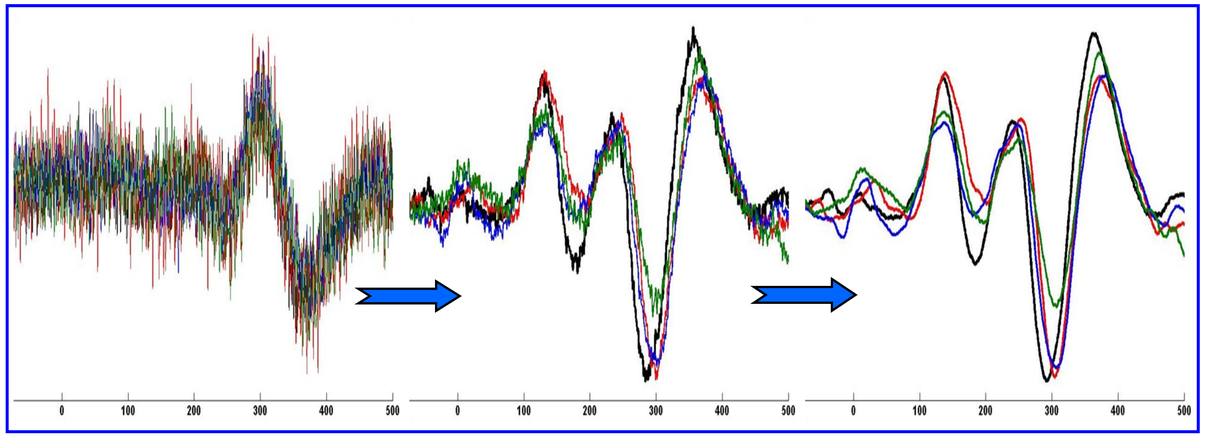

Figure 2: This figure shows a progression of improvements in ERP quality as hardware and software filters are utilized. Left: No hardware or software filtering. Center: Analog 2-100 Hz bandpass filter applied during recording. In addition, PC lag measurements between recording trigger command and stimulus presentation are accounted for in each trial to better time-lock data. Right: A digital FIR 50 Hz lowpass filter is applied offline to acquired data using the MATLAB Signal Processing Toolbox (Mathworks, Inc) to further remove electrical noise from the signal.

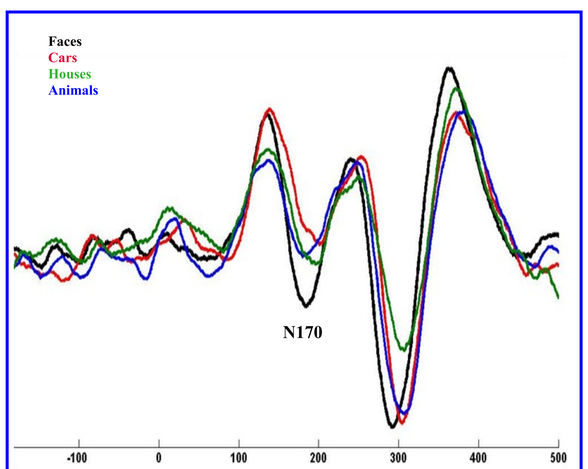

Figure 3: In our second experiment, we measured the N170 ERP, generated by the fusiform face area (FFA). The FFA is sensitive to faces (Bentin et al. 1996), so we compared visual responses at 170 msec post-stimuli to faces, cars, houses, and animals. During presentation, participants were tasked with deciding whether stimuli were man-made or natural. The face stimuli (black) evoked the

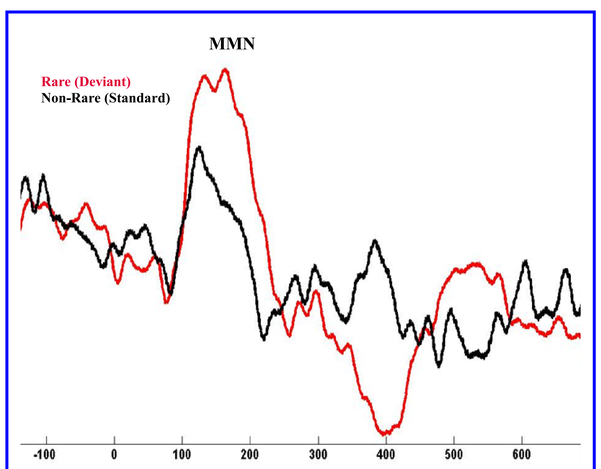

Figure 4: In our third experiment, an increased ERP amplitude in response to presentation of a rare stimulus (**red**) as compared to a common one (**black**), this auditory cortex-generated response, called Mismatch Negativity (MMN), occurs 100-225 msec post-stimulus in response to rare auditory events and is clearly visible in our recording (Al'tman, Vaitulevich, & Shestopalova, 2004; Korpilahti, Krause, Holopainen, & Lang, 2001).

Project Budget Estimate

EQUIPMENT REQUIRED	ESTIMATED PRICE
Electrical Amplifier: Grass 79D	$700
Analog-Digital Converter: NI USB-6009	$300
Standard PC	$800
Data Analysis Software: MATLAB Student	$100
Electrodes	$200
Electrode Application Supplies	$100
Estimated Professional Comparable Cost:	$2000 - $6000
Total Cost for All Equipment Listed Above:	$2,200
Estimated Educational Institution Expenses:	**$700 - $1400**

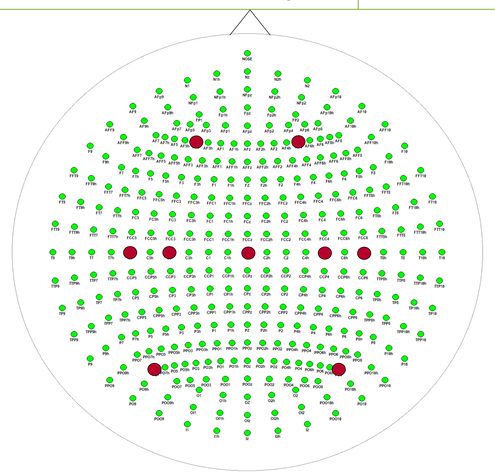

Figure 4: Locations where we have successfully recorded EEG. All recordings were ear- or nose– referenced.

Discussion

Despite some expected difficulties with electrical noise in our recordings, our three experiments successfully demonstrated the ability for our rig to measure human brain activity changes in response to stimulus presentation. Future studies will focus on developing simple open-source MATLAB functions aimed specifically at low-channel EEGs and improving accessibility for undergraduate students with little MATLAB experience to analyze electrophysiological data. In addition, we hope to continue studying the N170 and show a face inversion effect, an experiment whose results we hoped to present this year but were unable to perform yet due to time constraints.

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Al'tman, Y. A., Vaitulevich, S. F., & Shestopalova, L. B. (2004). Changes in Evoked Potentials during the Action of Sound Signals with Different Localizing Characteristics. *Neuroscience and Behavioral Physiology*, 34 (2), 139-146.

Bentin, S., Allison, T., Puce, A., Perez, E., & McCarthy, G. (1996). Electrophysiological Studies of Face Perception in Humans. *Journal of Cognitive Neuroscience*, 8, 551-565.

Korpilahti, P., Krause, C. M., Holopainen, I., & Lang, A. H. (2001). Early and Late Mismatch Negativity Elicited by Words and Speech-Like Stimuli in Children. *Brain and Language*, 76(3), 332-339.

Figure 2. Relationship between water loss rate and body size in stages of *C. lectularius*. Numbers correspond to the various nymphal stages; M, male; F, female.