Journal of Undergraduate Research at Minnesota State University, Mankato

Volume 4 Article 2

2004

Distinguishing Observed Inattentive Behaviors in the College Classroom as they Correlate to Brain Wave Activity Utilizing a Wireless Electroencephalograph

Christopher J. Aura
Minnesota State University, Mankato

Matthew R. Stanton
Minnesota State University, Mankato

DISTINGUISHING OBSERVED INATTENTIVE BEHAVIORS IN THE COLLEGE CLASSROOM AS THEY CORRELATE TO BRAIN WAVE ACTIVITY UTILIZING A WIRELESS ELECTROENCEPHALOGRAPH

Christopher J. Aura & Matthew R. Stanton (Psychology)
Edison Perdomo, Faculty Mentor (Psychology)

A significant amount of research has been devoted to the behavioral correlates of inattention in children (A.P.A., 2000; Arnold, 2000; Gordon & Barkley, 1998). It is proposed by the authors that college students, in their several years of experience, are much more capable of masking these trademark behaviors. When a child loses interest they will begin to openly look around the room, shift in their seat, or chat with their neighbors (Sandberg, Rutter & Taylor, 1978; Arnold, 2000). College students however, are proposed to candidly fidget, shift in their seat, or even maintain eye contact with their instructor while "daydreaming". Therefore, an additional physiological aid is required to better assess inattentive periods in college subjects. Given the invasive nature of past devices commonly used, such as the Electroencephalograph (EEG), accurate measurement proves to be very difficult in a natural setting (Boyd & Campbell, 1998). This study used a modified version of an EEG called the Attention Trainer (AT). The AT is smaller in size, and wireless thus alleviating distraction and allowing more reliable field assessment. The study found positive correlations (Table 1) between suggested and previously validated behaviors. Contrary to prior research, significant correlations were found between all four frequency bands (Beta, Theta, Delta, and SMR), suggesting the device may be inaccurate (Figure 1). While results can neither confirm nor discredit biofeedback applications for the AT, further research is needed for validation.

INTRODUCTION

Brain activity patterns have been used to determine levels of consciousness and awareness in individuals (Stewart, 1961). In particular, the use of electroencephalographic (EEG) devices has been effective in determining levels of attention in individuals suffering from attention disorders or differentiating different stages of sleep (Boyd & Campbell, 1998; Castellanos et al. 1996; Lubar & Shouse, 1976; Satterfield & Dawson, 1971). Austrian psychiatrist Hans Berger developed the EEG in 1924 as a method of measuring brain activity during different states of awareness. The EEG works by amplifying and measuring the electrical activity of firing neurons along various frequencies (Wood & Wood, 1999; Stewart, 1961). By measuring peaks in activity, areas involved in specific task can be determined (Stewart, 1961; Castellanos et al., 1996). The activity is detected by placing electrodes at various points on the scalp to produce a record called an Electroencephalogram. The output of EEG patterns display wavelengths, and the analysis is based on the measurement of the frequency and amplitude of the waves in cycles per second or Hertz (Hz) (Stewart, 1961). The brain produces different types of waves depending on the type of cognitive or emotional activities the participant is engaged in, thus the larger the Hertz the greater the level of arousal while lower frequencies are more indicative of sleep patterns (Hugdahl, 1995). For instance, Beta waves may be classified as exhibiting 14 Hz or higher, and are associated with arousal and focused attention. Theta waves range between 4 to 8 Hz and increase in amplitude when an individual is resting, lacking singular focus, or attending to multiple stimuli (Stewart, 1961; Hugdahl, 1995). Commonly associated with periods of dreaming sleep, spikes in amplitude on the Delta frequency band can also be used to distinguish more elusive turbid states (Lubar & Shouse,

https://cornerstone.lib.mnsu.edu/jur/vol4/iss1/2
DOI: 10.56816/2378-6949.1154

1976; Stewart, 1961). While one may have patterns consistent with focused attention on the Beta and Theta frequency bands, frequent Delta spikes can indicate the individual is merely daydreaming.

The Attention Trainer (AT) is a simplified EEG that has been proposed as an alternate treatment for children with Attention Deficit Hyperactivity Disorder (ADHD) with incorporation of biofeedback. Standard EEGs utilize from 36 to 146 sensors, the AT uses 3 multi-sensors that incorporate signals from the frontal lobe, temporal/parietal lobe and the visual cortex. These areas have been specifically correlated with attentional states and fine motor movements. Despite this drawback, the advantage of using the AT is that it allows for remote monitoring and recording of brain activity of individuals without need for obtrusive cables and heavy equipment. The headset transmits the brain wave pattern to the base station and then to a laptop computer where the information can be analyzed and organized from up to 50 feet.

The present study was based on a current graduate level investigation that is measuring brain activity in two types of teaching environments: lectures (Psychology 101) vs. laboratory courses (Biology 100). This study further investigated the behavioral and physiological correlates of attention.

While children often display more pronounced inattentive behaviors in the classroom, (playing with toys, openly talking, leaving their seats, etc.) (Sandberg, Rutter & Taylor, 1978; Boyd & Campbell, 1998) college age adults have developed much more discrete behaviors. It was the intention of this study to examine any relationship between the prevalence of behaviors proposed by the researchers and those previously validated in child subjects. Brain wave activity patterns associated with inattention (higher Theta and lower Beta) were also examined to investigate any physiological correlates of these behaviors.

METHODOLOGY

Procedure

Participants were 1 man and 5 women (N=6) between the ages of 18 to 25 enrolled at Minnesota State University, Mankato in Psychology 101. So as to not interfere with the lecture, each student was asked to come to his/her normal class 10 minutes before the scheduled class time. During this time the participant was asked to complete an informed consent form and a basic demographic questionnaire. This time allowed researchers to calibrate the helmet and collect baseline data for the student on the AT (required for accurate comparative measurement). Extra time also allowed the student to accommodate to wearing the helmet, minimizing distraction during the lecture. The subject then wore the helmet for the duration of the class period. Concurrent to the physiological recording, the subjects were filmed for the duration of the lecture period to later allow direct and taped observation. The video camera was positioned as to not interfere with the lecture while allowing researchers an adequate view of the participants' upper torso. If at any point the helmet became distracting or uncomfortable, the subjects were encouraged to remove the helmet and place it on an open desk next to them for the duration of the class period. Researchers did not interfere or disrupt the proceedings of the lecture under any circumstances. No identifying information was collected during the study, and no attempts to contact the participants were be made once the participant had completed the data collection process.

DOI: 10.56816/2378-6949.1154

Observation Protocol

The protocol developed by the authors and based on research by Sandberg, Rutter, and Taylor (1978) includes additional behaviors proposed to be more indicative of inattention for students at the college level. Adapted from "reaching objects" defined by Sandberg as, ". . . taking or reaching for objects or playing with objects that were not offered or on free display" (1978, pg. 284), any movement of the hands not directly pertaining to taking notes were recorded as Fine-Motor Movements. Gross-Motor movements, taken directly from Sandberg et al. (1978), were defined as any trunk movement or repositioning (i.e. shifting in their seats and stretching). As the camera was positioned in front of the subject to allow for the best possible view of their upper torso and face, it was very difficult to assess if the individual was making eye contact with the professor or the display. Consequently, for any breaks in eye contact to be recorded the subject must either significantly turn their head away from the front of the room in excess of 45 degrees in either direction or directing their visual attention to another object or person aside from their notebook. In addition to these previously validated behaviors defined by Sandberg et al., Facial Movements, note taking behaviors were also recorded. Any movement of the face, aside from blinking and gum chewing, such as yawning, sniffling, and any movement of the mouth, were recorded in the facial movement category. Lastly, intervals in which subjects were actively writing in their notebooks were recorded as note taking behaviors.

Attention Trainer

EEG recordings were conducted throughout the duration of the lecture simultaneous with the video recordings to allow more accurate sequential analysis. In addition to the Beta, Theta, and Delta frequency bands, fluctuations in amplitude were also recorded along the Skeletal Muscle Response (SMR) frequency band. While any motor movement can conflict with the accuracy of the AT, recording spikes in the SMR frequency band allow researchers to further distinguish potential movement related interference (Lubar & Shouse, 1976).

RESULTS

Activity on all four frequency bands were strongly positively correlated contrary to what current research would suggest given the AT is an accurate measure (Figure 1). No significant correlations were found between the prevalence of any and all of the observed behaviors further suggesting the AT is not a valid measure. On the contrary, moderately significant positive correlations were found between all of the defined inattentive behaviors (Table 1). Note Taking Behaviors, categorized as attentive, were found to have a moderate correlation with fine motor movements in a negative direction as was expected from prior research (Stewart, 1961) (Table 1) .

DISCUSSION

Several difficulties were encountered conducting this experiment vastly restricting the useable sample size. One subject was eliminated due to video recording difficulties shortly into the data collection period. Another had to be dismissed due to a crash of the AT software two minutes into the lecture period. The third subject was dismissed when direct view was obstructed due to late seating of non-participants limiting the view to the subject's head only. The subject was eliminated after author and mentor conference. The three remaining subjects were reviewed and provided concurrent EEG recordings and video footage.

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Overall the data output from the AT suggests that it is not a valid measure of attention, and therefore inadequate for research purposes. The SMR data was found to correlate highly with the fluctuations of the other frequency bands, indicating significant interference due to motor movements. In addition to this, past research suggests a negative correlation between the amplitude of waves of the Theta and Beta frequency bands. As the various frequency bands are measuring very different brain functions, the amplitudes of the waves should not have correlated so significantly, further indicating validity inaccuracies. Upon further investigation into the validating studies claimed by the creators of the AT, it was found that they had come to the same conclusion when the device was utilized in a similar fashion (Lubar, J. F.; personal communication February 15, 2004). Consequently, the authors do not recommend the AT for further use in similar research.

Significant correlations between the behaviors adapted from Sandberg et al. were found, thus confirming their internal validity. Facial Movements were also found to significantly correlate with the previously validated measures suggesting a relationship to inattention or attention. While note taking behaviors were found to only be related to fine motor movements the prevalence of the other behaviors in our limited sample size most likely weakened the statistical power.

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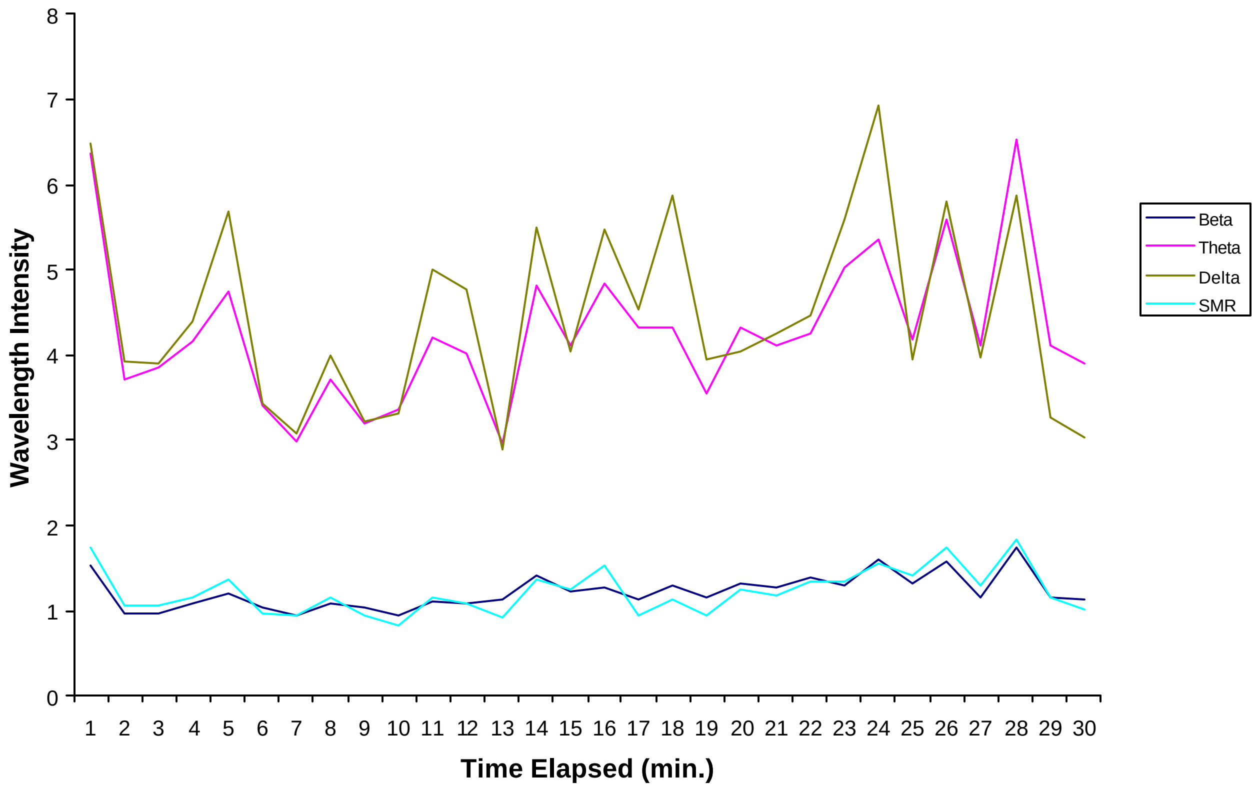
Fig. 1: Fluctuations in Wavelength Intensity over the Course of a Labratory Session; Subject 001



		FM	GM	EC	FA	N
Fine Motor Movements (FM)	Pearson Correlation	1	0.460	0.224	0.565	-0.280
	Sig. (1-tailed)	.	0.000	0.004	0.000	0.000
	N	135	135	135	135	135
Gross Motor Movements (GM)	Pearson Correlation	0.460	1	0.252	0.501	-0.033
	Sig. (1-tailed)	0.000	.	0.002	0.000	0.350
	N	135	135	135	135	135
Breaking Eye Contact (EC)	Pearson Correlation	0.224	0.252	1	0.347	-0.113
	Sig. (1-tailed)	0.004	0.002	.	0.000	0.097
	N	135	135	135	135	135
Facial Movements (FA)	Pearson Correlation	0.565	0.501	0.347	1	-0.134
	Sig. (1-tailed)	0.000	0.000	0.000	.	0.060
	N	135	135	135	135	135
Taking Notes (N)	Pearson Correlation	-0.280	-0.033	-0.113	-0.134	1
	Sig. (1-tailed)	0.000	0.350	0.097	0.060	.
	N	135	135	135	135	135

Highlighting Indicates Significance (p<.05)

Table 1: Correlations Found Within Measures of the Direct Observation Protocol

DOI: 10.56816/2378-6949.1154

Authors Biography:

Christopher Aura is an undergraduate student at Minnesota State University expecting to graduate with a B.A. in psychology. He has been involved on the research team of Dr. Edison Perdomo for two years and assisted on several research projects. Interested in continuing on the research track, upon graduation he plans to pursue graduate studies in Biopsychology or Neuropsychology.

Matthew Stanton is an undergraduate student currently enrolled in Minnesota State University. He has been actively involved on the research team of Dr. Edison Perdomo for three years. Upon graduation he plans to either enroll in medical school or a graduate program with an emphasis toward genetic or psychological research.

Faculty Mentor Biography:

Edison Perdomo received his Ph.D. from the University of Iowa. He as a professor of psychology at Minnesota State University, Mankato.