Archaeology of Intelligent Machines

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Abstract

In this paper, we set out to determine whether or not reading across different mediums has an impact on the attention and comprehension of the reader. We are doing so by using a portable 8-channel OpenBCI Cyton Biosensing board for gathering the required electroencephalogram data from a subject reading short prose texts, firstly from a print book, then from a smartphone, and analyzing it using MNE library.

1 Introduction

Contributions to this project go as follows:

- Eduard: orchestrating the experiment and overseeing it; analyzing the gathered data
- Cristina: being the first test subject and peer-reviewing Eduard's methods, creating a short, to the point, presentation for our course's final exam
- Cosmin: being the second test subject and peer-reviewing Eduard's methods, writing the present paper
- Sergiu Nisioi (our professor): providing us with the necessary tools and OpenBCI board

Previous work in this area of study ...

We glued electrodes to the subject's head using special EEG paste. Our approach was to require the subject to relax before the experiment started and after the first reading, the subject was asked to relax. It was handed a paperback book, opened at the specific short story, and instructed to read until the story ends, analogous reading from a given smartphone.

2 Approach

Our approach was inspired by previous work done on this question. However, due to the lack of possibilities, it was done in a home environment, using an OpenBCI Cyton board. The reading mediums compared were: a printed book and a smartphone.

The code ran, the dataset and the experiment timestamps can be seen in the project's Github repository.

From our research into this field of study, research has been done on predicting concentration states for ADHD patients, or correlating EEG activity with concentration metrics such as test quizzes for children after reading short texts [(1)]. What we tried to do, is to check if, for a young student reading from literary works of the same author, there is a significant difference between book reading compared with phone reading when it comes to theta/beta brain wave ratio. What we tried to replicate is: use the same electrode positions to capture brain signals, do the same pre-processing techniques and use a t-test to check if the difference occurred by chance or not.

Preprocessing the data was done using a low-cut and high-pass filter of 0.1 and 70, and a notch filter of 50Hz to eliminate electricity artefacts.

To eliminate biological artefacts (blinking and muscle contraction are captured by EEG electrodes, and we're interested only in signals from focus and language regions), we used Independent Component Analysis, which on a high-level interpretation, tries to identify the number of uncorrelated components that constitutes the EEG signal, solving the 'cocktail problem' (EEG signal is a combination of smaller and distinct brain region; ICA tries to separate the original signals into those smaller electrical components).

In order to compare the focus levels, we extracted the power spectral density using the Fourier Transform, which tries to decompose a signal in all its constituent frequencies, Adding the squared amplitude of all frequencies in theta(4-8Hz) and beta (13-30Hz) range and comparing their ratio for similar intervals from the experiment. In our analysis, the theta/beta ratio suggests that these values are

similar in both types of activity. This result might be from an experimental design error or wrong use of MNE library.

3 Limitations

We were limited in our project's scale by the number of subjects available and the working environment. A home experiment, albeit overseen by the others, is a random environment with multiple attention-seeking uncontrollable events. The number of subjects we were able to test on was also a limiting factor. In a statistical sense, higher number of individuals could lead to a catastrophically different result, but intuitively, the outcome of this paper should not stray far from the expected path.

4 Conclusions and Future Work

Now that we did this project, is there anything we could have done different ?
Like previously mentioned, we could have gathered more test subject and invest in equipment with a higher electrode count. One very important aspect that we should have assessed is an comprehension metric, a certain scale to address how much the individual was actually focusing and reading, not just fooling us by looking at words with a blank stare, based on questions regarding the text.

Did we like really this project ?
We suggested this idea to Sergiu and he was very stoked upon hearing it. For Eduard, it is a passion project that he was going to undertake in the future, whether or not this course existed. For Cosmin, this was a question that was on his mind well before, due to a mental limitation of his while reading long-form content on the Internet. Cristina found the experiment idea interesting and enjoyed working in a team.

References

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