

## Introduction

- Recent electroencephalographic (EEG) studies have shown that the human brain responds similarly to the same stimulus regardless of a subject's personal background or bias<sup>[1]</sup>
- Student engagement is correlated with academic success, but the mechanism by which this *attentional focus* translates into *improved performance* is unknown.
- Hypothesis:** The level of inter-subject correlation (ISC) of EEG evoked by educational stimuli predicts the extent to which subjects acquire and retain stimulus-related knowledge.

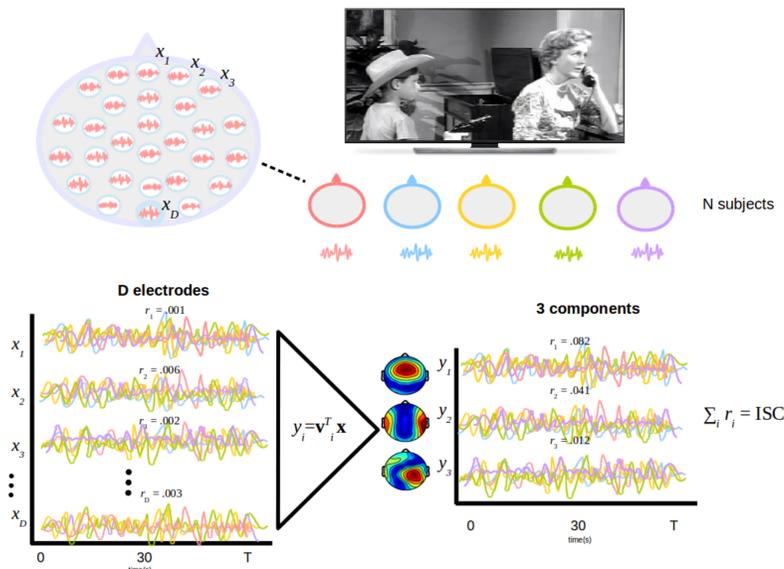


**Figure 1. Video stills from four videos.** Videos:

- Who Invented the Internet? And Why?<sup>[3]</sup> (top left)
- Why Do We Have More Boys than Girls?<sup>[4]</sup> (bottom right)
- The Immune System Explained - Bacteria Infection<sup>[5]</sup> (top)
- How do Modern Light Bulbs?<sup>[6]</sup>
- Why Are Stars Star-Shaped?<sup>[7]</sup> (bottom left)

## Methods and Materials

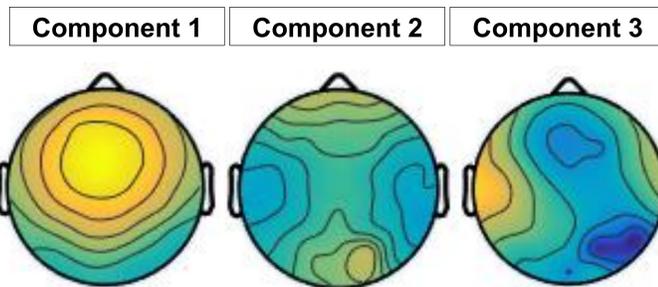
- EEG was recorded from 21 subjects while they watched five short educational video clips (Figure 1).
- Movie length lasted 4.53 +/- 2.29 minutes.
- Subjects' knowledge base was assessed before and after exposure to videos -- pre- and post- test (Figure 4).
- ISC components were derived by maximizing the correlation of each individual's neural responses to that of the rest of the group (Figure 2).
- The extent to which each individual correlated with their peers (measured via ISC) was used as a metric of their attentional engagement with the stimuli.



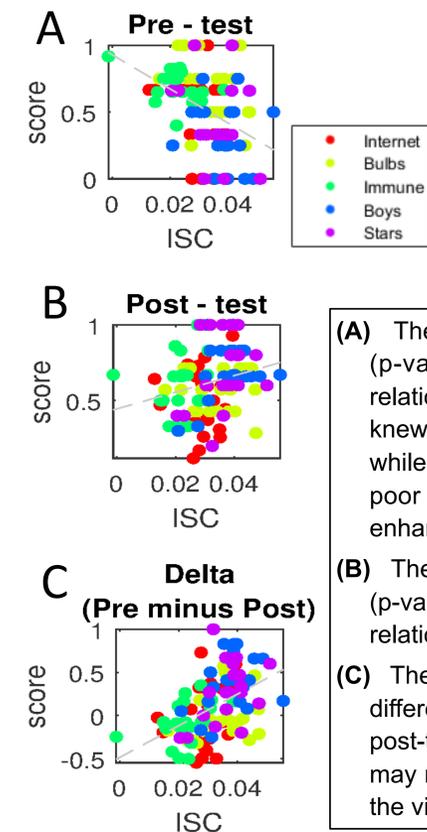
**Figure 2. Overview of neural reliability measure.** Neural response are recorded from N subjects during the presentation of a naturalistic stimulus. Each subject provides time courses  $x(t)$  recorded on D electrodes ( $D=64$ ). Correlations across subjects in each of these electrodes  $x_d(t)$  is small ( $r_d < 0.01$ ). The data is projected using projection vectors,  $v_i$ , which maximize correlations,  $r_i$ . In the first component projections,  $y_i$ , correlations are now larger. Inter-subject correlation (ISC) is measured as the sum of the correlation of the first 3 correlated components [1].

## Results

- ISC was correlated with an improvement on test scores after exposure to educational videos (Figure 4C).
- A generalized linear mixed model related the ISC measured from individual subjects during the viewing of a particular video and their test performance (Figure 4).



**Figure 3. Scalp topographies of the first three ISC components across subjects.** These projections were obtained from correlated component analysis.



**Figure 4.** A generalized linear mixed model related the ISC measured from individual subjects during the viewing of a particular video and their test performance. Each point is representative of an individual subject's ISC ( $N=20$ ) and test scores for a particular video ( $N=5$ ). All correlations are significant.

- (A) The ISC related to individual pre-test score ( $p$ -value = 0.0006). This is the strongest relationship found, suggesting that subjects who knew less about a subject elicited a higher ISC while viewing the content. This indicates that poor pretest performers may have had an enhanced motivation to attend to the video.
- (B) The ISC related to individual post-test score ( $p$ -value = 0.05). The trend indicates a linear relationship, albeit the scattered range.
- (C) The ISC related to delta score, which is the difference between an individual's pre-test and post-test scores ( $p$ -value = 0.0001). This score may measure the knowledge gained by watching the video.

## Conclusion and Future Studies

- The data illustrate that higher ISC values may be indicative of increased attentional engagement which is necessary for successful learning (Figure 4).
- In the future, ISC could be used as a metric when designing and assessing online educational content and presentation style.

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