EEG & Confusion

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Study Motivation

- Current online courses lack **feedback and interaction** found in classroom
    - Forums and quizzes attempt to fix this, but not enough

- Solutions for detecting students' confusion:
    - In classroom: students ask questions, teachers read body language
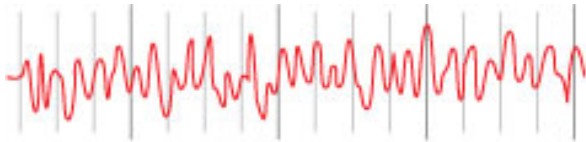   - Online: EEG detection, if works properly, is new idea

*EEG = electroencephalogram

More on EEG signals

- Neurons firing at same rate are grouped together ("synchronization")

- Brainwaves are produced by synchronized electric pulses from masses of neurons communicating with each other
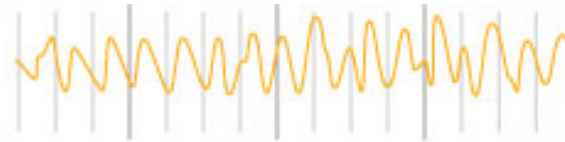 - Vary as function of mental state, cognitive activity
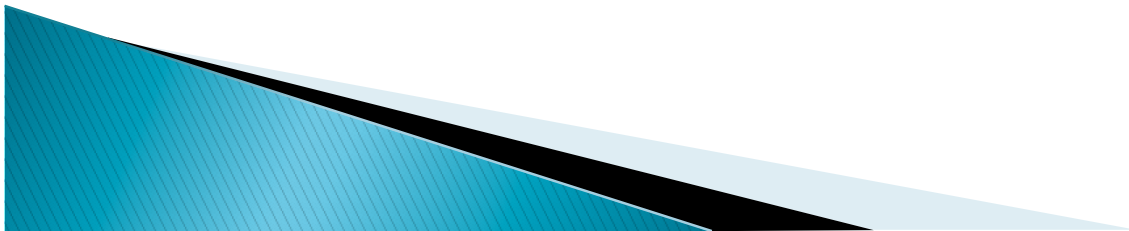
Beta (14-30 Hz)

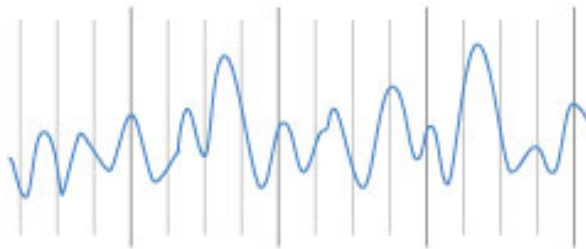Concentration, arousal, alertness, cognition

Higher levels associated with Anxiety, disease, feelings of separation, fight or flight

Alpha (8 - 13.9 Hz)

Relaxation, superlearning, relaxed focus, light trance, increased serotonin production

Pre-sleep, pre-waking drowsiness, meditation, beginning of access to unconscious mind
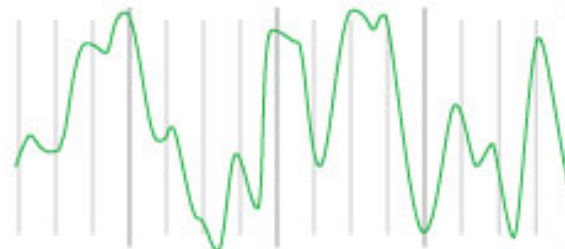
Theta (4-7.9 Hz)

Dreaming sleep (REM sleep)
Increased production of catecholamines (vital for learning and memory), increased creativity

Integrative, emotional experiences, potential change in behavior, increased retention of learned material

Hypnagogic imagery, trance, deep meditation, access to unconscious mind

Delta (0.1-3.9 Hz)

Dreamless sleep
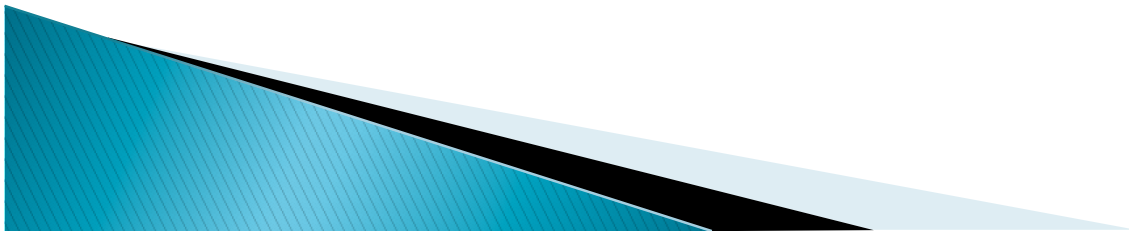Human growth hormone released

Deep, trance-like, non-physical state, loss of body awareness

Access to unconscious and "collective unconscious" mind,

Study Overview

- 10 college students watched 10 short educational videos while wearing EEG headset
  - 5 "confusing", 5 "easy to understand"

- Students then reported whether they found videos confusing

Data Overview

- Pre-defined Label of Confusion
  - Intro Algebra vs. Quantum Mechanics

- Reported Confusion

- Brainwaves
  - Gamma, Beta, Alpha, Theta, Delta

- Attention and Meditation

- Demographics

Study Findings

- Trained classifiers to estimate probability of whether a given session was confusing or not

- Average of 56% accuracy for detecting user-defined confusion label
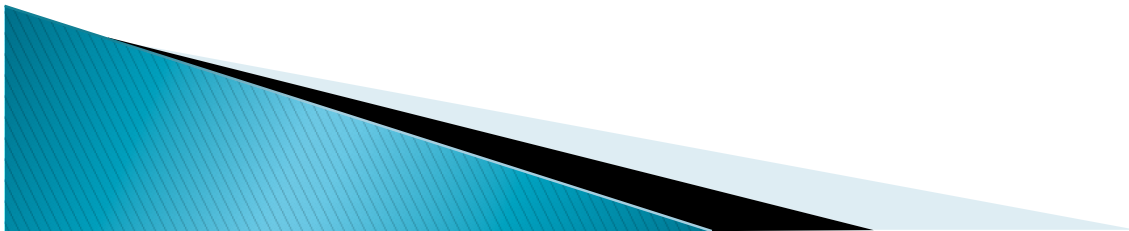
Our Objectives

▶ **Feature extraction**
- ◦ Can certain EEG signals predict confusion?
  - • Follow up on claim that theta waves correlate with confusion

▶ **Investigation of other trends in data**
- ◦ Do certain waves correlate with each other?
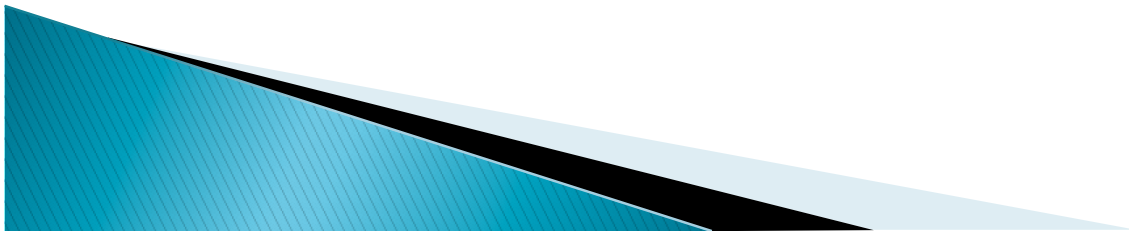
Design Process

- Normalized dataset (0-1 range)

- Implemented feature extraction algorithms
  - Visually compared algorithm performances for our mean data

- Extracted the most significant features from the linear algorithm (LDA)

- Constructed visualizations of these selected features to analyze trends
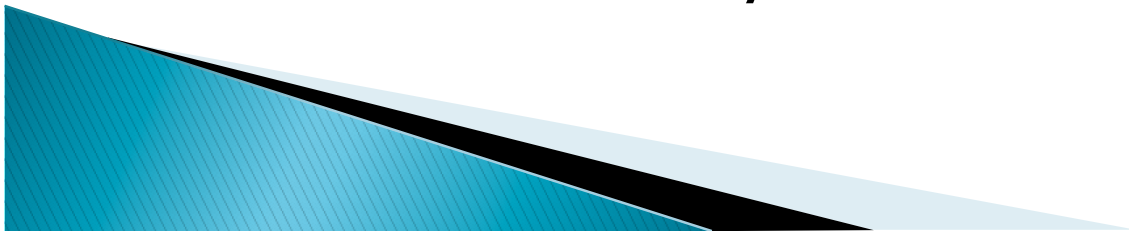
Main Conclusions

- Significant features hard to find in this data set.

- Interaction effect: High theta values correspond with confusion

- Alpha 2 and Beta 1 waves correlate with each other