Measuring Curiosity in Virtual Reality Classrooms

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Introduction

Background:

- Traditional college lectures are not engaging[1]
- Explore the role of curiosity as a tool to optimize learning
- Previous studies have used neuroimaging techniques, such as Electroencephalogram (EEG) to measure curiosity induction in lab settings[2]
- Curiosity is difficult to study in real-world due to situational factors[3]

Objective:

- Virtual reality (VR) can be used to model realistic environments
- Accurately collect EEG signals while participants engage in a distraction free, immersive environment

Research Question:

- Can we identify the EEG fluctuations associated with curiosity to improve classroom engagement?
- Can we successfully merge VR and EEG to allow for more accurate testing of the effect of curiosity on learning?

Virtual Reality Environment

- Used a virtual medium-sized college lecture hall in which participants were exposed to trivia (Figure 1)
- Participants rated their curiosity and satisfaction by interacting with cubes placed on desk in front of them
- Implemented a timed collision event to collect event markers (Figure 2)

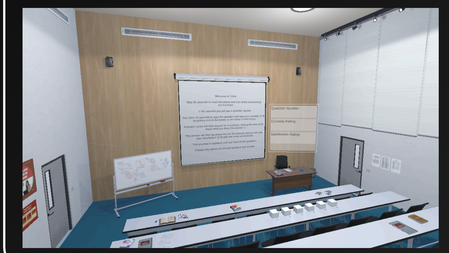

Figure 1: Classroom environment

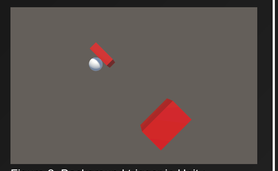

Figure 2: Background trigger in Unity

Methods

Wired EEG in Lab

- Developed trivia paradigm modeled after Gruber et al., 2014[4] (Figure 1, 2)
- Collected highly accurate EEG measurements using a 64-channel electrode cap on 10-20 EEG system (Figure 4)
- Participants progressed to Q&A phase after selecting low (1-3) and high (4-6) curiosity for 50 questions each (Figure 1)
- Participants were instructed to think about the answer during 4-second anticipation phase (Figure 2)
- Participants completed a free-recall memory test in an Excel spreadsheet after removing the cap

Muse 2 Headband in VR

- Implemented a modified trivia paradigm (figure 3)
- Participants were exposed to 60 questions to reduce risks associated with prolonged VR exposure
- Utilized wireless Muse 2 headband to allow participants to move their head freely in VR (Figure 5)
- Synchronized EEG data stream and event marker stream using Lab Streaming Layer (LSL) to accurately correlate brain activity with VR events
- Data was recorded using Lab Recorder, and processed in MATLAB with the EEGLAB toolbox

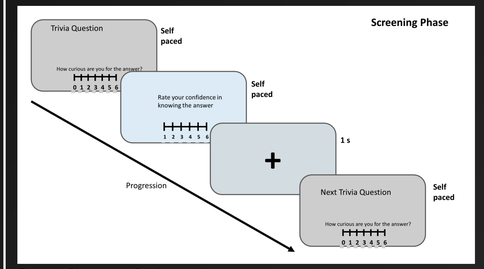

Figure 1: Phase one of trivia paradigm in lab

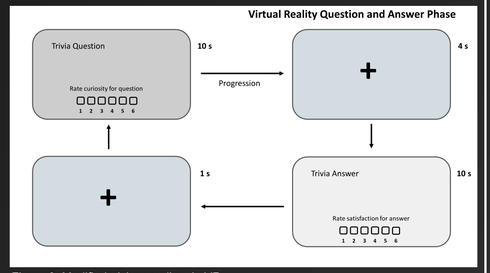

Figure 3: Modified trivia paradigm in VR

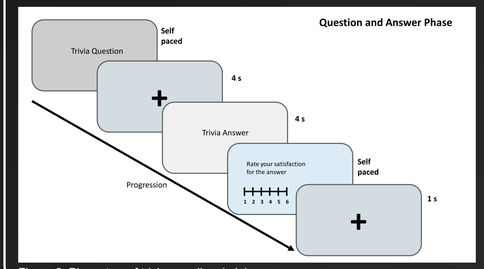

Figure 2: Phase two of trivia paradigm in lab

Figure 4: 64-Channel electrode cap

Figure 5: Muse 2 headband and VR HMD

Results

- Participants had higher recall for questions that induced high curiosity (Figure 1)
- Participants showed higher EEG theta (3-7 Hz) power frequencies during the anticipation phase (Figure 2)
- Successful communication between the VR and EEG streams (Figure 3)

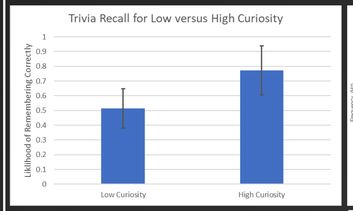

Figure 1: Trivia recall for memory test

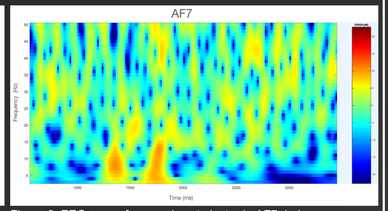

Figure 2: EEG power frequencies at electrode AF7 during anticipation phase of high minus low curiosity in lab test

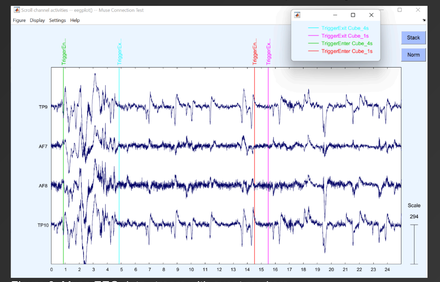

Figure 3: Muse EEG data stream with event markers

Discussion & Future Work

- Positive correlation between curiosity and memory
- Changes in theta frequency power represent a potential curiosity EEG indicator
- Integration of EEG and VR technology offers an unprecedented paradigm for testing methods that will optimize learning outcomes in educational settings

VRAC Visualize • Analyze • Reason • Collaborate

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