Project title: Grand PrEE-G (+ Tug of War)

Project concept *(2-3 sentences)***:**
- What is the core idea of the project:
    - Use the relative strength of EEG signals/the cognitive state of the player in order to "rival" the strength/state of their opponent
    - Alpha waves measured corresponds to the amount of focus you are putting in
    - For cognitive state: abstract metric decided by ML model that quantifies relative concentration (could also match to a specific cognitive state, e.g. "relaxation", "focus", etc)
    - The more focused you are, the faster your speed/the stronger your "pull", etc
    - Gameplay may also task a player with rapidly changing their wave strength/cognitive state in response to a stimulus (a powerup)

Goal/Purpose:
- What can the player do:
    - Racing:
        - Simple:
            - Player can maintain or change their concentration level (their alpha wave measure/threshold)
            - Player can blink/jaw-clench within a specific window to activate a power-up/interact with the screen
        - Hard:
            - Player can maintain or change their cognitive state in response to changes in the area (e.g. for an "icy" level the player must try to relax in order to keep pace, for a "fire" level the player must try to be "angry", etc)
    - Tug of war:
        - Player can maintain or change their concentration level (their alpha wave measure/threshold) to try and defeat their opponent
        - Staring contest blink on/off setting
            - If you blink, you lose (added backend benefit -> if players start laughing, their signals get railed and they also lose?)
- How do they interact with technology: See above
- What is the intended outcome of the game:
    - To "win the race"/"defeat the other opponent in tug of war" → e.g. maintain your concentration state/change with the game's terrain, react to powerups or other stimuli on time (via blinking/jaw-clenching)

Technology overview:
- ➔ What hardware will be used:
    - ◆ 16-electrode Unicorn headset
    - ◆ Arduino
- ➔ What signals will be measured:

- ◆ Node configuration: Fp1, Fp2, C3, C4, P7, P8, O1, O2 (P7, O1, O2, P8 to detect alpha waves)
  - ● Cognitive state? (Determined from those nodes' signals via an ML model)
- ◆ Alpha waves (8-13 Hz)
- ◆ Blinking/jaw-clenching artifacts
- ➔ How will EEG data be read into the app (describe how brain activity becomes an action):
  - ◆ Threshold-based control (if focus > X → action)
  - ◆ Continuous control (higher concentration → faster action)
  - ◆ Trigger-based control (blink=action/jaw-clench)

Development Plan:
- Describe the user interface / screen layout (what the paper will see in the main screen):
  - Racing:
    - Straight racing track. Every once in a while, there will be ramps. If you blink/jaw-clench right before the ramp, you will jump (aka sudden burst of speed)
    - "Speedometers" for the players will be displayed, and above them their EEG signals (cognitive state as well)
    - Number of laps completed will be shown in a corner, alongside player standings
    - A small map of the track could be in one of the corners as well
  - Tug of War:
    - Rope in the middle of the screen, "concentration" meters on the side to demonstrate players' "strength", middle of the rope will be pulled towards the side that is more concentrated
- Logical workflow (explain how the project will be built in steps):
  - Literature review
    - Determine final node configuration, potential models to attempt, try pretrained models as well
    - Key papers:
      - [Development of RelaxQuest: A Serious EEG-Controlled Game Designed to Promote Relaxation and Self-Regulation with a Potential Focus on ADHD Intervention](#)
      - [An Emotion Recognition Method for Game Evaluation Based on Electroencephalogram | IEEE Journals & Magazine](#)
      - [An overlapping sliding window and combined features based emotion recognition system for EEG signals | Applied Computing and Informatics | Emerald Publishing](#)
  - Create the backend for the threshold version of the game
    - Determine sensitivity and threshold measures of EEG nodes and how they can be mapped to game controls
  - Create the basic UI to match the threshold backend
  - Train/test the cognitive state model
  - Update the backend/UI to incorporate the cognitive state version's new gameplay features

Total Estimated Budget:
- Headset: sponsored
- Arduino: already own