MSc in Computational Cognitive Neuroscience

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Characterising the neurophysiological processes underlying expert performance in video games

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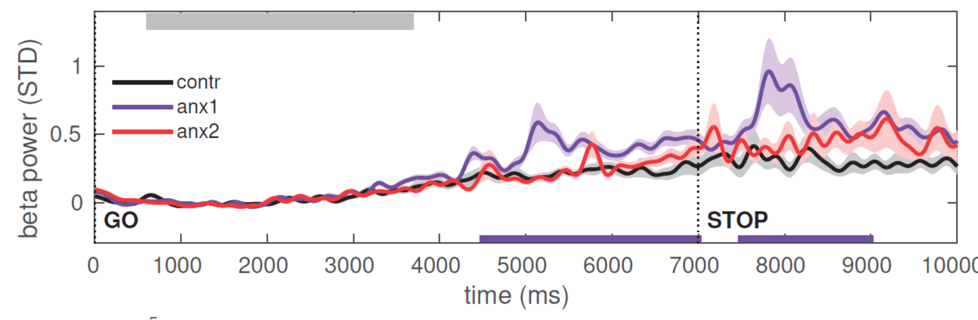
1. Introduction

Video games have many cognitive benefits e.g. flexible task switching, selective attention, working memory and decision-making (Dale & Green, 2017).

Video games have been described to utilise "*learning to learn*" models (Kemp et al., 2010) and predictive coding (Bastos et al., 2020). Exploration and exposure to new information facilitates feedback by updating beliefs and promoting faster and successful future performance.

This form of learning can be observed in beta oscillations in electroencephalogram (EEG).

Recent neuroscientific research has shown increased beta power links to impairments in learning and updating beliefs in motor tasks, where anxiety (induced by uncertainty) attenuates behavioral changes (Sporn et al., 2020; Hein and Ruiz, 2022).



(Sporn et al., 2020)

2. Rationale

This study is the first to investigate whether flexible modulation of beta oscillations during game-relevant cues is a marker of predictive coding in understanding skilled and successful gameplay performance.

3. Hypotheses

- Reductions in beta oscillations after failed events will correlate with faster learning and lead to better performance over time.
- Modulation of bodily signals can explain variance in successful gaming performance.

4. Experimental Design

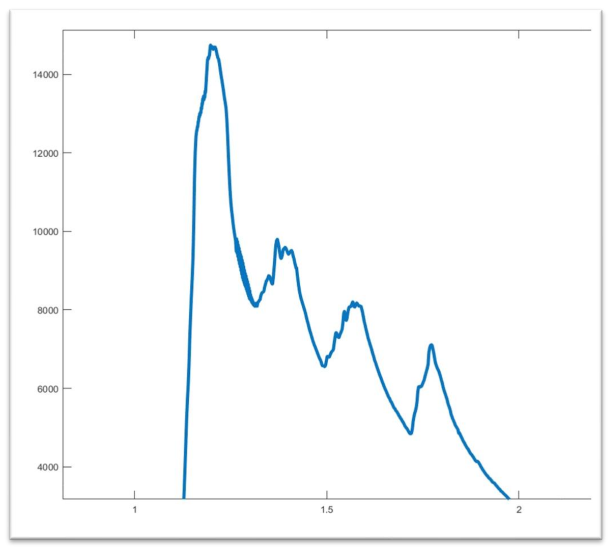
Participants: Twenty-five expert gamers have been currently recruited via to play third-person shooter game Outriders (Square Enix ®) for 1.5 –2 hours.

Measures: **Mobile EEG** • **ECG** • **Breathing band** • **Game logs** (game cues) • **Controller logs** (button presses) • **Pre-experiment questionnaires** (demographics, video game experience, Body Perception Questionnaire by Chen, 2013) • **Post-experiment questionnaires** (Final game questions, Player Experience Inventory (PXI) by Abeele et al., 2020, Temporal Expérience Tracing (TET) by Jachs et al., 2022).

Procedure:

1. Consent, information sheet and pre-experiment questionnaires.
2. EEG, ECG and breathing band fitting.
3. Five-minute fixation task to obtain baseline recordings.
4. Controller synchronisation and Outriders gameplay recording.
5. Controller synchronized again at end of gameplay, and recording will be stopped.
6. Post-experiment questionnaires and debrief.

Data Analysis:



The EEG data will be synced with the game and controller logs through time stamps so that key events and frequency bands can be identified and matched (shown on the right).

The data will then be filtered in MATLAB using the EEGLAB and Fieldtrip toolbox – an Independent Component Analysis (ICA) will be conducted.

A General Linear Model (GLM) will be conducted to identify correlations between key events and beta oscillations. GLM allows us to control different relationships and see how the addition or removal of key events would modulate beta oscillations.

5. Results

There are not yet results to report as recruitment is ongoing.

Supervisors briefly conducted analysis on pilot data, and results were showed support for the main hypothesis. There is also evidence that arousal from bodily signals are positively correlated with enjoyment – possibly explaining variance in performance.

6. Summary & Future Steps

Pilot results support the main hypothesis – predictive coding with beta oscillations correlate with updating beliefs and in turn, better gameplay performance over time.

Future Steps:

- Recruit more participants before conducting final analyses – our aim is 30 participants.
- Conducting GLM and ICA to reproduce pilot results in support of the main hypothesis.
- Linking the neural responses to enjoyment/arousal and seeing variance can explain successful game performance.

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