Neuroscience investigation of reward processing in young adults at-risk for alcohol dependency
Background

Dysfunctional reward pathways underlie addiction
(Luijten et al., 2017; Meyer et al., 2016; Nestor et al., 2017)

Alcohol dependency: blunted ventral striatum activation during reward anticipation
(Beck et al., 2009; Nestor et al., 2017; Wrase et al., 2007)
Is dysfunction present in populations at-risk for alcohol dependency?

Can this dysfunction (within deep brain structures) be detected with cortically/surface recorded EEG?
At-risk alcohol users have disrupted valence discrimination during reward anticipation

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**Event related potential (ERP)**

- Compares trial averaged amplitudes of conditions, across specific time windows.
- $P3$ (400 – 550 ms) correlates with ventral striatum activation during monetary incentive delay task (Pfabigan, 2014).

**Machine learning discrimination**

- Uses single trial information to look for time windows of maximum separation between conditions.

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3 (condition) x 2 (group) mixed ANOVA revealed no significant differences between the groups for the cue-P3 amplitude (F (1, 42) = 1.35, p = 0.25).

P3 gains > losses and neutral
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Machine Learning
Method Overview

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**Machine learning method**

Linear classifier finds best separation between two conditions.

- **Valence = Gain vs Loss cues**
- **Salience = Incentive (gain & loss) vs Neutral cues**
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Machine learning method

What is EEG Single Trial Variability (STV)?

EEG-STV index of how each condition is encoded on individual trials.

Can be related to other things changing trial-by-trial basis:
- Reaction time
- fMRI signals
- Cardiac signals
Machine learning method

How well can the brain discriminate between two conditions of interest?

- Classifier performance
- Area under ROC = “AZ value”
- Larger AZ → more accurate the classifier → better separation between conditions
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Group of low-risk drinkers can discriminate between gain and loss cues.

Group of hazardous drinkers cannot discriminate between gain and loss cues.

**Machine learning results (valence)**

![Graphs showing discrimination between gain and loss cues for low and high AUDIT groups.](Image)
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**Hypothesised P3 time window - between group comparison**

- **Significant difference between LA-Az and HA-Az from 480 – 550 ms**
- **Concrete evidence of hypoactive/blunted reward anticipation in high risk drinkers**
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Is there a relationship between brain and behaviour?

Higher STV (i.e., larger difference in EEG signal between gain and loss cues) → faster reaction time to target.
At-risk alcohol users have disrupted valence discrimination during reward anticipation

Key findings

- Disrupted valence (gain vs loss) processing in hazardous drinkers
  Temporally: 480 - 550ms
  Spatially: unknown? Combined fMRI-EEG needed

- No evidence of disrupted salience (incentive vs neutral) processing
  Temporally: any time between cue and target onset
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Ongoing research & next steps

Alcohol dependent vs control populations

Longitudinal research

How do valence and salience EEG markers change over time? Do these relate to transition to alcohol dependency? Can they be used in relapse prediction?
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Application for EEG markers

- High signal-to-noise ratio → statistically meaningful results for individuals
- Stratification – predict which patients will respond to different treatments
- Reduced cost of drug development, employ EEG instead of fMRI
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References


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