Disinhibition and poor error monitoring associated with alcohol and cannabis exposure in young adults

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Introduction

Adolescence and young adulthood is a period of biological, emotional, social and cognitive maturation, with the human brain continuing to develop until the mid-twenties.

The frontal cortex and lateral temporal lobes are the last areas to mature, subserving attention/executive function and memory processes, respectively.

Researchers are still seeking to understand the effects of substance use on the structure and function of developing brains.

In particular, new research is required into the effect of alcohol and cannabis on development, as they are the substances most prevalently used by young adults.

Executive dysfunction and frontal lobe damage caused by substance use as a young adult is particularly important to understand as executive functions are thought to contribute to the development and maintenance of dependence, and are known to be damaged in adult alcohol-dependent groups and heavy cannabis users.

The current research seeks to determine if there are subtle deficits in brain function in younger individuals who have been using for a shorter period of time.

Methods

60 participants aged 18-21 years will be recruited from the UNSW student population; approximately half the required participants have been recruited to date

Participants complete questionnaires (including Alcohol Use Disorders Identification Test – AUDIT) and interviews assessing their prior use of alcohol and cannabis, and then complete the following tests while EEG is recorded

Rey Verbal Learning Test: participants are presented with 15 words one at a time, and asked to recall as many words as possible, immediately as well as after subsequent presentations of the original and a new list, and after a delay of 20 minutes. They subsequently complete a recognition test.

Attentional capture task (drug Stroop): assesses the attentional capture of task-irrelevant, sometimes drug-related features of stimuli, at the expense of processing task-relevant features.

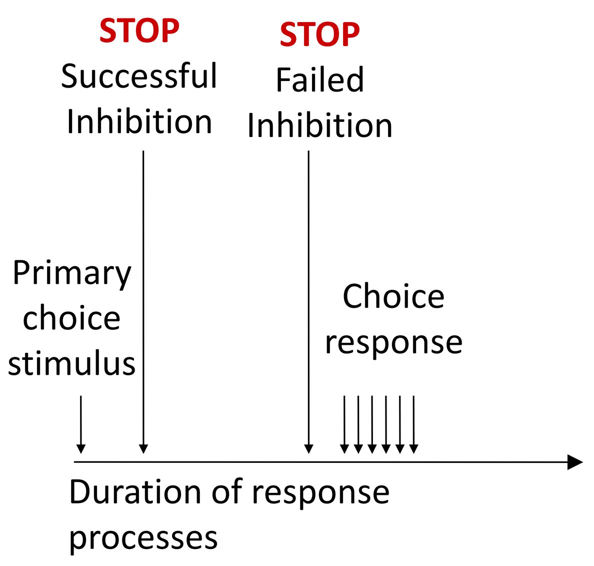
Iowa Gambling Task: assesses risky decision making, or a preference for short-term gains despite long-term losses.

The stop-signal task: assesses the time required to stop an overt response, and the behavioural response after errors are made.

Stop-signal task

Participants press a button according to the direction of arrow stimuli, and on 25% of trials, an auditory "stop-signal" tone is presented at variable delays after the arrow, indicating participants should stop their response.

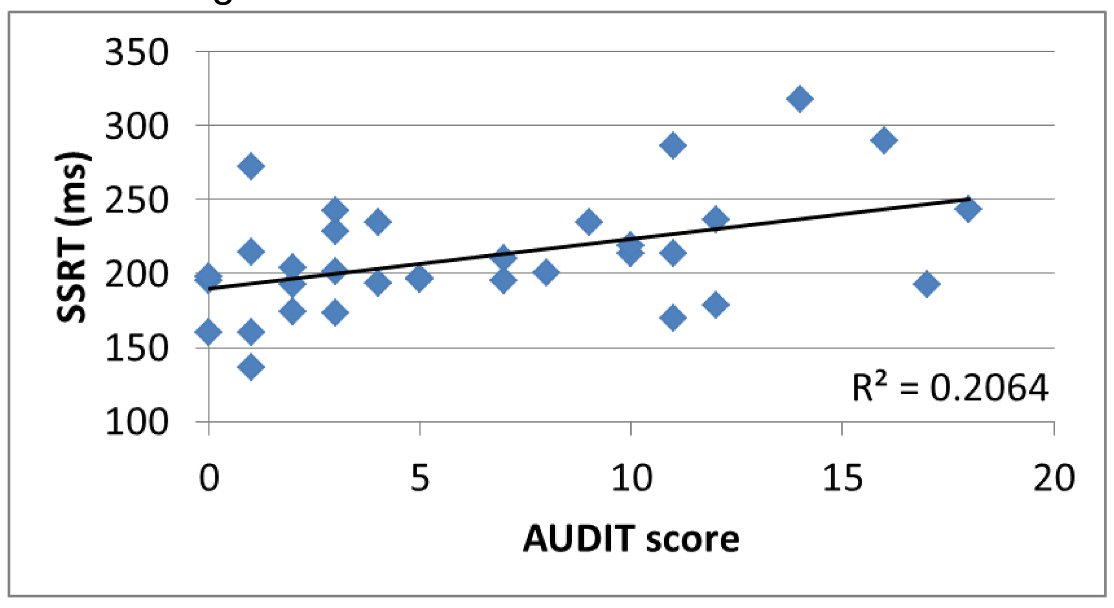
An estimate of the time required to stop a response, the "Stop-signal Reaction Time" (SSRT) can be calculated from the probability of stopping at different stop-signal delays.

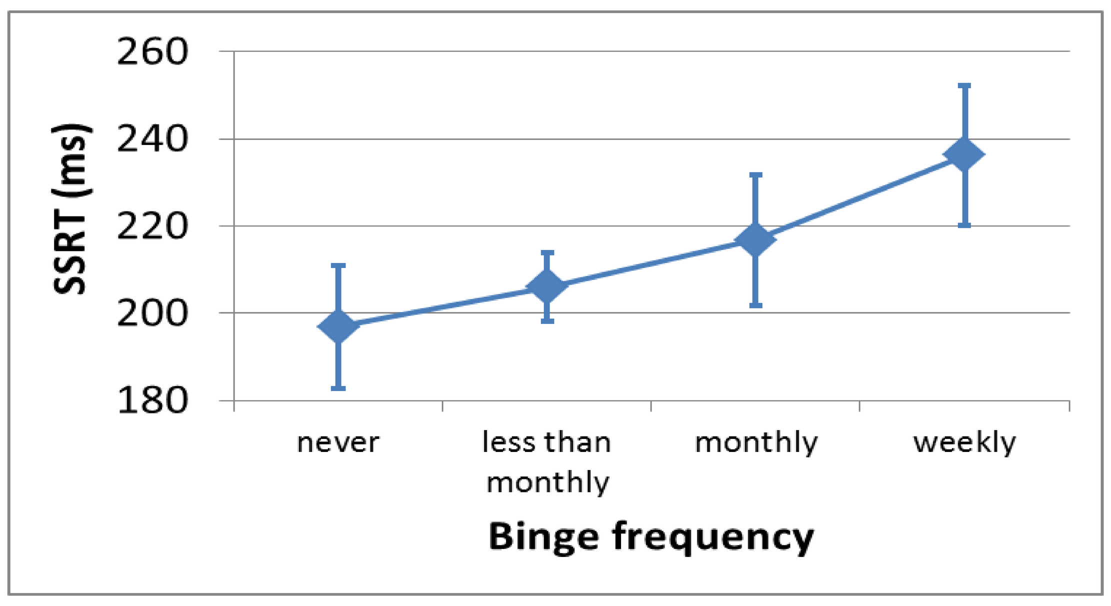


Stop-signal reaction time results

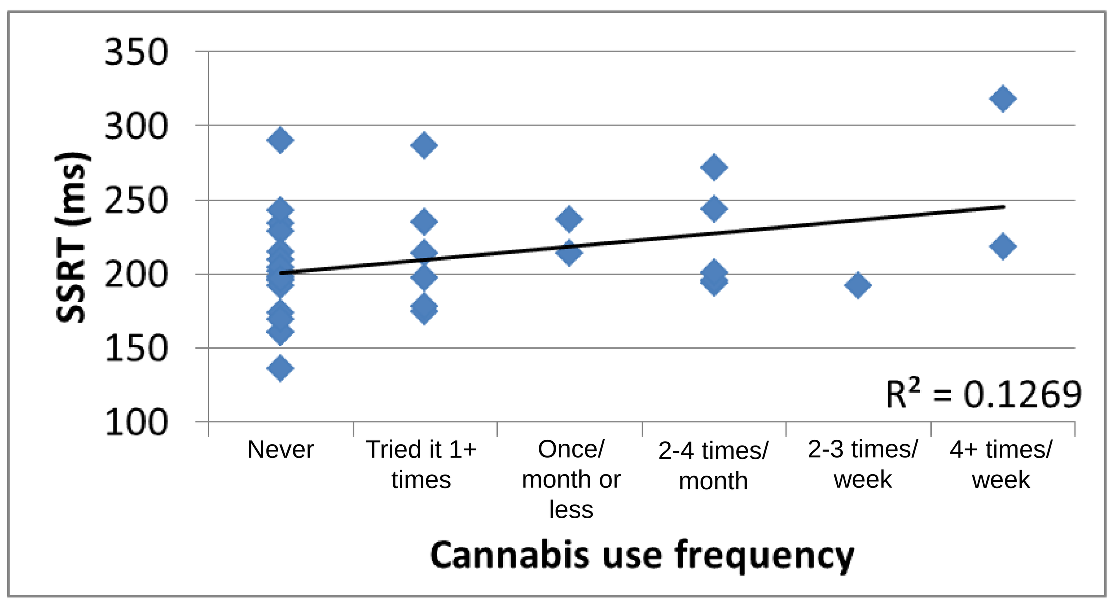
An estimate of the time required to stop a response, the "Stop-signal Reaction Time" (SSRT) can be calculated from the probability of stopping at different stop-signal delays.

SSRT correlates with total AUDIT score at r = .454, p = .008 (with hazardous score at .445), and shows trend to longer SSRT with more frequent binge drinking





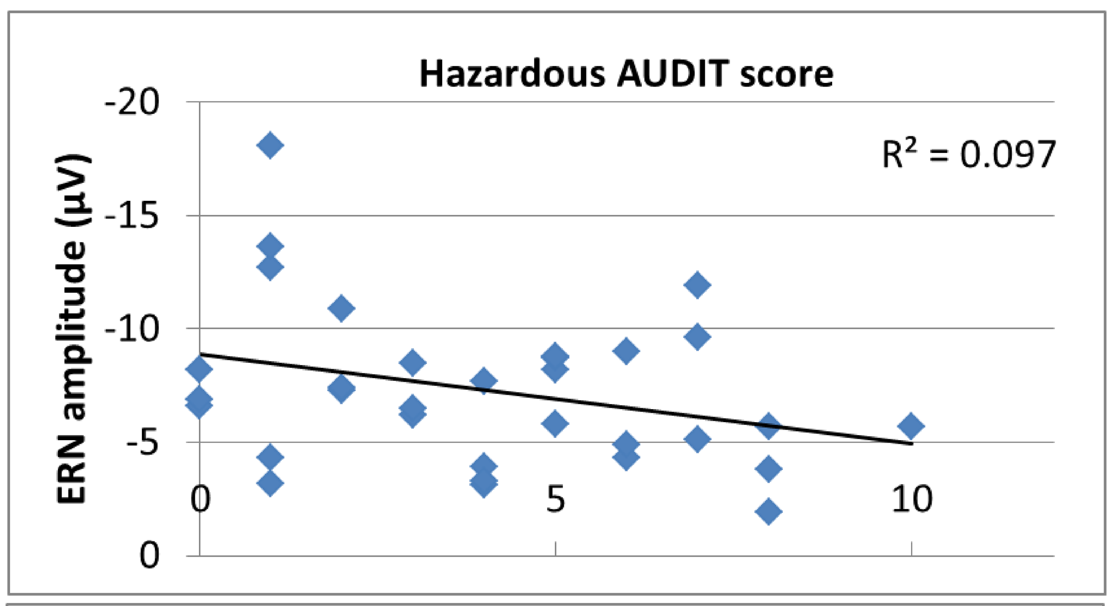
Cannabis use frequency correlates r = .356 – but probably driven by outlier

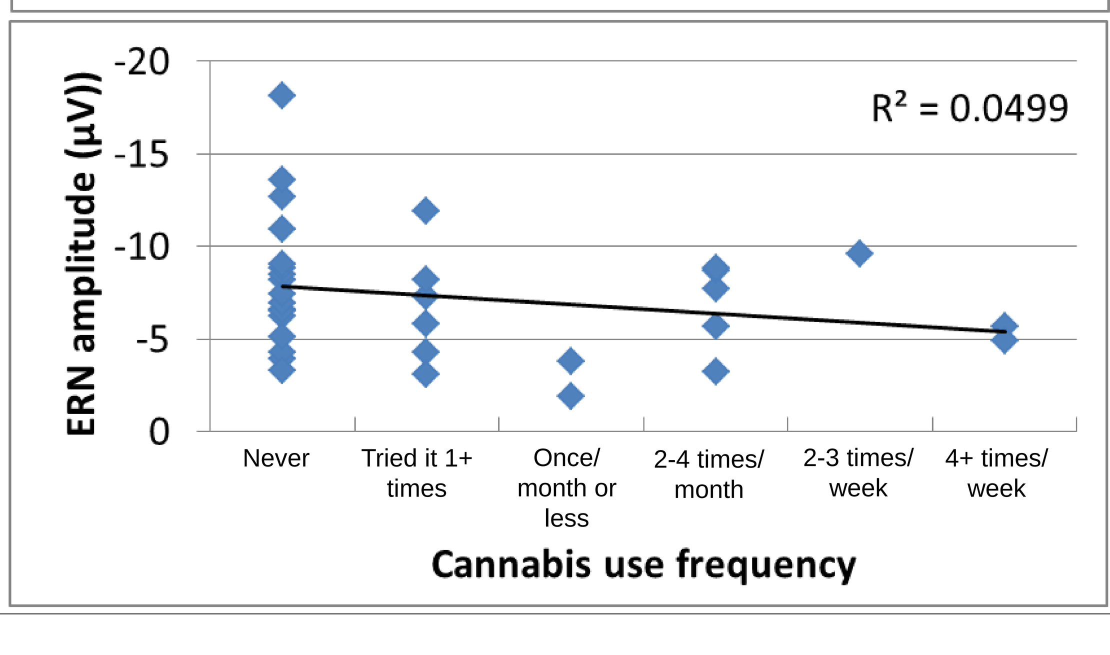


Error-related negativity

The Error-related negativity (ERN) is a brain potential involved in monitoring actions and detecting errors, peaking after an incorrect response has been executed.

The ERN appears to be inversely related to hazardous alcohol use (first three questions of AUDIT, r = .311, p = .078) and appears weakly related to cannabis use frequency (r = .223)

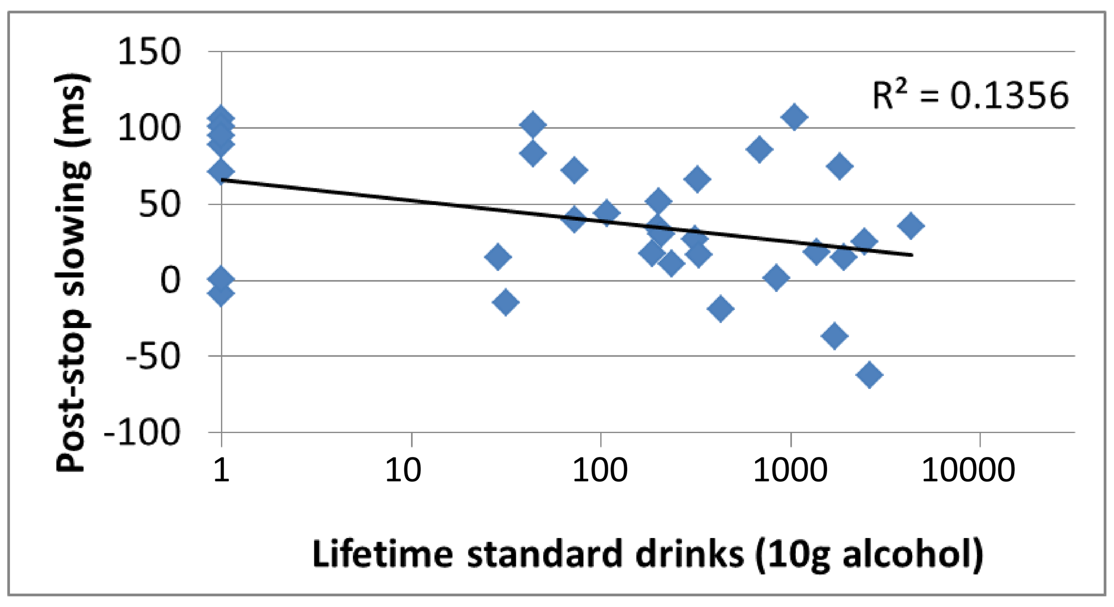




Post-error slowing

After making a performance error, healthy control adults typically go slower on the following trial to increase the chances of correct performance.

Post-stop slowing correlates negatively with log alcohol consumption (number of standard drinks) r = -.368, p = .035, but has no relationship with cannabis use frequency (r = -0.21).



Performance in other tasks

Attentional bias to alcohol and cannabis-related words in the drug Stroop task do not appear to be strongly related to alcohol or cannabis use patterns.

Proportion of risky decisions appears unrelated to alcohol and cannabis use on the Iowa Gambling Task.

On the Rey memory test, increased alcohol use is associated with faster reaction times on the recognition test. Contrary to expectations, cannabis use frequency is weakly associated with *better* memory performance.

Discussion

The majority of participants collected so far have been low-level drinkers and non-cannabis users. Recruitment now focuses on heavier drinkers and regular cannabis users.

For the sample we have so far, heavier alcohol use is associated with deficiencies in motor inhibition, impaired detection of errors when these occur, and subsequently with deficiencies in the normal adjustment of behaviour following errors.

These may relate to real-life deficiencies in inhibition (e.g., refusal of alcohol) and a failure to adjust goal-directed behaviour.

If these results hold when the remainder of the sample is collected and analysed, these atypicalities in inhibitory processing are apparent in a younger group with less alcohol exposure than previously considered.

The lack of substantial results in other tests of cognitive function and memory may indicate that heavier and/or longer periods of use are required to observe significant deficits.

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