# Predicting Adolescent Cannabis Use vs. Binge Drinking Using Random Forests

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## Introduction

- A goal for machine learning and psychiatric neuroimaging is to develop predictive models that differentially predict similar yet distinct phenotypes.
- Cannabis use and binge drinking are similar patterns of drug use in adolescence, but may be predicted by distinct features.
- Uncovering the predictors that differentially predict cannabis use vs. binge drinking in adolescence will inform etiological mechanisms and targets for intervention.

## Methods

- Participants were drawn from the longitudinal IMAGEN study and selected for being cannabis-naïve at the baseline assessment (age 14).
- A group of individuals who used cannabis (and some binge drinking) by age 16 were compared to a closely matched group of individuals who only had binge drinking experiences by age 16. Sex-specific samples were identified (Table 1).

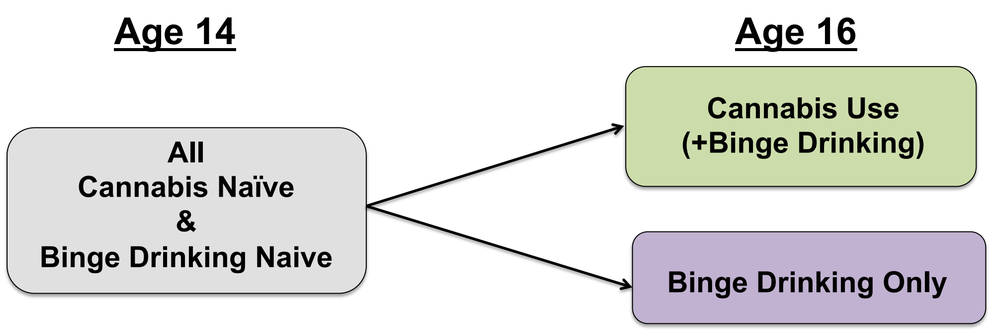



**Table 1**: Cannabis & Binge Drinking Levels For Each Group by Sex

| Use Level | Males (N=178) | | | Females (N=148) | | |
|---|---|---|---|---|---|---|
| | Cannabis Use (+Binge Drinking) Group n=89 | | Binge Drinking Only Group n=89 | Cannabis Use (+Binge Drinking) Group n=74 | | Binge Drinking Only Group n=74 |
| | Cannabis Level | Binge Drinking Level | Binge Drinking Level | Cannabis Level | Binge Drinking Level | Binge Drinking Level |
| 1-2x | 39 | 32 | 32 | 22 | 26 | 26 |
| 3-5x | 10 | 30 | 30 | 18 | 25 | 25 |
| 6-9x | 8 | 14 | 14 | 6 | 8 | 8 |
| 10-19x | 6 | 9 | 9 | 11 | 9 | 9 |
| 20-39x | 9 | 3 | 3 | 5 | 3 | 3 |
| 40+ | 17 | 1 | 1 | 12 | 3 | 3 |
| **Total** | **89** | | **89** | **74** | | **74** |

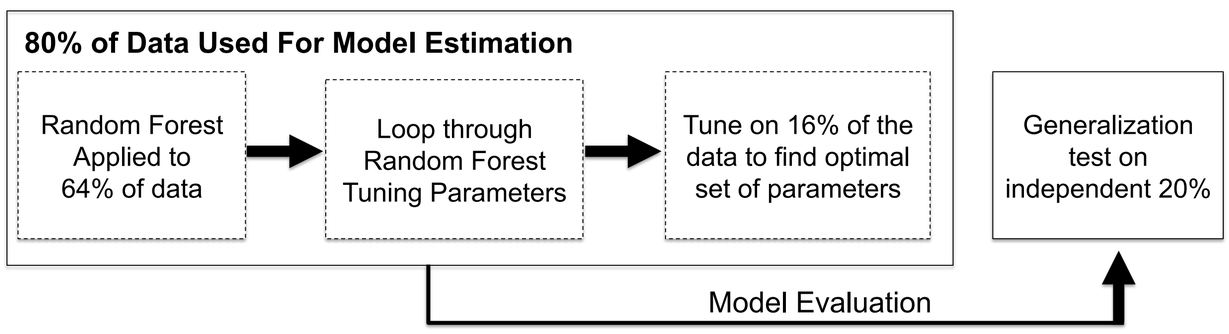
**Table 2**: Summary of Data Used as Predictors

| Domain | Measures | Data points |
|---|---|---|
| ***Psychosocial*** | • Demographics<br>• Cognitive assessments<br>• Personality assessment<br>• Life-events questionnaires<br>• Baseline cigarette use | • 80 measures |
| ***SNPs*** | • A-priori SNPs | • 108 SNPs |
| ***Structural Neuroimaging*** | • Total GMV<br>• Gray-Matter Volume ROIs | • 1 total GMV<br>• 278 GMV ROIs |
| ***Functional Neuroimaging*** | • Reward Task (2 Contrasts)<br>• Stop Signal Task (2 Contrasts)<br>• Face Processing Task (3 Contrasts) | • 278 per contrast<br>• 1946 Total ROIs |
| **Predictors per subject** | | **2413** |

## Machine Learning Methods

- Random Forests (www.scikit-learn.org) with nested 5-Fold cross validation were used to predict cannabis use vs. binge drinking for each sex.
- Prediction performance was evaluated using ROC AUC on the independent test set.

**Figure 1**: Random Forest Nested 5-Fold Cross Validation Framework




## Results

**Table 3**: Random Forest Prediction Accuracies

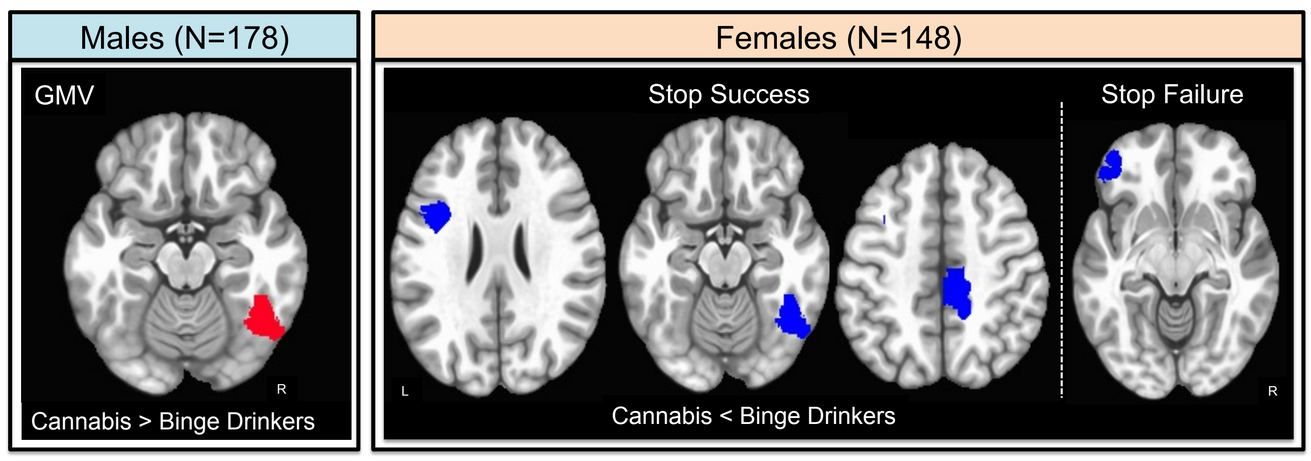
| Males (N=178) | | Females (N=148) | |
|---|---|---|---|
| AUC | P-value | AUC | P-value |
| 0.6286 | $1 \times 10^{-4}$ | 0.6593 | $1 \times 10^{-5}$ |

**Table 4**: Identified Predictors For Each Sex

| Domain | | Males | Males & Females | Females |
|---|---|---|---|---|
| ***Psychosocial*** | Drug Use (ESPAD) | | Lifetime Cigarettes* | |
| | Life Events (LEQ) | | Positive Feelings Toward Deviant Behaviors* | |
| ***Neuroimaging*** | Gray Matter Volume | R. Inferior Temporal Gyrus* | | |
| | Response Inhibition: Stop Success | | | L. Middle Frontal Gyrus† |
| | | | | R. Inferior Temporal Gyrus† |
| | | | | R. Paracentral Lobule† |
| | Response Inhibition: Stop Failure | | | L. Inferior Frontal Gyrus† |

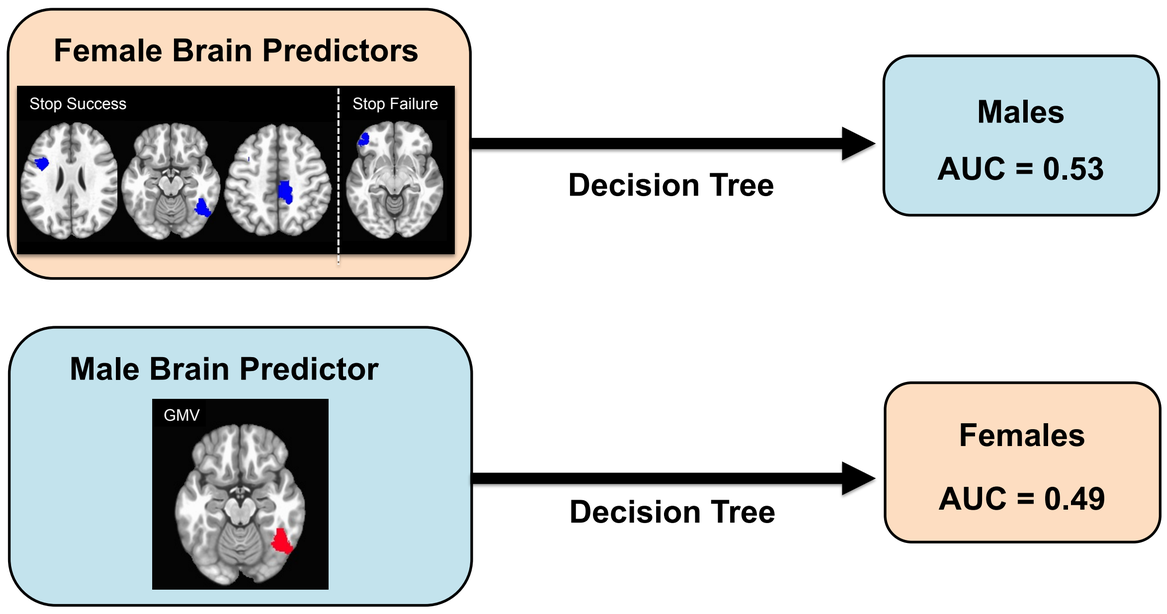
*Cannabis Users > Binge Drinkers
†Cannabis Users < Binge Drinkers

**Figure 2**: Brain Predictors For Each Sex




## Sex Specificity Results

- The identified brain predictors for one sex were used in a post-hoc decision tree predicting future cannabis use vs. binge drinking for the opposite sex




## Conclusions

- Random forests can reliably predict future cannabis use vs. binge drinking in adolescent males and females using data collected prior to exposure.
- A sparse set of predictors were identified despite starting with a very large set of multi-domain predictors.
- Two identified psychosocial predictors were common across the sexes whereas the identified neuroimaging predictors were sex-specific.
- Lower activations in brain regions supporting inhibitory control constitutes a female-specific risk profile for cannabis use in adolescence.
- More gray matter volume might indicate a neurodevelopmental delay characterizes males who go on to use cannabis in adolescence.

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