Cannabis Use And Brain Volumes: A Co-Twin Control Analysis

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Background

- Cannabis is the most commonly used illicit drug in the world (Yücel et al., 2008).
- Δ9-tetrahydrocannabinol, more commonly known as THC, is the major psychoactive component of cannabis (Lorenzetti et al., 2010).
- Animal studies have consistently shown that long-term exposure to THC has neurotoxic effects on brain regions rich in cannabinoid receptors (Ashtari et al., 2011; Scallet et al., 1987).
- Human studies examining cannabis use and brain morphology have been much more limited. They have had small sample sizes, and are heterogeneous in terms of imaging techniques, experiment design and sample characteristics (Lorenzetti et al., 2014).
- Recent studies have used structural magnetic resonance imaging (sMRI) as an imaging technique, and have found that regular cannabis use is associated with alterations in certain brain regions (Lorenzetti et al., 2014).

Purpose

The purpose of this study was to examine differences in a priori brain regions of interest between problematic cannabis users and non-abusers.

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Methods

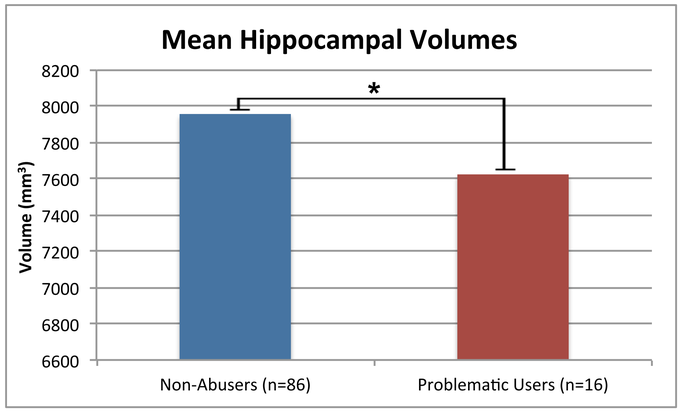
- 102 24-year-old female twin participants from the Minnesota Center for Twin and Family Research
- Structural neuroimaging data collected using magnetic resonance imaging (MRI) scans
- Brain region volumes obtained using FreeSurfer software
- Cannabis abuse and dependence (DSM-IV) diagnoses assessed at ages 17, 20, and 24 using the Substance Abuse Module of the Composite International Diagnostic Interview (CIDI-SAM; Cottler, 2000)
- Individuals classified into two groups based on lifetime (through age 24) diagnoses: problematic cannabis users—those who had cannabis abuse or cannabis dependence (n = 16), and non-abusers—those who did not have a diagnosis ("control" group; n = 86)
- Group comparisons of brain region volumes conducted using multilevel modeling analyses that accounted for the interdependence of the twin sample
- Follow-up co-twin control analyses (n = 10 discordant twin pairs) conducted for brain region volumes that were significantly different between groups to assess if association was due to premorbid risk for problematic cannabis use or due to a neurotoxic effect of cannabis exposure

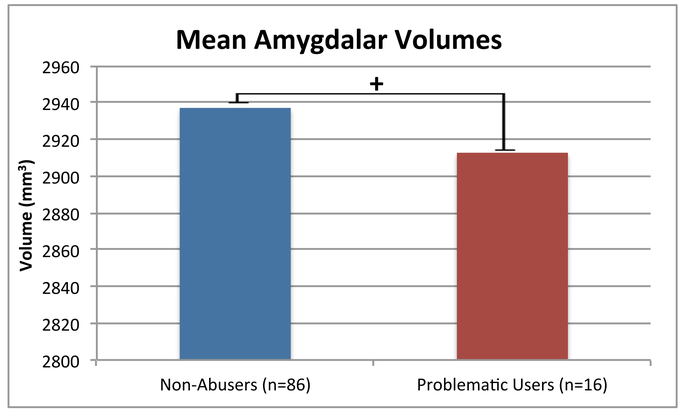
Results

Multilevel Modeling Analyses Comparing Brain Region Volumes (Problematic Cannabis Users vs. Non-Abusers)

Brain Volumes	Hippocampus	Parahippocampus	Amygdala	Orbitofrontal Cortex	Anterior Cingulate Cortex	Insula	Cerebellum
Estimate (Standard Error)	-409.565 (135.565) *	-111.810 (112.067)	-127.307 (25.124) +	-257.900 (381.002)	152.193 (265.079)	-135.227 (261.365)	838.443 (1640.874)

Note: Age and brain volume were used as covariates in the multilevel modeling analyses. All values are volumes in millimeters cubed, and indicate the difference in volume in problematic cannabis users compared to non-abusers. * $p < 0.05$; + $p < 0.10$.

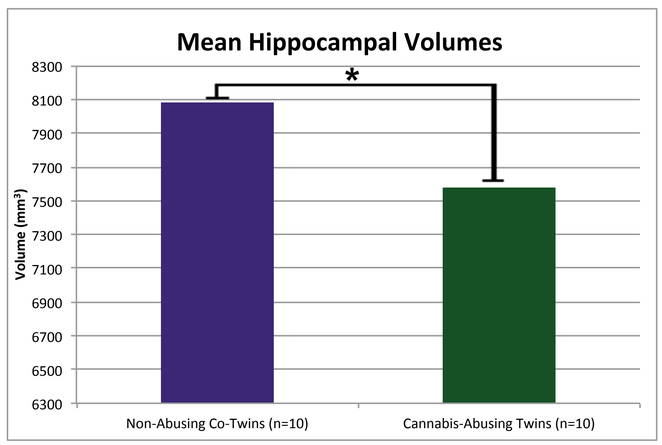


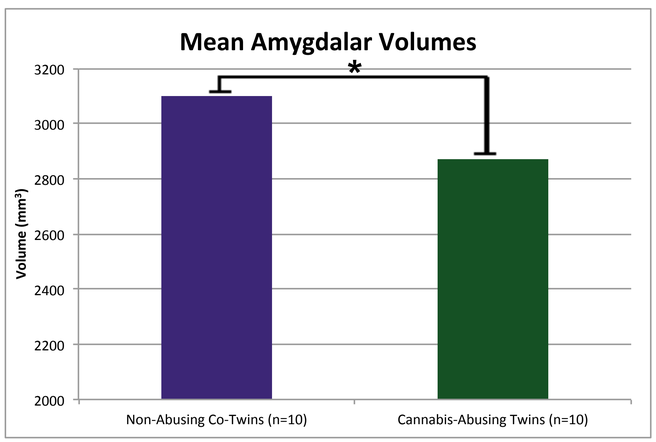


Co-Twin Control Paired *t*-Test Results for Hippocampus and Amygdala

Brain Region	*t*-value	*p*-value	*d* (Effect Size)
Hippocampus	-2.1879	0.0282 *	0.559
Amygdala	-2.6067	0.0142 *	0.622

Note: df = 9. Difference between pairs calculated by subtracting control twin's volume from cannabis-abusing twin's volume (abusing - control). * $p < 0.05$.





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Conclusions

- Only the problematic cannabis users' hippocampal volumes were significantly lower than the non-abusers' hippocampal volumes. Their amygdalar volumes were marginally significantly lower than the non-abusers' amygdalar volumes.
- These findings are similar to previous findings regarding these a priori brain regions of interest.
- These differences in brain volumes were determined to be due to the users' long-term exposure to cannabis, instead of premorbid risk factors.
- Long-term cannabis exposure has a neurotoxic effect on hippocampal and amygdalar volumes.