The Impact of Smoked Cannabis and Distraction on the Simulated Driving Behaviour of Young Recreational Cannabis Users

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Prevalence of cannabis use is highest amongst those aged 15 to 24 years.
Prevalence of cannabis use appears to have declined slightly from 2008 levels.
As of 2013, approximately 24% of this population reported using cannabis.
Percentage of Young Adult Drivers (Aged 18 to 29 Years) Reporting Driving a Motor Vehicle After Drinking Alcohol, and After Using Cannabis, 2013 CAMH Monitor

<table>
<thead>
<tr>
<th>%</th>
<th>Drinking and driving</th>
<th>Cannabis use and driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>(est. 130,158 drivers)</td>
<td>(est. 121,323 drivers)</td>
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<tr>
<td>20%</td>
<td></td>
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<tr>
<td>15%</td>
<td></td>
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<tr>
<td>10%</td>
<td>8.9</td>
<td>8.3</td>
</tr>
<tr>
<td>5%</td>
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<td>0%</td>
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Percentage of Drivers in Grades 10–12 Reporting Driving a Motor Vehicle After Drinking Alcohol, and After Using Cannabis, 2015 OSDUHS

- Drinking and driving: 5.1% (est. 15,300 drivers)
- Cannabis use and driving: 9.8% (est. 29,500 drivers)
Impact of Cannabis Use on Driving

- Cannabis is the psychoactive drug most often found in seriously and fatally injured drivers after alcohol 
  (Laumon et al., 2005; Stoduto et al, 1993; Woodall et al., 2015)

- Recent meta-analyses examining case-control and culpability studies have concluded that DUIC is associated with significant increases in collision risk (ORs=1.22 - 2.66) 
  (Asbridge et al., 2012; Li et al., 2012; Rogeberg & Elvik, 2016)
Cannabis Legalization in Other Jurisdictions

- **Colorado**: Legalization and commercialization of medical cannabis led to an increase in the proportion of fatally-injured drivers who were cannabis-positive
  (Salomonsen-Sautel et al., 2014)

- **Washington State**: Following legalization of recreational cannabis use, the prevalence of active THC and its metabolite carboxy-THC in suspected impaired driving cases increased significantly relative to the pre-legalization period
  (Couper & Peterson, 2014)
How Does Cannabis Impact Driver Behaviour?
Findings from Previous Simulation Studies

• **Compensatory Behaviour:**
  – Drive at a slower speed
    (e.g., Hartman et al., 2016; Ronen et al., 2008, 2010)
  – Take fewer risks (e.g., larger headway, attempting fewer passes, requiring wider gaps in traffic before attempting to pass)
    (e.g., Dott, 1972; Ellingstad et al., 1973)

• **Psychomotor Disturbance:**
  – Increased reaction time
    (Liguori et al., 1998; Sexton et al., 2000)

• **Driving Skills Deficits:**
  – Reduced lane control
    (e.g., Lenné et al., 2010; Papafotiou et al., 2005; Ronen et al., 2008)
  – Decline in performance under divided attention
    (Anderson et al., 2010; Lenné et al., 2010; Ronen et al., 2008; Smiley et al., 1981)
Current Analysis

• **Purpose:** To examine the acute effects of a moderate dose of smoked cannabis (12.5% THC), with or without distraction, on the simulated driving behaviour of young drivers aged 19-25 years

• **Study Design:** double-blind, 2:1 randomized, placebo-controlled, mixed-design trial
Study Design

• Inclusion criteria:
  – Aged 19-25 years
  – Smoked 1-4 days per week
  – Held a valid Ontario class G or G2 license (held for at least 1 year)
  – Able to provide urine positive for THC at eligibility screening

• Exclusion Criteria
  – Regular user of psychoactive medication
  – Met Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for Substance Dependence, has a severe medical or psychiatric condition, family history of schizophrenia, etc.
  – Positive for alcohol on any study day
## Sample Characteristics (Mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Placebo</th>
<th>Low THC</th>
<th>High THC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>31</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td>Dose (mg)</td>
<td>N/A</td>
<td>70.5 ± 20.9</td>
<td>92.2 ± 17.0</td>
</tr>
<tr>
<td>Age</td>
<td>22.0 ± 2.2</td>
<td>22.2 ± 1.8</td>
<td>22.3 ± 2.0</td>
</tr>
<tr>
<td>Sex</td>
<td>9 females, 22 males</td>
<td>14 females, 18 males</td>
<td>5 females, 28 males</td>
</tr>
<tr>
<td>BMI</td>
<td>24.8 ± 4.3</td>
<td>23.8 ± 4.7</td>
<td>25.2 ± 4.4</td>
</tr>
<tr>
<td>Cannabis smoking frequency (days/week)</td>
<td>2.7 ± 1.1</td>
<td>2.5 ± 0.9</td>
<td>2.6 ± 0.8</td>
</tr>
<tr>
<td>DUIC in last 30 days</td>
<td>2.5 ± 2.9</td>
<td>3.0 ± 6.6</td>
<td>3.1 ± 5.5</td>
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Procedures

• Study consisted of 5 sessions:
  – Session 1: Eligibility
  – Session 2: Practice Day
    • Driving, cognitive/psychomotor measures, VAS, self-report questionnaires about driving behaviour and personality
  – Session 3: Drug Administration (one 12.5% THC or placebo cannabis cigarette)
    • Ad libitum smoking procedure (max. 10 mins)
    • Pre-drug and post-drug driving tasks, cognitive/psychomotor measures, VAS, vitals and blood samples
  – Session 4: 24 Hours Measures
    • Driving tasks, cognitive/psychomotor measures, VAS, vitals and blood samples
  – Session 5: 48 Hours Measures
    • Driving tasks, cognitive/psychomotor measures, VAS, vitals and blood samples
Driving Scenarios and Instructions

- Rural two-lane highway, various interactions with other vehicles.
- Instructed to drive as they normally would – measuring behaviour not skills/abilities
- Divided Attention Task: Experimenter randomly selected a three digit number and participant was instructed to count backwards by threes (e.g., 784, 781, 778...)

(Lansdown & Saunders, 2012; North & Hargreaves, 1999)
Driving Measures

• Global Performance Measures:
  – Mean speed and SDLP across full simulation
  – Collisions

• Event-Specific Measures:
  – Mean speed and SDLP in straightaway zone with no traffic
  – Mean speed approaching risky roadway hazard (e.g., driver standing next to vehicle stopped at side of road)
  – Following distance behind a slow-moving vehicle
Analyses

• These are preliminary analyses.
• Attention x Group ANOVA framework (2 X 3)
• Change scores (Pre-Drug Measure – Post-Drug Measure)
  – Positive score = decrease in the measure after smoking
  – Negative score = increase in the measure after smoking
• Looking for interaction between Attention (counting or not counting) and Group (placebo, low THC, high THC)
• To control for violations of sphericity, a Greenhouse-Geisser correction was applied.
Results

• No significant Attention x Group interaction effect for:
  – Number of collisions
  – Mean speed approaching a risky hazard
  – Following distance behind a slow-moving vehicle

• However...
Attention x Group $F(2.00, 92.00) = 2.91, p = .06$
Attention x Group $F(2.00, 92.00) = 2.55$, $p = .084$
Attention x Group $F(2.00,92.00) = 2.30$, $p = .106$
Attention x Group $F(2.00, 92.00) = 6.68, \ p = .002$
Discussion

• Dose-related effects of cannabis on driver behaviour may be dependent on attention/cognitive load.
  – Dividing attention resulted in the High THC group becoming more extreme in their behaviour and setting themselves apart from Placebo and Low THC groups (SDLP).
  – Dividing attention also resulted in the Low THC group behaving more like the High THC group (Mean speed).

• Drug effects on speed and lane control appeared to be more more visible under one attention condition than another (usually divided attention).
Implications

• Compensatory behaviour when driving has been identified as an argument for why cannabis users are safer drivers when using.

• HOWEVER:
  
  – Predictability is an important component to a safe roadway environment.
  
  – When one road user’s behaviour deviates from the expected norm, anxiety, stress, and anger are induced in other road users. (Wickens et al., 2005, 2013)
  
  – Unpredictable actions on the roadway can increase the risk of sudden and unsafe manoeuvres by other drivers (e.g., sudden braking, quick lane changes). (Aarts & van Shagen, 2006)
Limitations

• Driver simulation may not accurately reflect real-world driving.
  – However, a recent study found that simulated driving and on-road driving were comparable after consumption of oral THC, at least for measures of lane weaving (Veldstra, Bosker, de Waard, Ramaekers, & Brookhuis, 2015)

• High degree of variability of blood THC concentrations in the active groups.
  – A failure to see significant group differences on some measures may be due to low THC levels being achieved in the active drug group.
    • However, this was largely mitigated by the decision to split the active group into a Low and High THC group.
Future Directions

• Cannabis + Alcohol
• Dosage effects
• Tolerance effects
• Methods cannabis administration (smoking, ingestion, vaporized)
• Synthetic cannabinoids
• Detection of cannabis in oral fluid, sweat, breath, etc.
• Evaluation of the public health impact of cannabis legalization
This research was supported by a grant from the Canadian Institutes of Health Research.

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