Cannabis and Cognition

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Peter Boris Chair in Addictions Research
Director, Peter Boris Centre for Addictions Research
Director, Michael G. DeGroote Centre for Medicinal Cannabis Research
Professor, Department of Psychiatry and Behavioural Neurosciences
## Disclosures

| James MacKillop, PhD | Unrestricted research funding from:  
|                     | Peter Boris Chair in Addictions Research  
|                     | Boris Family Foundation  
|                     | Michael G. DeGroote Centre for Medicinal Cannabis Research  
|                     | Canadian Institutes of Health Research,  
|                     | National Institute on Alcohol Abuse and Alcoholism  
|                     | National Institute on Drug Abuse  
|                     | Correctional Service of Canada  
|                     | Principal in BEAM Diagnostics, Inc.  
|                     | No consultancies to or ownership in commercial cannabis entities. |

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Overview

- Cannabis fundamentals and evolving landscape

- Cannabis and cognition:
  - Acute effects
  - Residual/chronic effects
  - Neuroanatomical localization

- Practical recommendations

- Conclusions
Cannabis Fundamentals
"There are biochemically distinct strains of Cannabis, but the sativa/indica distinction as commonly applied in the lay literature is total nonsense and an exercise in futility."

Piomelli & Russo (2016) Cannabis & Cannabinoid Research
Legal Status in the United States

Federal status: Schedule I controlled substance (high abuse potential, no therapeutic applications)

Hasin 2018, NPP
Legal Status in Canada

- Geneva International Convention on Narcotics Control
  - 1925
- Marihuana for Medical Purposes Regulations (MMPR)
  - 2001
- Medical Marihuana Access Regulations (MMAR)
  - 2014
- Access to Cannabis for Medical Purposes Regulations (ACMPR)
  - 2018
- Federal Legalization: October 17
  - 2018
Legal Status in Canada

- Geneva International Convention on Narcotics Control
- Marihuana for Medical Purposes Regulations (MMPR)
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- Access to Cannabis for Medical Purposes Regulations (ACMPR)
- Federal Legalization: October 17

Health Canada
Registered Medical Cannabis Users, 2014-2017 (Health Canada)
Complexities of Cannabis

PHARMACODYNAMICS

Compound(s)

PHARMACOKINETICS

Formulation/RoA

Acute and Chronic Effects (Positive and Negative)
Complexities of Cannabis

**PHARMACODYNAMICS**

Cocaine

**PHARMACOKINETICS**

Inhalation
Intranasal
Intravenous

Acute and Chronic Effects (Positive and Negative)
Complexities of Cannabis

**PHARMACODYNAMICS**

Nicotine

**PHARMACOKINETICS**

Inhalation
Oral
Intranasal
Transdermal

Acute and Chronic Effects
(Positive and Negative)
Complexities of Cannabis

**PHARMACODYNAMICS**

Cannabis

>100 cannabinoids (!)

**PHARMACOKINETICS**

Inhalation
Oral
Transdermal

Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Acute and Chronic Effects (Positive and Negative)

THC
Complexities of Cannabis

PHARMACODYNAMICS

Cannabis

>100 cannabinoids (!)

CBD

PHARMACOKINETICS

Inhalation
Oral
Transdermal

Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Acute and
Chronic
Effects
(Positive and
Negative)
Complexities of Cannabis

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CBC

**PHARMACOKINETICS**

Inhalation
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Acute and Chronic Effects (Positive and Negative)
Complexities of Cannabis

**PHARMACODYNAMICS**

Cannabis

>100 cannabinoids (!)

**PHARMACOKINETICS**

Inhalation
Oral
Transdermal

Acute and Chronic Effects (Positive and Negative)

- Cigarette
- Pipe
- Waterpipe
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CBG
Complexities of Cannabis

**PHARMACODYNAMICS**

Cannabis

>100 cannabinoids (!)

**PHARMACOKINETICS**

Inhalation
Oral
Transdermal

Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Acute and Chronic Effects (Positive and Negative)

CBN
Complexities of Cannabis

**PHARMACODYNAMICS**

- Cannabis
- >100 cannabinoids (!)

**PHARMACOKINETICS**

- Inhalation
  - Oral
  - Transdermal

- Cigarette
- Pipe
- Waterpipe
- Vaporizer
- Edible
- Oil
- Patch
- Salve

**Acute and Chronic Effects (Positive and Negative)**

"Entourage Effect"
Escalation in THC Over Time

El-Sohly, 2014; Drug Abuse Warning Network, 2011
New Formulations

“Wax”

“Shatter”

“Budder”

Butane Hash Oil Extractions (up to 90% THC)

“Concentrates”
Pharmaceutical Cannabinoids

- Dronabinol (Marinol)
- Nabilone (Cesamet)
- Nabiximols (Sativex)
- Cannabidiol (Epidiolex)
Smoked cannabis for chronic neuropathic pain: a randomized controlled trial

Mark A. Ware MBBS, Tongtong Wang PhD, Stan Shapiro PhD, Ann Robinson RN, Thierry Ducruet MSc, Thao Huynh MD, Ann Gamsa PhD, Gary J. Bennett PhD, Jean-Paul Collet MD PhD

Table 2: Pairwise comparisons of the effects of four potencies of smoked cannabis on average daily pain

<table>
<thead>
<tr>
<th>Potency, % of THC</th>
<th>Potency, % of THC, mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>2.5</td>
<td>–0.13 (–0.83 to 0.56)</td>
</tr>
<tr>
<td>6.0</td>
<td>–0.09 (–0.78–0.60)</td>
</tr>
<tr>
<td>9.4</td>
<td>–0.71 (–1.40 to –0.02)</td>
</tr>
</tbody>
</table>

Note: CI = confidence interval, THC = tetrahydrocannabinol.
Trial of Cannabidiol for Drug-Resistant Seizures in the Dravet Syndrome

Orrin Devinsky, M.D., J. Helen Cross, Ph.D., F.R.C.P.C.H., Linda Laux, M.D., Eric Marsh, M.D., Ian Miller, M.D., Rima Nabbout, M.D., Ingrid E. Scheffer, M.B., B.S., Ph.D., Elizabeth A. Thiele, M.D., Ph.D., and Stephen Wright, M.D., for the Cannabidiol in Dravet Syndrome Study Group*

Table 2. Primary Efficacy End Point of Percentage Change in Convulsive-Seizure Frequency in Each Trial Group.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cannabidiol</th>
<th>Placebo</th>
<th>Adjusted Median Difference (95% CI)</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of convulsive seizures per mo — median (range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>12.4 (3.9 to 1717)</td>
<td>14.9 (3.7 to 718)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment period</td>
<td>5.9 (0.0 to 2159)</td>
<td>14.1 (0.9 to 709)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change in seizure frequency — median (range)</td>
<td>-38.9 (-100 to 337)</td>
<td>-13.3 (-91.5 to 230)</td>
<td>-22.8 (-41.1 to -5.4)</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Low Quality Evidence of Overall Efficacy

Of 79 trials, 4 judged to have low risk of bias

Increased risk of short-term AEs

Low quality evidence in general

Moderate quality evidence for pain and spasticity in MS

NAS report also identifies anti-nausea effects in chemotherapy

Cannabinoids for Medical Use
A Systematic Review and Meta-analysis

Penny F. Whiting, PhD; Robert F. Wolff, MD; Sohan Deshpande, MSc; Marcello Di Nisio, PhD; Steven Duffy, PGd; Adrian V. Hernandez, MD, PhD; J. Christiaan Keurentjes, MD, PhD; Shona Lang, PhD; Kate Misso, MSc; Steve Ryder, MSc; Simone Schmidtkofer, MSc; Marie Westwood, PhD; Jos Kleijnen, MD, PhD

Importance
Cannabis and cannabinoid drugs are widely used to treat disease or alleviate symptoms, but their efficacy for specific indications is not clear.

Objective
To conduct a systematic review of the benefits and adverse events (AEs) of cannabinoids.

Data Sources
Twenty-eight databases from inception to April 2015.

Whiting et al. 2015, JAMA
Epidemiology and Harm

- United States
  - Last year use = 9.5% in 2012-2013,
    - 4.1% in 2001-2002
  - Cannabis use disorder
    - Lifetime prevalence = ~7%
    - 12-month prevalence = 2.9% 2012-2013
      - 1.5% in 2001-2002

- Canada
  - Last year prevalence of use = 12.2% (2012)
  - Cannabis Use Disorders:
    - Lifetime prevalence = 6.8%
    - 12-month prevalence = 1.3%
Epidemiology and Harm

- Increased motor vehicle accident risk
- Chronic bronchitis
- Cannabinoid hyperemesis syndrome
- Cannabinoid-induced delirium/psychosis
- Increased risk of psychotic disorders
- Reduced educational attainment
- Adverse effects on cognition
Contextualizing Risks and Harm

<table>
<thead>
<tr>
<th>Drug</th>
<th>Lifetime Likelihood</th>
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<tr>
<td>Tobacco</td>
<td>67.5%</td>
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<tr>
<td>Alcohol</td>
<td>22.7%</td>
</tr>
<tr>
<td>Cocaine</td>
<td>20.9%</td>
</tr>
<tr>
<td>Cannabis</td>
<td>8.9%</td>
</tr>
</tbody>
</table>

Nutt et al., 2010, *Lancet*; Lopez-Quintano et al., 2011, *Addiction*
Cannabis and Cognition
Cannabis and Cognition

Broyd et al., 2016, Biological Psychiatry
<table>
<thead>
<tr>
<th>Cognitive Domain</th>
<th>Acute&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Chronic&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Persistence With Abstinence&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Pertinent Cannabis Use Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td></td>
<td></td>
<td></td>
<td>Frequency; lifetime use; duration; age of onset; sex</td>
</tr>
<tr>
<td>Verbal learning and memory</td>
<td>+++</td>
<td>+++</td>
<td>+--</td>
<td>Frequency; lifetime use; recency; sex</td>
</tr>
<tr>
<td>Working memory</td>
<td>+--</td>
<td>+--</td>
<td>+--</td>
<td>Age of onset; frequency; recency</td>
</tr>
<tr>
<td>Other memory function</td>
<td>+</td>
<td>+--</td>
<td>--</td>
<td></td>
</tr>
<tr>
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<td></td>
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<td>Dose; age of onset; length of abstinence; withdrawal effects</td>
</tr>
<tr>
<td>Attention bias</td>
<td>+</td>
<td>+++</td>
<td>NA</td>
<td>Craving; dependence; frequency; CBD</td>
</tr>
<tr>
<td>Psychomotor Function</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td></td>
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<tr>
<td>Executive Function</td>
<td></td>
<td></td>
<td></td>
<td>Neurodevelopmental stage; age of onset; frequency</td>
</tr>
<tr>
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<td>+--</td>
<td>+--</td>
<td>+--</td>
<td>Frequency; task complexity</td>
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<tr>
<td>Verbal fluency</td>
<td>-</td>
<td>+--</td>
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<tr>
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<td>+--</td>
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<td>−</td>
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</tbody>
</table>
| Cognitive Domain                  | Acute
|----------------------------------|----------|
| Memory                           | Chronic
| Verbal learning and memory       | Abstinence | Pertinent Cannabis Use Parameters |
| Working memory                   | Frequency; lifetime use; duration; age of onset; sex
| Other memory function            | Frequency; lifetime use; recency; sex
| Attention                        | Age of onset; frequency; recency
| Attention                        | Dose; age of onset; length of abstinence; withdrawal effects
| Attention bias                   | Craving; dependence; frequency; CBD
| Psychomotor Function             | Neurodevelopmental stage; age of onset; frequency
| Executive Function               | Frequency; task complexity
| Planning, reasoning, interference control, and problem solving | Age of onset; lifetime exposure; frequency; cannabis use disorder
| Inhibition                       | Verbal fluency | Time estimation | Decision Making |
| Verbal fluency                   | -- | -- | -- | -- | -- |
| Time estimation                  | -- | -- | -- | -- | -- | -- |
| Decision Making                  | -- | -- | -- | -- | -- | -- |
Cannabis and Cognition

Limitations and considerations

- Inconsistent empirical findings
- Small study (publication) bias
- Measurement error
- Confounding variables
# Cannabis and Cognition

<table>
<thead>
<tr>
<th>Neuropsychological Test</th>
<th>Cognitive Function</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Verbal Episodic Memory</td>
</tr>
<tr>
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<td>Inhibitory Control</td>
</tr>
<tr>
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<td>Set Shifting</td>
</tr>
<tr>
<td>Short Penn CPT</td>
<td>Sustained Attention</td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
<td>Pattern Completion Task</td>
<td>Processing Speed</td>
</tr>
<tr>
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<td>Working Memory</td>
</tr>
<tr>
<td>9-hole Pegboard Task</td>
<td>Psychomotor Dexterity</td>
</tr>
</tbody>
</table>

Participants \((N=1121)\): 53.4% female, M age = 28.83

Petker et al., under review
## Cannabis and Cognition

<table>
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<tr>
<th>Neuropsychological Test</th>
<th>Cognitive Function</th>
<th>$\Delta R^2$</th>
<th>$p$</th>
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<tr>
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</table>

Participants ($N=1121$): 53.4% female, M age = 28.83

THC+  CUD+
Cannabis and Cognition

THC+ Status and N-Back Performance
(covariate-adjusted $\beta = -0.08$, $t = 2.58$, $p = 0.01$)

Participants ($N=1042$): 54.3% female, $M$ age = 28.8

No differences based on lifetime consumption, CUD status, or age of first use
## Cannabis and Cognition

<table>
<thead>
<tr>
<th>Domain/Day</th>
<th>Former vs CTL</th>
<th>Active vs CTL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Recall</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>ns</td>
<td><strong>p&lt;.01</strong></td>
</tr>
<tr>
<td>1</td>
<td>ns</td>
<td><strong>p&lt;.01</strong></td>
</tr>
<tr>
<td>7</td>
<td>ns</td>
<td><strong>p&lt;.001</strong></td>
</tr>
<tr>
<td>28</td>
<td>ns</td>
<td>ns</td>
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<tr>
<td><strong>Long-term Storage</strong></td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>ns</td>
<td><strong>p&lt;.01</strong></td>
</tr>
<tr>
<td>1</td>
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<td></td>
</tr>
<tr>
<td>7</td>
<td>ns</td>
<td><strong>p&lt;.01</strong></td>
</tr>
<tr>
<td>28</td>
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</tr>
<tr>
<td><strong>Consistent Long-term Retrieval</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>ns</td>
<td><strong>p&lt;.001</strong></td>
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<tr>
<td>1</td>
<td>ns</td>
<td><strong>p&lt;.001</strong></td>
</tr>
<tr>
<td>7</td>
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</tr>
<tr>
<td>28</td>
<td>ns</td>
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</table>

### Post 28 Days Abstinence

<table>
<thead>
<tr>
<th>Test</th>
<th>CTL</th>
<th>Former</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMS total</td>
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<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>COWAT</td>
<td>REF</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>WCST</td>
<td>REF</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>WAIS-BD</td>
<td>REF</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Stroop</td>
<td>REF</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>RPM</td>
<td>REF</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>
Impulsivity as Measured by Delay Discounting

- Behavioral economic index of self-control (impulsivity)
  - Delay discounting refers to the amount that a reward is discounted based on its delay in time
  - Smaller-Sooner vs. Larger-Later Preference

- Delay Discounting Task
  - Would you rather have $A$ today or $B$ in $C$ days?
  - Points of indifference gathered across time periods
  - Temporal Discounting Function(s):
    \[ V = \frac{A}{1 + kD} \]
    Ainslie, 1975; Bickel & Marsh, 2000; Mazur, 1987; Rachlin & Green, 1972;
Temporal Discounting Function

![Graph showing subjective value vs. delay in days. The x-axis represents delay in days ranging from 0 to 100, while the y-axis represents subjective value ranging from $0 to $100. The graph includes several data points indicating a decrease in subjective value as delay increases.](image-url)
Temporal Discounting Function

Subjective Value vs. Delay in Days
Relative Levels of Delay Discounting

![Diagram showing the relationship between delay and current value, illustrating the concept of delay discounting with terms like 'More Impulsive' and 'Less Impulsive'.]
Delay Discounting and AUD Severity

MacKillop et al. (2010) 
Journal of Abnormal Psychology
Findings from Case-Control Designs

Tobacco Use Disorder

Alcohol Use Disorder

Opioid Use Disorder

Gambling Disorder

Alcohol Use Disorder

Stimulant Use Disorder

Bickel et al., 1999; Coffey et al., 2003; MacKillop et al., 2010; Madden et al., 1997; Petry, 2000
Meta-Analysis of Case-Control Studies

### Overall
- $d = 0.49$, $p < 10^{-8}$

### Clinical
- $d = 0.67$, $p < 10^{-5}$

### Subclinical
- $d = 0.46$, $p < 10^{-10}$

All individual addictive behaviors significant except cannabis.

Minimal evidence of publication bias.
Delay Discounting, ADHD, and Obesity

- $d = .43$
- $p < 10^{-15}$
- $N=3913$

Developmental Considerations
Developmental Considerations

- **Youth (15-24)**
- **General Population (15+)**
- **Adults (25+)**

![Graph showing developmental considerations over years](image-url)
Developmental Considerations

Gogtay et al., 2004, PNAS
## Developmental Considerations

### Persistent cannabis users show neuropsychological decline from childhood to midlife

Madeline H. Meier\textsuperscript{a,b,1}, Avshalom Caspi\textsuperscript{a,b,c,d,e}, Antony Ambler\textsuperscript{e,f}, Honalee Harrington\textsuperscript{b,c,d}, Renate Houts\textsuperscript{b,c,d}, Richard S. E. Keefe\textsuperscript{d}, Kay McDonald\textsuperscript{d}, Aimee Ward\textsuperscript{d}, Richie Poulton\textsuperscript{1}, and Terrie E. Moffitt\textsuperscript{a,b,c,d,e}

\textsuperscript{a}Duke Transdisciplinary Prevention Research Center, Center for Child and Family Policy, \textsuperscript{b}Department of Psychology and Neuroscience, and \textsuperscript{c}Institute for Genome Sciences and Policy, Duke University, Durham, NC 27708; \textsuperscript{d}Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, NC 27710; \textsuperscript{e}Social, Genetic, and Developmental Psychiatry Centre, Institute of Psychiatry, King’s College London, London SE5 8AF, United Kingdom; and \textsuperscript{f}Dunedin Multidisciplinary Health and Development Research Unit, Department of Preventive and Social Medicine, School of Medicine, University of Otago, Dunedin 9054, New Zealand

Edited by Michael I. Posner, University of Oregon, Eugene, OR, and approved July 30, 2012 (received for review April 23, 2012)

### Table: IQ test/subtest performance

<table>
<thead>
<tr>
<th>IQ test/subtest</th>
<th>Never used, never diagnosed, $n = 242$</th>
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<th>1 diagnosis, $n = 80$</th>
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<th>3+ diagnoses, $n = 38$</th>
<th>Linear trend $t$ test*</th>
<th>$P$</th>
</tr>
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<tbody>
<tr>
<td>Full-scale IQ</td>
<td>0.05</td>
<td>−0.07</td>
<td>−0.11</td>
<td>−0.17</td>
<td>−0.38</td>
<td>−4.45</td>
<td>$&lt;0.0001$</td>
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<td>0.05</td>
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<td>−2.40</td>
<td>0.0168</td>
</tr>
<tr>
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<td>0.03</td>
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<tr>
<td>Arithmetic subtest</td>
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<tr>
<td>Digit symbol coding subtest</td>
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<td>Block design subtest</td>
<td>−0.03</td>
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<tr>
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<td>−0.08</td>
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# Developmental Considerations

## Persistent cannabis users show neuropsychological decline from childhood to midlife

Madeline H. Meier\(^{a,b,1}\), Avshalom Caspi\(^{a,b,c,d,e}\), Antony Ambler\(^{e,f}\), Honalee Harrington\(^{b,c,d}\), Renate Houts\(^{b,c,d}\), Richard S. E. Keefe\(^{e}\), Kay McDonald\(^{d}\), Aimee Ward\(^{d}\), Richie Poulton\(^{d}\), and Terrie E. Moffitt\(^{a,b,c,d,e}\)

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Developmental Considerations

2562 Records were identified through electronic database searching
30 Additional records were identified through other searching

1324 Records after duplicates were removed

1324 Records were reviewed by title and abstract

961 Records were excluded as unrelated

363 Full-text articles were assessed for eligibility

291 Records were excluded
67 No relevant neurocognitive testing
48 No cannabis-only group
35 Outside of age range
34 No appropriate comparison group
29 Measures only administered during neuroimaging
19 Review articles without new data
17 Insufficient data to code
16 Participants with psychosis
8 Acute use
7 Prenatal exposure
5 Insufficient cannabis data or cannabis use
3 Measures of IQ only
1 Intervention study

74 Articles met inclusion criteria

5 Articles had overlapping samples

69 Studies were included in systematic review
Developmental Considerations

Scott et al., 2018, JAMA
Practical Recommendations & Conclusions
Assessment Resources

- Cannabis Use Questionnaire
- Cannabis Use Disorder Identification Test - Revised (CUDIT-R)
- Marijuana Motives Questionnaire
- Reasons for Using Medical Marijuana
- Urine Drug Screens
Conclusions

- Cannabis is a complex, widely-used drug with acute and chronic effects on cognition that are highly relevant to neuropsychologists

- Acute effects
  - Psychomotor impairment
  - Diminished behavioral inhibition
  - Reduced attention
  - Impaired verbal learning and memory
Conclusions

- Cannabis is a complex, widely-used drug with acute and chronic effects on cognition that are highly relevant to neuropsychologists

- Chronic/residual effects
  - Reduced attention
  - Impaired verbal learning and memory
  - Psychomotor impairment

- *Closely linked to recent use*
Conclusions

- Cannabis is a complex, widely-used drug with acute and chronic effects on cognition that are highly relevant to neuropsychologists.

- Long-term effects post-abstinence
  - Evidence of decrements in very heavy users
  - Lower overall IQ
  - Ambiguities
    - Less consistent findings
    - Dose-decrement relationship unclear
    - Small effect sizes
Conclusions

- Cannabis is a complex, widely-used drug with acute and chronic effects on cognition that are highly relevant to neuropsychologists

- Developmental considerations
  - Differential impact is a highly credible hypothesis
  - Inconsistent findings, but reasonable to err on the side of caution
https://cannabisresearch.mcmaster.ca
Evidence-based Information

Research Summaries
Synopses of high impact research publications from clinical and research experts studying cannabis.

Evidence Briefs
Consolidated overviews of the state of medicinal cannabis across various clinical and research areas.

Evidence Syntheses
‘Deep dive' explorations of topics related to medicinal cannabis via the McMaster Health Forum
Evidence-based Information

https://www.drugabuse.gov

Canadian Centre on Substance Abuse
Centre canadien de lutte contre les toxicomanies

http://www.ccdus.ca
Thank You