Cannabis and Cognition

James MacKillop, PhD
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

St. Joseph's Healthcare Hamilton

Peter Boris Centre FOR ADDICTIONS RESEARCH

Michael G. DeGroote CENTRE FOR MEDICINAL CANNABIS RESEARCH

McMaster University 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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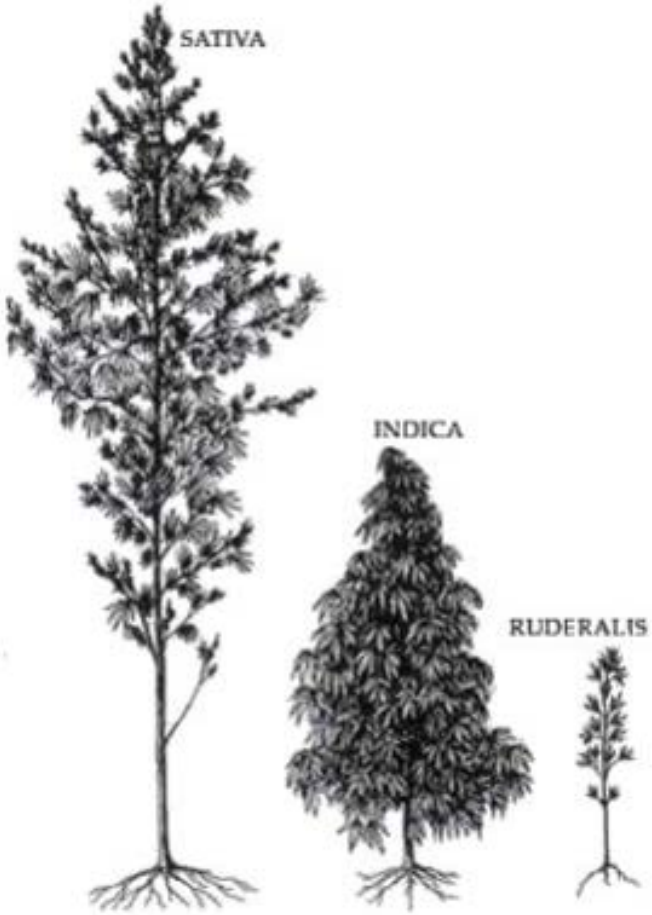
Overview

- Cannabis fundamentals and evolving landscape
- Cannabis and cognition:
  - Acute effects
  - Residual/chronic effects
  - Neuroanatomical localization
- Practical recommendations
- Conclusions

Cannabis Fundamentals

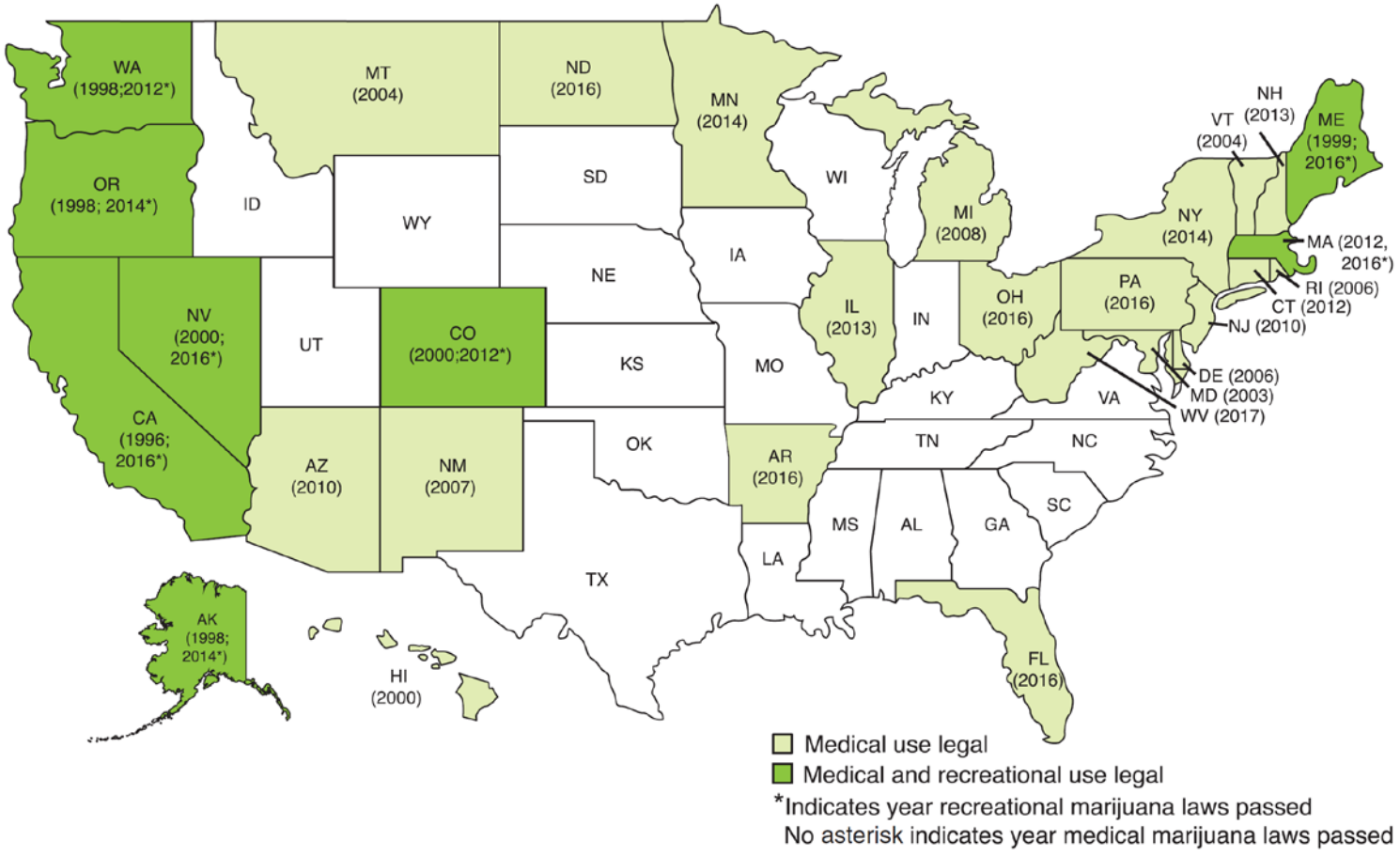
Cannabis Fundamentals



"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."***

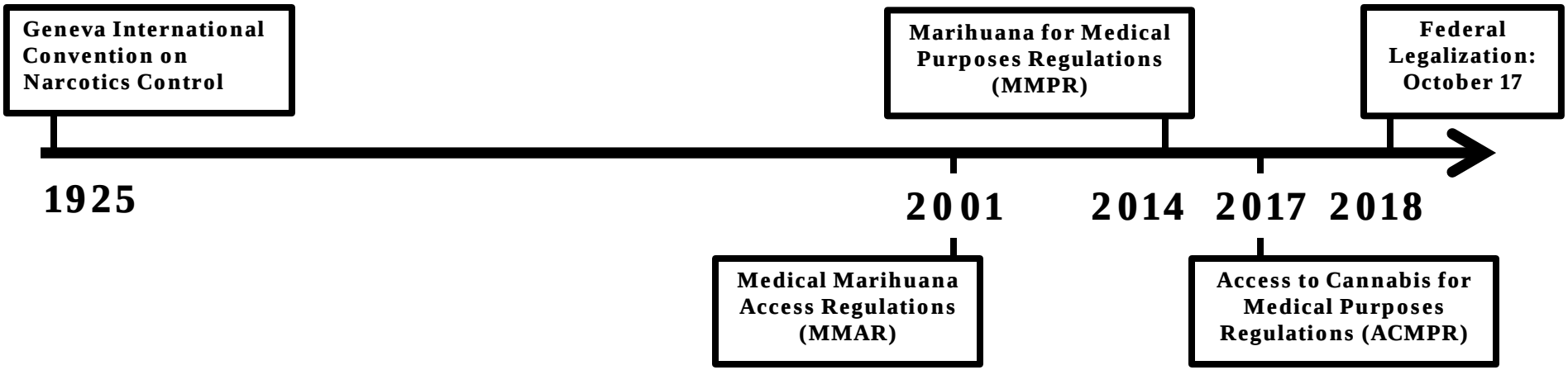
Piomelli & Russo (2016) *Cannabis & Cannabinoid Research*

Legal Status in the United States

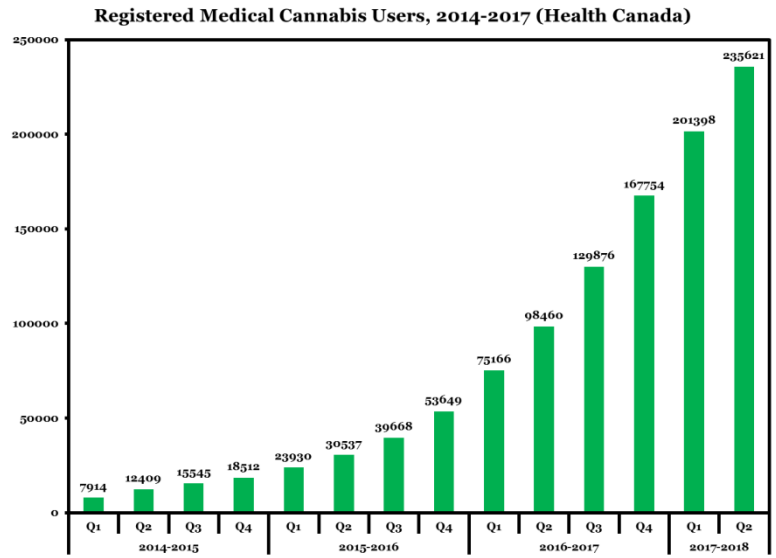


Federal status: Schedule I controlled substance (high abuse potential, no therapeutic applications)

Legal Status in Canada



Legal Status in Canada



Geneva International Convention on Narcotics Control

1925

Medical Marihuana Access Regulations (MMAR)

2001

Marihuana for Medical Purposes Regulations (MMPR)

2014

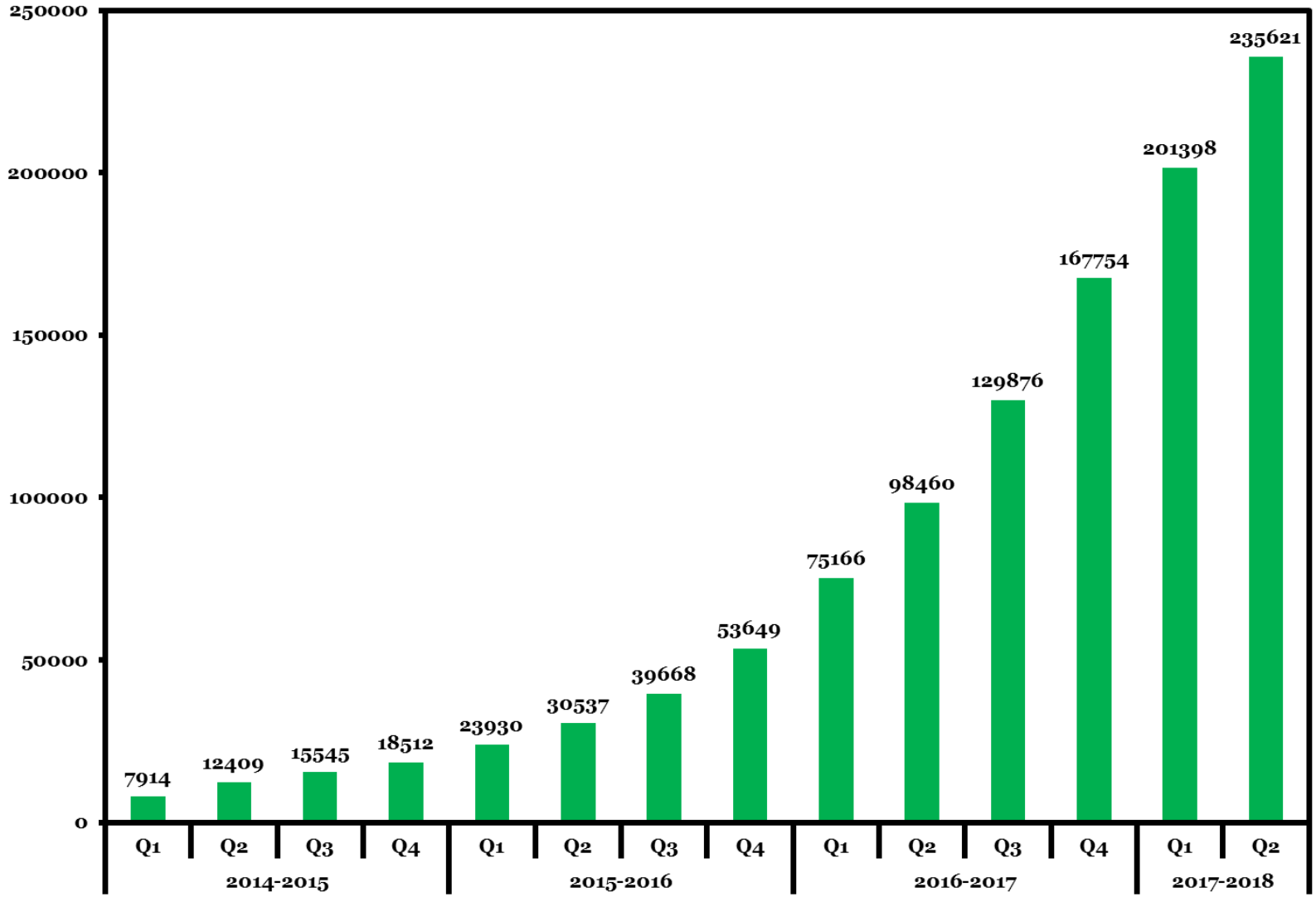
Access to Cannabis for Medical Purposes Regulations (ACMPR)

2017

Federal Legalization: October 17

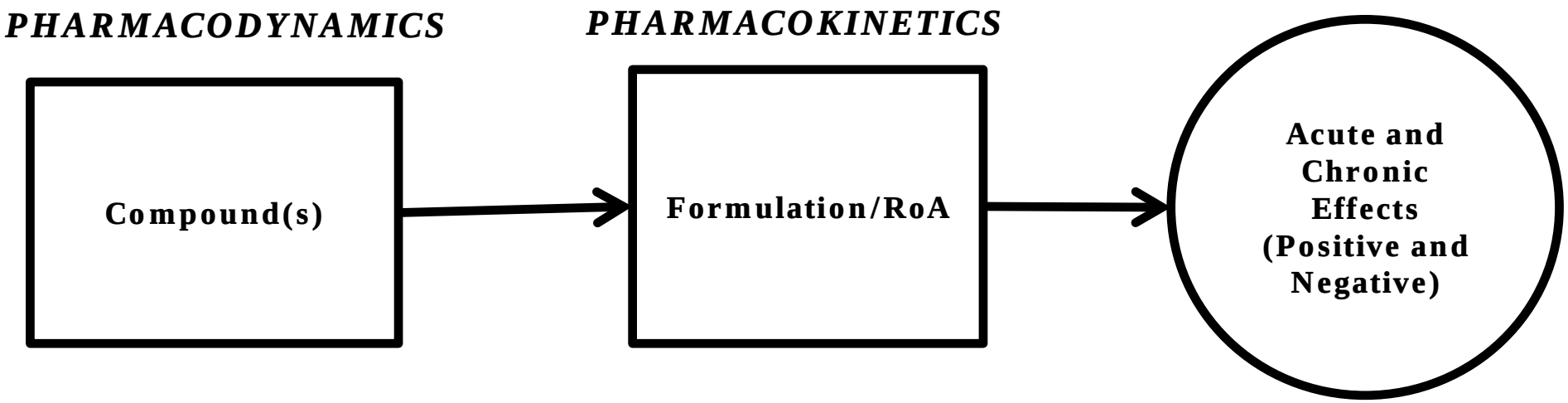
2018

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



Health Canada

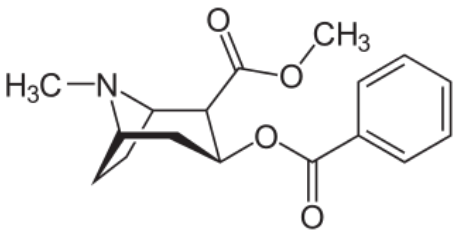
Complexities of Cannabis



Complexities of Cannabis

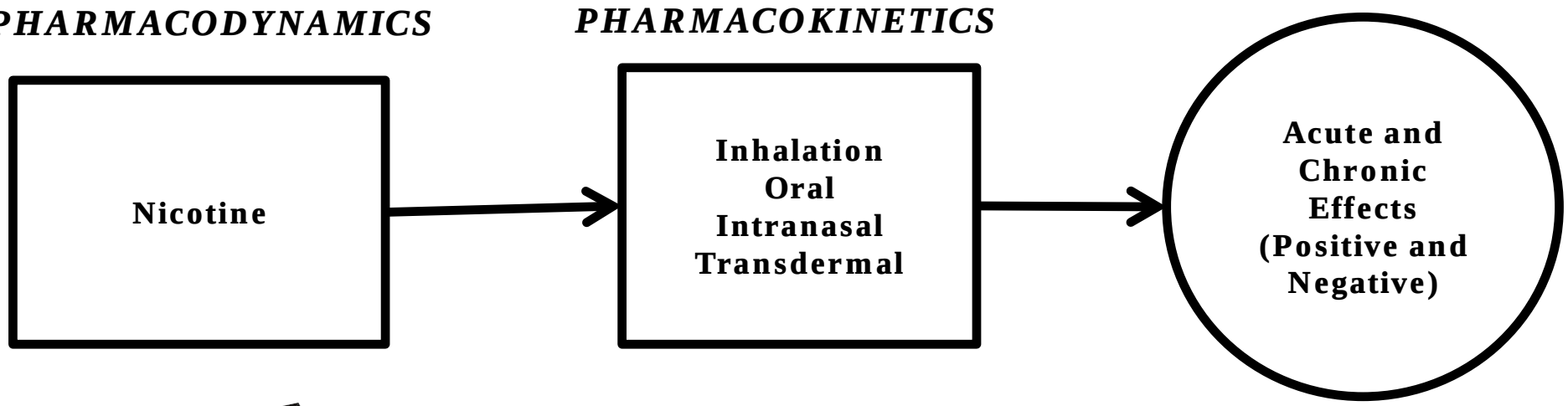
PHARMACODYNAMICS ***PHARMACOKINETICS***

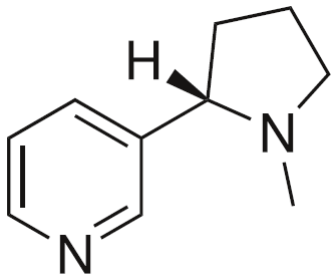
Cocaine → **Inhalation Intranasal Intravenous** → **Acute and Chronic Effects (Positive and Negative)**



Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***



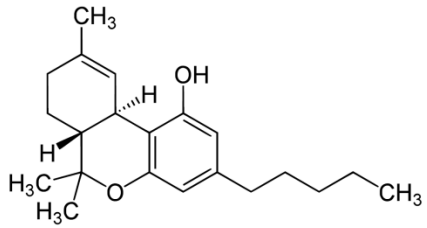


Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***

Cannabis

>100 cannabinoids (!)



THC

Inhalation
Oral
Transdermal

Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

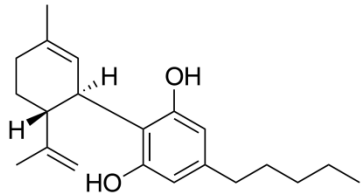
Acute and Chronic Effects (Positive and Negative)

Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***

Cannabis → **Inhalation Oral Transdermal** → **Acute and Chronic Effects (Positive and Negative)**

>100 cannabinoids (!)



CBD

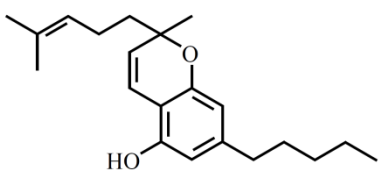
Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***

Cannabis → **Inhalation**
Oral
Transdermal → **Acute and Chronic Effects (Positive and Negative)**

>100 cannabinoids (!)



CBC

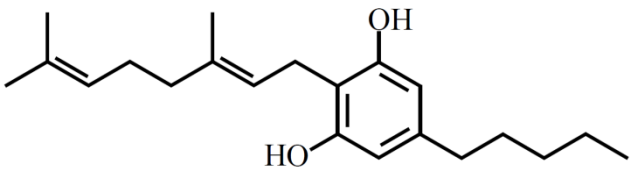
Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***

Cannabis → **Inhalation Oral Transdermal** → **Acute and Chronic Effects (Positive and Negative)**

>100 cannabinoids (!)



CBG

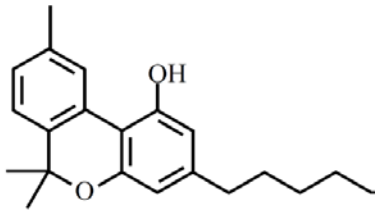
Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Complexities of Cannabis

PHARMACODYNAMICS ***PHARMACOKINETICS***

Cannabis → **Inhalation Oral Transdermal** → **Acute and Chronic Effects (Positive and Negative)**

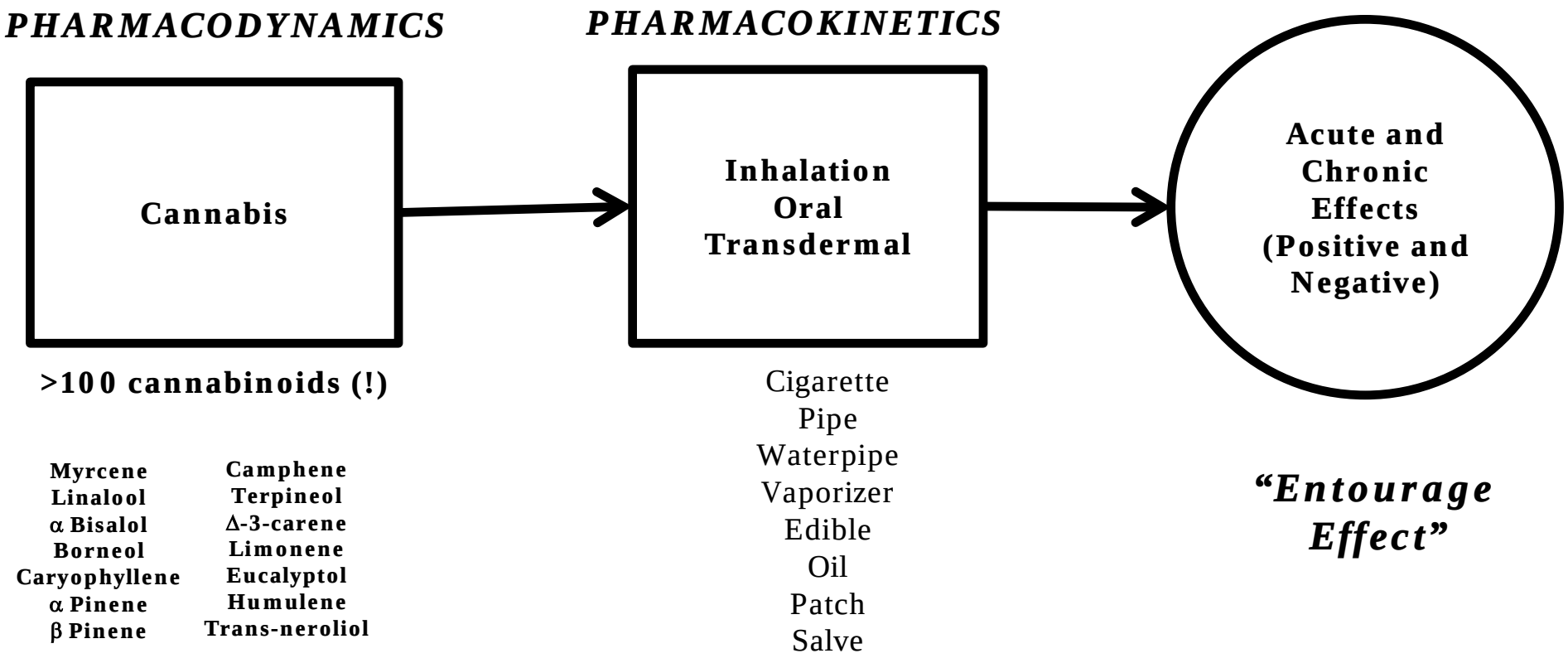
>100 cannabinoids (!)



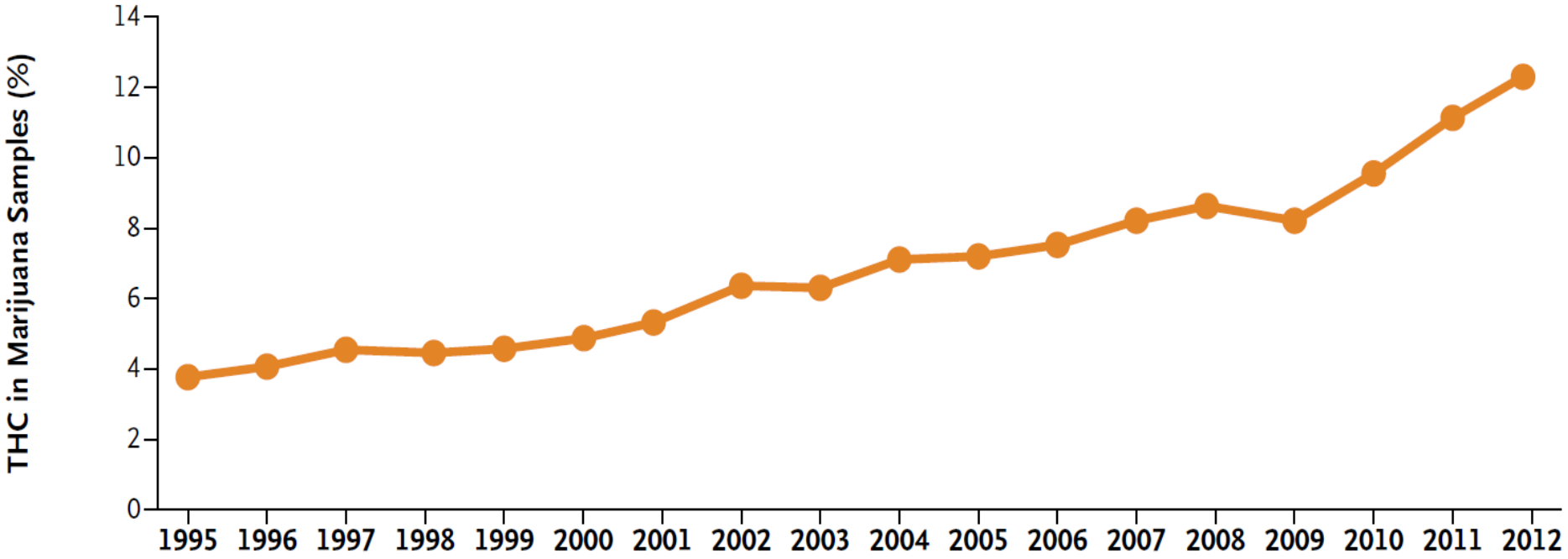
CBN

Cigarette
Pipe
Waterpipe
Vaporizer
Edible
Oil
Patch
Salve

Complexities of Cannabis



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)

RESEARCH CMAJ

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

Potency, % of THC	Potency, % of THC, mean difference (95% CI)							
	0		2.5		6.0		9.4	
0	–	–	–	–	–	–	–	–
2.5	–0.13	(–0.83 to 0.56)	–	–	–	–	–	–
6.0	–0.09	(–0.78–0.60)	0.04	(–0.64 to 0.73)	–	–	–	–
9.4	–0.71	(–1.40 to –0.02)	–0.58	(–1.27 to 0.11)	–0.63	(–1.30 to 0.06)	–	–

Note: CI = confidence interval, THC = tetrahydrocannabinol.

Ware et al. 2010, CMAJ

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 25, 2017 VOL. 376 NO. 21

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.*

Variable	Cannabidiol	Placebo	Adjusted Median Difference (95% CI)	P Value†
			percentage points	
No. of convulsive seizures per mo — median (range)				
Baseline	12.4 (3.9 to 1717)	14.9 (3.7 to 718)		
Treatment period	5.9 (0.0 to 2159)	14.1 (0.9 to 709)		
Percentage change in seizure frequency — median (range)	−38.9 (−100 to 337)	−13.3 (−91.5 to 230)	−22.8 (−41.1 to −5.4)	0.01

Devinsky et al. 2017, *NEJM*

Low Quality Evidence of Overall Efficacy

Research

Original Investigation

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 Schmidlkofer, 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.

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

Whiting et al. 2015, *JAMA*

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Epidemiology and Harm

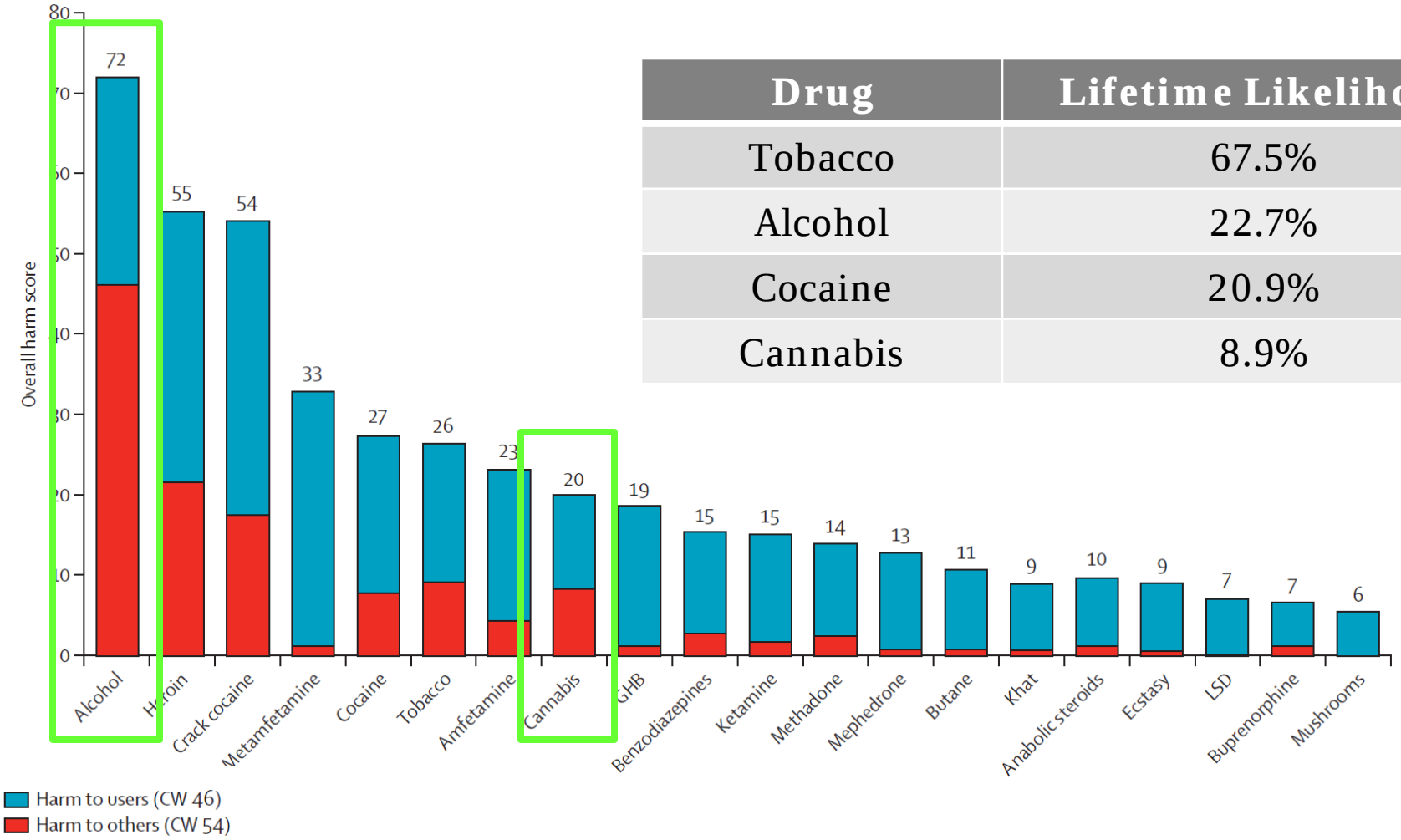
- United States
  - Last year use = 9.5% in 2012-2013,
    - 4.1% in 2001-2002
  - Cannabis use disorder
    - Lifetime prevalence = ~7%
    - 12-month prevalence = 2.9% 2012-2013
      - 1.5% in 2001-2002
- Canada
  - Last year prevalence of use = 12.2% (2012)
  - Cannabis Use Disorders:
    - Lifetime prevalence = 6.8%
    - 12-month prevalence = 1.3%

Statistics Canada; Hasin 2018, NPP

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

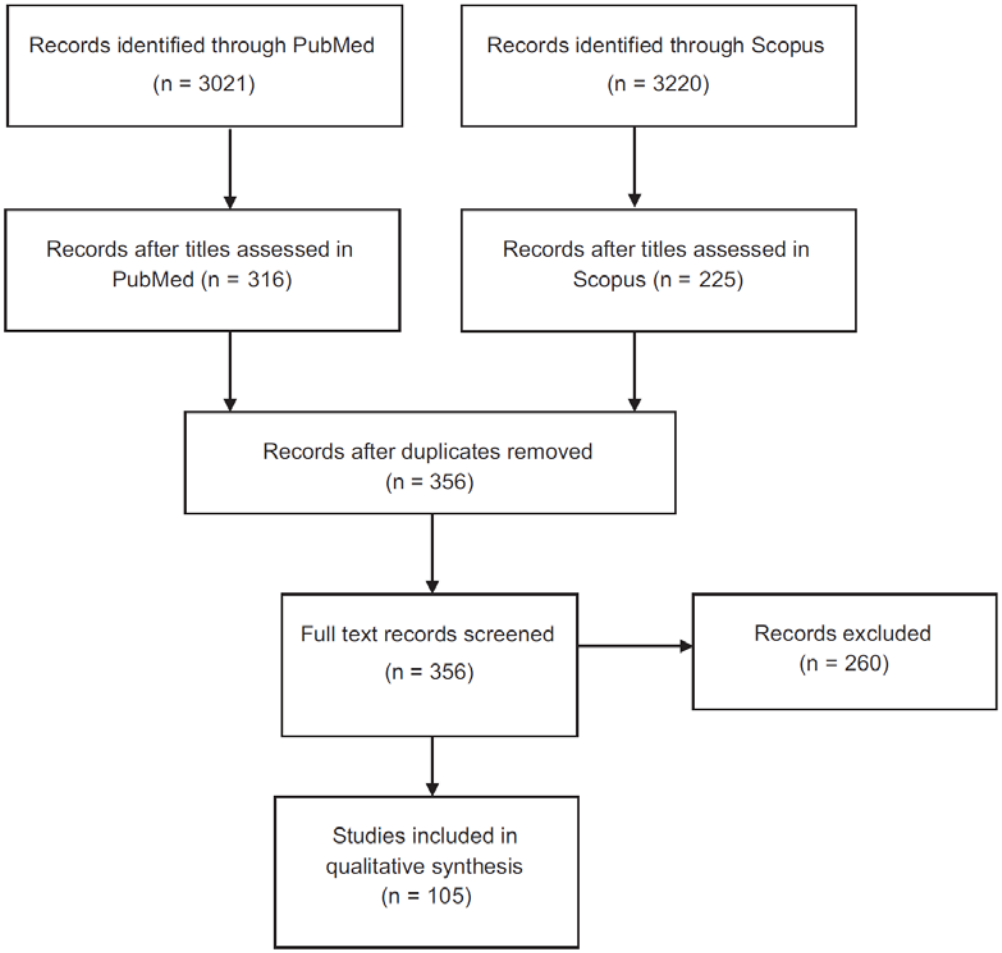


Drug	Lifetime Likelihood
Tobacco	67.5%
Alcohol	22.7%
Cocaine	20.9%
Cannabis	8.9%

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

Cannabis and Cognition

Cannabis and Cognition



Broyd et al., 2016, *Biological Psychiatry*

Cognitive Domain	Acute[b]	Chronic[b]	Persistence With Abstinence[b]	Pertinent Cannabis Use Parameters
Memory				
Verbal learning and memory	+++	+++	+−	Frequency; lifetime use; duration; age of onset; sex
Working memory	+−	+−	+−	Frequency; lifetime use; recency; sex
Other memory function	+	+−	−	Age of onset; frequency; recency
Attention				
Attention	+++	+++	+−	Dose; age of onset; length of abstinence; withdrawal effects
Attentional bias	+	+++	NA	Craving; dependence; frequency; CBD
Psychomotor Function	+++	+	+	
Executive Function				
Planning, reasoning, interference control, and problem solving	+−	+−	+−	Neurodevelopmental stage; age of onset; frequency
Inhibition	++	+−	NA	Frequency; task complexity
Verbal fluency	−	+−	+−	
Time estimation	+−	−	−	
Decision Making	+−	+−	−	Age of onset; lifetime exposure; frequency; cannabis use disorder

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Psychomotor Function	+++	+	+	
Executive Function				
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Attention	+++	+++	+−	Dose; age of onset; length of abstinence; withdrawal effects
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Psychomotor Function	+++	+	+	
Executive Function				
Planning, reasoning, interference control, and problem solving	+−	+−	+−	Neurodevelopmental stage; age of onset; frequency
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Verbal fluency	−	+−	+−	
Time estimation	+−	−	−	
Decision Making	+−	+−	−	Age of onset; lifetime exposure; frequency; cannabis use disorder

Broyd et al., 2016, *Biological Psychiatry*

Cannabis and Cognition

- Limitations and considerations
  - Inconsistent empirical findings
  - Small study (publication) bias
  - Measurement error
  - Confounding variables

Broyd et al., 2016, *Biological Psychiatry*

Cannabis and Cognition

Neuropsychological Test	Cognitive Function
Penn Word Memory Test	Verbal Episodic Memory
Flanker Task	Inhibitory Control
Dimensional Change Card Sort	Set Shifting
Short Penn CPT	Sustained Attention
Penn Progressive Matrices	Fluid Intelligence
Delay Discounting Tasks	Impulsive Choice Preference
Picture Sequence Task	Non-verbal Episodic Memory
Pattern Completion Task	Processing Speed
List Sorting Task	Working Memory
9-hole Pegboard Task	Psychomotor Dexterity

HUMAN Connectome PROJECT

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

St. Joseph's Healthcare Hamilton

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McMaster University PSYCHIATRY AND BEHAVIOURAL NEUROSCIENCES

Petker et al., under review

Cannabis and Cognition

Neuropsychological Test	Cognitive Function	ΔR^2	*p*
Penn Word Memory Test	Verbal episodic memory	--	--
Flanker Task	Inhibitory Control	--	--
Dimensional Change Card Sort	Set Shifting	--	--
Short Penn CPT	Sustained Attention	--	--
Penn Progressive Matrices	Fluid Intelligence	.010	.004
Delay Discounting Tasks	Impulsive Choice Preference	--	--
Picture Sequence Task	Non-verbal Episodic Memory	.011	.004
Pattern Completion Task	Processing Speed	.014	.001
List Sorting Task	Working Memory	--	--
9-hole Pegboard Task	Psychomotor dexterity	--	--

HUMAN Connectome PROJECT

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

THC+ **CUD+**

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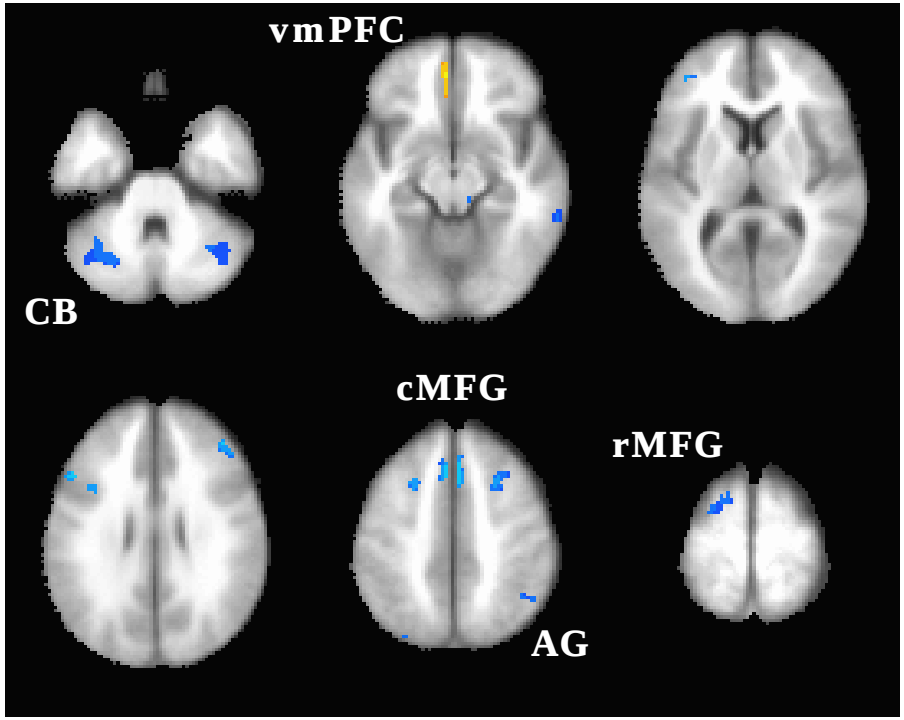
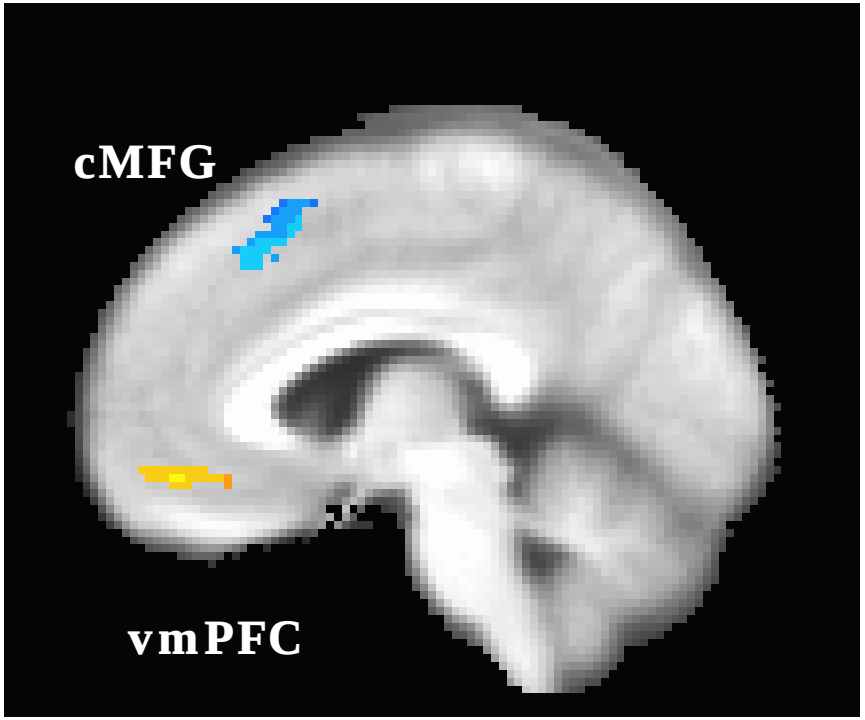
Petker et al., under review

Cannabis and Cognition

THC+ Status and N-Back Performance

(covariate-adjusted β = -.08, t = 2.58, *p* = .01)





HUMAN Connectome PROJECT

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

No differences based on lifetime consumption, CUD status, or age of first use

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Owens et al., 2018, *NeuroImage* & under review

Cannabis and Cognition

Domain/Day	Former vs CTL	Active vs CTL
Total Recall		
0	*ns*	*p<.01*
1	*ns*	*p<.01*
7	*ns*	*p<.001*
28	*ns*	*ns*
Long-term Storage		
0	*ns*	*p<.01*
1	*ns*	
7	*ns*	*p<.01*
28	*ns*	*ns*
Consistent Long-term Retrieval		
0	*ns*	*p<.001*
1	*ns*	*p<.001*
7	*ns*	*p<.001*
28	*ns*	*ns*

Post 28 Days Abstinence

Test	CTL	Former	Active
WMS total	REF	*ns*	*ns*
COWAT	REF	*ns*	*ns*
WCST	REF	*ns*	*ns*
WAIS-BD	REF	*ns*	*ns*
Stroop	REF	*ns*	*ns*
RPM	REF	*ns*	*ns*

Pope et al. (2001) *Archives of General Psychiatry*

Impulsivity as Measured by Delay Discounting

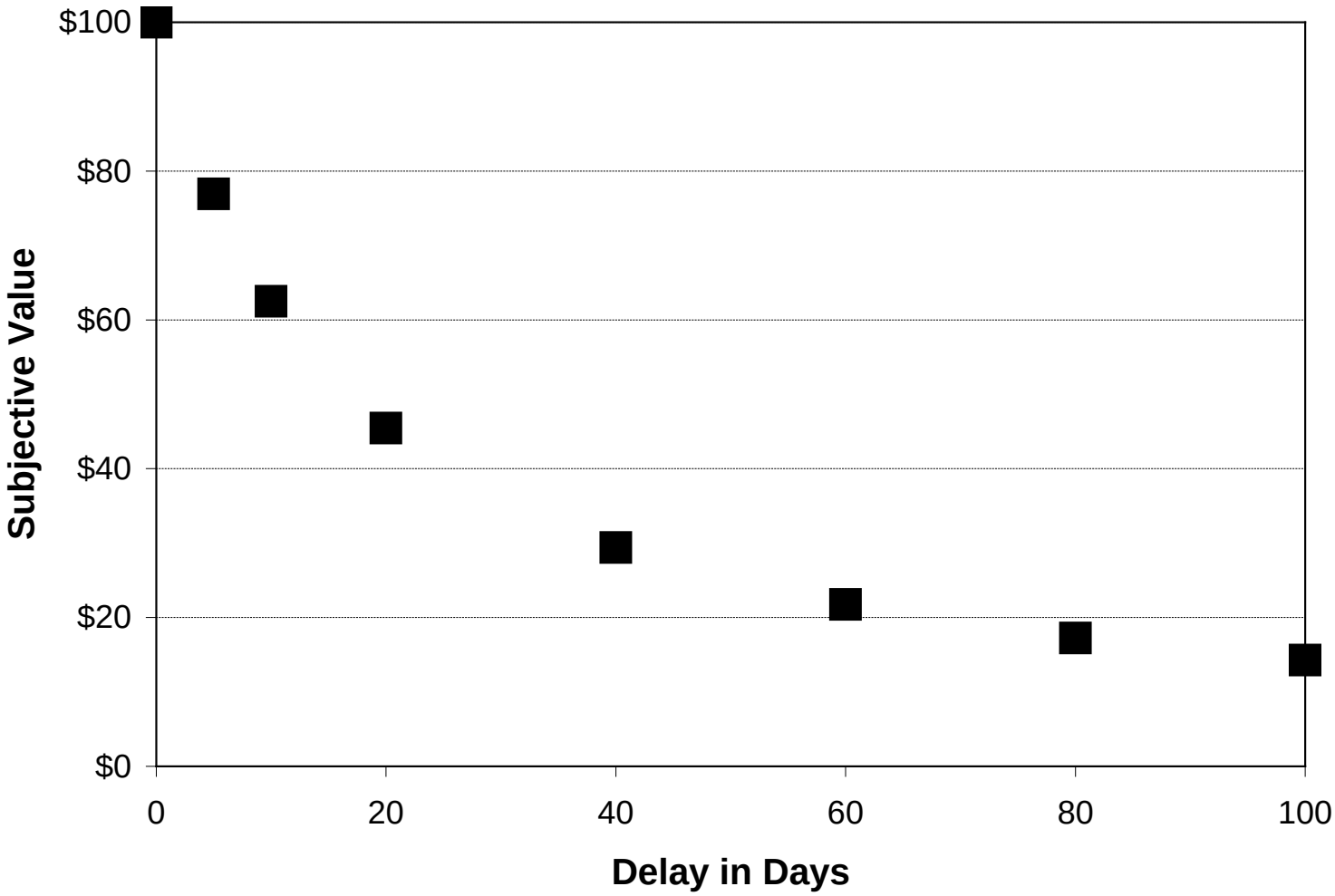
- Behavioral economic index of self-control (impulsivity)
  - Delay discounting refers to the amount that a reward is <u>discounted</u> based on its <u>delay</u> in time
  - Smaller-Sooner vs. Larger-Later Preference

- 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):

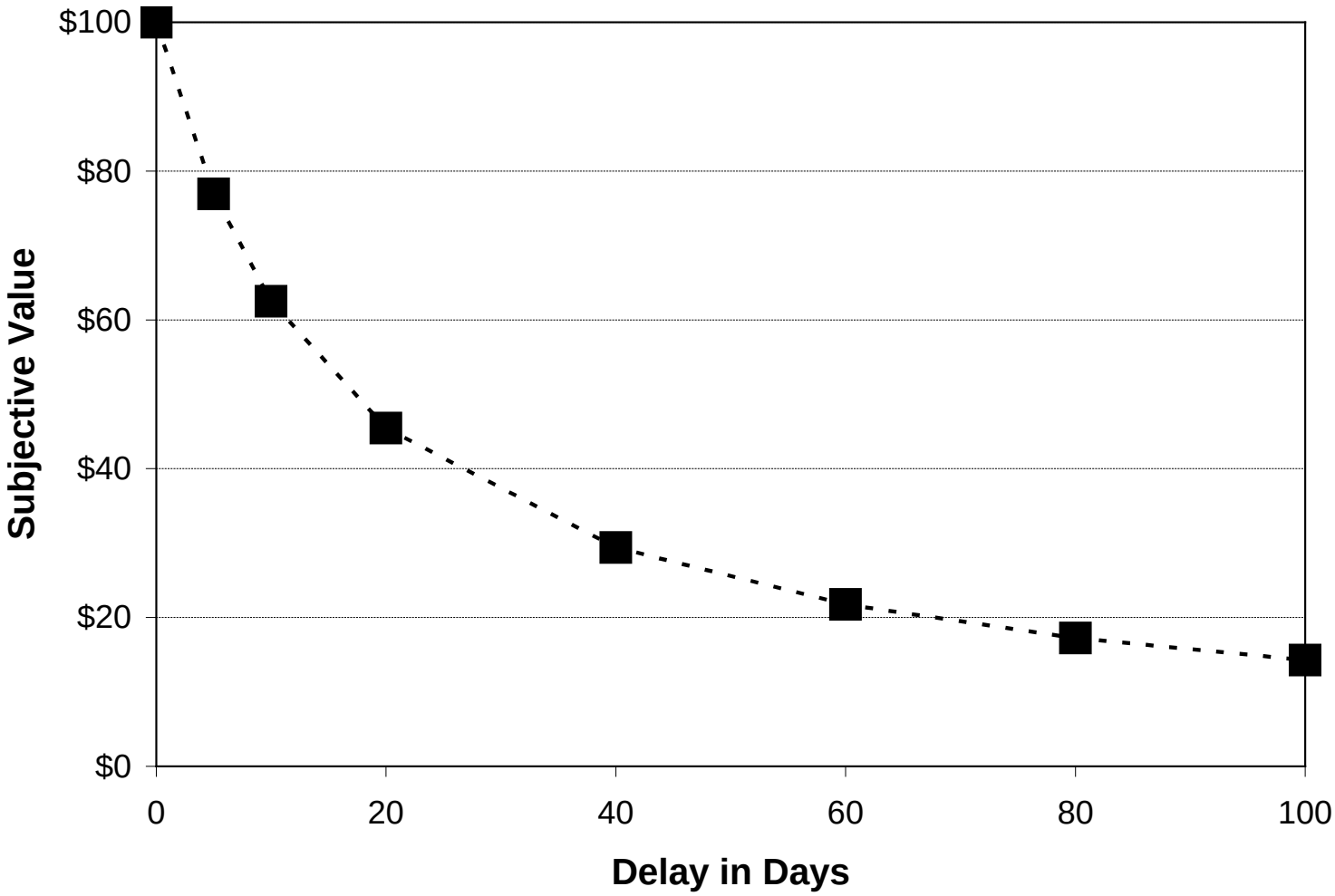
$$V = A/(1 + kD)$$

Ainslie, 1975; Bickel & Marsh, 2000; Mazur, 1987; Rachlin & Green, 1972;

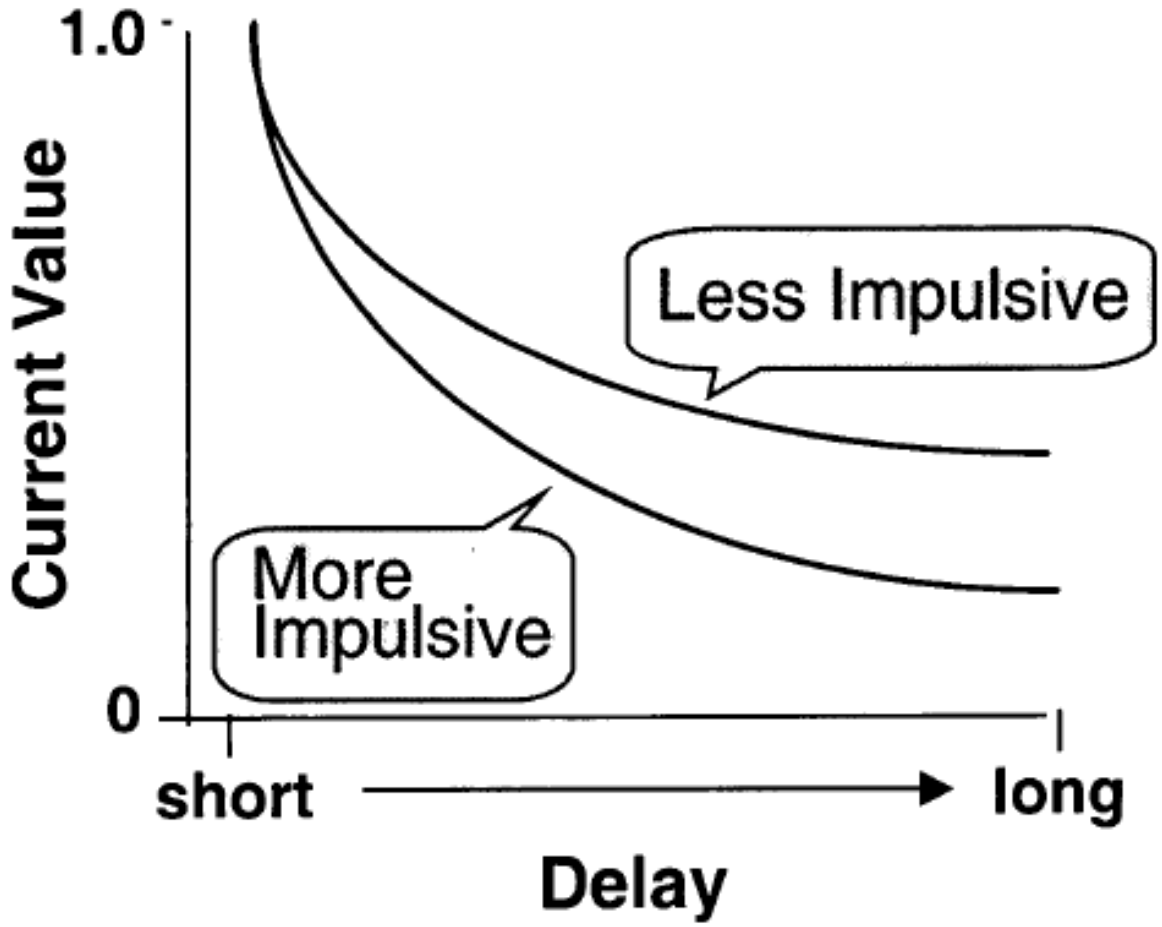
Temporal Discounting Function



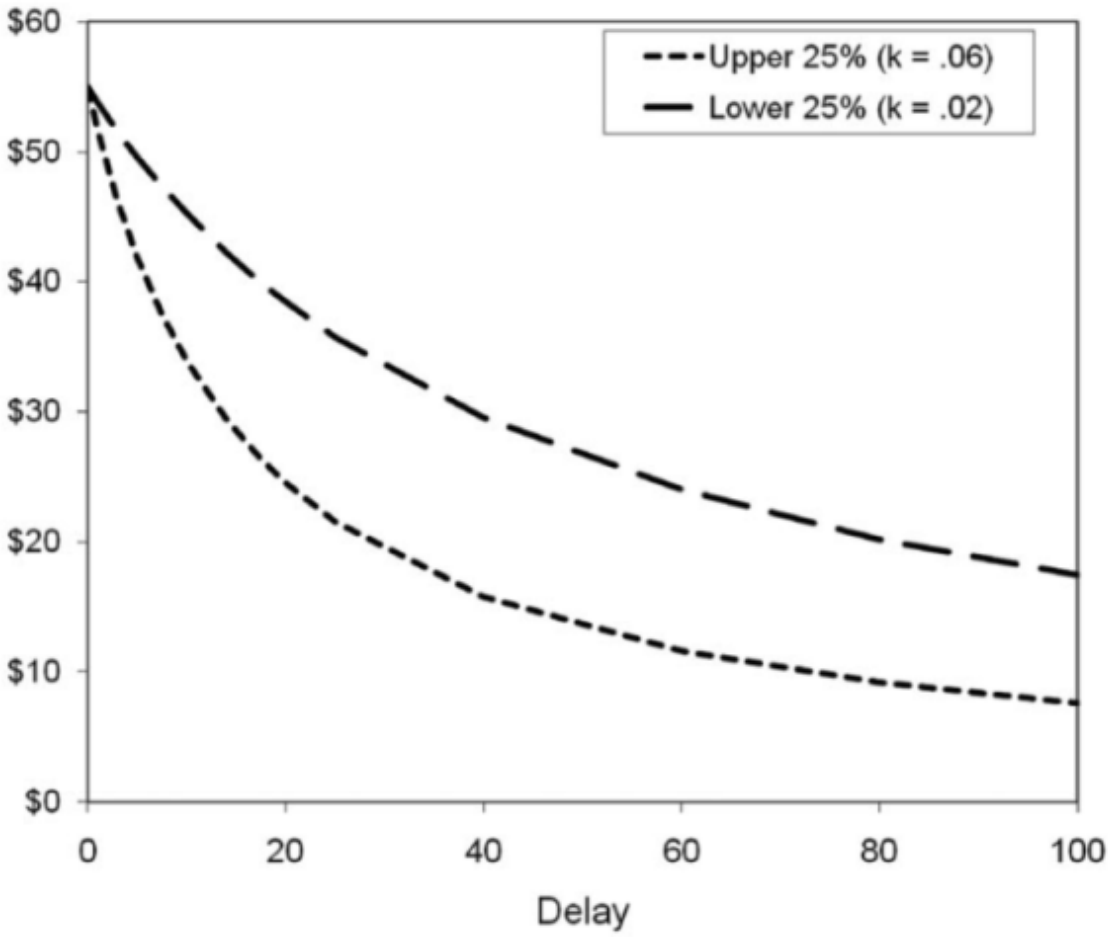
Temporal Discounting Function



Relative Levels of Delay Discounting

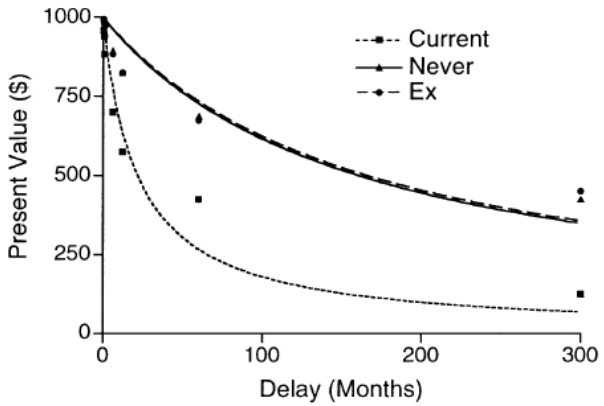


Delay Discounting and AUD Severity

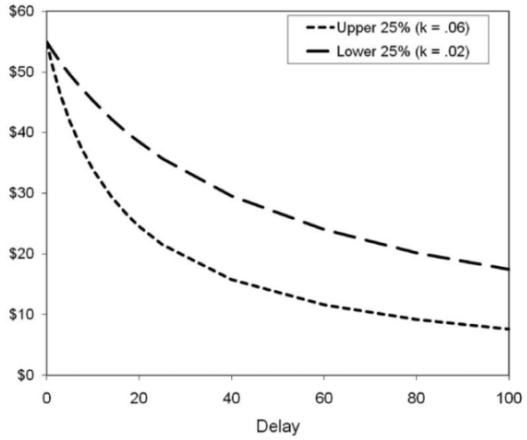


MacKillop et al. (2010)
Journal of Abnormal Psychology

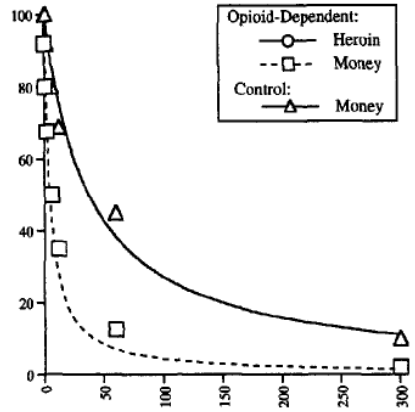
Findings from Case-Control Designs



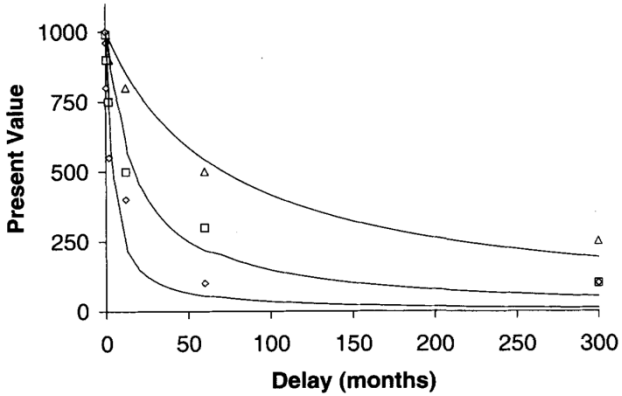
Tobacco Use Disorder



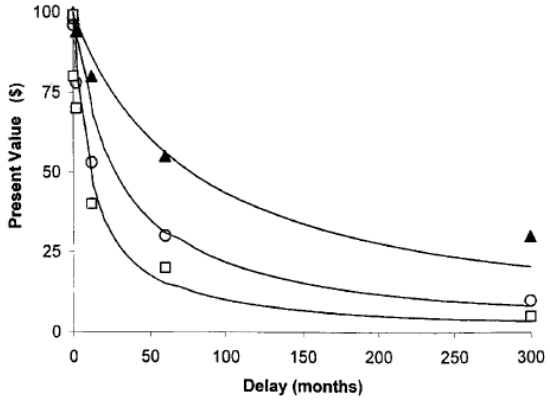
Alcohol Use Disorder



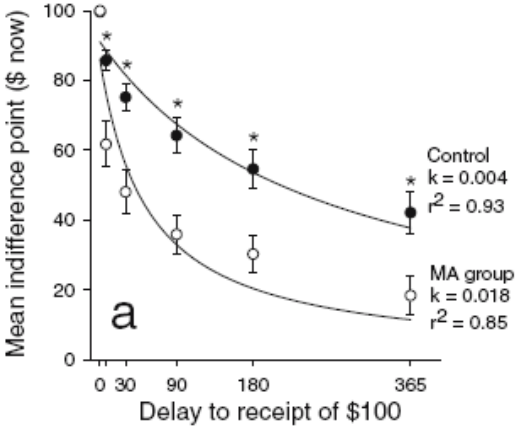
Opioid Use Disorder



Gambling Disorder



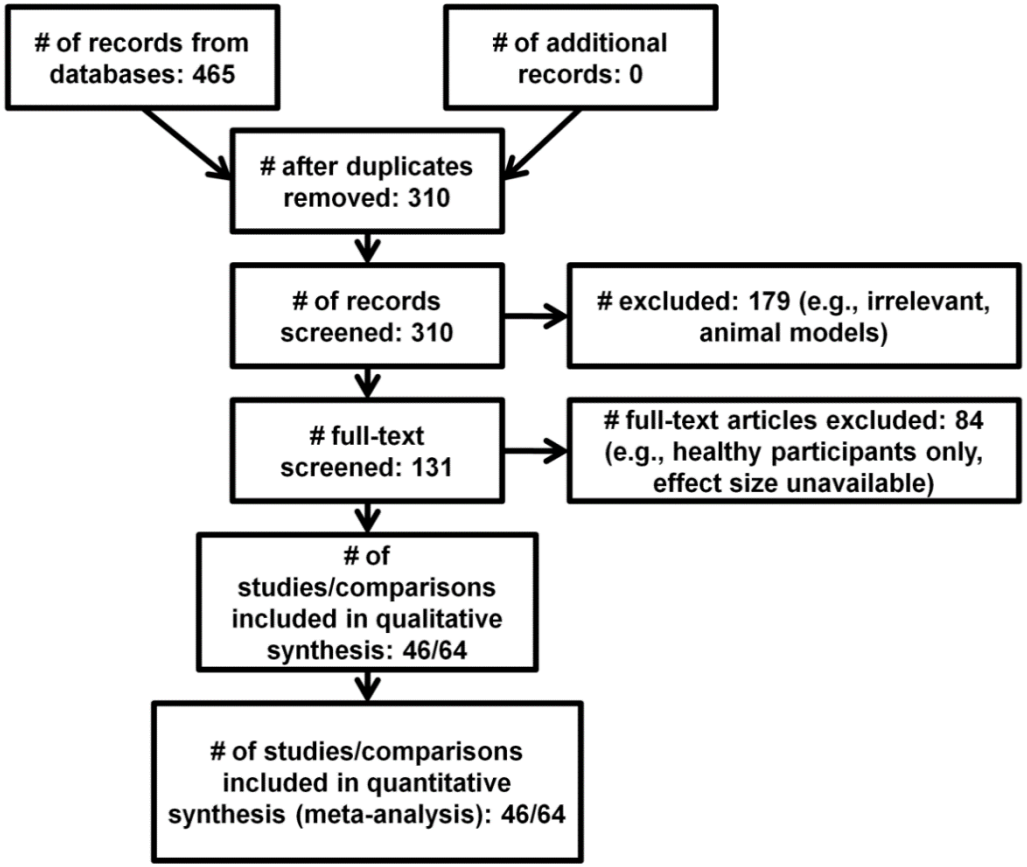
Alcohol Use Disorder



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

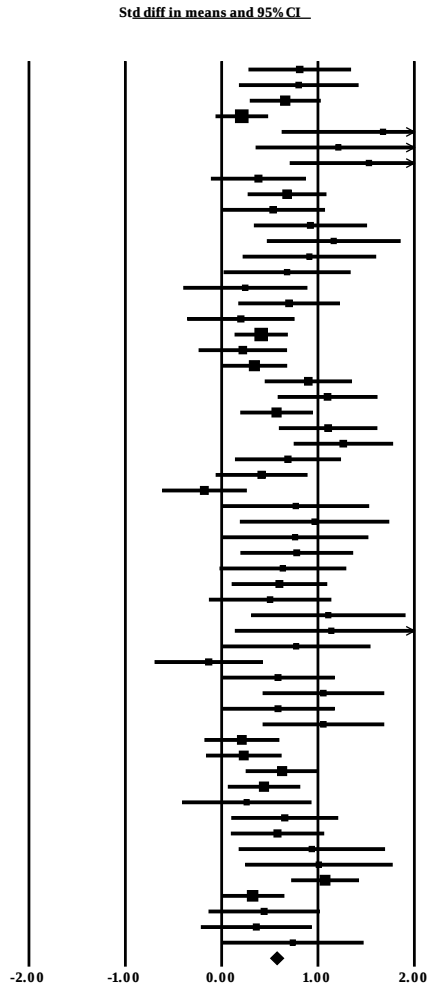


Total *N* = 56,013

MacKillop et al. (2011). *Psychopharmacology*

Meta-Analysis of Case-Control Studies

Model	Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
	Baker et al., 2003	0.810	0.269	0.072	0.284	1.336	3.016	0.003
	Bickel et al., 1999	0.800	0.314	0.098	0.185	1.415	2.551	0.011
	Bjork et al., 2004	0.660	0.185	0.034	0.298	1.022	3.571	0.000
	Bobova et al., 2009	0.209	0.136	0.019	-0.058	0.476	1.536	0.125
	Boettiger et al., 2007	1.675	0.534	0.285	0.629	2.721	3.138	0.002
	Coffey et al., 2003	1.212	0.435	0.190	0.358	2.065	2.783	0.005
	Dixon et al., 2003	1.529	0.417	0.174	0.713	2.346	3.670	0.000
	Field et al., 2007	0.382	0.249	0.062	-0.105	0.869	1.536	0.124
	Fields et al., 2009	0.679	0.206	0.042	0.275	1.082	3.299	0.001
	Heil et al., 2006	0.534	0.271	0.074	0.002	1.066	1.969	0.049
	Heyman & Gibb, 2006	0.922	0.297	0.088	0.340	1.503	3.106	0.002
	Hoffman et al., 2006	1.163	0.351	0.123	0.475	1.852	3.313	0.001
	Hoffman et al., 2008	0.911	0.351	0.123	0.224	1.598	2.597	0.009
	Holt et al., 2003a	0.679	0.334	0.111	0.025	1.333	2.036	0.042
	Holt et al., 2003b	0.245	0.326	0.106	-0.393	0.884	0.753	0.451
	Johnson et al., 2007	0.700	0.266	0.071	0.179	1.221	2.632	0.008
	Johnson et al., 2010	0.200	0.281	0.079	-0.351	0.751	0.711	0.477
	Jones et al., 2009	0.411	0.138	0.019	0.140	0.681	2.971	0.003
	Kirby & Petry, 2004a	0.220	0.231	0.053	-0.233	0.673	0.953	0.341
	Kirby & Petry, 2004b	0.340	0.171	0.029	0.005	0.675	1.992	0.046
	Kirby & Petry, 2004c	0.900	0.228	0.052	0.454	1.346	3.951	0.000
	Kirby & Petry, 2004d	1.100	0.261	0.068	0.588	1.612	4.209	0.000
	Kirby et al., 1999	0.570	0.190	0.036	0.199	0.941	3.007	0.003
	Ledgerwood et al., 2009a	1.105	0.258	0.066	0.600	1.610	4.292	0.000
	Ledgerwood et al., 2009b	1.263	0.260	0.068	0.753	1.773	4.854	0.000
	MacKillop et al., 2006a	0.688	0.278	0.077	0.144	1.232	2.480	0.013
	MacKillop et al., 2006b	0.415	0.240	0.058	-0.056	0.885	1.728	0.084
	MacKillop et al., 2007	-0.179	0.221	0.049	-0.613	0.255	-0.808	0.419
	MacKillop et al., 2010a	0.770	0.385	0.148	0.015	1.525	2.000	0.045
	MacKillop et al., 2010b	0.965	0.393	0.154	0.195	1.734	2.457	0.014
	MacKillop et al., 2010c	0.763	0.385	0.148	0.009	1.517	1.982	0.047
	Madden et al., 1997	0.780	0.295	0.087	0.201	1.359	2.640	0.008
	Madden et al., 2009	0.635	0.333	0.111	-0.016	1.287	1.911	0.056
	Melanko et al., 2009	0.600	0.250	0.062	0.110	1.089	2.401	0.016
	Mitchell et al., 1999	0.503	0.321	0.103	-0.127	1.132	1.566	0.117
	Mitchell et al., 2005	1.107	0.406	0.165	0.311	1.902	2.727	0.006
	Mitchell et al., 2007	1.139	0.508	0.258	0.143	2.135	2.241	0.025
	Monterosso et al., 2007	0.774	0.390	0.152	0.008	1.539	1.981	0.048
	Ohmura et al., 2005	-0.134	0.284	0.081	-0.691	0.423	-0.471	0.638
	Petry & Cassarella, 1999a	0.585	0.297	0.088	0.003	1.168	1.971	0.049
	Petry & Cassarella, 1999b	1.056	0.319	0.102	0.431	1.682	3.309	0.001
	Petry & Cassarella, 1999c	0.585	0.297	0.088	0.003	1.168	1.971	0.049
	Petry & Cassarella, 1999d	1.056	0.319	0.102	0.431	1.682	3.309	0.001
	Petry, 2002a	0.210	0.195	0.038	-0.173	0.593	1.075	0.283
	Petry, 2002b	0.230	0.197	0.039	-0.156	0.616	1.168	0.243
	Petry, 2003a	0.628	0.191	0.036	0.255	1.001	3.296	0.001
	Petry, 2003b	0.440	0.189	0.036	0.070	0.809	2.331	0.020
	Reynolds et al., 2003	0.260	0.340	0.115	-0.405	0.926	0.766	0.444
	Reynolds et al., 2004	0.655	0.280	0.078	0.106	1.204	2.339	0.019
	Reynolds et al., 2007	0.580	0.244	0.060	0.101	1.058	2.375	0.018
	Reynolds et al., 2009	0.936	0.385	0.148	0.182	1.690	2.434	0.015
	Reynolds, 2006	1.009	0.388	0.150	0.249	1.769	2.603	0.009
	Sweitzer et al., 2008a	1.073	0.177	0.031	0.727	1.419	6.078	0.000
	Sweitzer et al., 2008b	0.322	0.165	0.027	-0.001	0.645	1.956	0.050
	Vuchinich & Simpson, 1998a	0.442	0.292	0.085	-0.131	1.015	1.512	0.130
	Vuchinich & Simpson, 1998b	0.361	0.291	0.085	-0.210	0.931	1.239	0.215
	Vuchinich & Simpson, 1998c	0.739	0.371	0.138	0.011	1.467	1.989	0.047
Fixed		0.575	0.033	0.001	0.509	0.641	17.174	0.000



Overall d = .49, $p<10^{-8}$

Clinical d = .67, $p<10^{-5}$

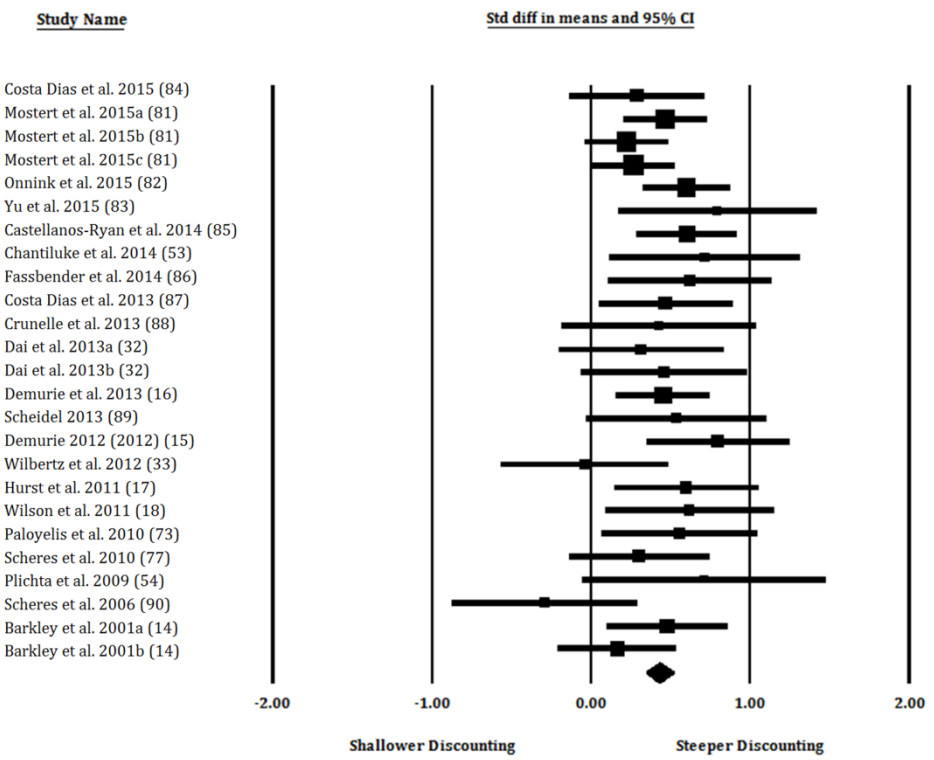
Subclinical d = .46, $p<10^{-10}$

All individual addictive behaviors significant <u>except cannabis</u>

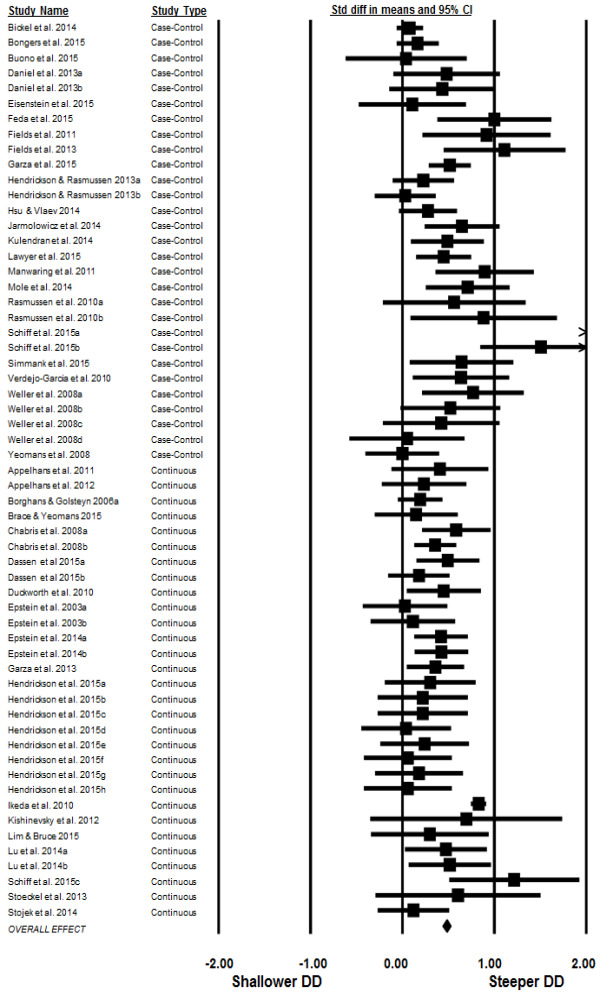
Minimal evidence of publication bias

MacKillop et al. (2011) *Psychopharmacology*

Delay Discounting, ADHD, and Obesity



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

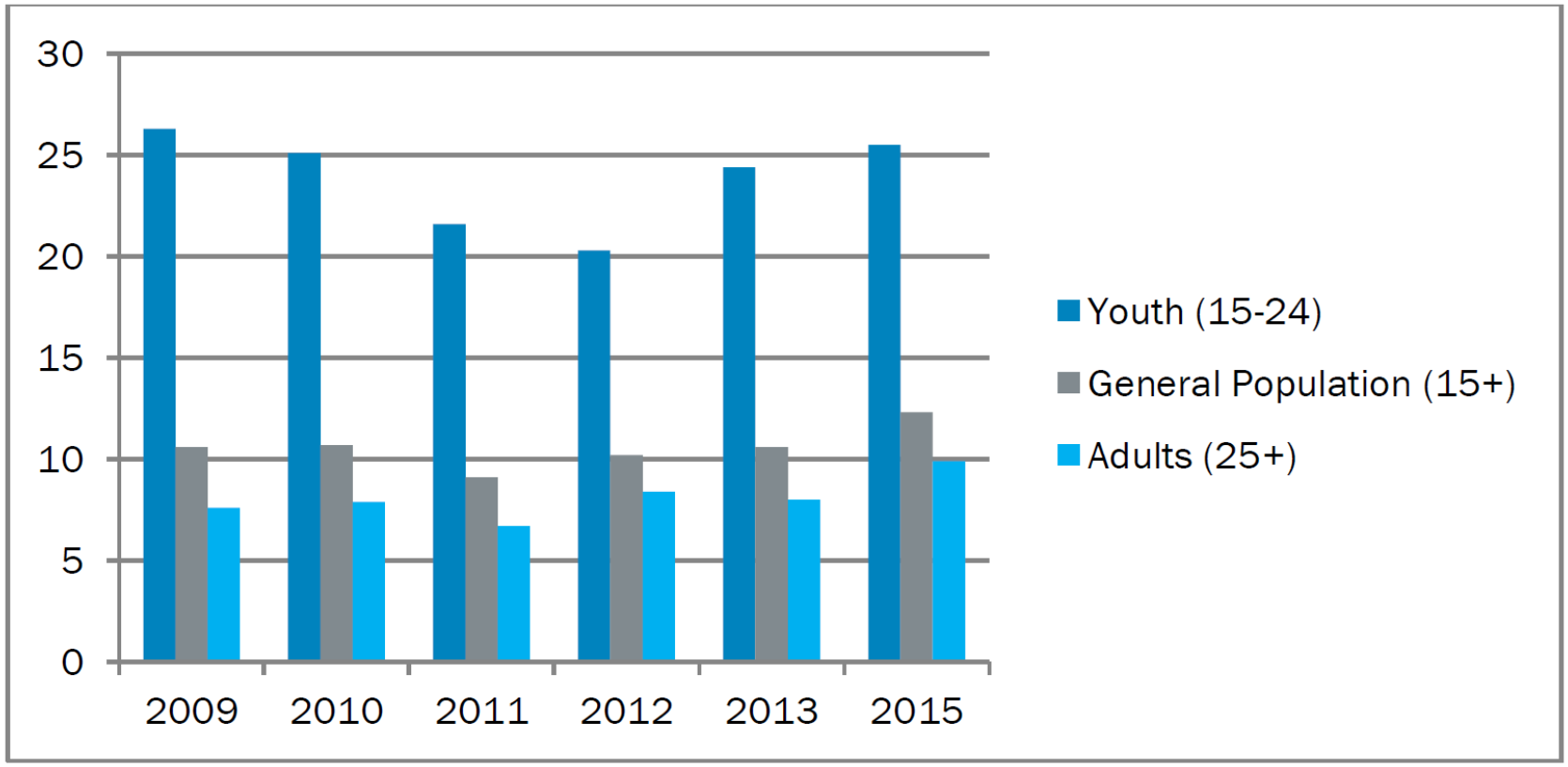


***d* =.43**
***p* <10^{-14}**
***N*=10,278**

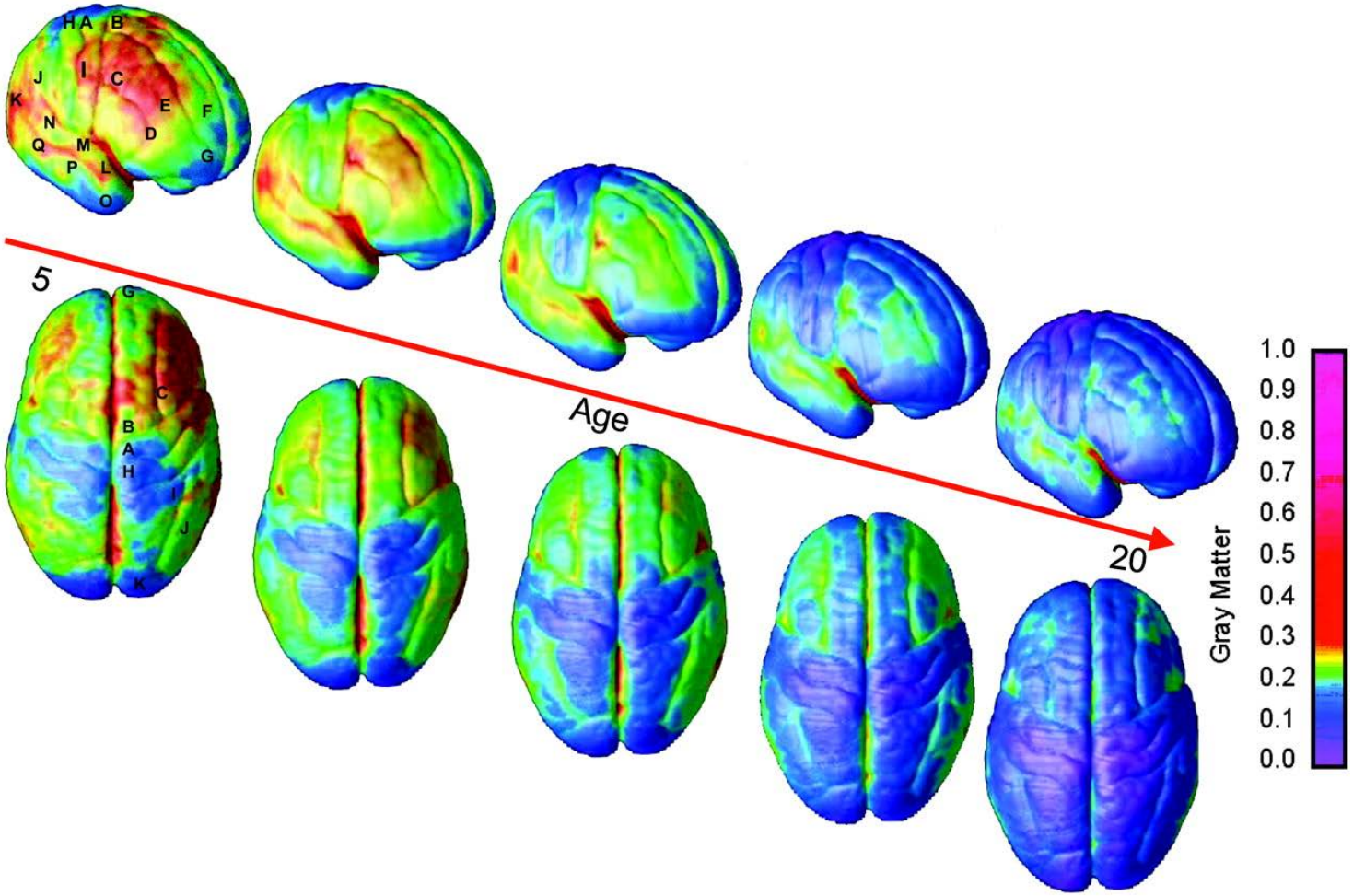
Jackson & MacKillop (2016)
Biological Psychiatry: CNNI;
Amlung et al. (2017)
Psych Med

Developmental Considerations

Developmental Considerations



Developmental Considerations



Gogtay et al., 2004, PNAS

Developmental Considerations

PNAS

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[d], Kay McDonald[f], Aimee Ward[f], Richie Poulton[f], and Terrie E. Moffitt[a,b,c,d,e]

[a]Duke Transdisciplinary Prevention Research Center, Center for Child and Family Policy, [b]Department of Psychology and Neuroscience, and [c]Institute for Genome Sciences and Policy, Duke University, Durham, NC 27708; [d]Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, NC 27710; [e]Social, Genetic, and Developmental Psychiatry Centre, Institute of Psychiatry, King's College London, London SE5 8AF, United Kingdom; and [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)

IQ test/subtest	Never used, never diagnosed, *n* = 242	Used, never diagnosed, *n* = 479	1 diagnosis, *n* = 80	2 diagnoses, *n* = 35	3+ diagnoses, *n* = 38	Linear trend *t* test*	*P*
Full-scale IQ	0.05	−0.07	−0.11	−0.17	−0.38	−4.45	<0.0001
Verbal IQ	0.02	−0.05	−0.13	−0.19	−0.31	−4.15	<0.0001
Information subtest	0.05	−0.08	0.02	−0.25	−0.15	−2.40	0.0168
Similarities subtest	0.03	−0.05	−0.03	−0.19	−0.44	−2.78	0.0056
Vocabulary subtest	0.07	−0.05	−0.16	−0.16	−0.45	−3.67	0.0003
Arithmetic subtest	−0.05	−0.07	−0.05	0.00	0.06	−0.73	0.47
Performance IQ	0.08	−0.08	−0.09	−0.08	−0.42	−2.84	0.0046
Digit symbol coding subtest	0.15	−0.09	−0.17	−0.23	−0.62	−5.60	<0.0001
Block design subtest	−0.03	−0.07	−0.01	−0.11	0.02	−0.55	0.58
Picture completion subtest	−0.01	−0.08	0.08	0.05	0.15	1.18	0.24

Meier et al., 2012, *PNAS*

Developmental Considerations

PNAS

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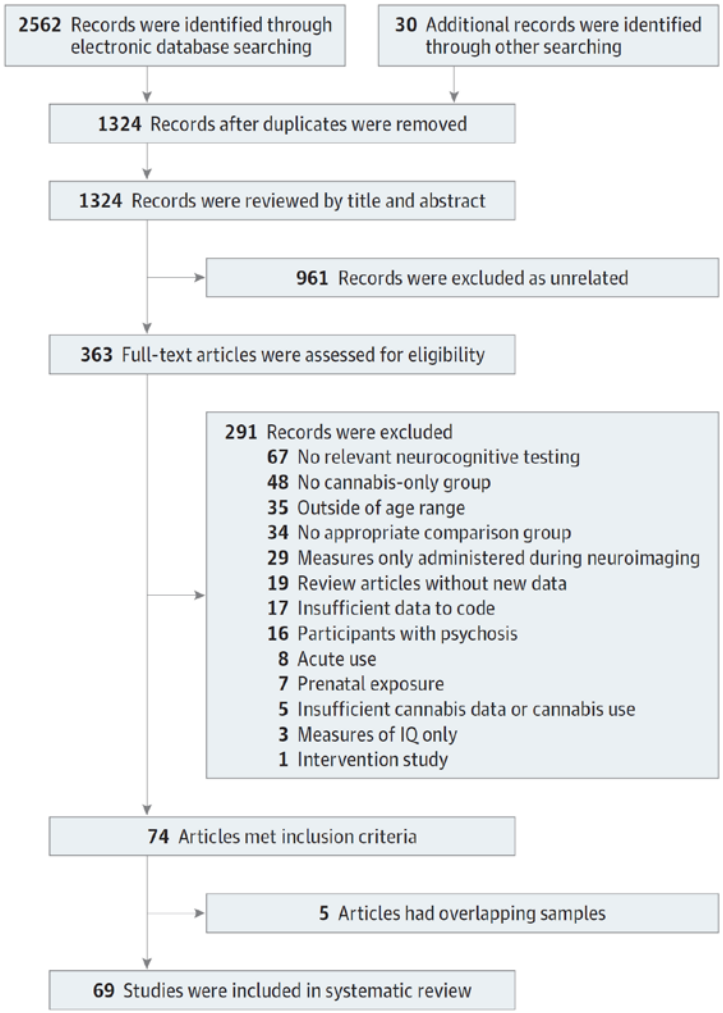
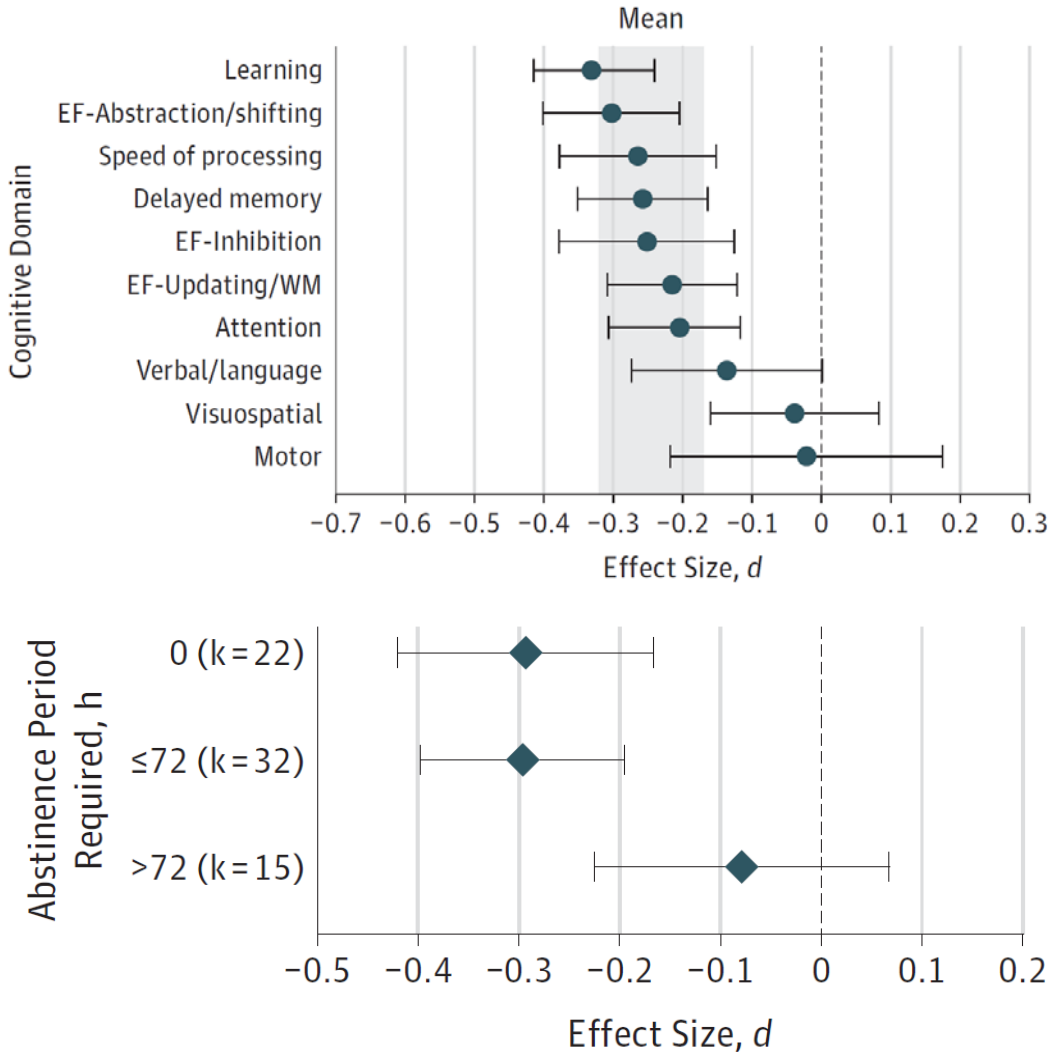
Meier et al., 2012, *PNAS*

Developmental Considerations



Scott et al., 2018, *JAMA*

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

MEDICINAL CANNABIS+ PREMIUM LITERATURE SERVICES McMaster PLUS

St. Joseph's Healthcare Hamilton | Peter Boris Centre for Addictions Research | Michael G. DeGroote Centre for Medicinal Cannabis Research | McMaster University Psychiatry and Behavioural Neurosciences

Evidence-based Information

NIDA NATIONAL INSTITUTE ON DRUG ABUSE

https://www.drugabuse.gov

Canadian Centre **on Substance Abuse**

Centre canadien **de lutte contre les toxicomanies**

http://www.ccdus.ca

Thank You