



Addiction

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Overview

- *Epidemiology of substance use and related harms*
- *Dependence syndrom: diagnostic criteria*
- *Factors leading to addiction*
- *Neurobiological Perspective*

Risk factor	Mean rank (95% UI)	% change (95% UI)
1 High blood pressure	1·1 (1-2)	27% (19 to 34)
2 Smoking (including SHS)	1·9 (1-2)	3% (-5 to 11)
3 Household air pollution	4·6 (3-7)	-37% (-44 to -29)
4 Low fruit	5·0 (4-8)	29% (25 to 34)
5 Alcohol use	5·1 (3-7)	32% (17 to 47)
6 High body-mass index	6·1 (4-8)	82% (71 to 95)
7 High fasting plasma glucose	6·6 (5-8)	58% (43 to 73)
8 Childhood underweight	8·5 (6-11)	-61% (-66 to -55)
9 Ambient PM pollution	8·7 (7-11)	-7% (-13 to -1)
10 Physical inactivity	10·0 (8-12)	0% (0 to 0)
11 High sodium	11·2 (8-15)	33% (27 to 39)
12 Low nuts and seeds	12·9 (11-17)	27% (18 to 32)
13 Iron deficiency	13·5 (11-17)	-7% (-11 to -4)
14 Suboptimal breastfeeding	13·8 (10-18)	-57% (-63 to -51)
15 High total cholesterol	15·2 (12-17)	3% (-13 to 19)
16 Low whole grains	15·3 (13-17)	39% (32 to 45)
17 Low vegetables	15·8 (12-19)	22% (16 to 28)
18 Low omega-3	18·7 (17-23)	30% (21 to 35)
19 Drug use	20·2 (18-23)	57% (42 to 72)
20 Occupational injury	20·4 (18-23)	12% (-22 to 58)
21 Occupational low back pain	21·2 (18-25)	22% (11 to 35)
22 High processed meat	22·1 (17-32)	22% (2 to 44)
23 Intimate partner violence	23·8 (20-28)	0% (0 to 0)
24 Low fibre	24·5 (19-32)	23% (13 to 33)
25 Lead	25·5 (23-29)	160% (143 to 176)
26 Sanitation		
29 Vitamin A deficiency		
31 Zinc deficiency		
34 Unimproved water		

— Ascending order in rank
 - - - Descending order in rank

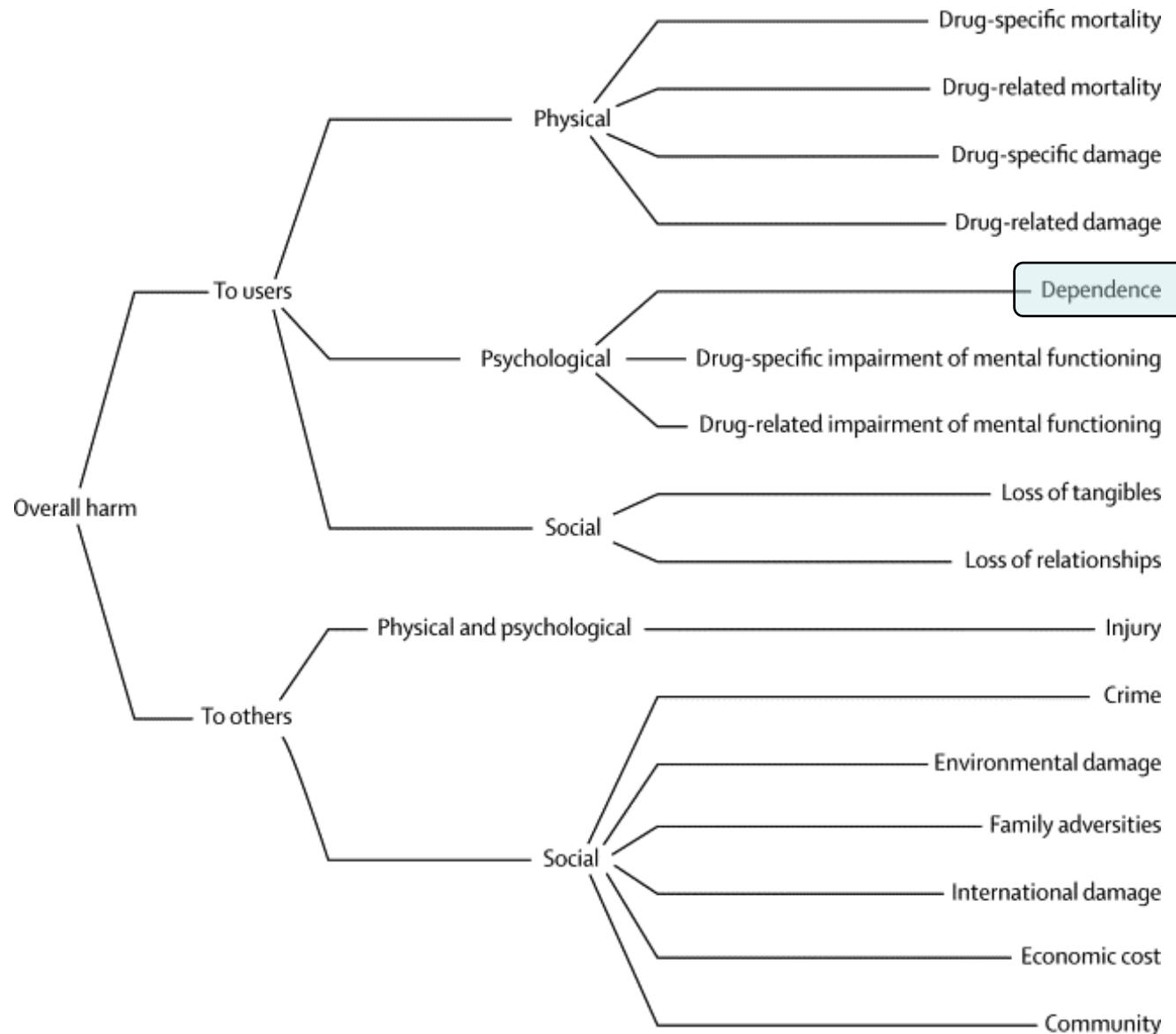
Global Burden of Disease Study 2010

Most important risk factors

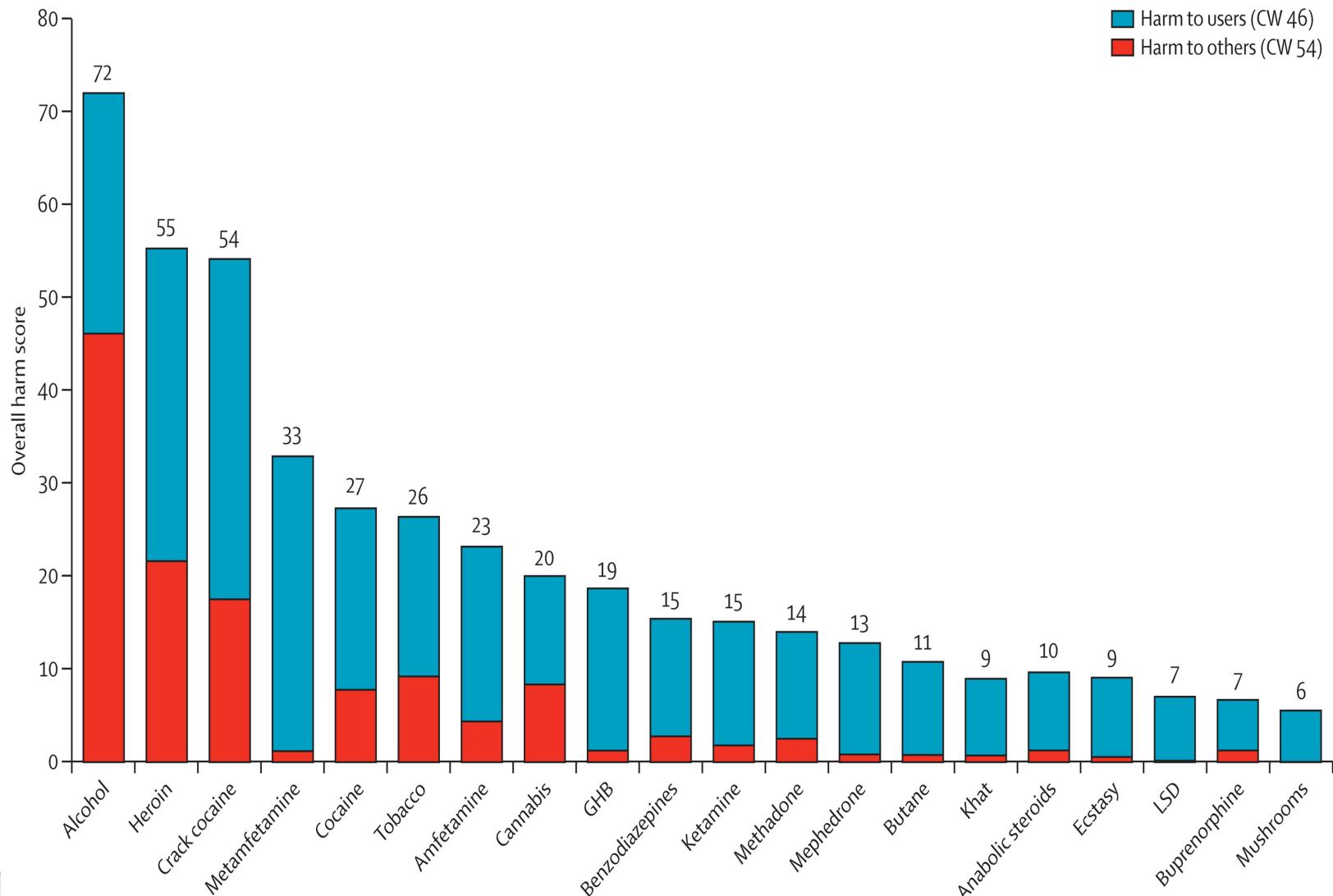
Lim et al., 2012
 The Lancet

„Alcohol and illicit drug use account for 5.4% of the world's annual disease burden, with tobacco responsible for 3.7%“ WHO ATLAS 2010

Harm related to the use of drugs



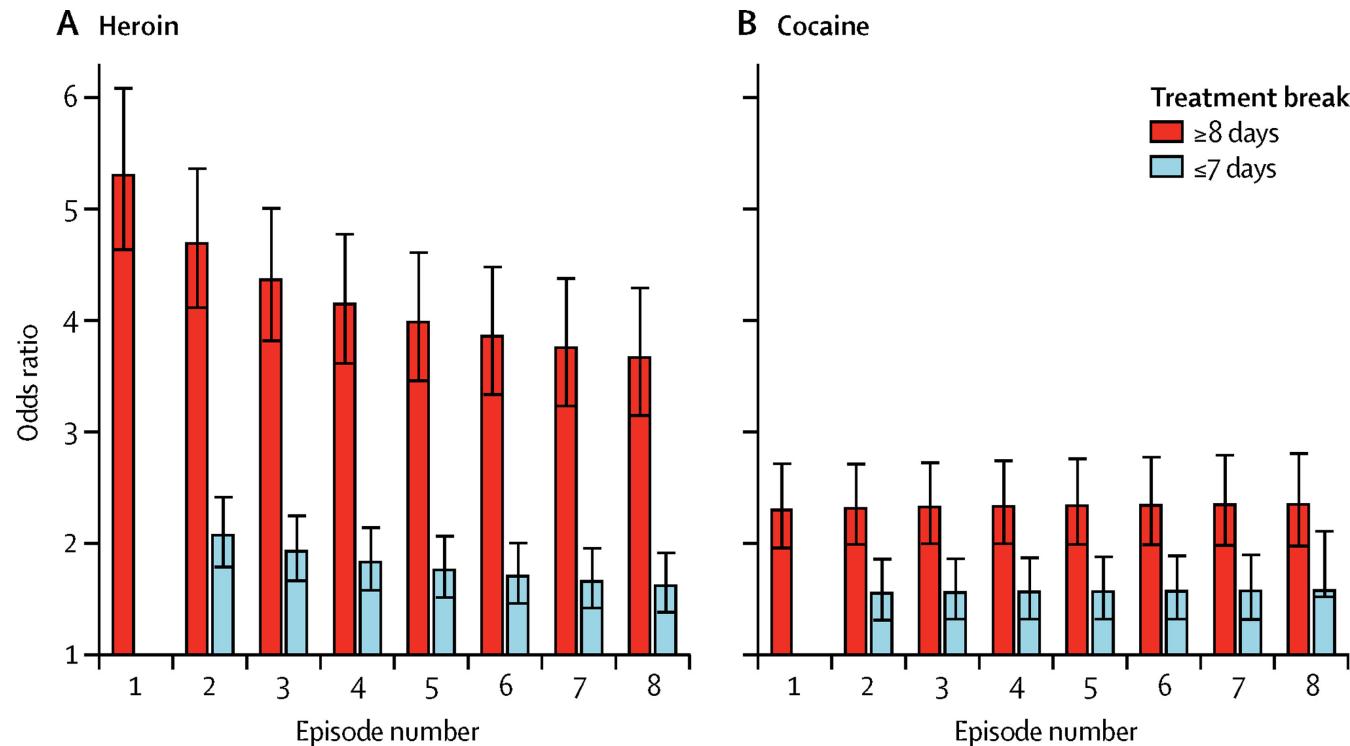
Harm related to the use of drugs



Open drug scene/Heroin crisis in Zurich, 1980/90ies



Heroin (and cocaine) use is substantially reduced in patients entering opioid agonist treatments

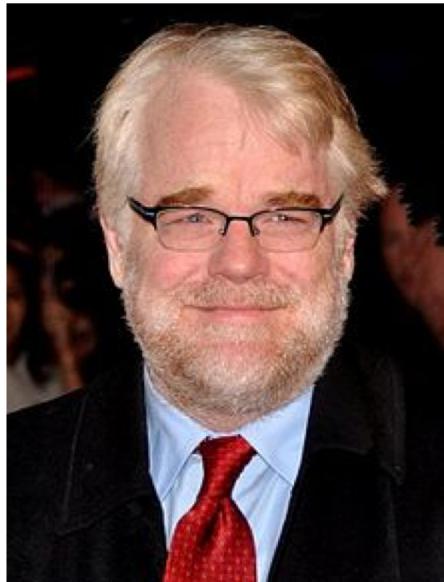


Opioid agonist treatment („substitution therapy“)

- Good evidence for the efficacy of opioid agonist treatment (Cochrane review Mattick et al., 2009)
 - Reduction of heroin use (and cocaine use)
 - Reduction of (Co-)morbidity (infectious diseases etc.)
 - Reduction of mortality
 - Improve quality of life
 - Increases treatment retention
 - cost-efficient

“For most patients, opioid agonist maintenance treatment will result in better outcomes than attempts at withdrawal [...] In particular, patients on opioid agonist maintenance treatment are more likely than those not undergoing such treatment to stay alive, not use heroin, and be in contact with the treatment system” (WHO, 2009)

Opioid Crisis in the USA



„Inside a Killer Drug Epidemic: A Look at America’s Opioid Crisis

The opioid epidemic killed more than 33,000 people in 2015.“

New York Times, Jan, 2017

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Alcohol significantly contributes to the disease burden worldwide and in Switzerland

9/10 people (>15yrs) in Switzerland drink alcohol

8/10 people use alcohol at very low risk levels

A minority of users carry a huge proportion of the disease burden caused by alcohol

Some alcohol users suffer from a state that is considered a mental disorder/disease, i.e. a clinically relevant condition characterised by psychological dysfunctions that are accompanied or result in individual harm and/or severe impairment of social participation (Heinz 2015, 2017)

Alcohol dependence: provisional description of a clinical syndrome

GRIFFITH EDWARDS, MILTON M GROSS

British Medical Journal, 1976, 1, 1058-1061

The American National Council on Alcoholism has recently analysed diagnostic criteria,² and a World Health Organisation group is preparing a report that seeks to define this syndrome and examine its importance.* Furthermore, we take the term syndrome to mean no more than the concurrence of phenomena. Not all the elements need always be present, nor always present with the same intensity. No assumptions need be made about the cause or the pathological process, though the obvious scientific challenge is to understand the underlying reasons for the clustering and covariance.

Essential elements of the syndrome

Essential elements might provisionally include: a narrowing in the repertoire of drinking behaviour; salience of drink-seeking behaviour; increased tolerance to alcohol; repeated withdrawal symptoms; repeated relief or avoidance of withdrawal symptoms by further drinking; subjective awareness of a compulsion to drink; reinstatement of the syndrome after abstinence. All these elements exist in degree, thus giving the syndrome a range of severity. They represent the dimensions along which the clinician can order the information given to him; one clinical element may reflect underlying psychobiological happenings of several types, and different clinical elements may be partial descriptions of the same underlying psychobiological process. In discussing the clinical presentations of each element we shall give particular attention to degrees of possible development and to patterning in presentation by personal and social factors.³





Implication for research and practice

The presumptive clinical identification of this syndrome has considerable significance for research; one important priority is the sharper delineation of the actual syndrome and of its natural histories and social settings—matters to which the everyday business of clinical observation, as well as more formal research, has much to contribute. Beyond this the research challenge is one of determining piece by piece the psychobiological basis. Better theoretical understanding should open possibilities of more effective treatment, in terms of attack on both biological and learning elements in the pathology.

Dependence syndrome (ICD-10)

- A strong desire or sense of compulsion to take the substance
- Impaired capacity to control substance-taking behaviour
- A physiological withdrawal state when substance use is reduced or ceased
- Evidence of tolerance to the effects of the substance (need for significantly increased amounts of the substance)
- Preoccupation with substance use, as manifested by important alternative pleasures or interests being given up or reduced because of substance use
- Persistent substance use despite harmful consequences

Three or more of the these manifestations should have occurred together for at least 1 month or, if persisting for periods of less than 1 month, should have occurred together repeatedly within a 12-month period

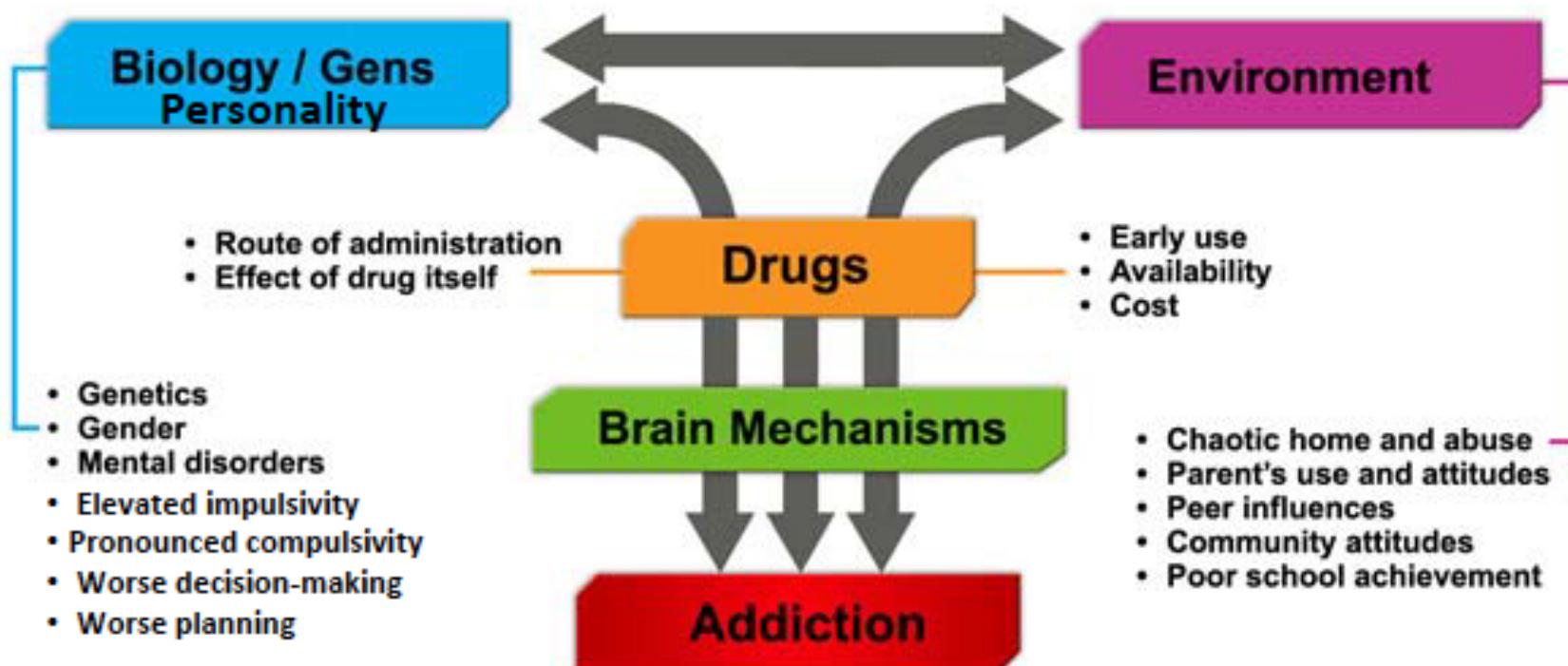
High reliability and psychometric validity of the dependence syndrom
(Hasin, 2006)



Overview

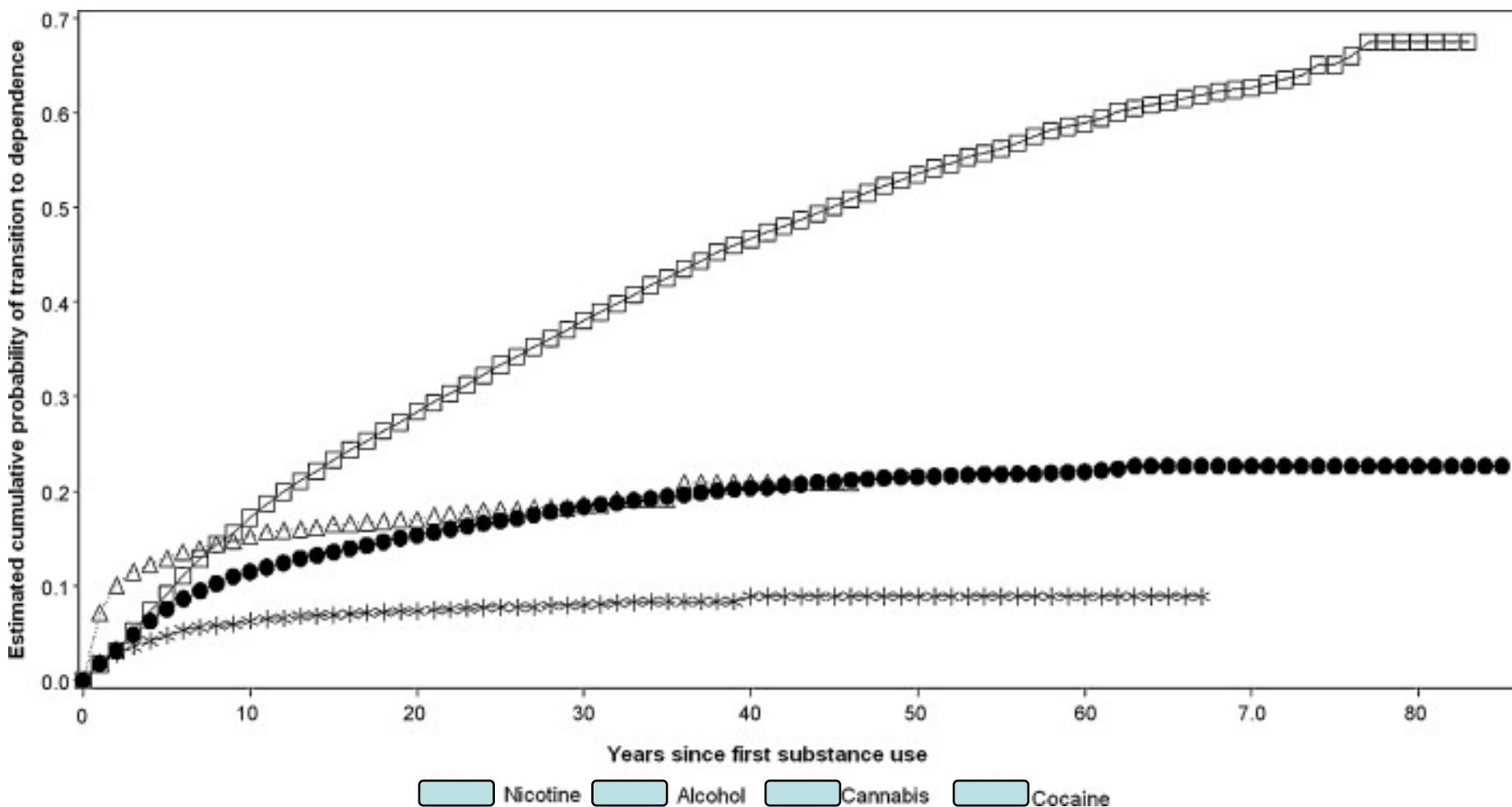
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Factors Leading to Addiction



NIDA, www.drugabuse.gov

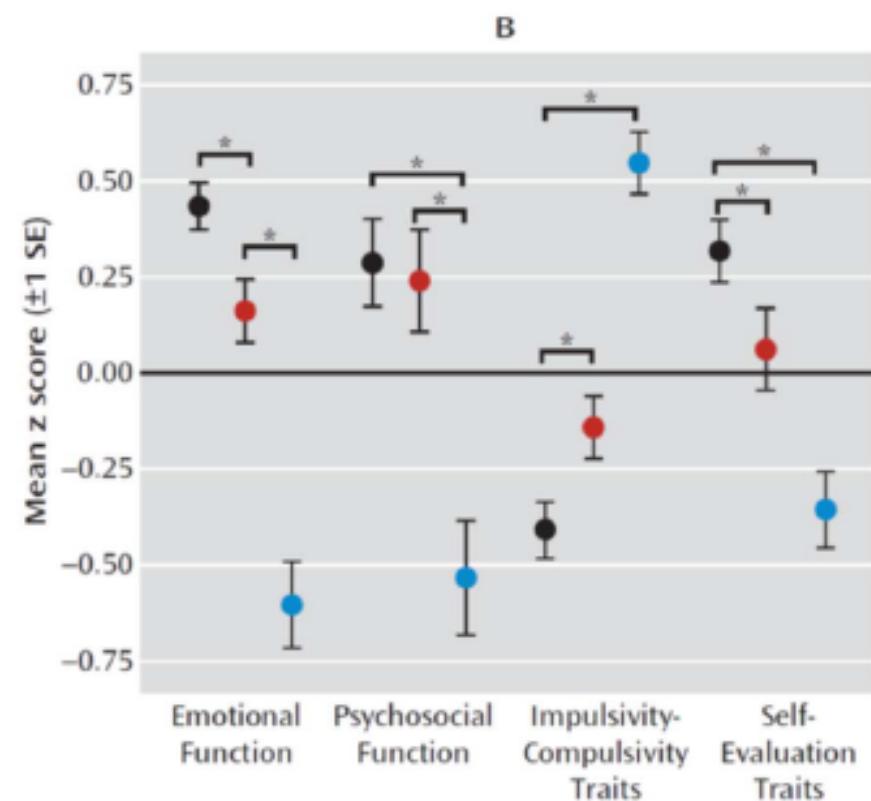
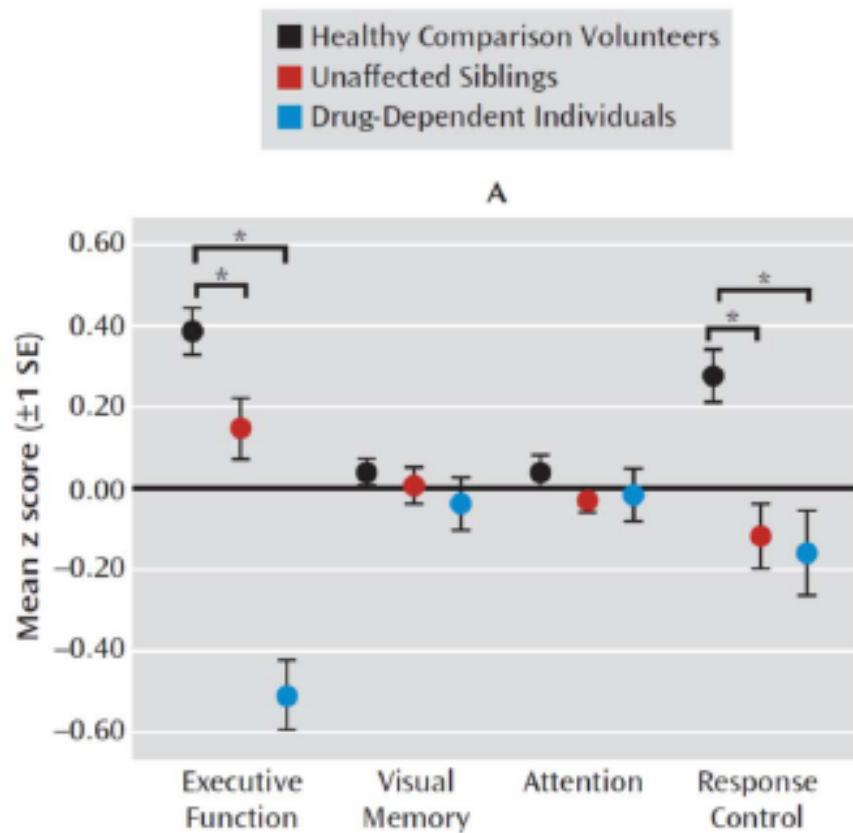
Proportion of users becoming dependent



Lopez-Quintero et al., Drug and Alcohol Dependence, 2011

FIGURE 1. Cognitive and Emotional Profiles of Participants in a Study of Endophenotypes for Drug Dependence^a

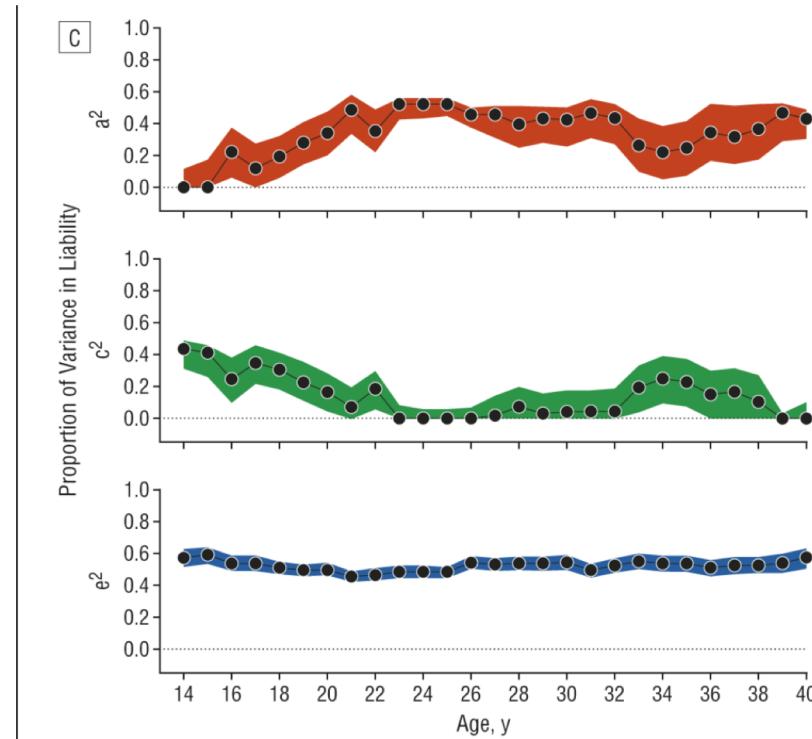
Ersche et al 2012, AJP



Genetic and Environmental Influences on Alcohol, Caffeine, Cannabis, and Nicotine Use From Early Adolescence to Middle Adulthood (Kendler et al)

Arch Gen Psychiatry. 2008;65(6):674-682. doi:10.1001/archpsyc.65.6.674

Liability to alcohol use



Genetic effects

Familial environmental factors

Individual-specific environment

Figure Legend:

Parameter estimates \pm 1 SE for the contributions to variation in liability to psychoactive drug use of additive genetic effects (a^2), familial environmental factors (c^2), and the individual-specific environment (e^2) by year for the average daily number of caffeine-containing drinks for ages 9 to 35 years (A), the average daily number of cigarettes for ages 13 to 35 years (B), the average number of alcoholic drinks consumed per month for ages 14 to 40 years (C), and the average number of units of cannabis consumed per month for ages 14 to 35 years (D). The actual parameter estimates are depicted by the black lines, and the colored regions represent the possible range of estimates \pm 1 SE.

Initiation and early patterns of use are strongly influenced by social and familial environmental factors while later levels of use are strongly influenced by genetic factors

Potential problems of categorical/binary classification systems (ICD/DSM):

- *heterogeneity within category is high*
- *Framework of binary thinking has impact not only on diagnosis but also on therapy and outcome measures (one size fits all-approach)*



Overview

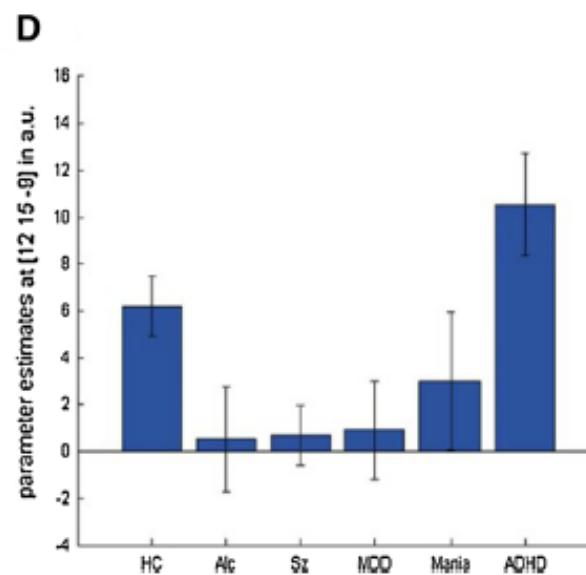
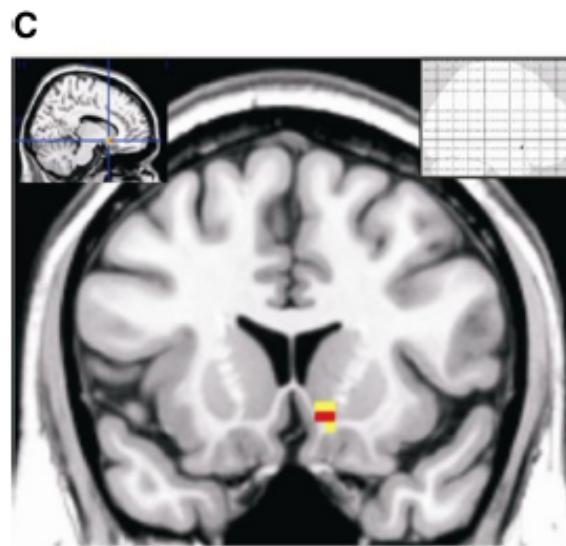
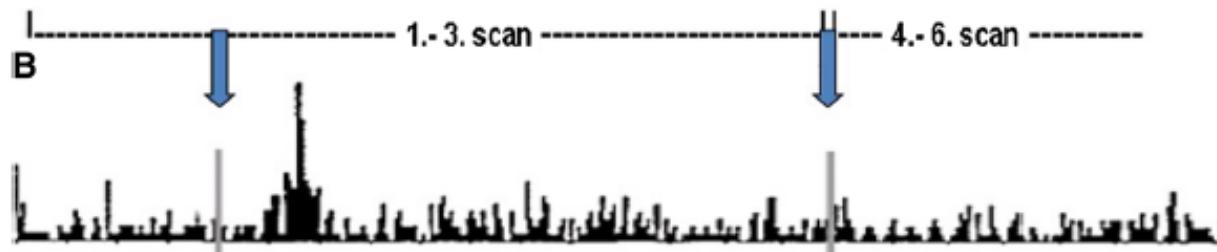
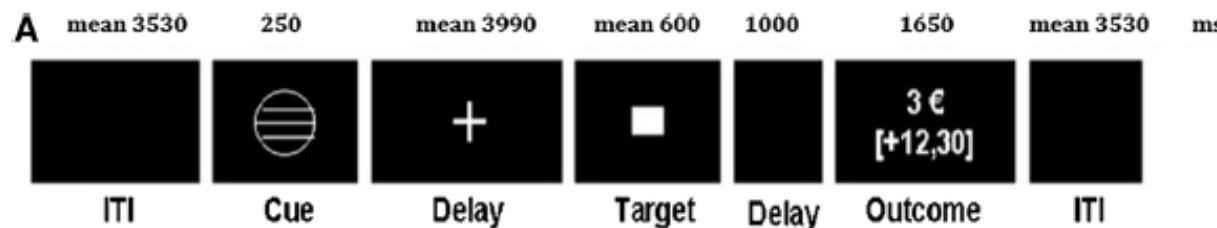
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Neurobiological Perspective

Criticism to categorical/binary systems:

- *Currently more than 300 mental disorders: all with a distinct neurobiological correlate?*
- *Still too much (etiological and functional) heterogeneity within current categories (DSM-5 11 items, i.e. > 2000 potential combinations for fulfilling criteria of SUD)*
- *Need for a framework based on pathophysiology rather than clinical syndromes*

Alternative approach: Basic dimensions of mental dysfunction (RDoC) have common biological correlates that contribute to clinical syndromes across traditional nosologic boundaries.

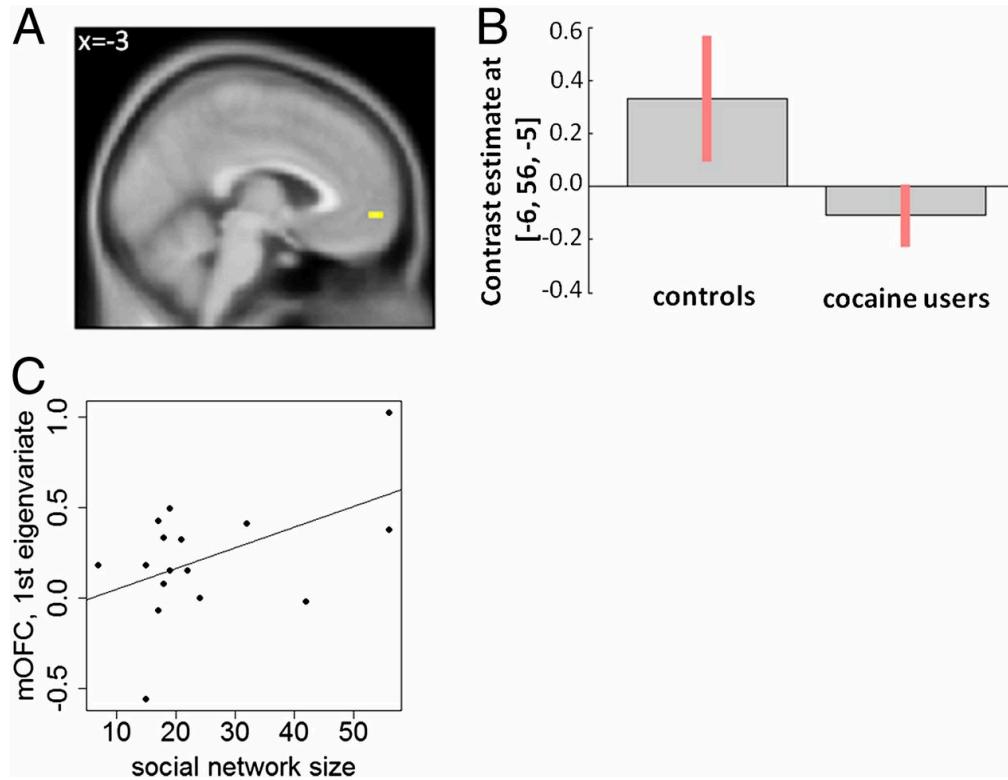


From Heinz et al., 2017

Reward-Deficit Disorder?

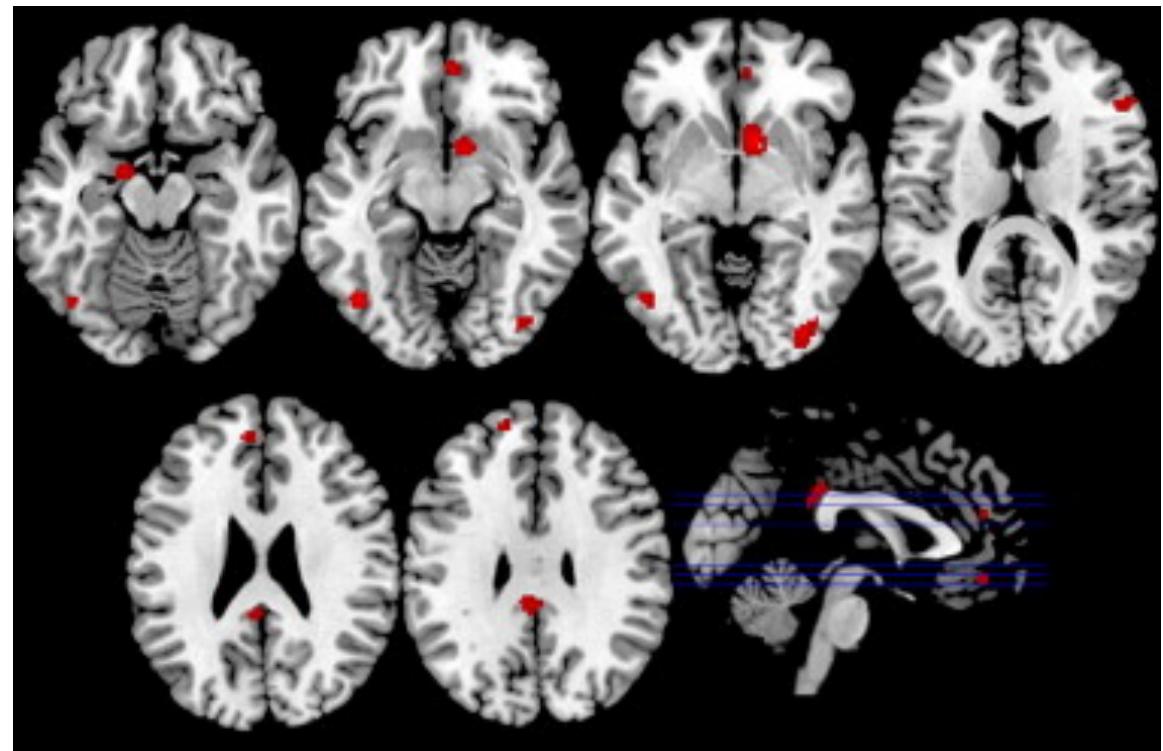
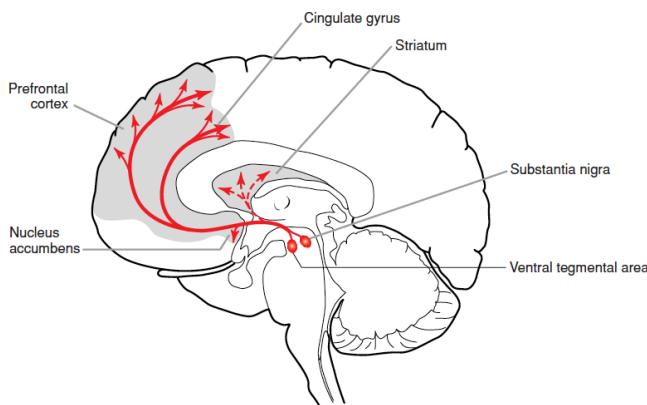
Money is not so important anymore?

Reduced sensitivity to social rewards in cocaine users



Preller et al., PNAS, 2014

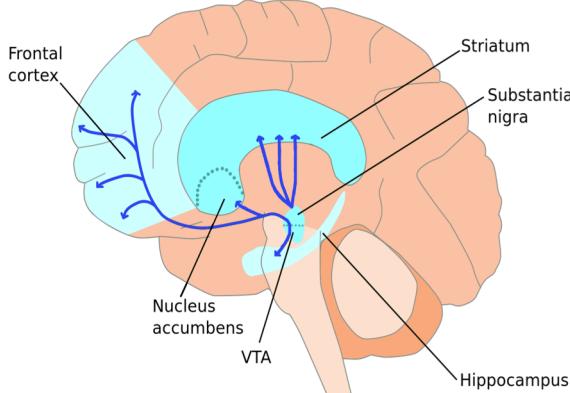
Enhanced drug-cue induced BOLD activity in individuals with SUD



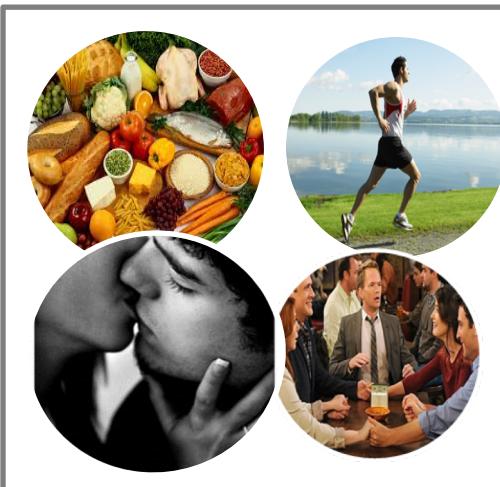
Chase, 2011

Changes within reward circuitry in addictive disorders

Brain reward (dopamine) pathways



Devaluation of non-drug related reinforcers



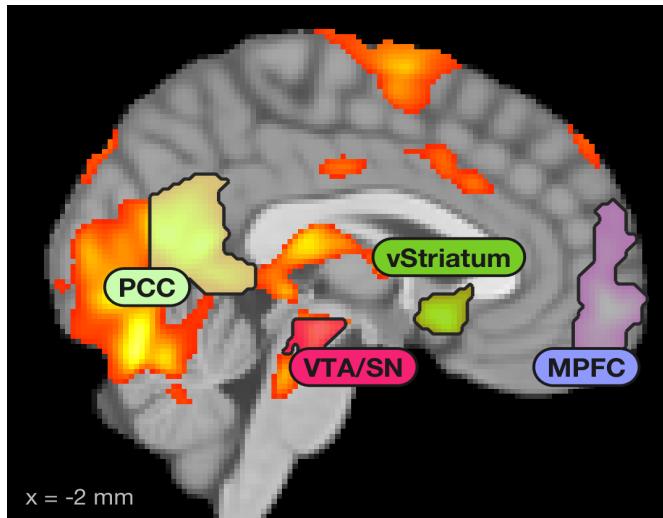
Enhanced sensitivity to drug related cues



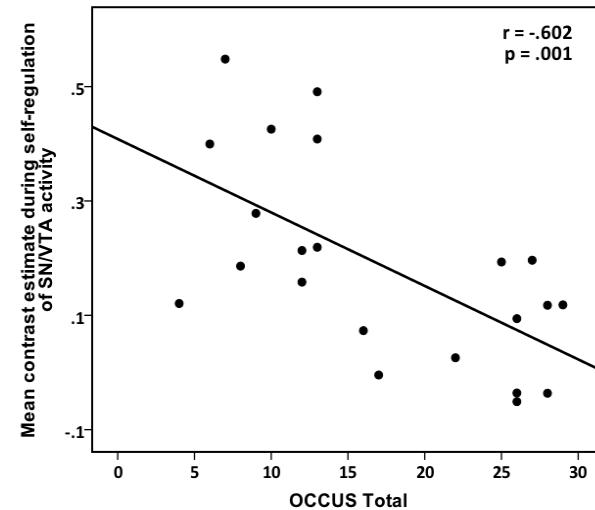
ICD/DSM:

- Craving
- important alternative pleasures or interests being given up

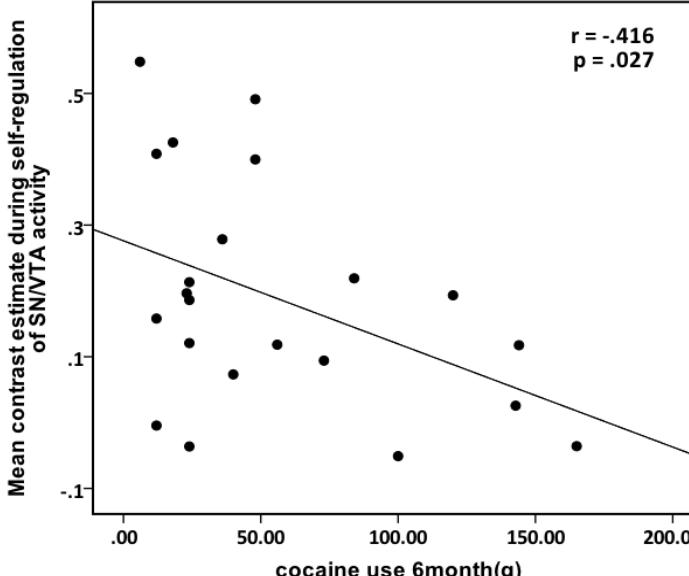
Changes within reward circuitry in addictive disorders



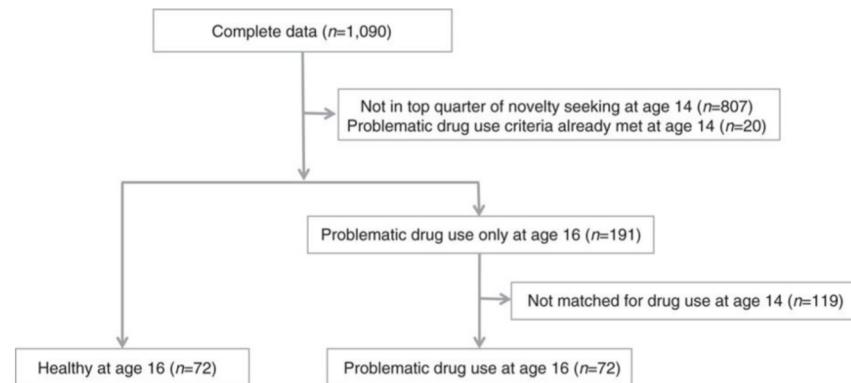
ACTIVITY INDUCED BY IMAGINATION OF
ALTERNATIVE PLEASURES



CRAVING

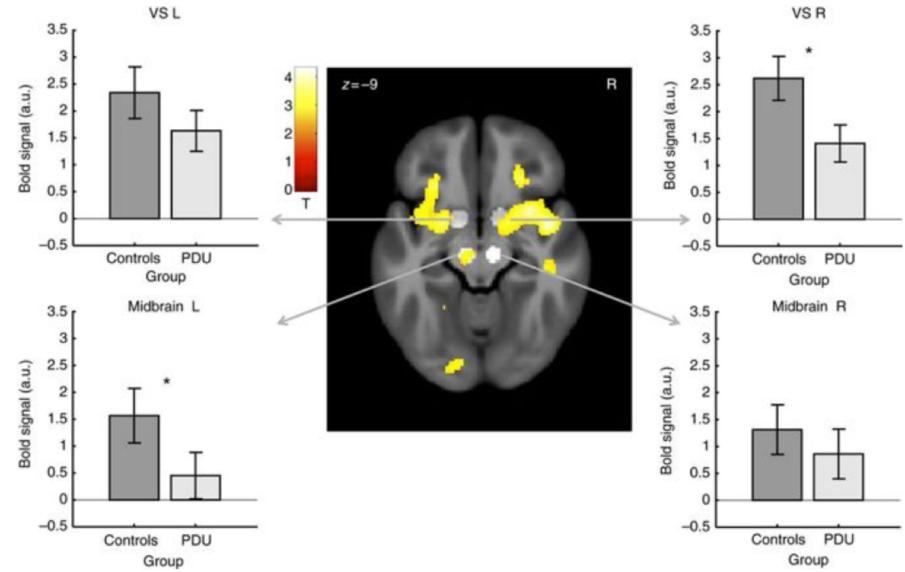


Blunted ventral striatal responses to anticipated rewards foreshadow problematic drug use in novelty-seeking adolescents



Out of 1090 subjects with full datasets, the top quarter of novelty seekers who had not already met criteria for problematic drug use at age 14 were selected. Those who showed problematic drug use at age 16 were matched with those who did not with respect to drug use at age 14 (n=72 per group, 144 total).

Figure 2: Subcortical brain activity in anticipation of large versus small gains for control subjects (n=72) versus problematic drug users (n=72).



Büchel et al., *Nature Communications*, 2017

Review

Addictions Neuroclinical Assessment: A Neuroscience-Based Framework for Addictive Disorders

Laura E. Kwako ^a  , Reza Momenan ^b, Raye Z. Litten ^c, George F. Koob ^d, David Goldman ^{a, e}**Table 1. Comparison of ANA and Related Initiatives**

	ANA	RDoC	iRISA	IMAGEN	PhenX	CNTRICS
Neuroscience Domains	✓	✓	✓	✓		✓
Standardized Assessment Package	✓			✓	✓	✓
Disseminate Package to Various Settings	✓			✓	✓	✓
Identify Meaningful Subtypes of Disorder	✓	✓			✓	
Describe Individualized Treatments		✓			✓	

ANA, Addictions Neuroclinical Assessment; CNTRICS, Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia; iRISA, Impaired Response Inhibition and Salience Attribution; RDoC, Research Domain Criteria.

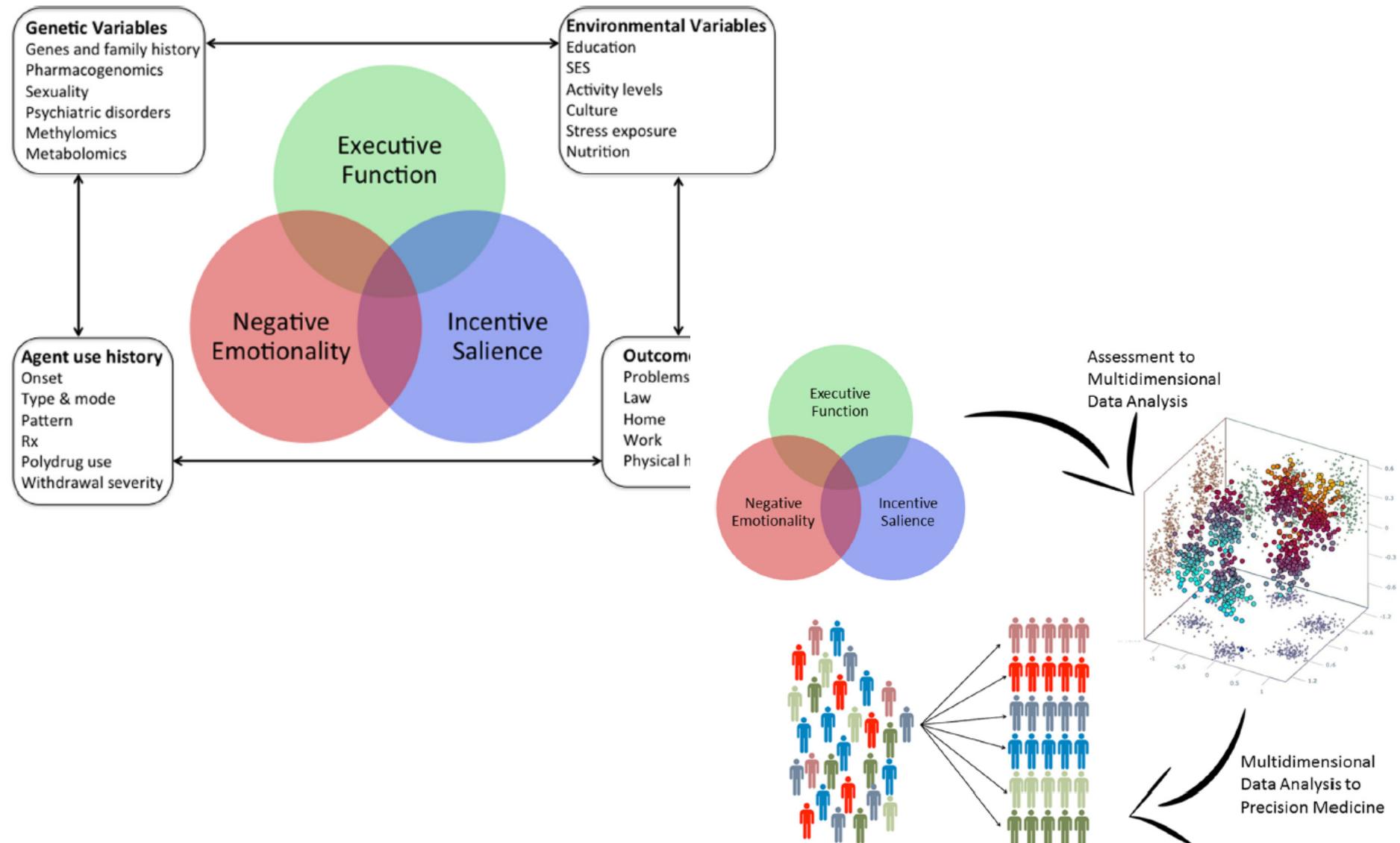
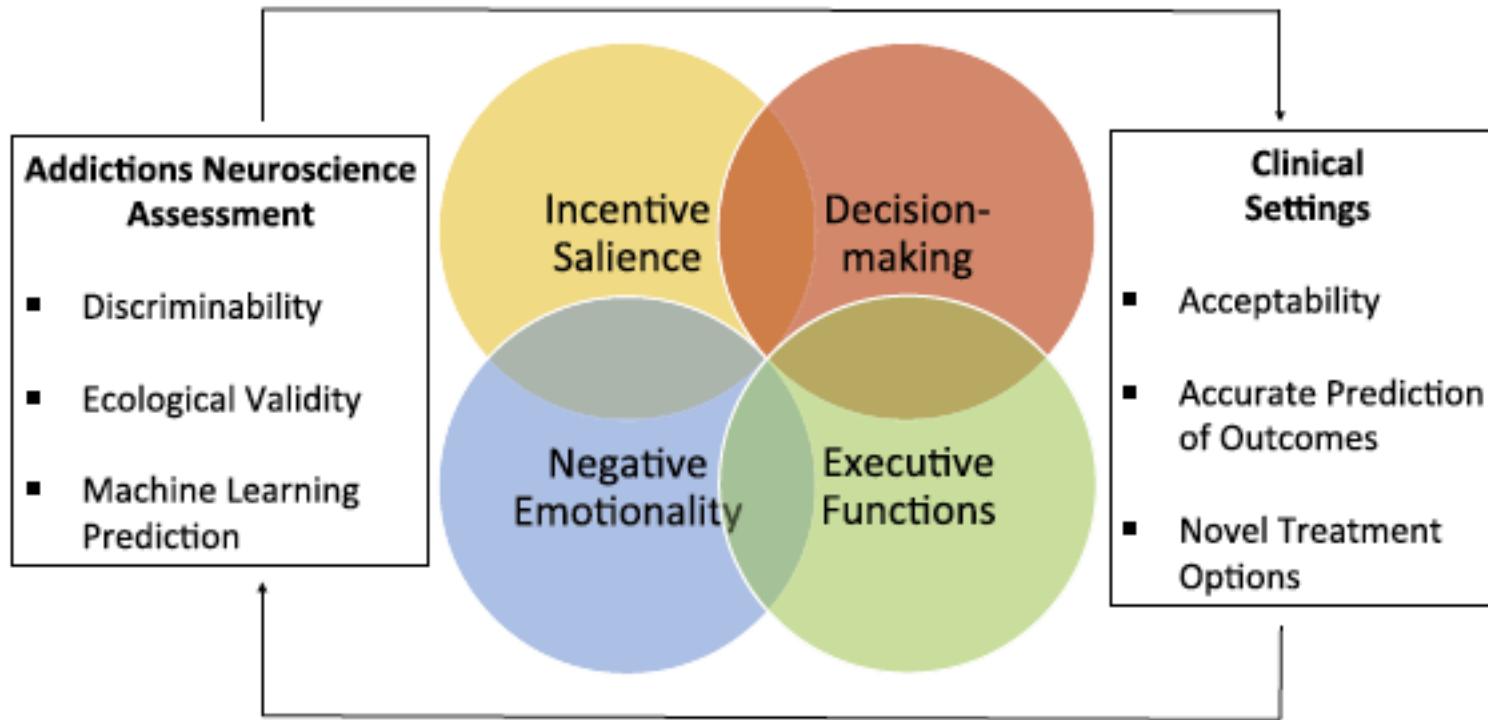


Table 2. Proposed Measures for ANA

Measure	Time to Complete	Type of Task
Executive Function		
Stop Signal Reaction Task (123)	10 minutes	Behavioral
Appetitive Go-NoGo (124)	10 minutes	Behavioral
Continuous Performance Test (125)	15 minutes	Behavioral
Tower of London (126)	15 minutes	Behavioral
Wisconsin Card Sorting Test (127)	15 minutes	Behavioral
Delay Discounting (128)	15 minutes	Behavioral
N-Back (129)	10 minutes	Behavioral
Beads in a Jar Task (130)	5 minutes	Behavioral
Barratt Impulsiveness Scale (131)	5 minutes	Self-report
Negative Emotionality		
Approach Avoidance Task (132)	10 minutes	Behavioral
Cyberball (133)	10 minutes	Behavioral
Trier Social Stress Test (134)	20 minutes	Behavioral
Cold Pressor Task (135)	10 minutes	Behavioral
Digit Span (136)	5 minutes	Behavioral
Two-Step Task (Model-Free Model-Based) (137)	15 minutes	Behavioral
Beck Depression Inventory (138)	5 minutes	Self-report
Beck Anxiety Inventory (139)	5 minutes	Self-report
Fawcett-Clark Pleasure Scale (140)	5 minutes	Self-report
Toronto Alexithymia Scale (141)	5 minutes	Self-report
Childhood Trauma Questionnaire (142)	5 minutes	Self-report
Facial Emotion Matching Task (143)	10 minutes	Neuroimaging
Incentive Salience		
Choice Task (Explicit Version) (144)	15 minutes	Behavioral
Dot-Probe Attentional Bias Task (Cues) (145)	10 minutes	Behavioral
Obsessive-Compulsive Drinking Scale (146)	5 minutes	Self-report
Cue Reactivity Task (80)	10 minutes	Neuroimaging
Monetary Incentive Delay Task (147)	10 minutes	Neuroimaging

ANA, Addictions Neuroclinical Assessment.



- *Adds another functional domain*
- *Suggests other task set to evaluate domain*
- *Questioning ecological validity (relationship between neuropsychological assessment and measures of daily life involvement and meaningful clinical outcomes)*
- *Questioning acceptance (>10h) also in clinical settings*

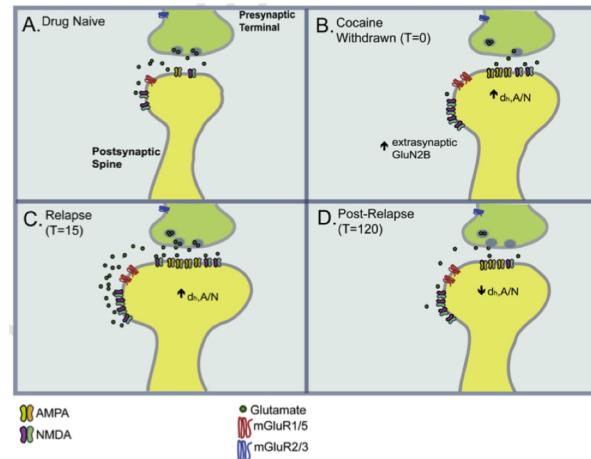
Verdejo-Garcia 2016, Comment on Kwako et al.

Animal models of addiction

The glutamate homeostasis hypothesis of addiction

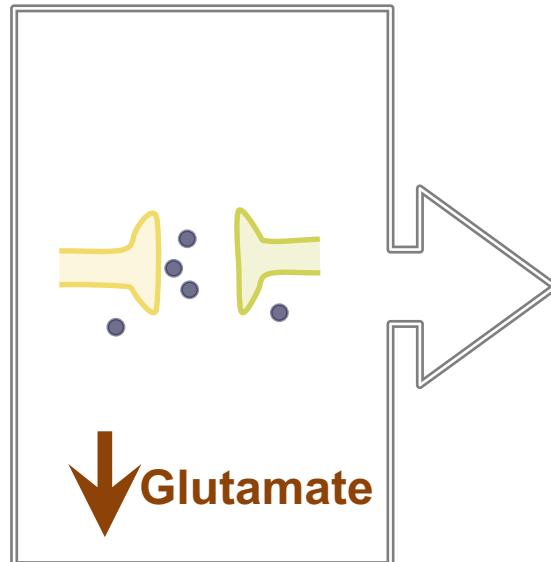
Peter W. Kalivas

Abstract | Addiction is associated with neuroplasticity in the corticostriatal brain circuitry that is important for guiding adaptive behaviour. The hierarchy of corticostriatal information processing that normally permits the prefrontal cortex to regulate reinforcement-seeking behaviours is impaired by chronic drug use. A failure of the prefrontal cortex to control drug-seeking behaviours can be linked to an enduring imbalance between synaptic and non-synaptic glutamate, termed glutamate homeostasis. The imbalance in glutamate homeostasis engenders changes in neuroplasticity that impair communication between the prefrontal cortex and the nucleus accumbens. Some of these pathological changes are amenable to new glutamate- and neuroplasticity-based pharmacotherapies for treating addiction.

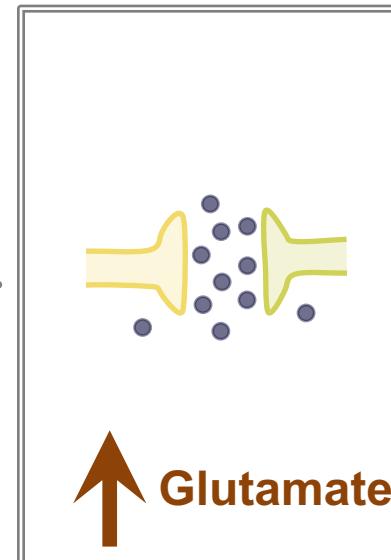


Gipson et al. 2014,
Neuropharmacology

Withdrawal

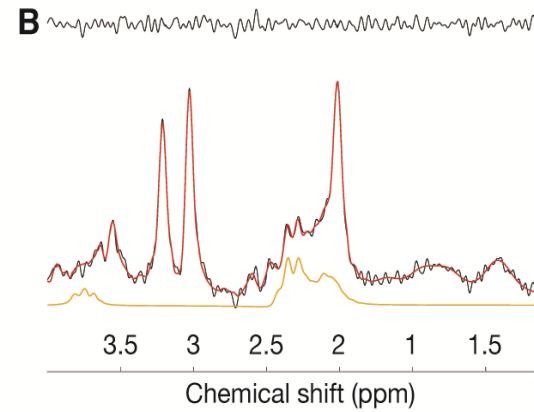
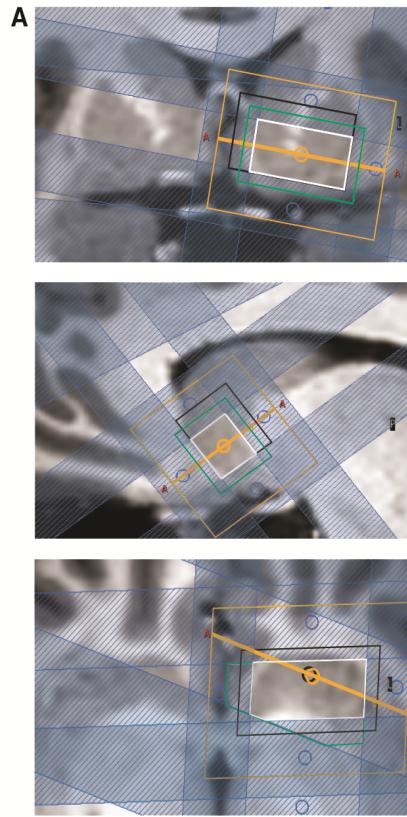


Cue-induced Craving/Relapse state



Adapted from Kalivas, NRN, 2009

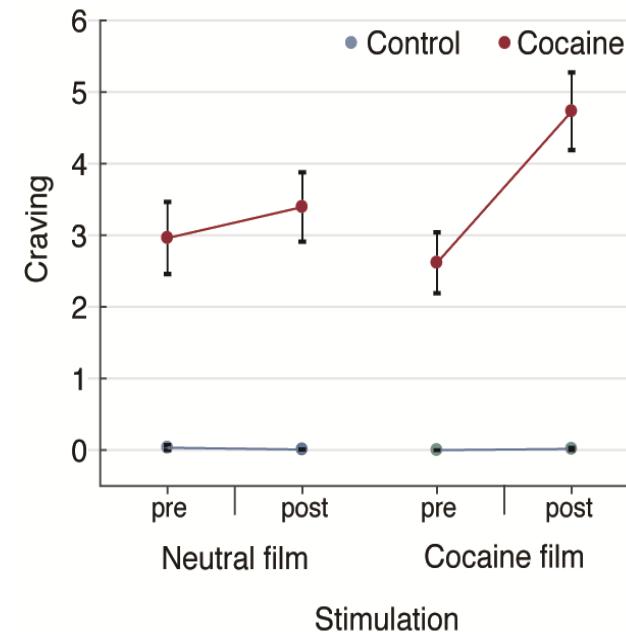
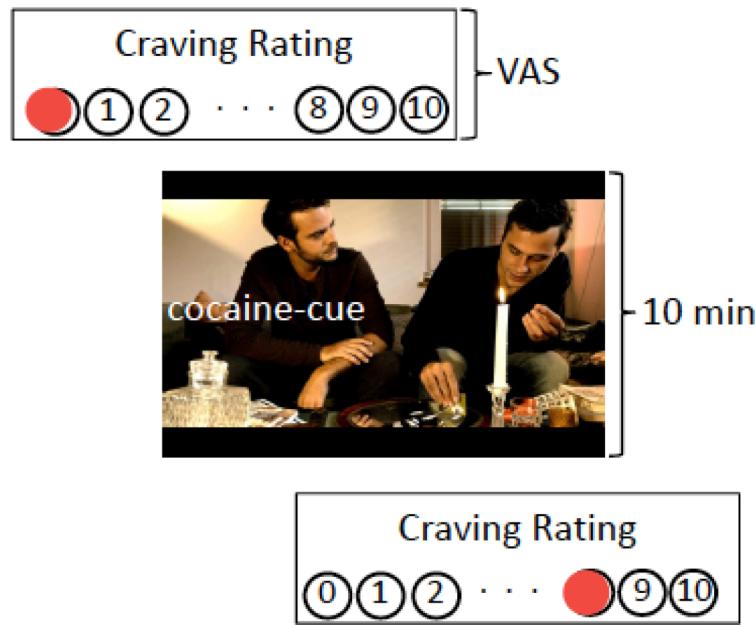
Improved MRS enable Glu Quantification in small voxels



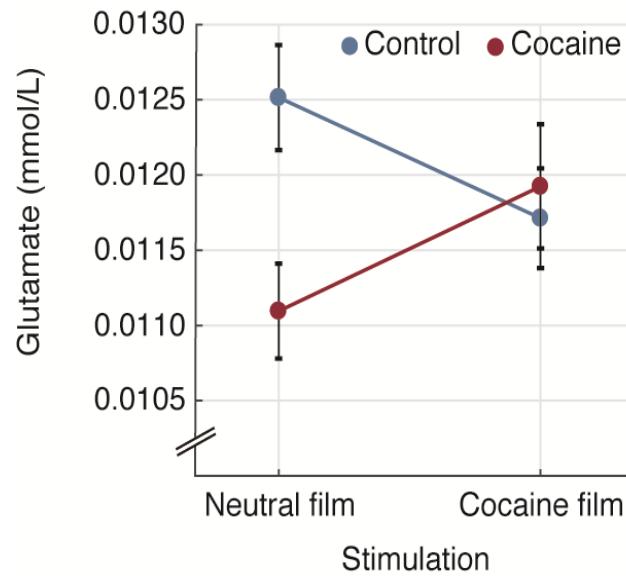
Engeli et al., under review

Optimised MRS protocols (PRESS, non-water-suppressed, metabolite cycling, drive scale; Hock et al. 2013, 2014, 2016; Zoelch in prep.): good signal in Nucl. Accumbens ; absolute Glu quantification

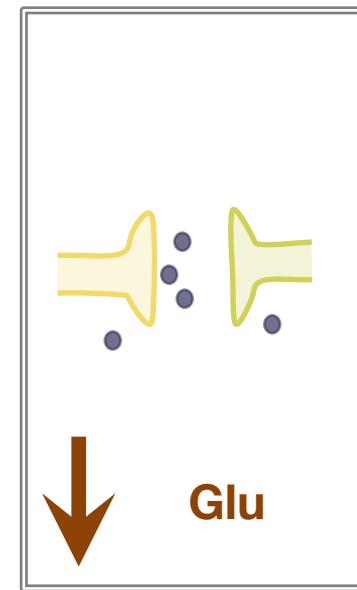
Craving Induction Paradigm



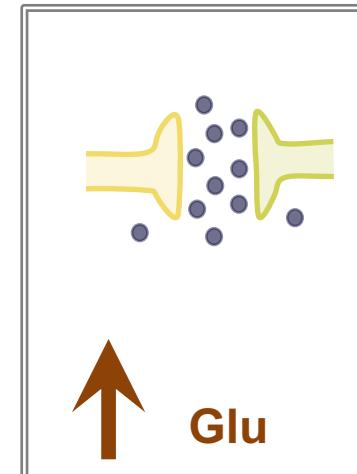
Engeli et al., under review



Engeli et al., under review

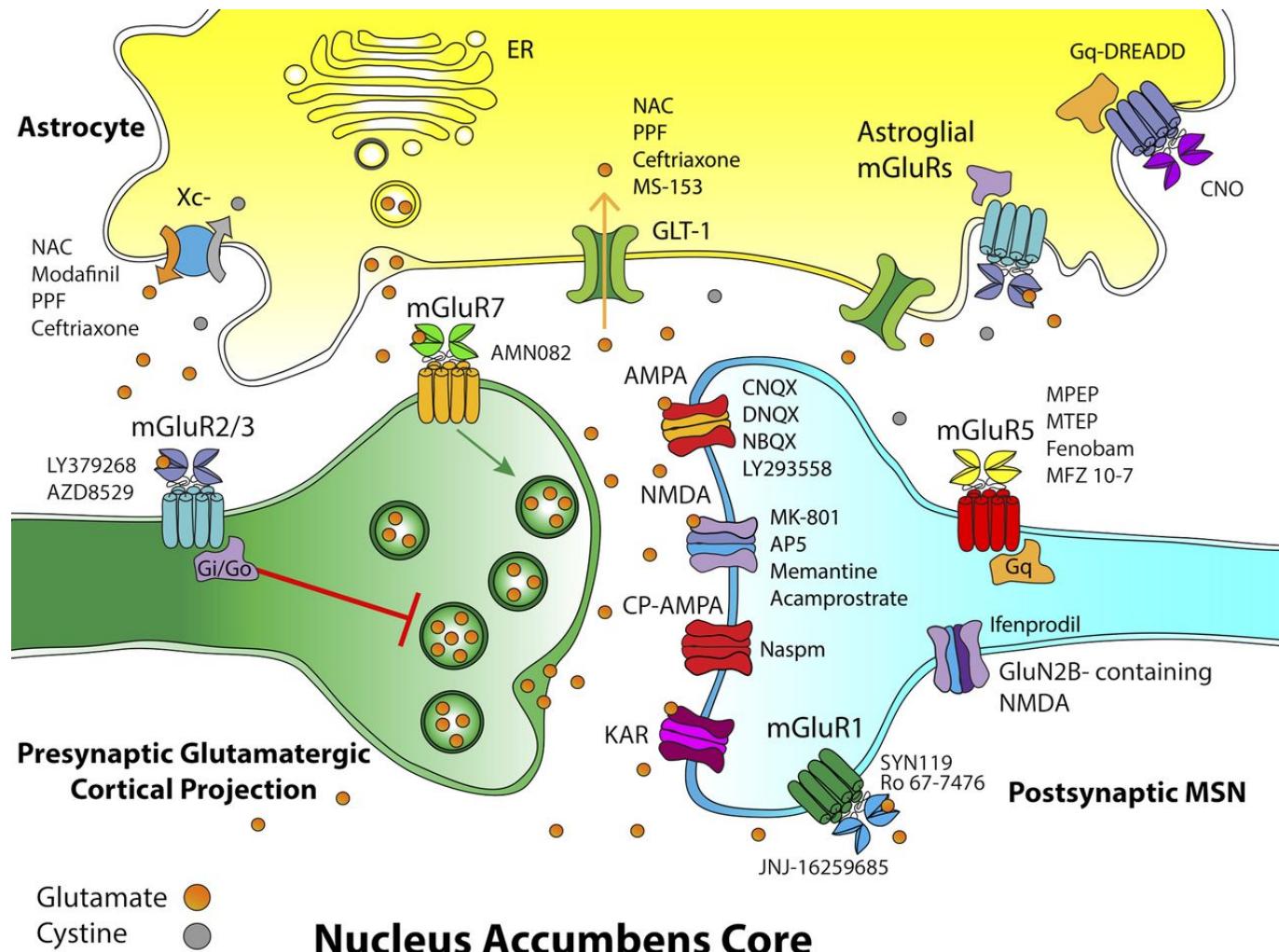


*After
chronic use*



Craving

Pharmacological targets at the glutamatergic NAcore synapse.



M. D. Scofield et al., *Pharmacol Rev*, 2016



PHARMACOLOGICAL
REVIEWS

Summary / Questions



- *Use of psychotropic substances is common and significantly contributes to global disease burden; only a minority of users becomes addicted (multifactorial etiology)*

Who is at risk for becoming addicted?

Can we developed individualised preventive interventions?

- *Current categorical classifications are well suited for identification of individuals with clinically significant dysfunction (high validity and reliability); however, binary classifications are not suited to characterise the heterogeneity of SUD well enough in order to further improve etiological understanding, therapy, and prediction of outcome;*

How can we better „characterise“ affected individuals across different domains (bio-psycho-social) and across different levels (molecular, circuit, etc.)?

Can such a multidimensional characterisation enable e.g. better predictions of treatment response for individuals (personalised medicine)?

- *Good animal models of addictive behavior (as compared to other psychiatric conditions)*

Can CP ease the transfer of knowledge from animal models to clinics (or vice versa) and thus foster translational research?