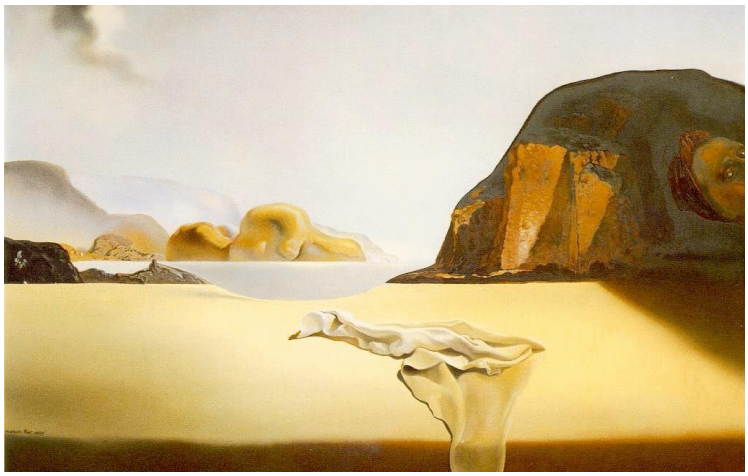
University of Sussex

Drugs, Brain & Behaviour (C8528)



3rd year
15 Credits
Spring Term 2017

Conveners:
Dr. Hans S. Crombag & Dr. Eisuke Koya
Behavioural & Clinical Neuroscience (BCN) Research Group
School of Psychology and Sussex Neuroscience
The University of Sussex

Module Structure Aims & Objectives

The ‘Drugs, Brain and Behaviour’ module examines the biological- and behavioural bases of drugs of abuse and addiction, by integrating knowledge from psychology, neuroscience, behavioural pharmacology and psychopharmacology. The module assumes that you have completed both the Psychobiology (c8003) and Brain & Behavior (c8518) modules (or equivalent modules/courses elsewhere) and that you have an interest in biological approaches to the study of behaviour. The module begins by reviewing some basic pharmacology, including drug nomenclature, pharmacokinetic- and dynamic factors that influence the actions of drugs on biological tissue, and behavioural pharmacological models used to assess the behavioural, cognitive and motivational effects of psychoactive drugs. Next, we review and extend your understanding of synaptic transmission, examine evidence of how different psychoactive drugs affect key neurotransmitter systems (and more generally, how these neurotransmitter systems are regulated), and the acute and long-term consequences for neuronal function, mood, cognition, and behaviour including behaviours thought to contribute to abuse and addiction. The following major classes of recreational and potentially addictive drugs are discussed: opiates (heroin, morphine, opium), psychomotor stimulants (amphetamine, cocaine), sedative-hypnotics (alcohol), nicotine, marijuana, hallucinogens (PCP, ketamine, LSD, mescaline), and hallucinogenic-stimulants (MDA, MDMA). Finally, with this knowledge in hand, the last 3 lectures of the module are dedicated to exploring contemporary concepts and theories of addiction, including opponent-process/negative reinforcement views, positive incentive-learning views and more recent ideas around prefrontal dysfunction in addiction. In doing so, we further explore the psychology and neurobiology of learning and motivation, including the role of dopamine and the nucleus accumbens and its connections, and the long-term actions (plasticity) of addictive drugs on these and related brain systems.

Note that the module does not deal with the social aspects of addiction nor does it explicitly cover therapeutic approaches to treat addiction and relapse, simply because there is insufficient time to cover all these topics in a single module. To be sure, a complex behaviour such as addiction may or must have several levels of explanation and the module attempts to integrate these different levels of explanation to provide an account of drug abuse and addiction from the biopsychological perspective.

Module learning outcomes

The learning outcomes of the module are:

- Understand concepts and principles in pharmacology, behavioural pharmacology and the neuroscience of drugs of abuse;
- Understanding how drugs alter biological function and behaviour in the context of addiction;
- Understanding the relevance of underlying biological phenomena to the explanation of drug abuse and addictive behaviour;
- Critically discuss and analyze (including in the form of an extended essay) major concepts and theoretical models of drug abuse addiction.

Pre-requisites

If you are a psychology student, you should (will) have taken Psychobiology in your 1st year and Brain & Behaviour in your 2nd year. If you are from Life Sciences, or a visiting (V&E) student, you should have taken equivalent biological psychology/neuroscience module(s) in the preceding years.

Module Contact Information

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Teaching and Learning

Lectures

There are two 2-hr lectures per week and the times and location are available through your Sussex Direct timetable. Though timetabled for 2 hours (see below for a more detailed lecture schedule), most of the lectures are aimed to last between 1 and 1.5 hrs. so to allow ample opportunity for questions and discussion. To avoid disruption to others, please arrive at least 5 minutes before the start time of the lecture.

IMPORTANT: As you will be aware, the University has an 80% attendance requirement and attending the lectures will ensure that you are maximally engaged with the materials. So, though we record all lectures, you should not take this to mean that you can readily skip lectures and catch up by listening to the recordings. First, because the temptation will be to catch up ‘at a later date’, i.e., just before the tests when it matters most, but in that case you will fall behind during the term and have a much more difficult time comprehending and integrating the subsequent lectures. Second, because listening to lectures ‘at home’ is much less likely to grab and hold your attention then when you are physically present and listening. How well you do in this (or any) module during your studies is directly related to how frequent, consistently and attentively you engage with the materials. This is one of the most consistent findings in the field of educational psychology and is furthermore supported by a wealth of evidence about how learning and memory fundamentally work. Certainly, ‘cramming’ for exams/tests works to a degree, but attending lectures, self-studying *consistently* (before and/or after each lecture) by reading the textbook and all essential and suggested (and especially finding additional sources of information yourself) will avoid you a lot of ‘headache’ and help you do well in this and future modules.

Student Feedback Sessions

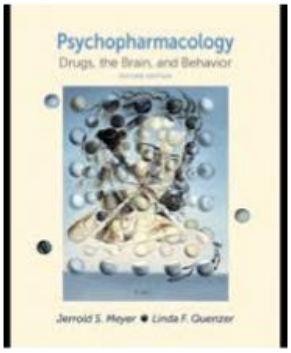
Your module conveners will hold student feedback sessions each week and students may use these (without appointment) to discuss or ask about anything module-related.

Study Direct

All the critical module materials are provided through the module's Study Direct site, including essential and suggested Readings. Additionally, the lecture slides will be made available for downloading the day (usually, but perhaps not always, 24 hrs.) before the actual lecture meeting so you are able to download and/or print these before attending the lecture.

One of the best ways to share ideas amongst your fellow students and ask questions about the module is through the Study Direct Forum. The module conveners will monitor the Forum and, if necessary, answer specific questions that you may have and that have not been addressed already by fellow students, correct and/or add to ongoing discussions etc. But, to encourage discussion between the students, the convener will wait for students to engage in discussion first.

Module materials



Textbook and readings

The required text for this module is: J. S. Meyer & L. F. Quenzer, Psychopharmacology: *Drugs, the Brain and Behavior*, Sinauer, 2013. (ISBN 978-0-87893-510-9) and is available at a reduced price through the John Smith's bookstore.

Additionally, we have indicated selected essential or suggested readings for each lecture-topic separately. Most of these are journal articles and therefore freely available for you to download while on campus, via e.g., Google Scholar or pubmed.

Assessment

One hundred percent of your final mark for Drugs, Brain & Behaviour consists of course work consisting of the following components:

1) Two (in-class) Tests (50% of your final mark)

You are required to complete 2 in-class tests consisting of multiple choice and short answer questions. Each test is worth 25% of your final mark and will focus on the materials covered in the lectures and the assigned readings. Further details about these tests are provided during the first lecture(s) and via Study Direct.

2) One 3000-word Essay (50% of final mark)

Information about the essay, including requirements, expectations, and essay titles that you can choose from will be made available at the end of week 2 through the module's Study Direct side. Make sure that you take a look at the assessment criteria used to mark your essay so that you have a better idea of 'what we are looking for' in your assessments.

In line with University regulations, every effort will be made to ensure that a marked copy of the tests and essay are available with feedback within 15 working days of the relevant submission deadline.

Assessment information

Assessments deadlines and methods of submission can be found on your assessment timetable via Sussex Direct.

Information on the following can be found at the link below:

- Submitting your work
- Missing a deadline
- Late penalties
- Exceptional circumstances
- Exams
- Help with managing your studies and competing your work
- Assessment Criteria

http://www.sussex.ac.uk/psychology/internal/students/examinationsandassessment

Attendance, Absence and Engagement

You are expected to be 'in attendance' at the University for the full duration of the published term dates for your course of study. That means you should be regularly attending lectures, seminars, labs etc. and committing time to your studies to be in a position to comply with academic and administrative expectations.

The university has an 80% attendance policy in place, so it's really important that you let us know if you are ill or cannot attend classes so that we can register this as a notified absence.

If you are unable to attend your seminars or workshops, you need to send an email to psychologyabsence@sussex.ac.uk setting out the following information:

- Seminar(s) / workshop(s) that you will be absent from (list all of them)

- Tutor name

- Brief reason for absence

Please see the following link for further information:
http://www.sussex.ac.uk/psychology/internal/students/attendance

Student Evaluations

The module convenor will create opportunities for you to provide feedback (online, on paper, and/or in person) on your experience of the module during the term. In addition, you will be asked to complete an online course evaluation questionnaire at the end of every term, and this will provide an opportunity for you to comment on each module as well as the course overall.

Lectures and seminar schedule (subject to some change)

Wk.	Day	Date	Lecture topic	Lecturer
1	Mon	30-Jan	1. Introduction	Crombag
	Tues	31-Jan	2. Kinetics	Crombag
2	Mon	6-Feb	3. Dynamics	Crombag
	Tues	7-Feb	4. Behavioral Pharmacology	Crombag
3	Mon	13-Feb	5. Synaptic transmission I	Koya
	Tues	14-Feb	6. Synaptic transmission II	Koya
4	Mon	20-Feb	7. Opioids I	Crombag
	Tues	21-Feb	8. Opioids II	Crombag
5	Mon	27-Feb	9. Stimulants I	Koya
	Tues	28-Feb	10. Stimulants II	Koya
6	Mon	6-Mar	11. Synaptic plasticity I	Koya
	Tues	7-Mar	Revision meeting	Crombag/Koya
7	Mon	13-Mar	In class test 1	
	Tues	14-Mar	12. Synaptic plasticity II	Koya
8	Mon	20-Mar	13. Hallucinogenics	Koya
	Tues	21-Mar	14. Marijuana	Koya
9	Mon	27-Mar	15. Nicotine	Dixon
	Tues	28-Mar	16. Alcohol	Dixon
10	Mon	3-Apr	17. Addiction I	Crombag
	Tues	4-Apr	18. Addiction II	Crombag
			(April 8th- 23rd) Easter Teaching Break	
11	Mon	24-Apr	19. Addiction III	Crombag
	Tues	25-Apr	Revision meeting	Crombag/Koya
12	Mon	1-May	May Bank holiday	
	Tues	2-May	In class test 2	

Lecture 1. Introduction

In addition to outlining the module's organization and logistics, including the assessment structure, the first meeting explores common terminology related to drug classifications, drug abuse and addiction.

Suggested reading

Nutt, D. J., King, L. A., Phillips, L. D., & Independent Scientific Committee on Drugs. (2010). Drug harms in the UK: A multicriteria decision analysis. *Lancet*, *376*(9752), 1558-65.

Lectures 2 & 3. Pharmacokinetics and dynamics

These 2 lectures provide some necessary understanding from two sub-disciplines of pharmacology that examine the factors and conditions that determine how drugs reach their brain target (pharmacokinetics) and, once they do, whether and how they produce their pharmacological action(s) (pharmacodynamics). This basic knowledge is essential for better understanding aspects of drug abuse and addiction (e.g., why certain routes of administration are 'preferred' over others) as well as for your ability to appreciate experimental approaches used to study drug abuse and addiction.

Essential reading

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013: Chapter 1.

Suggested readings

Gossop, M., Griffiths, P., Powis, B., & Strang, J. (1992). Severity of dependence and route of administration of heroin, cocaine and amphetamines. *British Journal of Addiction*, *87*(11), 1527-36.

Samaha, A. N., & Robinson, T. E. (2005). Why does the rapid delivery of drugs to the brain promote addiction? *Trends in Pharmacological Sciences*, *26*(2), 82-7.

Lecture 4. Behavioural Pharmacology

In first instance, understanding drug abuse and addiction is about understanding behaviour and how behaviour changes as a result of drug use. For this reason, experiments in this area use a multitude of behavioural assays and methods, most often using non-human subjects. This lecture offers an initial overview of some of the most commonly used assays and methods and critically explores what these (claim to) measure and their methodological and interpretational limitations.

Essential readings

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013: Chapter 4.

Suggested readings

Lynch, W. J., Nicholson, K. L., Dance, M. E., Morgan, R. W., & Foley, P. L. (2010). Animal models of substance abuse and addiction: Implications for science, animal welfare, and society. *Comparative Medicine*, *60*(3), 177-88.

Shippenberg, T.S., & Koob, G.F. (2002). Recent advances in animal models of drug addiction. In K. Davis (Ed.), *Neuropsychopharmacology: The fifth generation of progress : An official publication of the american college of neuropsychopharmacology.* Philadelphia: Lippincott Williams & Wilkins.

Stephens, D. N., Duka, T., Crombag, H. S., Cunningham, C. L., Heilig, M., & Crabbe, J. C. (2010). Reward sensitivity: Issues of measurement, and achieving consilience between human and animal phenotypes. *Addiction Biology*, *15*(2), 145-68.

Lecture 5 & 6. Synaptic transmission

The principal effect of drugs in the central nervous systems is to alter synaptic neurotransmission (NT), e.g., by inhibiting or increasing NT release, blocking or facilitating receptor binding, or by mimicking endogenous NTs. Therefore, to understand how (acute or chronic) experience with drugs of abuse alter neurobiological function requires a thorough understanding of synaptic neurotransmission, including the mechanisms involved in the release of NTs, the pre- and post-synaptic receptors these bind to, and the neurobiological consequences (e.g., gene expression).

Essential readings

J. S. Meyer and L. F. Quenzer, Psychopharmacology: Drugs, the Brain and Behavior, Sinauer, 2013. Chapter 2 for a quick review, Chapter 3, pp. 78-93, Chapter 8, pp. 202-214

Suggested readings

Rizzoli, S. O., & Betz, W. J. (2005). Synaptic vesicle pools. *Nature Rev Neuroscience*, *6*(1), 57-69.

Bennett, M. R. (1999). The early history of the synapse: From plato to sherrington. *Brain Research Bulletin*, *50*(2), 95-118.

Lecture 7 and 8. Opioids

These 2 lectures examine the 1st major class of recreational and addictive drugs, Opioid drugs. There are many different, naturally occurring or (semi-)synthetic compounds that belong to this class (e.g., morphine, heroin, fentanyl), but they all have in common that they act on opioid receptor mechanisms in- and outside the central nervous system. The lectures cover the history of (medical and recreational) use of different opioid compounds, their origins, the role, function and synthesis of endogenous opioid peptide transmitter- and receptor mechanisms, and the physiological, neurobiological and behavioural factors (including the role of associative learning) and consequences of opioid action.

Essential readings

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013: Chapter 11.

O'Brien, C. P., Testa, T., O'Brien, T. J., Brady, J. P., & Wells, B. (1977). Conditioned narcotic withdrawal in humans. *Science*, *195*(4282), 1000-1002.

Suggested readings

Robins, L. N. (1993). The sixth thomas james okey memorial lecture. Vietnam veterans' rapid recovery from heroin addiction: A fluke or normal expectation? *Addiction, 88*(8), 1041-54.

De Vries, T. J., & Shippenberg, T. S. (2002). Neural systems underlying opiate addiction. *The Journal of Neuroscience*, *22*(9), 3321-3325.

Lectures 9 and 10. Psychomotor stimulants

These lecture examine a second, major class of commonly abused compounds roughly defined by their ability to produce stimulatory effect and that includes a large number of compounds such as cocaine and amphetamines. These 2 lectures explore their history of use and abuse, how different forms are produced, the physiological, neurobiological, and behavioural effects and the role of catecholamine NT systems and the experimental procedures used to study these.

Essential readings

J. S. Meyer and L. F. Quenzer, Psychopharmacology: Drugs, the Brain and Behavior, Sinauer, 2013. Chapters 5 and 12.

Suggested readings

Dackis CA, O'Brien CP. (2001) Cocaine dependence: a disease of the brain's reward centers. J Subst Abuse Treat. Oct;21(3):111-7.

Wood S, Sage JR, Shuman T, Anagnostaras SG. Psychostimulants and cognition: a continuum of behavioral and cognitive activation. Pharmacol Rev. 2013 Dec 16;66(1):193-221. doi: 10.1124/pr.112.007054. Print 2014. Review.

Revision and test 1

Test 1 will assess your knowledge of all topics discussed in lectures 1 through 10 (so NOT including Synaptic Plasticity I). This includes the materials covered in these lectures and the essential readings. The meeting prior to the scheduled test serves as a revision meeting during which you are able to ask questions about the materials on the test.

Lecture 11 and 12. Synaptic plasticity

Both single and repeated exposure to drugs of abuse cause both short and long-term behavioural changes by altering the properties of synapses which are the critical sites of neuronal communication. Also, these alterations are modified by where the drug is administered. In these lectures we will see how both single and repeated exposure to cocaine can produce alterations in neuronal morphology, synaptic transmission, and neuronal activity in the brain’s reward system including the ventral tegmental area (VTA) and nucleus accumbens (Nac).

Essential readings

The lecture is primarily based on empirical data from recent papers. It is important that you try to understand the key rationale for doing these experiments and interpreting the key findings. Although there is no textbook chapter that covers all of the material, the reviews listed below will contain relevant information from this lecture.

General reading about the glutamate synapse, LTP and LTD: J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013. Chapters 8 (Pages 202-213)

Review about drug-induced changes in neuronal morphology: Robinson TE, Kolb B. Structural plasticity associated with exposure to drugs of abuse. *Neuropharmacology. 2004;47* Suppl 1:33-46.

Review about drug-induced changes at glutamate synapse in the accumbens and VTA: Bowers MS, Chen BT, Bonci A. AMPA receptor synaptic plasticity induced by psychostimulants: the past, present, and therapeutic future. *Neuron. 2010 Jul15;67(1)*:11-24. Review.

Review about the 3 criterion model of addiction in the rat and LTD: Deroche-Gamonet V, Piazza PV. Psychobiology of cocaine addiction: Contribution of a multi-symptomatic animal model of loss of control. *Neuropharmacology. 2014 Jan;76 Pt B*:437-49. Epub 2013 Aug 2. Review.

Suggested readings
For each study mentioned in the lecture I have indicated the reference in the notes section of the power point file. Please go through these papers if you wish to know more about these studies in detail.

Koya E, Golden SA, et al. Targeted disruption of cocaine-activated nucleus accumbens neurons prevents context-specific sensitization. *Nat Neurosci. 2009 Aug;12(8)*:1069-73.

Lecture 13. Hallucinogenics

This lecture will discuss the widely abused hallucinogen drugs that act directly on the serotonergic system such as LSD, psilocybin, mescaline, MDMA, and those that directly act on glutamate system such as ketamine and PCP. We will cover the history of hallucinogen use, the mechanisms of action in the brain, and the effects on mood and behaviour.

Essential readings

J. S. Meyer and L. F. Quenzer, Psychopharmacology: Drugs, the Brain and Behavior, Sinauer, 2013. Chapter 6 and 15.
Suggested readings

Meyer J.S. 3,4-methylenedioxymethamphetamine (MDMA): current perspectives. Subst Abuse Rehabil. 2013 Nov 21;4:83-99.

Vollenweider F.X. and Kometer M. The neurobiology of psychedelic drugs: implications for the treatment of mood disorders. Nat Rev Neurosci. 2010 Sep;11(9):642-51.

Lecture 14. Marijuana

By far the most commonly abused, illicit drug is marijuana. This lecture will discuss the history of marijuana use, methods of consumption, its mechanism of action in the brain, effects on physiology, mood and memory. We will also discuss the endocannabinoid system that is targeted by the active ingredients of marijuana, and its role in mediating feeding-related behaviours.

Essential readings

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013. Chapter 14.

Suggested readings

Covey DP, Wenzel JM, Cheer JF. Cannabinoid modulation of drug reward and the implications of marijuana legalization. Brain Res. 2014 Nov 25 (doi:10.1016/j.brainres.2014.11.034)

Burns JK. Pathways from cannabis to psychosis: a review of the evidence. Front Psychiatry. 2013 (4:128. doi: 10.3389/fpsyt.2013.00128)

Lecture 15. Nicotine

This lecture focusses on one of two (the other being alcohol) legally available psychoactive, but (potentially) highly addictive drugs, nicotine. A second quality in common with alcohol is nicotine's harmful consequences for the user and society. The status of nicotine as a harmful, addictive drug is nonetheless controversial, in part because preclinical (non-human) evidence for it's abuse/addictive potential has ostensibly been hard to come by, even leading some in the tobacco industry to (falsely) claim that nicotine is not addictive. The lecture examines it's use, effects on brain and behaviour, and evidence for it's status as an addictive drug.

Essential readings

J. S. Meyer and L. F. Quenzer, Psychopharmacology: Drugs, the Brain and Behavior, Sinauer, 2013. Chapter 7 and Chapter 13, pp. 374-393.

Caggiula, A. R., Donny, E. C., White, A. R., Chaudhri, N., Booth, S., Gharib, M. A., Sved, A. F. (2001). Cue dependency of nicotine self-administration and smoking. *Pharmacology, Biochemistry, and Behavior*, *70*(4), 515-30.

Lecture 16. Alcohol

This lecture focusses on alcohol, the most commonly used, frequently abused and arguably most harmful but nonetheless legal psychoactive drug. We will examine the neurobiological, physiological, and psychological effects of alcohol.

Essential readings

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013. Chapter 10 (alcohol).

Suggested readings

Vengeliene V., Bilbao A., Molander A. & Spanagel R. Neuropharmacology of alcohol addiction. *Br J Pharmacol. 2008 May;154(2):*299-315.

Lectures 17-19. Theories of addiction

Understanding the acute pharmacological, neurobiological and psychological effects of drugs only gets us so far when trying to understand a complex behavioural phenomenon as addiction. Many 'non-drug' factors influence drug action, and especially the long-term effects (e.g., ability to persistently change the brain) of repeated drug exposure are a result of complex interactions between the drug, the individual set and the setting of drug taking. A

number of theories have tried to capture these complex dynamics and the plethora of biopsychological findings that now exist in the literature. These 3 lectures will explore a number of these theories, their origins, main assumptions, the evidence that supports (or challenges) them, and where they agree (e.g., as to the role of associative learning mechanisms) and disagree (e.g., as to the role of tolerance versus sensitization).

Essential readings for all 3 lectures

J. S. Meyer and L. F. Quenzer, *Psychopharmacology: Drugs, the Brain and Behavior*, Sinauer, 2013: Chapter 9

Lecture 17: Addiction I

Essential readings

Koob, G.F. & LeMoal, M.(1997). Drug abuse: hedonic homeostatic dysregulation. *Science, 278*(5335), pp. 52-58.

Kenny, P.J., Chen, S.A., Kitamura, O., Markou, A. & Koob, G.F. (2006). Conditioned withdrawal drives heroin consumption and decreases reward sensitivity. *J Neurosci*, 26(22), pp. 5894-5900.

Suggested readings

Wikler, A. (1984). Classics revisited. Conditioning factors in opiate addiction and relapse. *J Subst Abuse Treat*, 1(4), pp. 277-285.

O'Brien,C.P., Testa,T., O'Brien,T.J., Brady, J.P.,& Wells, B.(1977). Conditioned narcotic withdrawal in humans. *Science, 195(4282)*, pp. 1000-1002.

Siegel, S., Hinson, R. E., Krank, M. D., & McCully, J. (1982). Heroin "overdose" death: contribution of drug-associated environmental cues. *Science, 216(4544)*, pp. 436-437.

Solomon, R.L. & Corbit, J.D.(1973). An opponent-process theory of motivation. II. *Cigarette addiction. J Abnorm Psychol, 81(2)*, pp. 158-171.

Ahmed S.H. & Koob G.F. (1998) Transition from moderate to excessive drug intake: change in hedonic set point. *Science, 282(5387)*, pp. 298-300.

Lecture 18: Addiction II

Essential readings

Robinson, T.E. & Berridge, K.C.(2001). Incentive-sensitization and addiction. *Addiction*, *96(1)*, pp. 103-114.

Wyvell, C.L. & Berridge, K.C (2001). Incentive sensitization by previous amphetamine exposure: increased cue-triggered "wanting" for sucrose reward. *J Neurosci, 21(19)*, pp. 7831-7840.

Flagel, S. B., Clark, J. J., Robinson, T.E., et al (2011). A selective role for dopamine in stimulus–reward learning. *Nature, 469(7328)*, pp. 53-57.

De Wit, H., & Stewart, J. (1981). Reinstatement of cocaine-reinforced responding in the rat. *Psychopharmacology, 75(2)*, pp. 134-143.

Suggested readings

Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Res Rev, 18(3)*, pp. 247-291. (this is the original publication but it is also very long and detailed)

Stewart J. & Baldiani A. (1993) Tolerance and sensitization to the behavioural effects of drugs. Behavioural Pharmacology 4: 289 - 312.

Everitt, B.J., Dickinson, A. & Robbins, T.W. (2001). The neuropsychological basis of addictive behaviour. *Brain Res Rev, 36(2-3)*, pp. 129-138.

Koya, E. et al, (2009) Targeted disruption of cocaine-activated nucleus accumbens neurons prevents context-specific sensitization. *Nature Neuroscience, 12 (8)*, pp. 1069-1073.

Crombag H.S., Gorny G., Li Y., Kolb B. & Robinson T.E. (2005) Opposite effects of amphetamine self-administration experience on dendritic spines in the medial and orbital prefrontal cortex. *Cereb Cortex,* 15(3), pp. 341-8.

Volkow, N.D., Wang, G.J., Telang, F., Fowler, J.S., Logan, J., Childress, A.R., et al. (2006). Cocaine cues and dopamine in dorsal striatum: mechanism of craving in cocaine addiction. *J Neurosci, 26(24)*, pp. 6583-6588.

Shalev, U., Grimm, J. W., & Shaham, Y. (2002). Neurobiology of relapse to heroin and cocaine seeking: a review. *Pharmacological Reviews, 54(1)*, pp. 1-42.

Robinson, T. E. & Berridge, K. C. (2008). The incentive sensitization theory of addiction: Some current issues. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1507), pp. 3137-3146.

Stewart, J., De Wit, H., & Eikelboom, R. (1984). Role of unconditioned and conditioned drug effects in the self-administration of opiates and stimulants. *Psychological Review*, *91*(2), pp. 251-268.

Lecture 19: Addiction III

Essential readings

Jentsch, J.D. & Taylor, J.R.(1999). Impulsivity resulting from frontostriatal dysfunction in drug abuse: implications for the control of behavior by reward-related stimuli. *Psychopharmacology, 146(4)*, pp. 373-390.

Schoenbaum, G. & Setlow, B.(2005). Cocaine makes actions insensitive to outcomes but not extinction: implications for altered orbitofrontal-amygdalar function. *Cereb Cortex, 15(8)*, pp. 1162-1169.

Dalley, J.W., Fryer, T.D., Brichard L., Robinson E.S. et al (2007). Nucleus accumbens D2/3 receptors predict trait impulsivity and cocaine reinforcement. *Science, 315,* pp. 1267-70

Suggested Readings

Schoenbaum, G. & Shaham,Y. (2008).The role of orbitofrontal cortex in drug addiction: a review of preclinical studies. *Biol Psychiatry, 63(3)*, pp. 256-262.

Volkow, N.D. & Fowler, J.S.(2000). Addiction,a disease of compulsion and drive: involvement of the orbitofrontal cortex. *Cereb Cortex, 10(3)*, pp. 318-325.

Verdejo-Garcia, A., Bechara, A., Recknor, E. C., & Perez-Garcia, M. (2006). Executive dysfunction in substance dependent individuals during drug use and abstinence: an examination of the behavioral, cognitive and emotional correlates of addiction. *J Int Neuropsychol Soc, 12(3)*, pp. 405-415.

Morgan, D., Grant, K.A., Gage, H.D., Mach, R.H.,Kaplan, J.R., Prioleau, O.,et al. (2002). Social dominance in monkeys: dopamine D2 receptors and cocaine self- administration. *Nat Neurosci, 5(2)*, pp. 169-174.

Revision and test 2

Test 2 will assess your knowledge of all topics discussed in lectures 11 through 19. This includes again the materials covered in these lectures and the essential readings. The meeting prior to the scheduled test serves as a revision meeting during which you are able to ask questions about the materials on the test.

Additional review articles by topic

In addition to the above essential and suggested readings, the following published review articles (some of which have already been mentioned) offer both broad and/or specific information on various relevant topics.

Methodological and theoretical issues

Shalev, U., Grimm, J.W. & Shaham, Y. (2002) Neurobiology of relapse to heroin and cocaine seeking: a review. *Pharmacol Rev, 54*: pp.1-42.

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Finally, a variety of other published and excellent sources of information are freely available to you online which you may want to explore. These sources often go well beyond what is covered in the module but for those interested they all provide outstanding reviews of the 'state-of-the-art' in the field.

- There is a very useful issue of *Nature Neuroscience (Vol 8, Number 11, November 2005)* on Addiction. Just about every article in this collection is useful in one-way or another.

- A fairly recent series of reviews by leaders in addiction research is available in the Oct 2008 issue of *Philosophical Transaction of the Royal Society (B)* dedicated to the topic of Addiction. Some of these are updates on the authors' earlier theoretical writings, but will give you an excellent insight into current thinking.

- Finally, there is a good set of reviews available from a 'recent' exercise carried out by the "Foresight Project on Brain Science, Addiction and Drugs", that reviews the state-of-the-art in addiction research, across a range of approaches. These reviews are available at: http://www.bis.gov.uk/foresight/our-work/projects/published-projects/brain-science/reports-and-publications/research-reviews