

Too much dopamine can be bad for you: I. Addiction



*"That's the thing when you start living with someone
– you discover all of their little habits."*

PSY/NEU338: Animal learning and decision making:
Psychological, computational and neural perspectives

drug addiction

- huge and diverse field of research (many different drugs)
- addiction (abuse) = continued making of maladaptive choices even in the face of explicitly stated desires to do otherwise (Redish et al. 2008)
- fundamental problem: relapse
- addictive drugs thought to access same neurophysiological mechanisms as natural rewards, just in an aberrant way
- e.g., drugs that increase availability of dopamine (directly: amphetamine, cocaine or indirectly: heroin, nicotine) are addictive



models of psychopathology

- Model = any experimental preparation developed for studying a condition in the same or a different species
- usually try to imitate a condition in humans
 - neuropathology
 - psychopathology
- Construct validity (similar etiology) examples?
- Face validity (the behavior in the model resembles the symptoms of the disorder) examples?
- Predictive validity (model with pharmacological similarity to the disorder; screening tests) examples?
- a good model will have predictive validity (otherwise we can't do much with it); structural validity is good (but don't always know cause); face validity is nice but not necessary



3

is there a good animal model of drug abuse?

- can give animals drugs and see effects
- ...also need a model of an animal *choosing* to take the drug, relapsing, even at a cost
- at minimum: compare to natural rewards to study differences not commonalities



Model of relapse: Reinstatement
(what types of validity does it have?)

4

how can we make our computational models ‘addicted’?

- goal: the model inappropriately selects to take the drug (in face of other rewards)
- explain some phenomena of addiction: likelihood to select drug is sensitive to length of exposure to drug, size of other non-drug rewards, and cost (but ultimately the demand is inelastic, or at least not as elastic as that for natural rewards)
- Redish (2004) - addiction as a computational process gone awry
- predictions?
- note: “A neuropharmacologically driven increase in dopamine is not the sole effect of these drugs, nor is it likely to be the sole reason that drugs of abuse are addictive.”

5

Everitt & Robbins (2005)

Neural systems of reinforcement for drug addiction: from actions to habits to compulsion
Nature Neuroscience

is drug abuse a habit?

- drugs: initially used voluntarily due to rewarding/hedonic value, slowly transition to habitual and compulsive behavior (loss of control over behavior)
- why are drugs compulsive? become S-R habits
- how does this explain elaborate, seemingly goal directed behavior?
- distinction between drug taking and drug seeking behaviors

6

vulnerabilities in decision making

1. disrupted planning
(tree search)

2. incorrect state

space (overgeneralize →
perseveration, overclassify →
illusion of control)

1. overestimate
outcome value

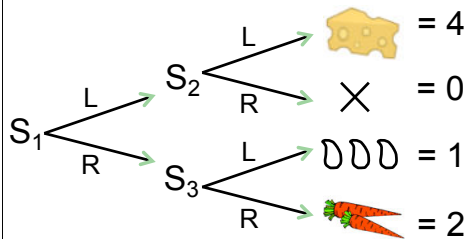
2. too steep discounting

3. disrupted arbitration
(goal-directed can't
override habits)

1. disrupted PEs

2. altered learning
process due to
abnormal learning
rate, attention

goal-directed system



habit system

$$Q(S_0, L) = 4$$

$$Q(S_0, R) = 2$$

$$Q(S_1, L) = 4$$

$$Q(S_1, R) = 0$$

$$Q(S_2, L) = 1$$

$$Q(S_2, R) = 2$$