When Rationality Fails

–Modern Theories of Addiction



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Rationality & Behavior

- When it comes to how to obtain our goals, rationality often wins
  - we often plan and execute our behavior with machine-like efficiency
- When it comes to choosing our goals, rationality often fails
  - we choose our goals based on biological, social, and experiential factors (often lacking apparent rationality)

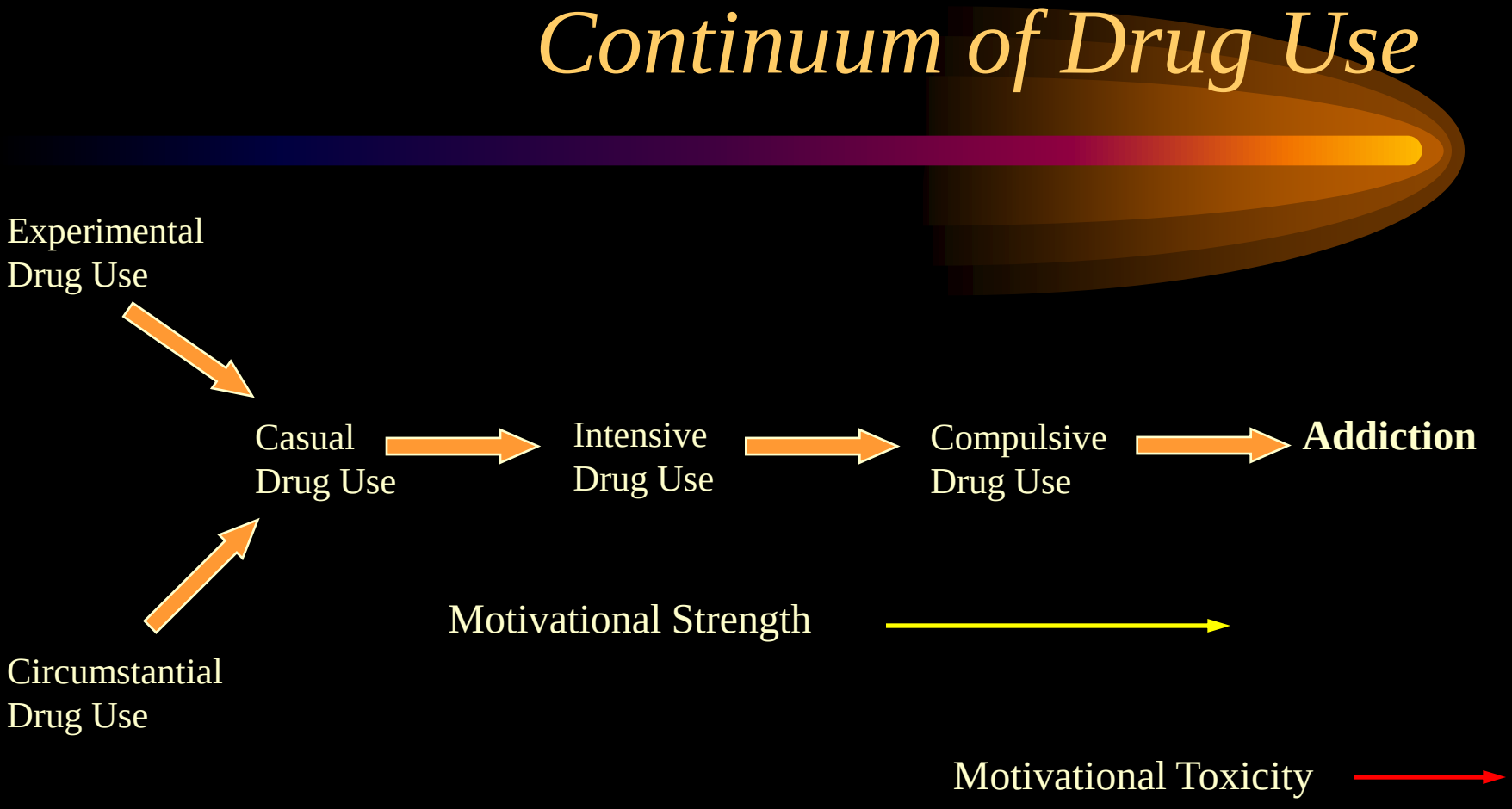
Drug Addiction & Rational Behavior

- Drug addiction seems to cause a break down in the rationality associated with many of our behaviors
- People seldom "voluntarily" give up their addiction
  - According to NIDA director Alan Leshner, "Virtually no one wants drug treatment. Two of the primary reasons people seek drug treatment are because the courted ordered them to do so, or because loved ones urged them to seek treatment."
- Addictive drugs chemically change our behavior, our values, and even our concept of the "self"
- Addictive drugs offer a portal to the "mind"

What is Addiction?

- *Addiction* is a behavioral syndrome where drug procurement and use seem to dominate the individual's motivation and where the normal constraints on the individual's behavior are generally ineffective (e.g., self-perceived "loss of control")
  - *motivational toxicity* may be a defining characteristic
  - *physical dependence* is neither a necessary nor a sufficient condition

Continuum of Drug Use

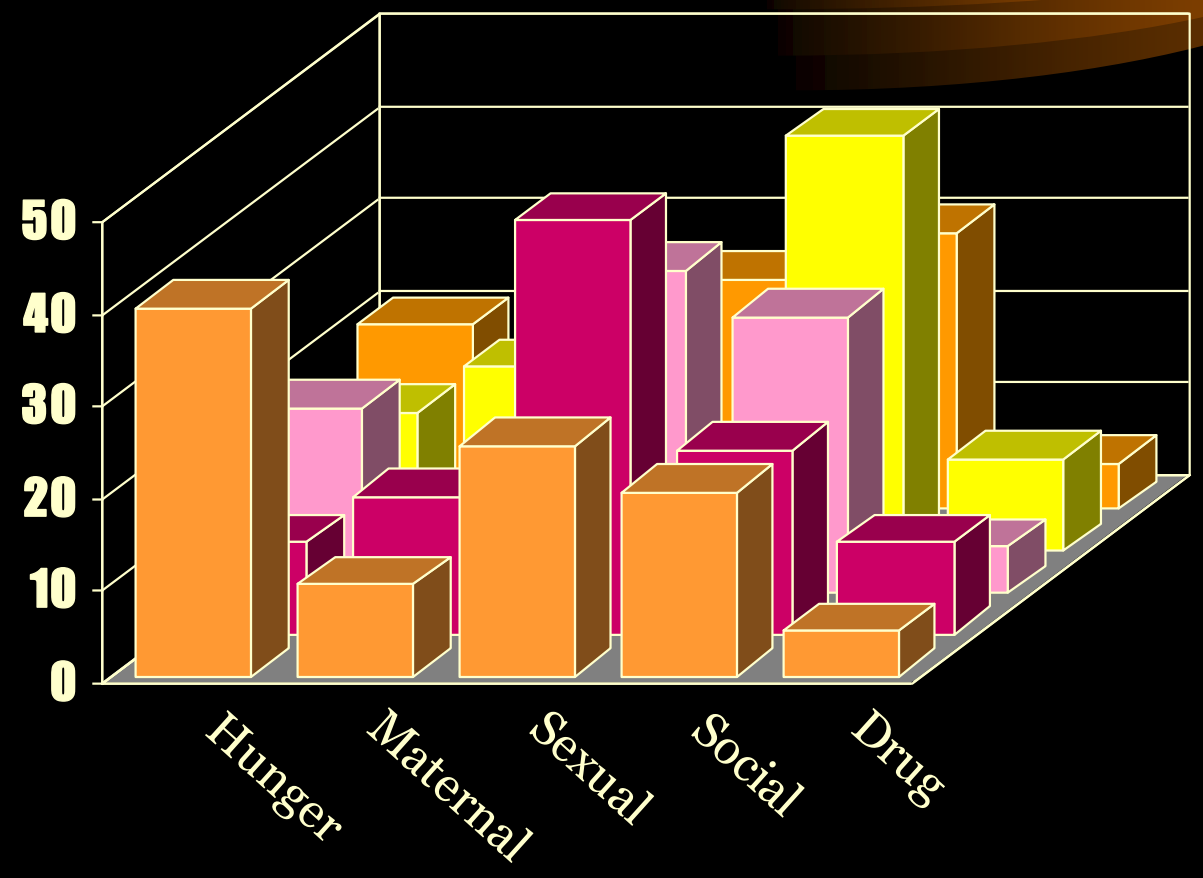


From Bozarth (1990); terms described on the continuum were suggested by Jaffe (1975).

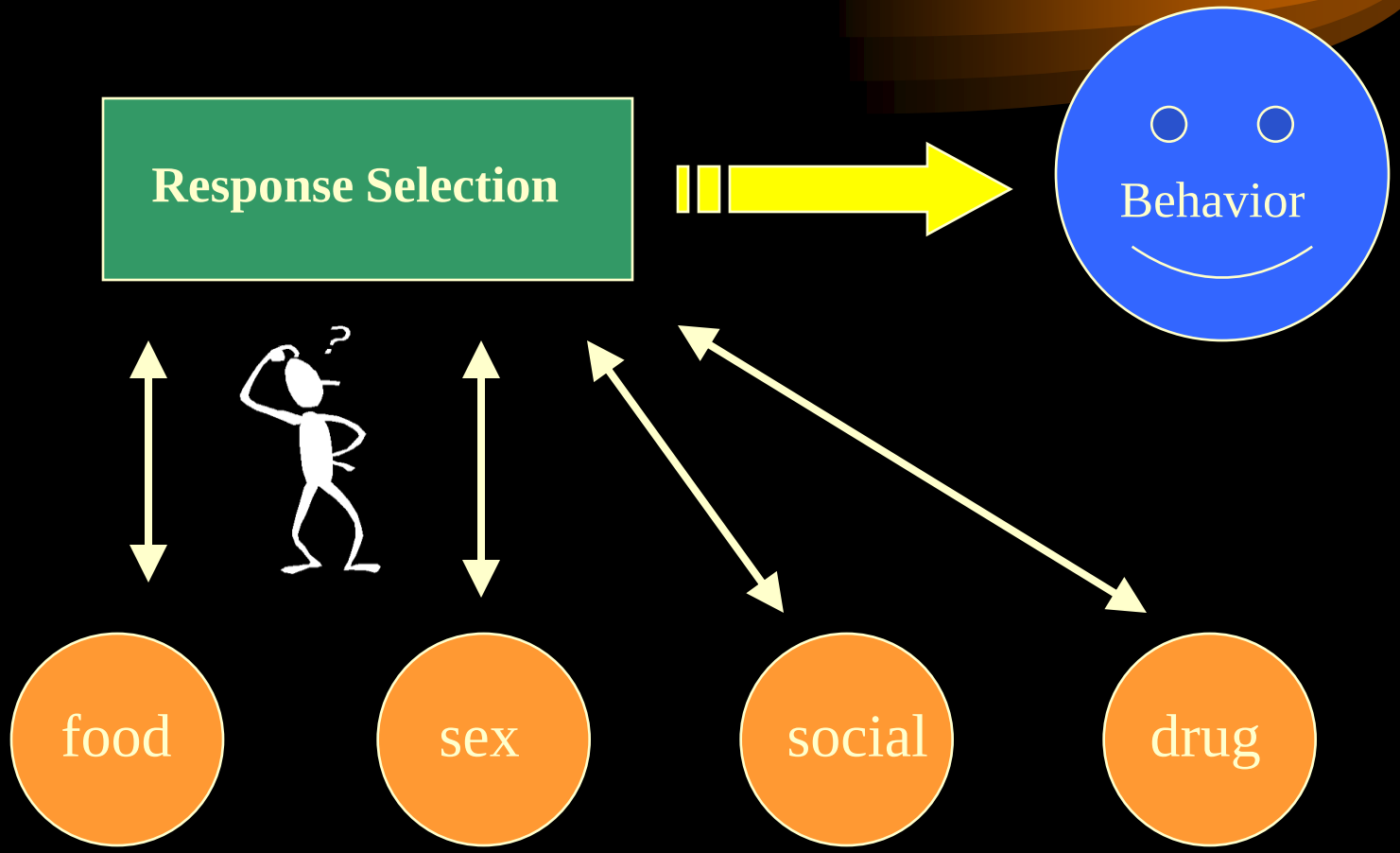
Addiction as a Motivational Problem

- Addiction is best understood by considering the drug's impact on the individual's motivation
- Experimental psychology and behavioral neuroscience provide the methods for analysis

Dynamic Feature of the Motivational Hierarchy



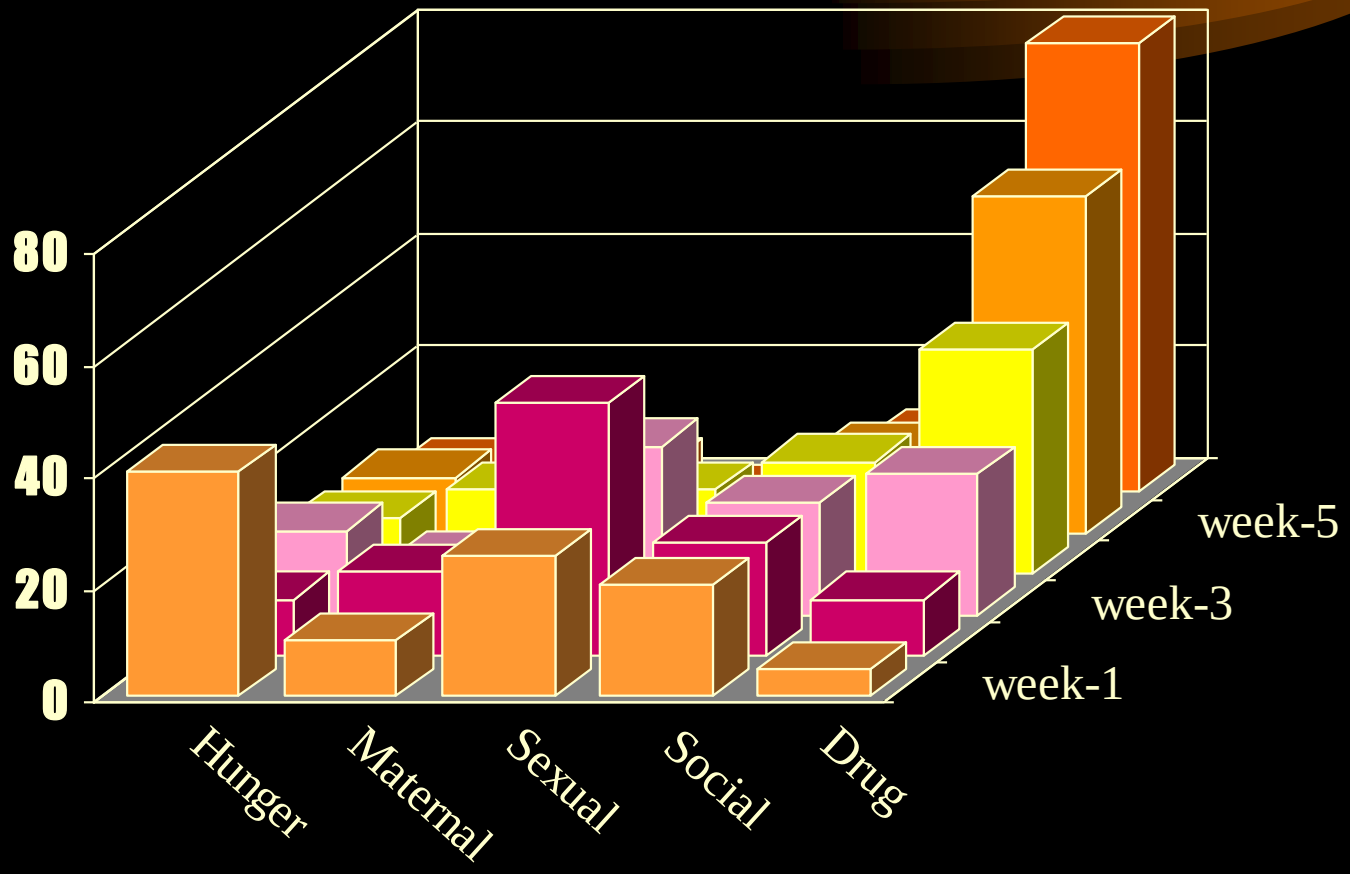
Choice Behavior and the Notion of "Self-Control"



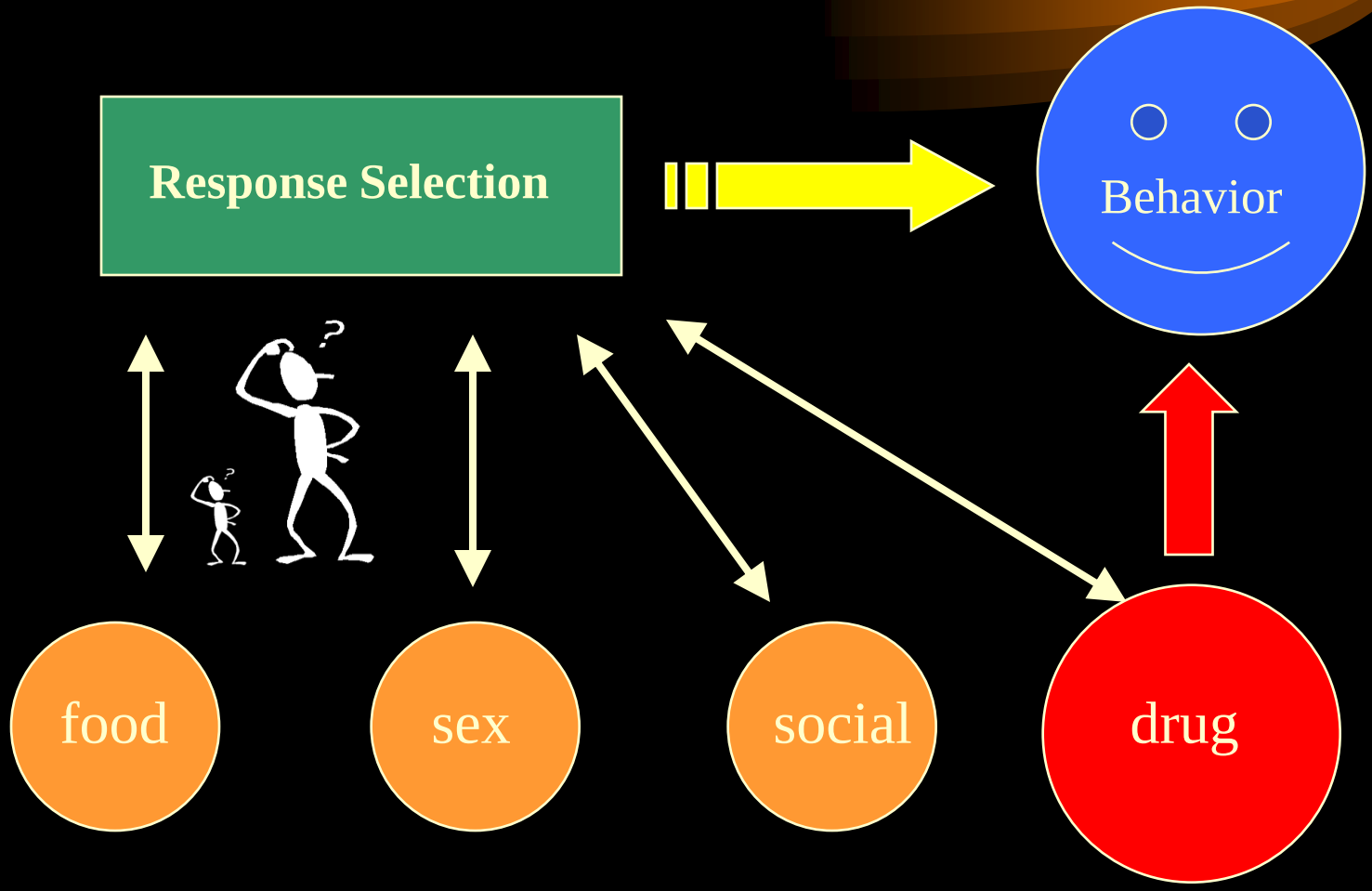
Motivational Toxicity

- *Motivational toxicity* describes a disruption of the motivational hierarchy. This is manifest as
  - increased motivational efficacy of the drug
  - decreased motivational efficacy of natural rewards
- Motivational toxicity produces the intense motivational focusing characteristic of addiction and the apparent “enslavement” inherent in the etymology of this term

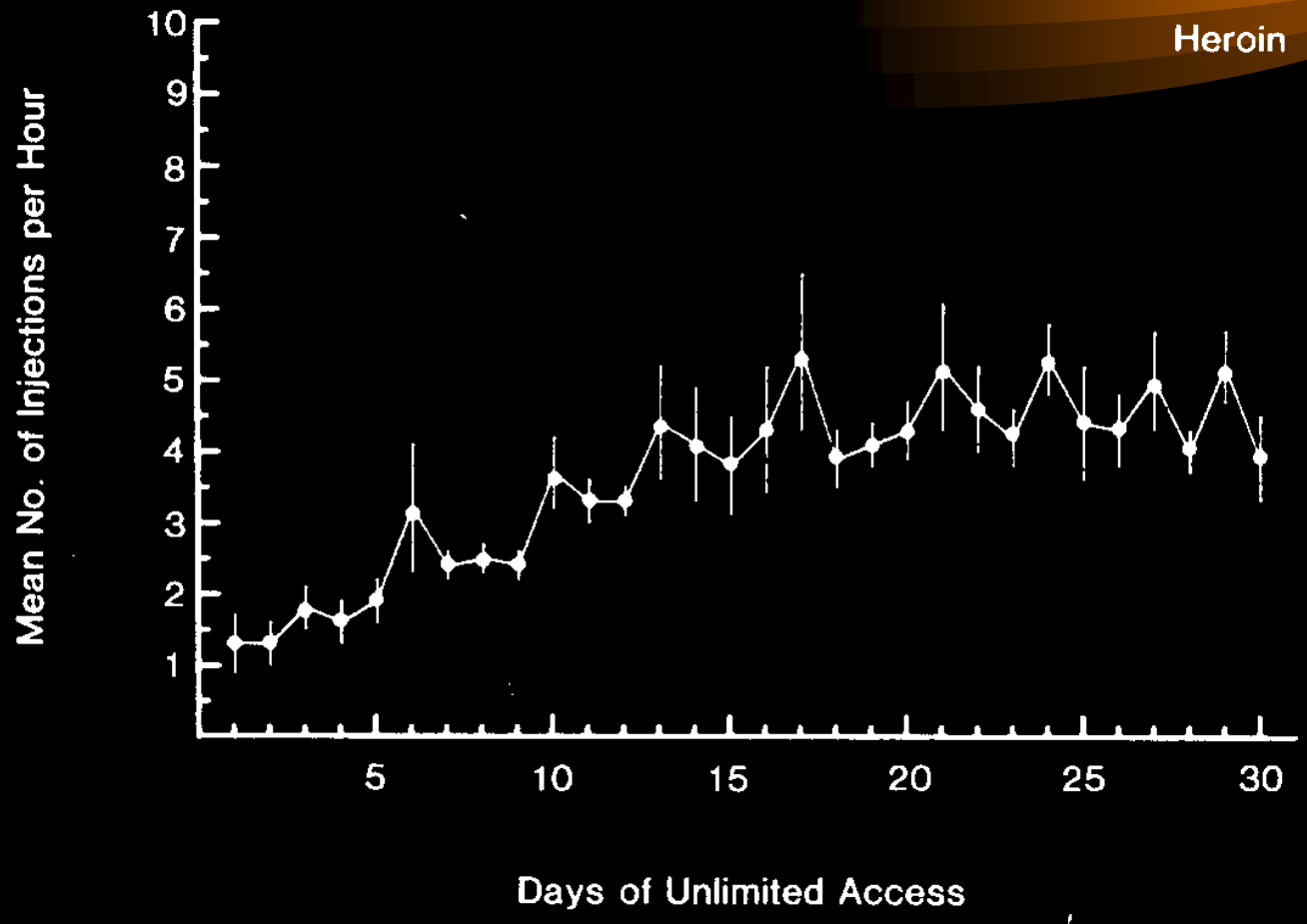
Progressive Focusing of Motivational Energy on Drug



Motivational Toxicity Producing a Self-Perceived "Loss of Control"

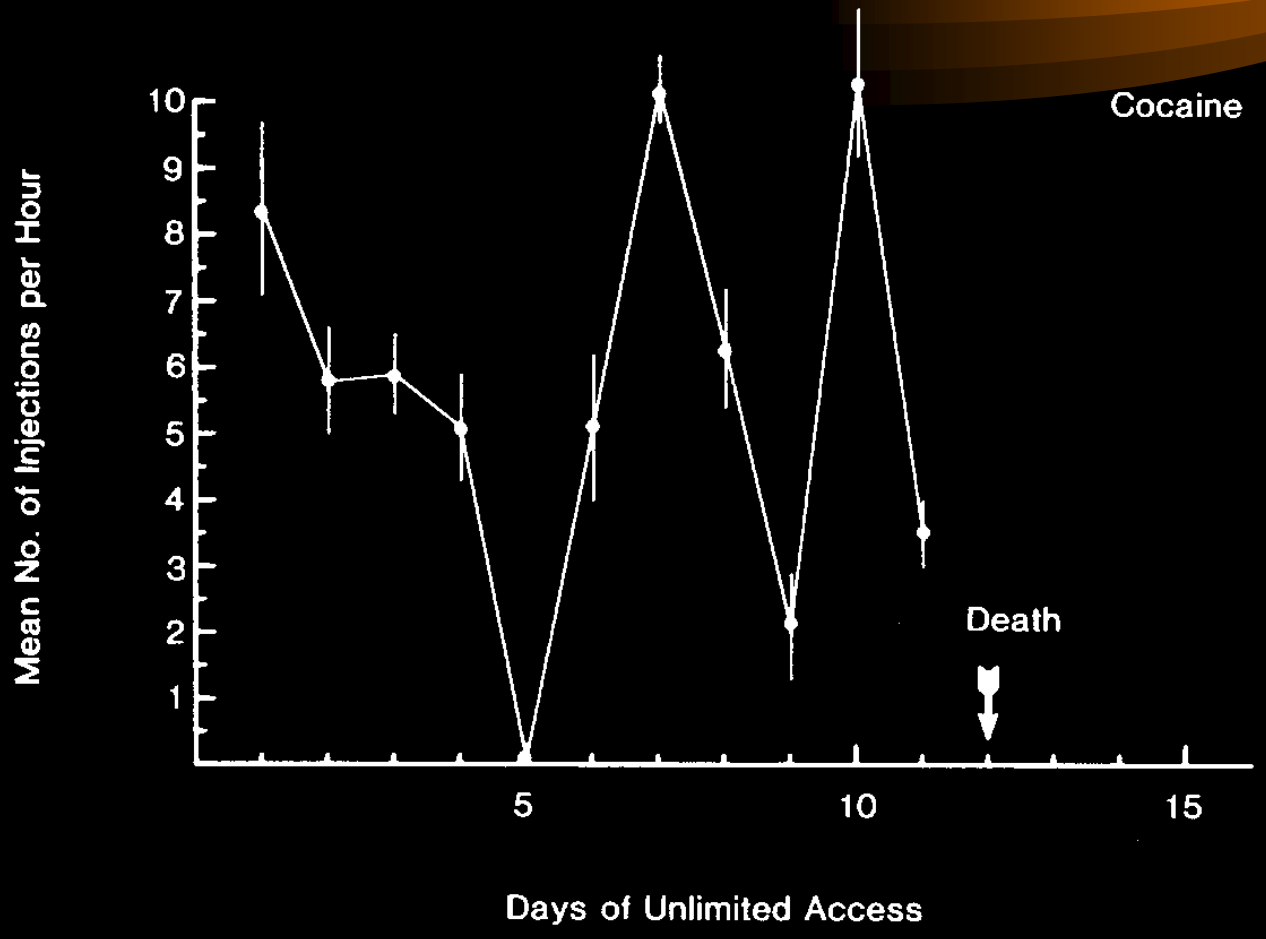


Heroin Intake During Unlimited Access Testing



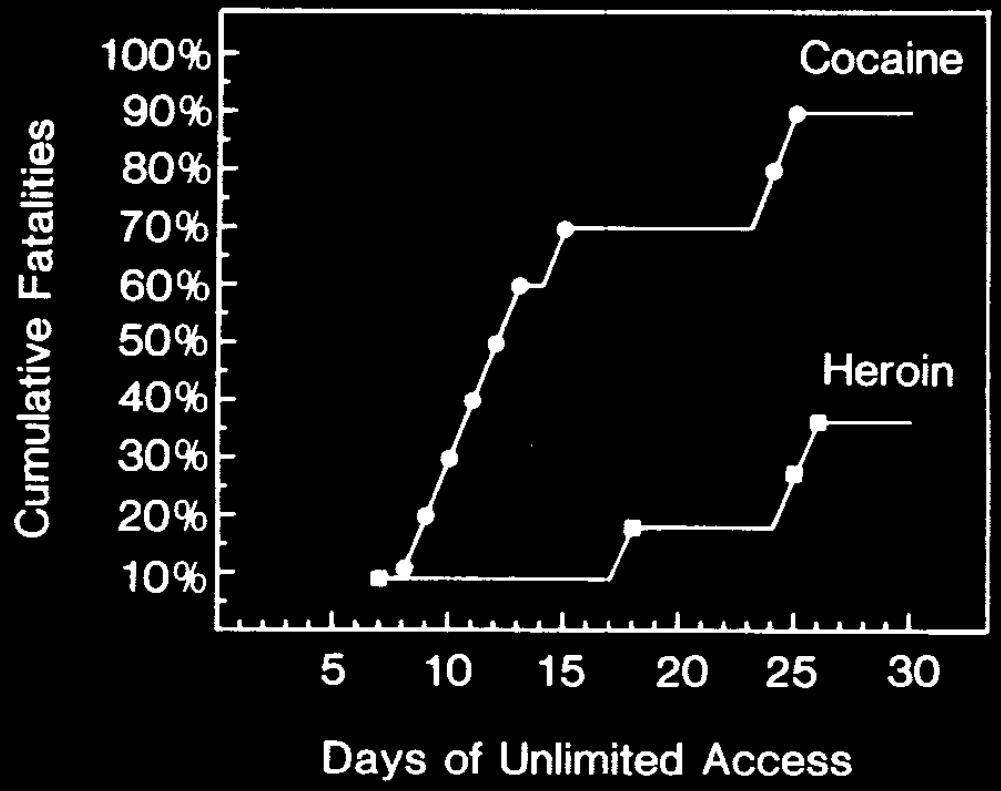
From Bozarth & Wise, 1985.

Cocaine Intake During Unlimited Access Testing



From Bozarth & Wise, 1985.

Comparison of Fatalities from Unlimited Access to Intravenous Cocaine and Heroin

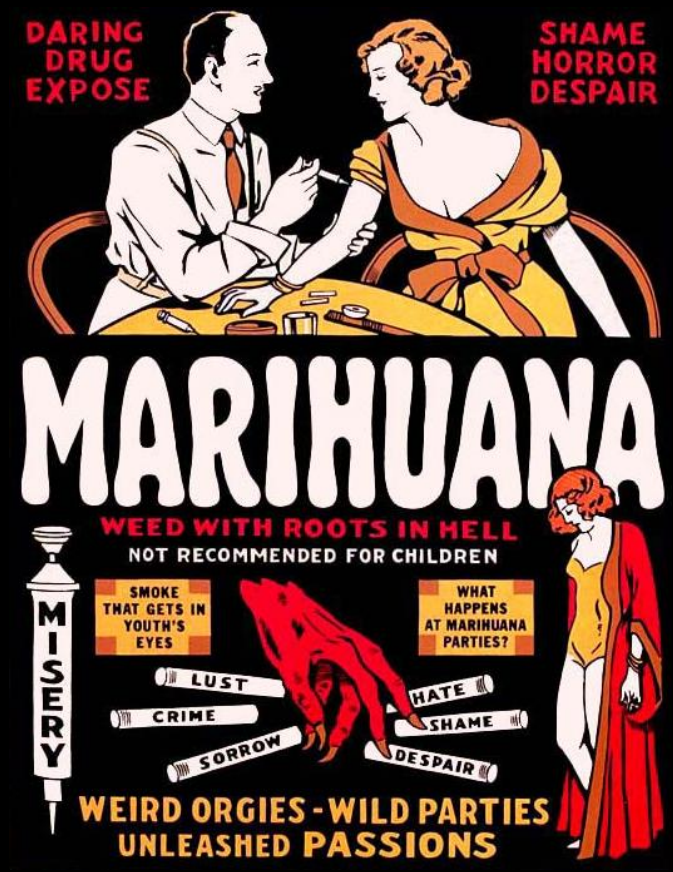


From Bozarth & Wise, 1985.

The Yin and Yang of Addictive Drugs



The "Yin"

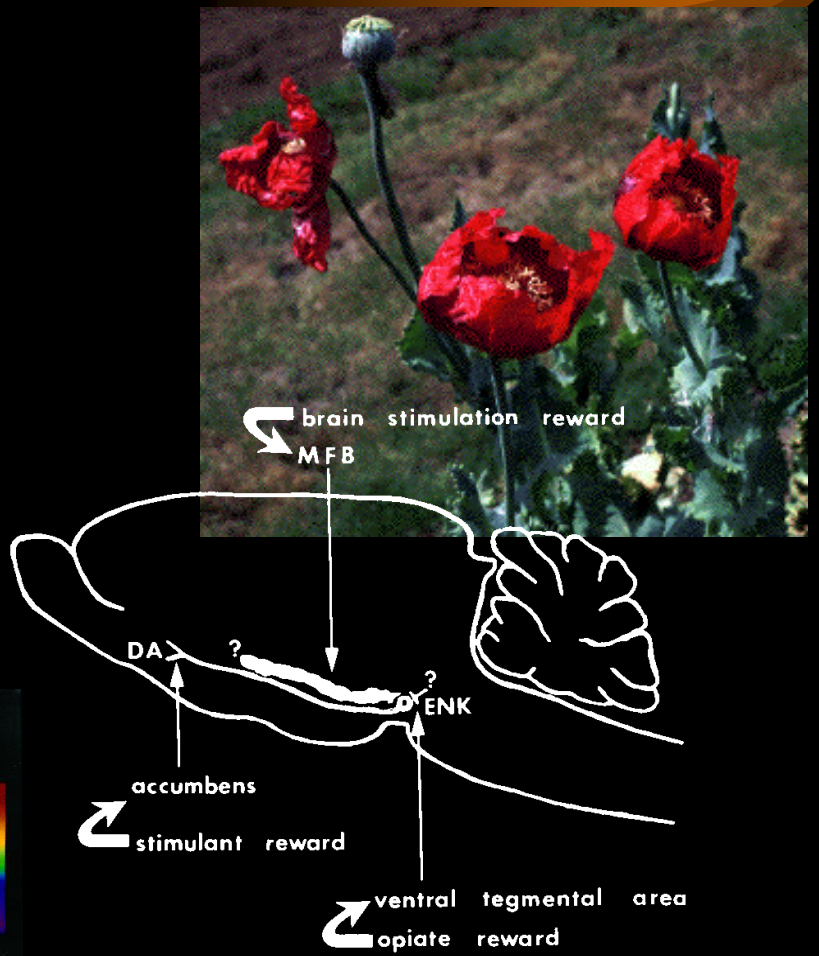


- Addictive drugs take a horrific toll on humanity
  - personal
  - social
  - economic

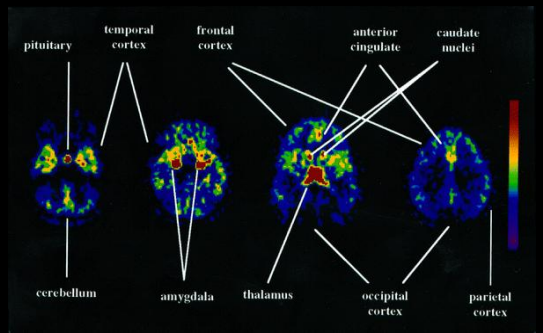


The "Yang"

- But addictive drugs also provide probes for understanding brain function
  - addictive drugs provide a tool for probing the mind and its underlying neurochemical and neuroanatomical basis



From Bozarth, 1987.

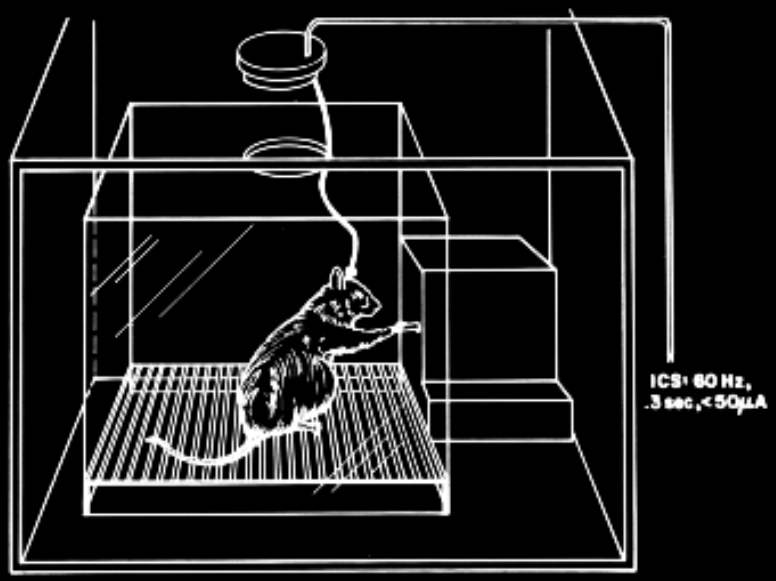


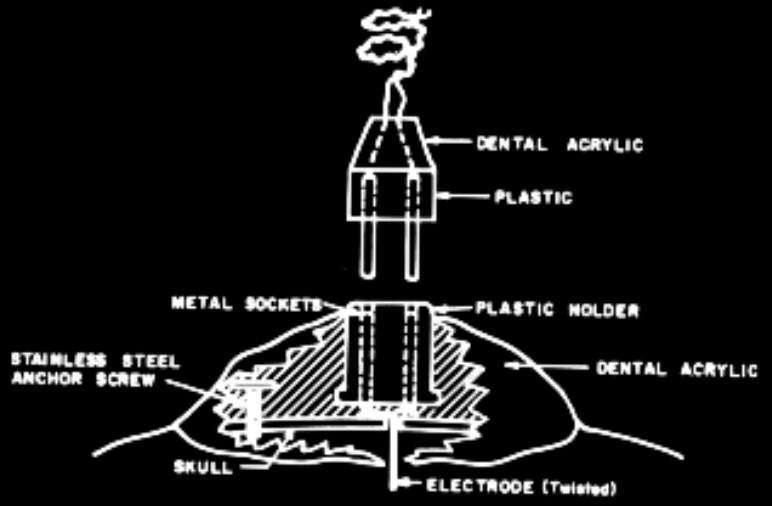
From Smith et al., 1998.

Notion of Brain Reward Systems

- Pioneering work of
  - Hess (1940s)
    - complex goal-directed behavior from electrical brain stimulation
  - Olds & Milner (1950s-1960s)
    - direct reinforcement from electrical brain stimulation
  - Reid (1960s)
    - similarities between reinforcement from direct electrical stimulation and “natural” rewards

Experimental Preparation to Study Rewarding Effects of Electrical Brain Stimulation



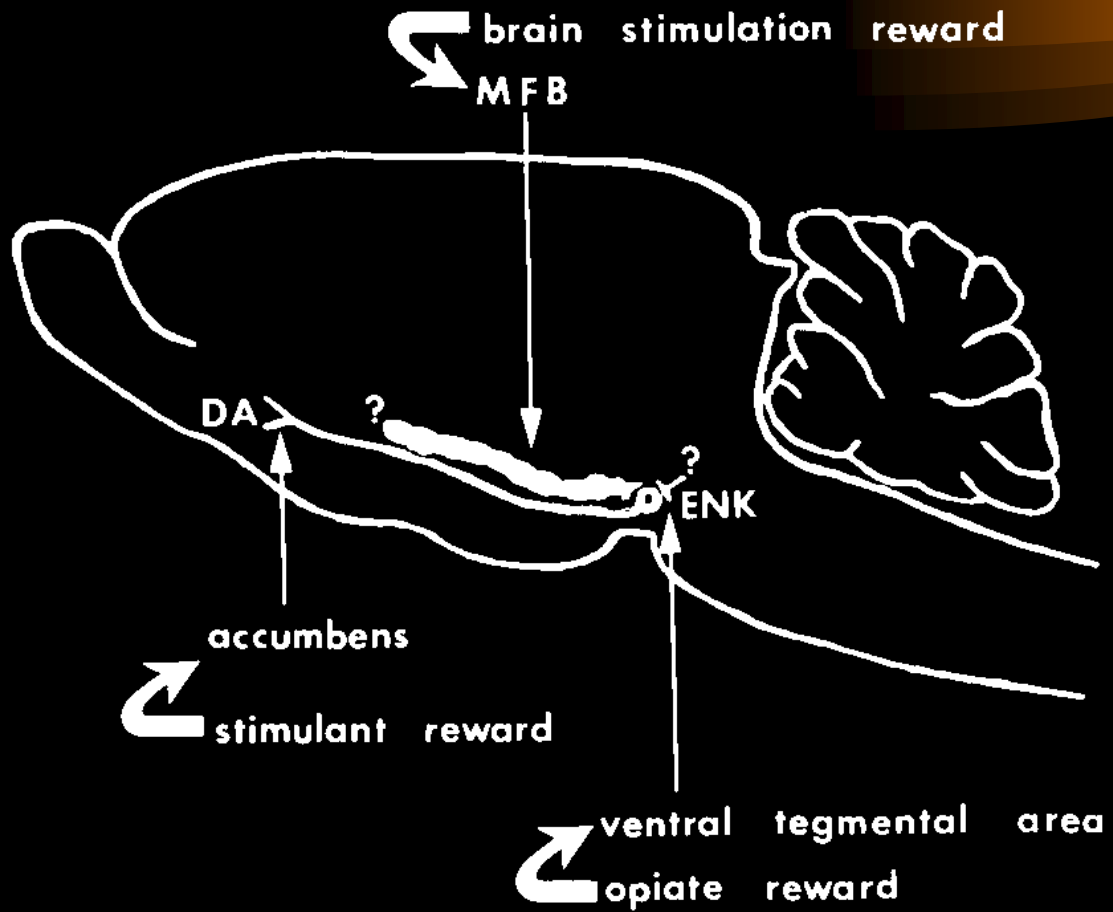


From Reid, 1987.

Notion that Addictive Drugs May Work on Brain Reward Systems

- Opiate activation of substrate for electrical brain stimulation reward (1970s)
  - Reid
  - Korntesky
  - Broekkamp
- Delineation of pharmacological and anatomical substrate for opiate and psychomotor stimulant reward (1970s-1980s)
  - Wise; Bozarth & Wise
  - Roberts & Fibiger

Brain Reward Circuitry

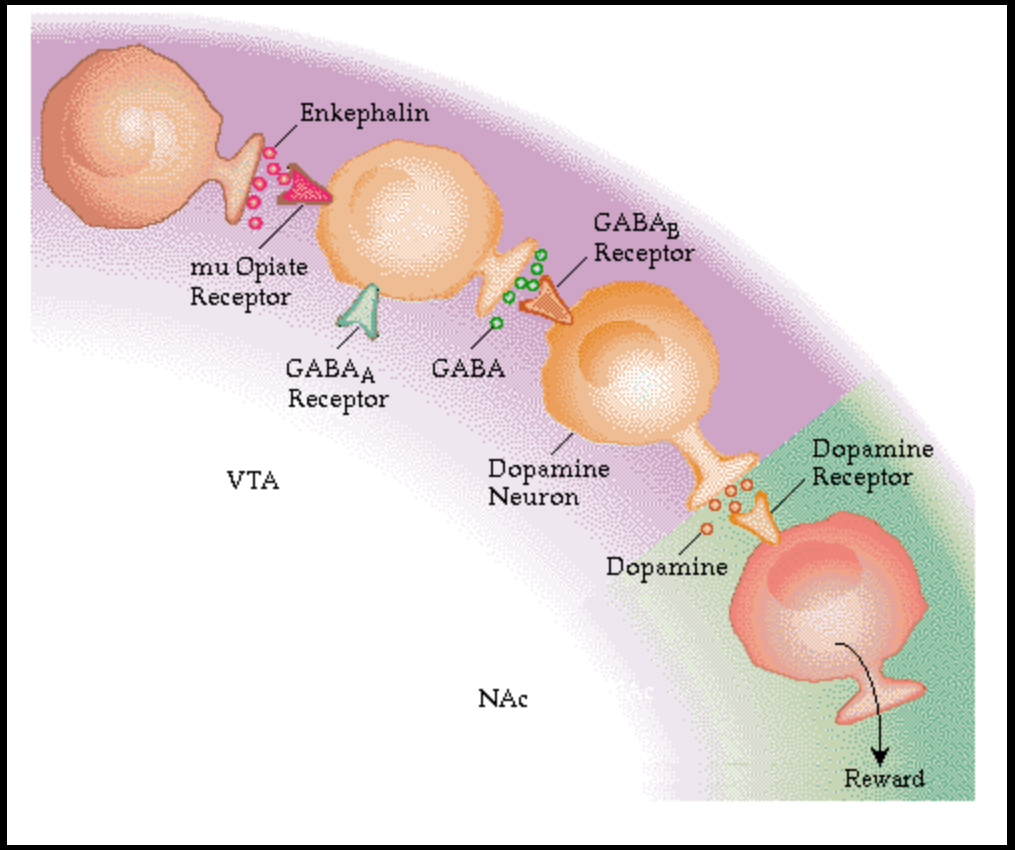


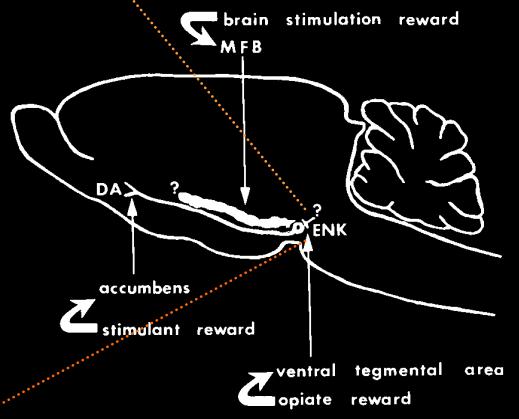
From Bozarth, 1987.

Continued Progress in Understanding Drug Addiction

- Detailed analysis of the effects of addictive drugs on brain systems mediating reward and motivation (1980s-1990s)
- Extension of experimental findings to human studies (1990s)
- Exploration of CNS neuroadaptive effects produced by addictive drugs (1990s-2000s)
- Clinical applications (2000 and beyond)

Opiate/Dopamine Link in Brain Reward Circuitry

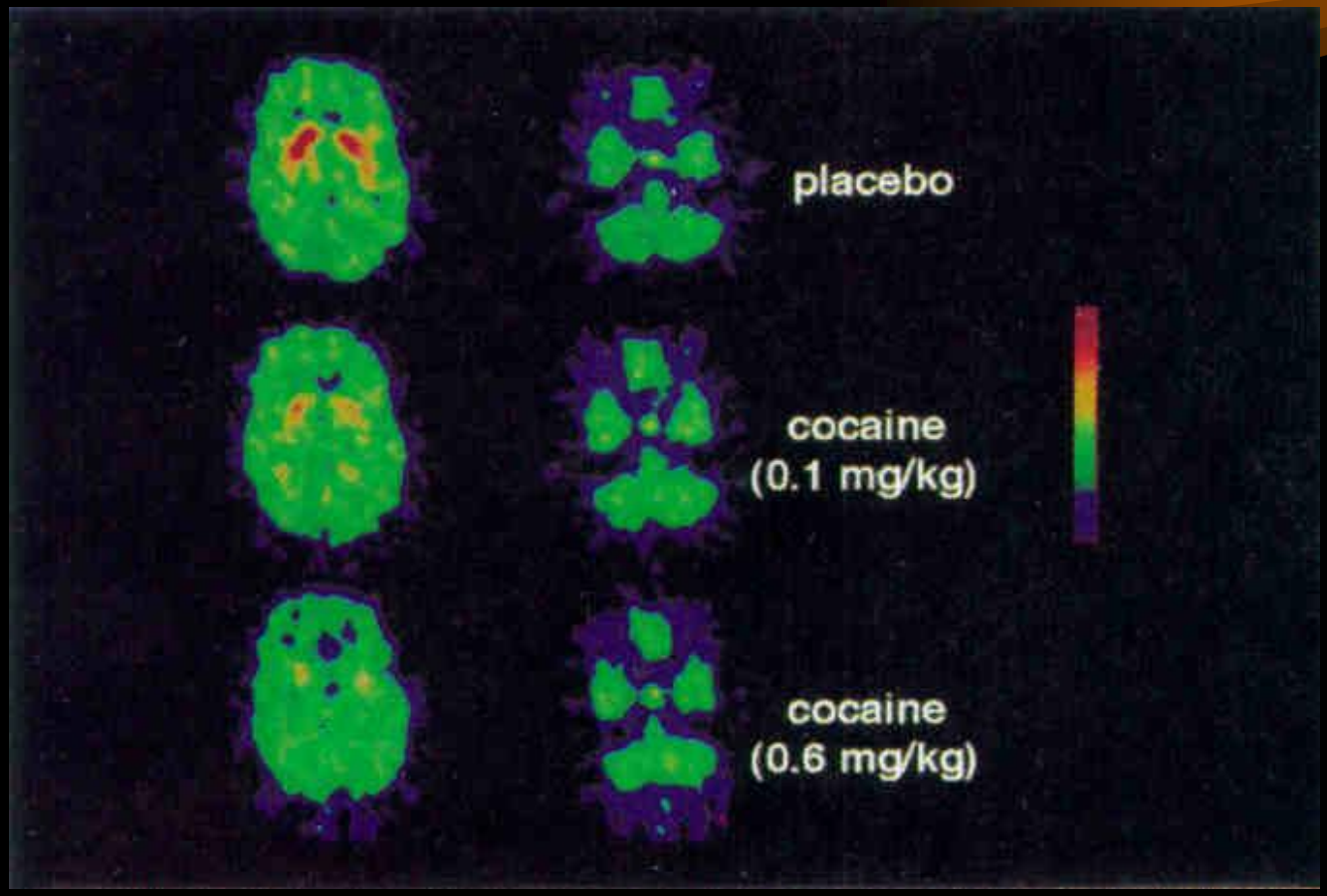




From *Scientific American Medicine Online*, 2000.

From Bozarth, 1987.

Dopamine Transporter Occupancy following Cocaine Administration



From Volkow et al., 1997.

Revised Role of the Mesolimbic Dopamine System in Drug Addiction

- Activation provides positive reinforcement and maintains initial drug use
- Neuroadaptive changes produce . . .
  - negative reinforcement (normalization)
  - enhanced positive reinforcement (sensitization)
  - increased net change in affective tone (opponent processes)
  - motivational toxicity (derived process)
- Simple activation of this dopamine system is **not** sufficient to produce addiction

Importance of Neuroadaptive Effects in Drug Addiction

- Drug-induced neuroadaptive effects may distinguish the normal influence this brain reward system has on behavior from the extreme control characteristic of drug addiction
- Events that activate this system without producing neuroadaptive changes may lack the ability to produce an addiction

Bio-Cognitive Reciprocity

- Brain chemistry influences “psychological” states
- “Psychological” states influence brain chemistry
  - unconscious processes (e.g., conditioning)
  - conscious processes (e.g., “thoughts”)

Yes! Pharmacology ⟺ Addiction,

but other factors can be important too!

- Addiction is ultimately pharmacologically determined
  - the result of the action of certain drugs on brain reward mechanisms
- Several factors can
  - hasten the development of an addiction
  - make certain individuals more likely to develop an addiction

The Importance of "Psychological" Factors in the Genesis of Addiction

- Thrill-seeking personality (Bardo, LeMoal)
  - e.g., hyperactive dopamine system
- Stress-induced "priming" (Goeders, Stewart)
  - e.g., cross-sensitized dopamine system
- Reward deficiency syndrome (Blum)
  - e.g., hypoactive dopamine system

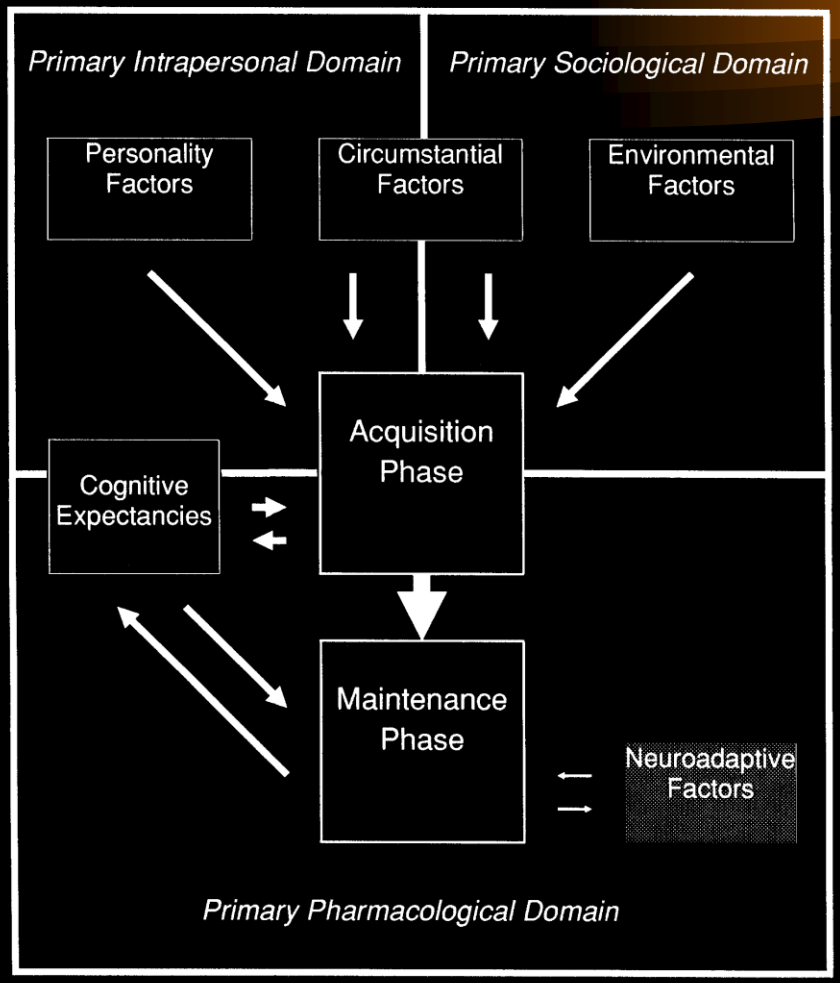
Some Possible Predisposing Factors for Drug Addiction

- Psychological
  - specific trait (e.g., addictive personality)
  - nonspecific trait (e.g., risk-taking behavior)
- Biochemical
  - genetic (e.g., dopamine-receptor deficiency)
  - acquired
    - environmental (e.g., *in utero* drug exposure)
    - conditioning (e.g., psychological stress)

Role of Predisposing Factors

- Predisposing factors affect mainly the acquisition stage of drug addiction
  - by influencing the tendency to experiment with the drug and to continue drug usage beyond the initial experimental stage
  - by modulating the initial rewarding impact of the drug and its subsequent effects on neuroadaptive processes
- Pharmacological factors remain the primary determinant of drug addiction

A Psychobiological Model of Drug Addiction



From Bozarth, 1990.