Motivation

Applying lessons from neuroscience

We acknowledge the traditional custodians of the land on which we meet today and pay respect to Elders past, present and emerging.

We also extend that respect to other Aboriginal and/or Torres Strait Islanders who are joining us here today.

David R Horton, creator, © Aboriginal Studies Press, AIATSIS and Auslig/Sinclair, Knight, Merz, 1996.
View an interactive version of the AIATSIS map
www.abc.net.au/indigenous/map/

Header Artwork produced for Queensland Health by Gilimbaa
Relevance

• Teaching/ Work behaviour/ organisational performance
• Illness behaviour and health behaviour
• Preventative health
• Addictions
• Disorders of Dopamine: schizophrenia
Generation of Motivation

Role of Reward

- Reward-driven approach
- Reward anticipation
- Incentive salience

- Value-based decision
- Associative learning
- Positive reward-prediction error

- Goal-directed control
- Cognitive control
- Negative reward-prediction error

Ventral Striatum
Amygdala

Striatum
OFC

ACC
DLPFC

Expectancy
Instrumentality
Valence
Motivation
Role of Reward

- Induce positive emotions
- Encourage approach
- Increase frequency of targeted behaviour
- & Prevent extinction
Reward Processing

- Anticipation
- Association of reward with behaviour
- Planning to obtain a reward
- Encoding the value of reward
- Updating the relative value of the reward
Dopamine Pathway of Reward
Development & Reward

Exploration-Exploitation dilemma

- **Exploratory learning**
  New alternatives sort requiring value judgements & inferences
  Frontopolar cortex & intraparietal sulcus

- **Exploitative learning**
  Decisions habitual & based on prior learning
  Striatum & MPFC

Amygdala avoidance
Development

- Nacc – sensitive to reward grows rapidly in adolescence
- Amygdala- avoidance of danger grows slowly
- PFC – control grows slowest

Liking & Wanting

Hedonics (liking)
Opioid and GABA systems in striatum, OFC

Reward Prediction
(wanting), Reinforcement learning
Dopaminergic systems and basal ganglia

Integration of information to update and maintain values (OFC)

Cost-Benefit Analysis
Computing effort of plan in relationship to reward value (ACC)

Constructing action plans to obtain valued outcomes (DLPFC)

Behavioral Response

Components of Reward to Outcome Translation
Note: After Wallis (2007)
Motivation maintenance

Value based decision process
Reward prediction & learning

• Sustained motivation requires learning & memory
• Stimulus-action-outcome association is learned & actions become automatic
• DA associated with reward & pleasure but also motor performance, conditioning, learning & memory
• Reinforcement learning theory - magnitude of learning depends on DA release
• Reward prediction error (RPE): difference between predicted & actual reward > RPE > DA released
Dopamine & rewards

Volkow et al. The Addictive Dimensionality of Obesity (2013) Biological Psychiatry
Outcome Evaluation

1. Pavlovian
   Values relate to salience of stimulus
   Amygdala, Nacc, OFC

2. Habitual
   Values relate to stimulus response association following the reward
   Dorsal striatum + corticothalamic

3. Goal directed
   Calculates the association of action & outcomes & evaluates reward assigned to other outcomes
   OFC /DLPFC
Action Selection

Expected utility:
• Judgement value of action & probability of desired outcome
• Sub cortical area (Nacc) relates to physical properties & emotions

Cortical
• PFC higher order computation of probability of obtaining the reward
• OFC value judgement & decision making
• DLPFC retains information to plan
• MPFC evaluates effort required for plan
Regulation Motivation

Goal directed control process
Control

• Immediate rewards are favoured over delayed rewards
• Temporal discounting - decrease value reward if delayed
• Self control ability to select larger delayed over smaller immediate rewards & relies on PFC
• Differences in self control depend on WM capacity
Motivation & Schizophrenia
| Problems representing and maintaining goals |
| Problems allocating attentional resources |
| Problems focusing attention |
| Problems sustaining attention |
| Problems evaluating functions |
| Problems monitoring performance |
| Problems prioritizing |
| Problems modulating behavior based upon social cues |
| Problems with serial learning |
| Impaired verbal fluency |
| Difficulty with problem solving |
Liking & Wanting

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Behavioral Response

Components of Reward to Outcome Translation
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Findings

• 1. DA BG systems associated with reinforcement learning & ability to predict cues that lead to rewarding outcomes

• 2. OFC deficits in generating, updating & maintain value representations

• 3. Aberrant effort value computations

• 4. Altered PFC activation involved in generating exploratory behaviour
Implications

1. Profiling symptoms esp. negative symptoms & cognition (WM)
2. Profiling personal goals & interests
3. Component goals & tight reinforcement scheduling with high expectations of success
4. Errorless learning
5. Choice, intrinsic motivation
6. Greater environmental supports esp. in context of prominent negative symptoms
Schizophrenia

Comorbid substance use
Activation of the reward pathway by addictive drugs

Dopamine Pathways

Nucleus accumbens

VTA

Amphetamines
Opiates
THC
PCP
Ketamine
Nicotine

alcohol

cocaine
heroin
nicotine

heroin

Alcohol
benzodiazepines
barbiturates
Main dopamine pathways

- Frontal cortex
- Mesocortical pathway
- Corpus striatum
- Nigrostriatal pathway
- Nucleus accumbens
- Olfactory tubercle
- Entorhinal cortex
- Hypothalamus
- Pituitary
- Mesolimbic pathway
- Arcuate nucleus
- Corpus callosum
- Substantia nigra
- Ventral tegmental area
- Cerebellum
Brain reward (dopamine) pathways

These brain circuits are important for natural rewards such as food, music, and sex.

Drugs of abuse increase dopamine

Typically, dopamine increases in response to natural rewards such as food. When cocaine is taken, dopamine increases are exaggerated, and communication is altered.
How Drugs Effect Dopamine

• Inhibit Reuptake of Dopamine
• Stimulate Dopamine transporter
  – Cocaine, Amphetamine, Methamphetamine, XTC
• Modulate firing of Dopamine releasing cells by actions on GABA and Glutamate
  – Nicotine, alcohol, opiates, cannabis
  – Cocaine, Amphetamine, Methamphetamine, XTC
Dopamine Neurotransmission

AMPHETRANINE

% of Basal Release

Time After Amphetamine

FOOD

% of Basal Release

Time (min)

Di Chiara et al.
Initiation of Addiction

- Adolescents
  - Risk taking
  - Novelty seeking
  - Responsive to peer pressure
  - Incomplete development of frontal regions involved in “executive function”
Effects of Withdrawal

• Decrease in Dopamine levels
  – Decrease in response to normally rewarding stimuli
• Increase in “stress system” elevated CRF
  – Significant increase in anxiety and dysphoria
Dopamine Gating Hypothesis

• Because drugs cause dopamine release (due to pharmacological actions), dopamine firing upon use does not decay over time → brain repeatedly gets positive predictive error signal: “better than expected!”

• Drug cues become ubiquitous (drug cues difficult to extinguish)

• Cues that predict drug availability take on enormous incentive salience (consolidates drug seeking behavior)

• Drug cues will become powerfully overweighted compared to other choices (contributes to loss of control over drug use)
Clinical Implications

• Addictive behaviors are an important and normal part of human behavior.
• Addictive drugs pharmacologically modify functioning of reward circuits to overvalue drug rewards and reduce the comparative value of other rewards.
• Intention to stop use is not enough to stably quit substance use.
• Ongoing use not an indication of liking.
Implications DD

• High intensity Integrated programs
• Modify programs based on illness
• Focus on specific behaviours
• Frequent reminders of cost/benefits & goal
• Frequent reinforcement
• Modify interventions if prominent –ve symptoms & cognitive challenges
• ? Role of technology - texting
References/Resources/Recommended Reading


• Queensland Health dual diagnosis clinical guidelines. Drug and alcohol treatment strategy unit and mental health and other drugs directorate, Queensland health 2010.

• Volkow ND et al., Role of dopamine, the frontal cortex and memory circuits in drug addiction: insight from imaging studies. Neurobiology of learning and memory 78, 610-624 (2002)