Learning (part II)
Operant Conditioning

Stefan Bode, PhD

Melbourne School of Psychological Sciences,
Decision Neuroscience Laboratory
The University of Melbourne, Australia

sbode@unimelb.edu.au

Short repetition: Classical Conditioning

- UCS, UCR, CS, CR

Principles of Operant Conditioning (OC)

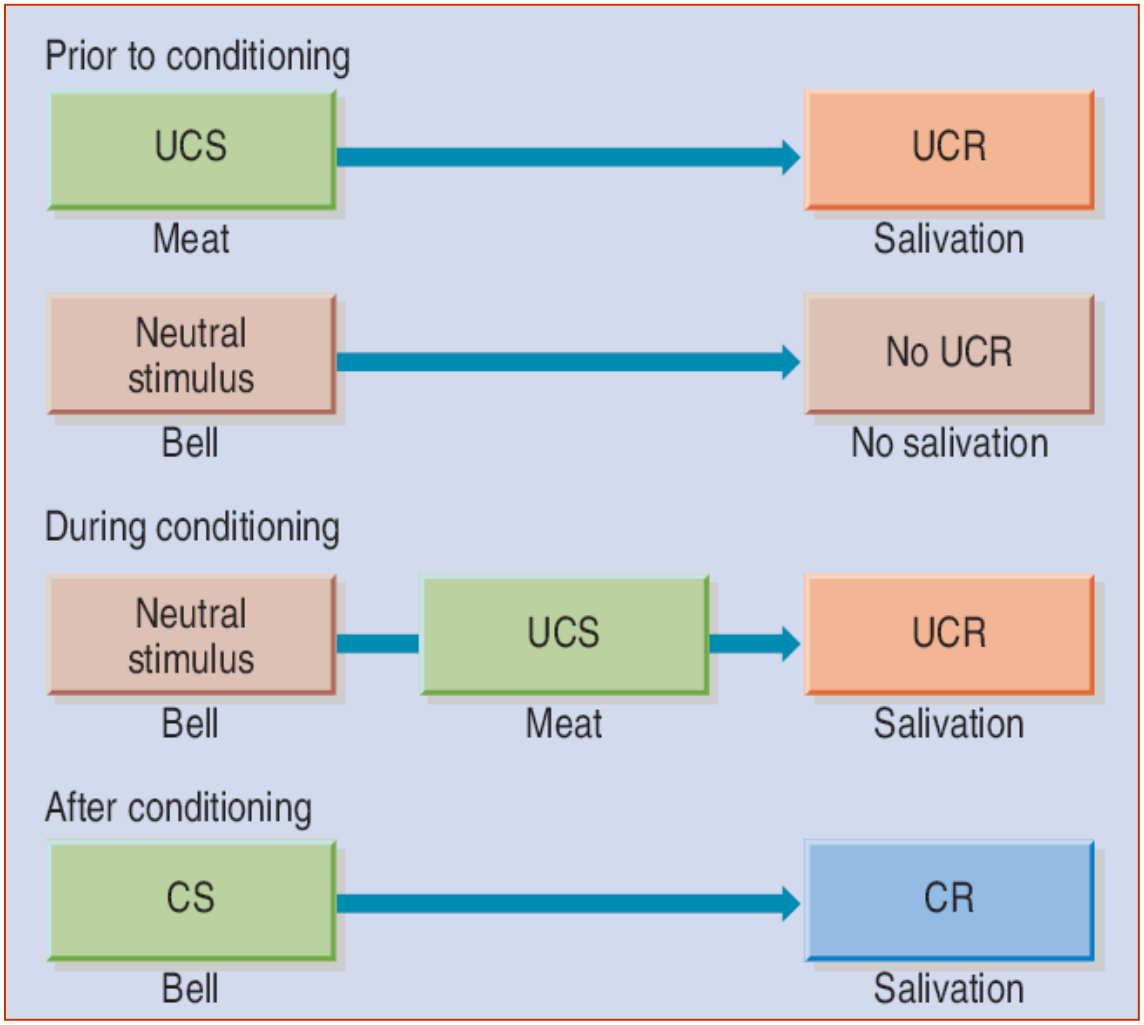
- Thorndike, Skinner, and a lot of animals (è *also in the lab class*)
- Reinforcement, Punishment, Extinction, Shaping
- Learned Helplessness

Overview: Classical and Operant Conditioning

Something Extra

- The scary story of “Little Albert”... to be continued in the lab class

Basic Principles of Learning: Classical Conditioning



Basic Principles of Learning: Operant Conditioning

- Classical Conditioning provided an explanation for how organisms (including humans) learn
- New stimulus-response relationships are *learned by association* but always involve a reflex response to a stimulus first
- However, a full account of human behaviour needs to account for *"goal-directed"* behaviours
- The question is, how do environmental stimuli shape complex goal-directed behaviours?

Basic Principles of Learning: Operant Conditioning

Edward Thorndike

- His experiments, conducted at the turn of the 20th century, paved the way for a behaviourist account of voluntary behaviour
- He worked with different animals: e.g. chicks, cats and dogs
- He wanted to find out whether animals use reasoning to solve problems

Basic Principles of Learning: Operant Conditioning

- Thorndike's "puzzle box": the hungry cat is inside, but the visible food is outside the box

- Can the cat work out mechanism to open the door?

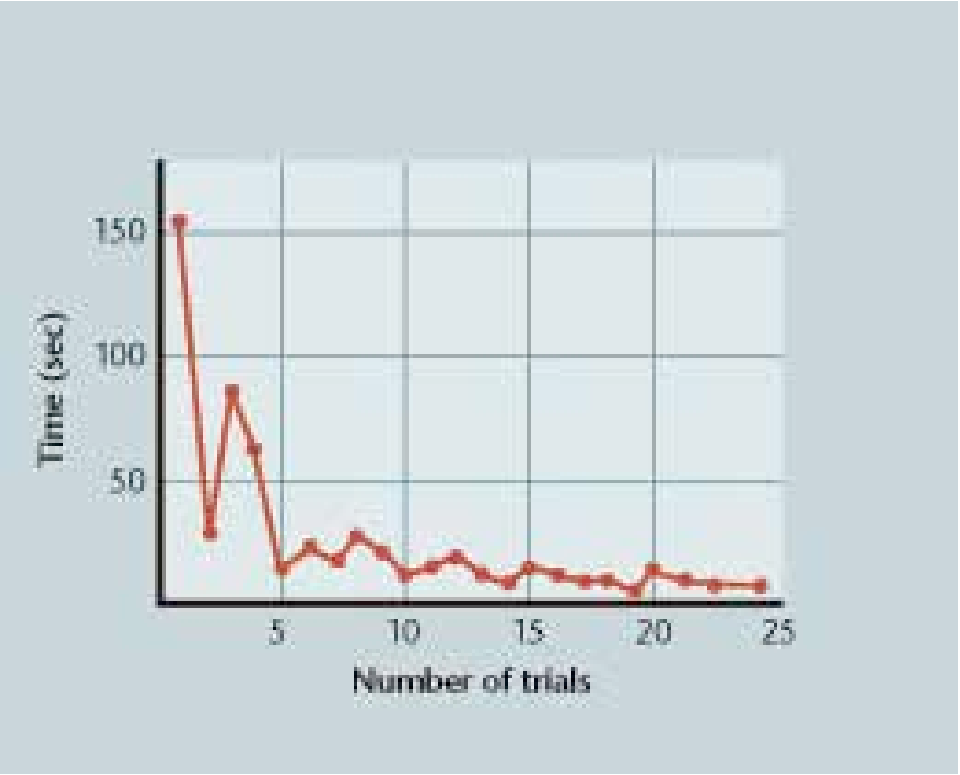
Basic Principles of Learning: Operant Conditioning

- The cat learned by *trial and error (and success)*: first attempts are random, then it stumbled across solution

- Cats became *faster* on subsequent trials in the same puzzle box

- Cats learn to associate response with rewarding consequence

- ***consequences shape behaviour:*** unsuccessful responses are gradually eliminated



Basic Principles of Learning: Operant Conditioning

- The conclusion is that cats learn *simple stimulus-response (S-R) associations* rather than complex reasoning processes

Law of Effect:

- Responses followed by a satisfying state of affairs are strengthened and are more likely to occur again (*rewards*)

- Responses followed by an annoying or unsatisfactory state of affairs are weakened and are unlikely to occur again (*punishment*)

Basic Principles of Learning: Operant Conditioning

B.F. Skinner (1904 – 1990)

- He was influenced by Thonrndike's work describing voluntary human behaviour using basic S-R associations and without resorting to mentalistic concepts

- "Behaviour operates on the environment to generate consequences."

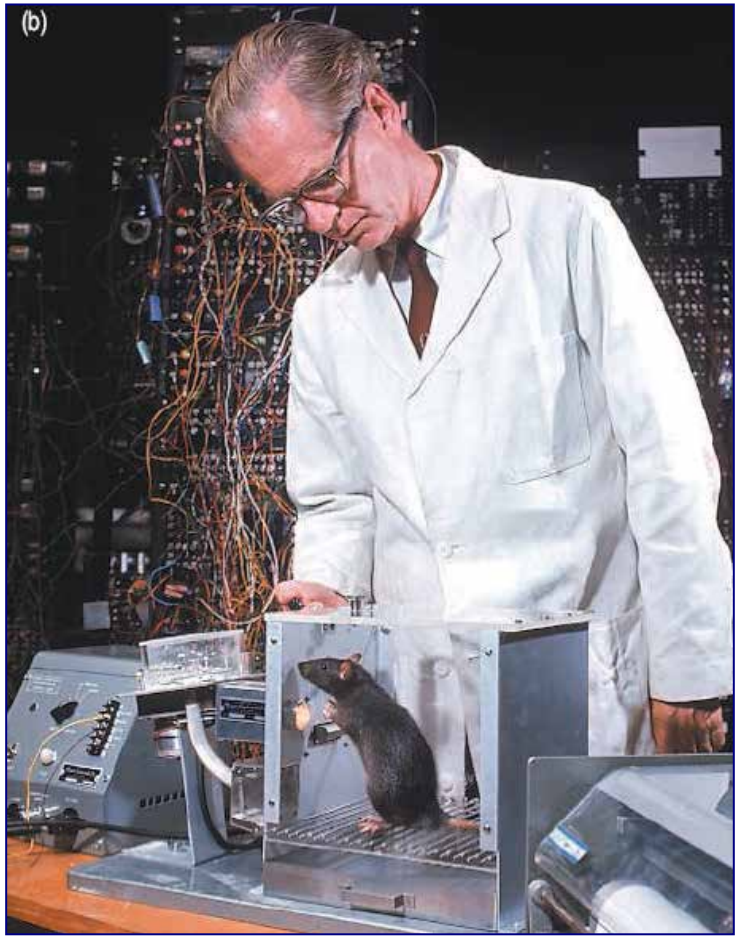
- Organisms learn which behaviours are emitted to earn rewards or avoid punishments

- *Operant* describes any active (voluntary) behaviour that is produced in order to generate consequences, or is instrumental in generating consequences

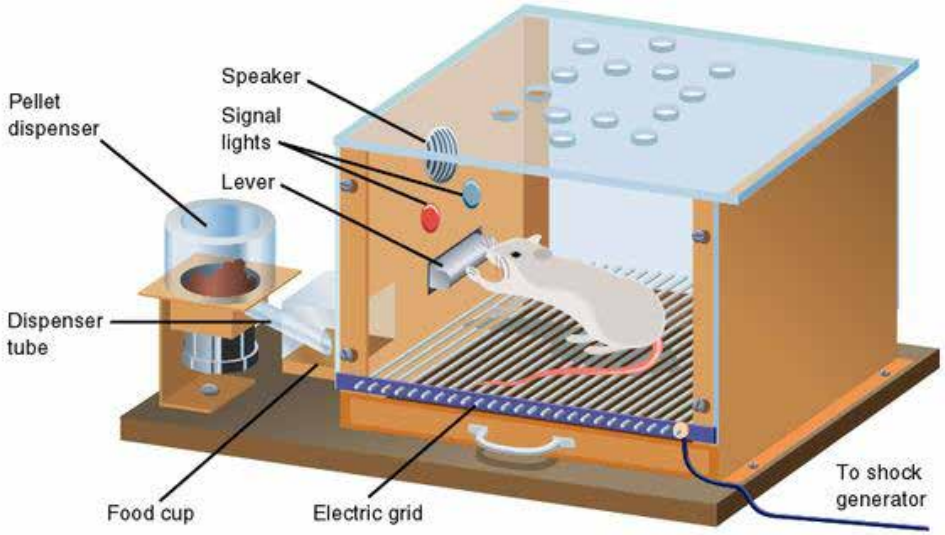
- Everyone is trying to gain something desired or avoid something unpleasant

Basic Principles of Learning: Operant Conditioning

consequences shape behaviour: unsuccessful responses are gradually eliminated



- controlled environment
- automation of experiment
- manipulate motivation (e.g. hunger)
- reduce opportunities for irrelevant responses



Basic Principles of Learning: Operant Conditioning

Reinforcement

- Reinforcement occurs when the consequences of an action *increase the likelihood of the action being repeated*

- Reinforcement increases or strengthens the occurrence of a behaviour in the future

Positive (+) reinforcement:

- stimulus or event which, when *presented* as a consequence of a behaviour, increases the likelihood of that behaviour recurring in the future

Negative (-) reinforcement:

- stimulus or event which, when *reduced* or *terminated*, increases the likelihood that an associated behavior will recur

Basic Principles of Learning: Operant Conditioning

Reinforcement Schedules

continuous reinforcement:

- each response is reinforced

intermitted / partial reinforcement:

- reinforcement does not follow each response

ratio schedules:

- fixed ratio
- variable ratio

timing schedules:

- fixed interval
- variable interval

Basic Principles of Learning: Operant Conditioning

Reinforcement Schedules

partial reinforcement:

- Reinforcement is given only for *some* correct responses

- Generates behavior that persists longer: learners keep "testing" for a reward

fixed ratio schedule:

- rewarded after a fixed number of correct responses

- high rate of responding

- faster responses yield quicker payoffs (“bursts”)

- e.g. paid for producing a specific number of items

variable ratio schedule:

- rewarded after an average number of correct responses

- high rate of responding

- persistent responding

- hope that the next response will bring reward

- e.g. gambling

Basic Principles of Learning: Operant Conditioning

Reinforcement Schedules

partial reinforcement:

- Not only the ratio can be manipulated, but also the interval:

fixed interval schedule:

- reinforcement for first correct response after a fixed time period

- flurry of responding right before a reward is due

- e.g. test scheduled every four weeks

variable interval schedule:

- rewarded for first correct response after an average time period

- less predictable

- slow but steady pattern of responding (“testing”)

- e.g. surprise quizzes

Basic Principles of Learning: Operant Conditioning

Shaping

Learning more *complex behaviours* by reinforcing *successive approximations* to the desired behaviour:

- reinforce *high frequency* component of desired response

- drop reinforcement – behaviour becomes more variable again

- await response that is still close to desired response – then reintroduce reinforcement

- keep cycling: closer approximations are achieved

è Shaping of behaviour which is not in the animal's natural repertoire

Image from: CartoonStock.com

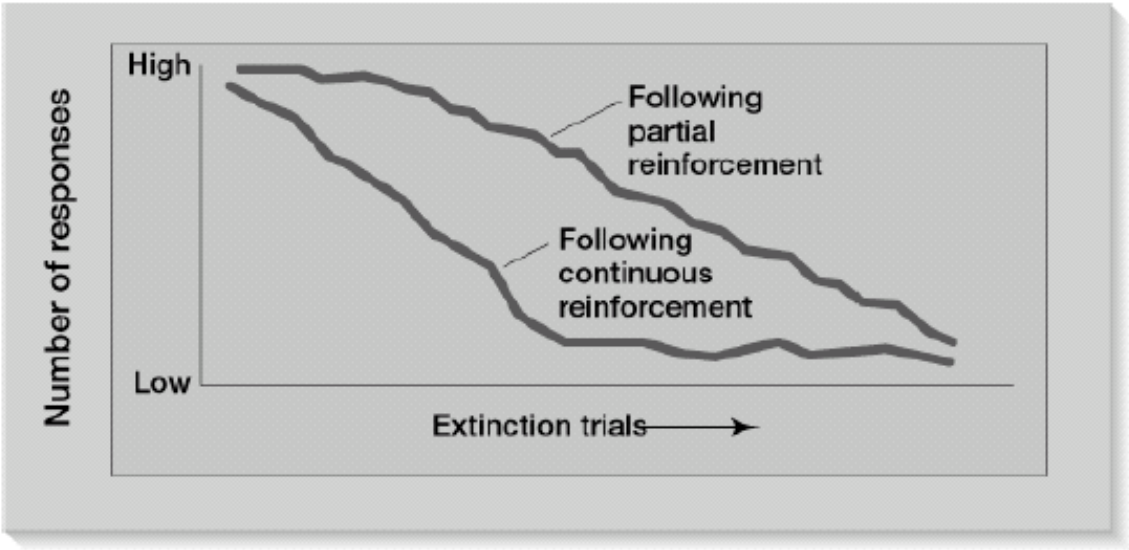
Basic Principles of Learning: Operant Conditioning

Extinction

- Extinction occurs when reinforcement is withheld

- It is not an immediate process, often brief increase in responding

- Partially reinforced responses are harder to extinguish



Basic Principles of Learning: Operant Conditioning

Punishment

- the use of *aversive consequences* to reduce undesirable behavior

- any event which *decreases* the likelihood that ongoing behaviour will recur

positive punishment:

- behaviour is followed by the *presentation* of an aversive stimulus

- stimulus is *added* to situation

- e.g. electric shock

negative punishment:

- behaviour is followed by *withdrawal* of rewarding stimulus

- stimulus is *taken away*

- e.g. remove food

Basic Principles of Learning: Operant Conditioning

Punishment

- Punishment is more effective when it is swift (no delay) and consistent (not just administered sometimes)

- It is less effective than reinforcement because no desired behaviour is established

- It does *not* cause long-term behaviour change: *suppression* of behaviour

- When threat of punishment is removed, the behaviour returns (e.g. speed cameras)

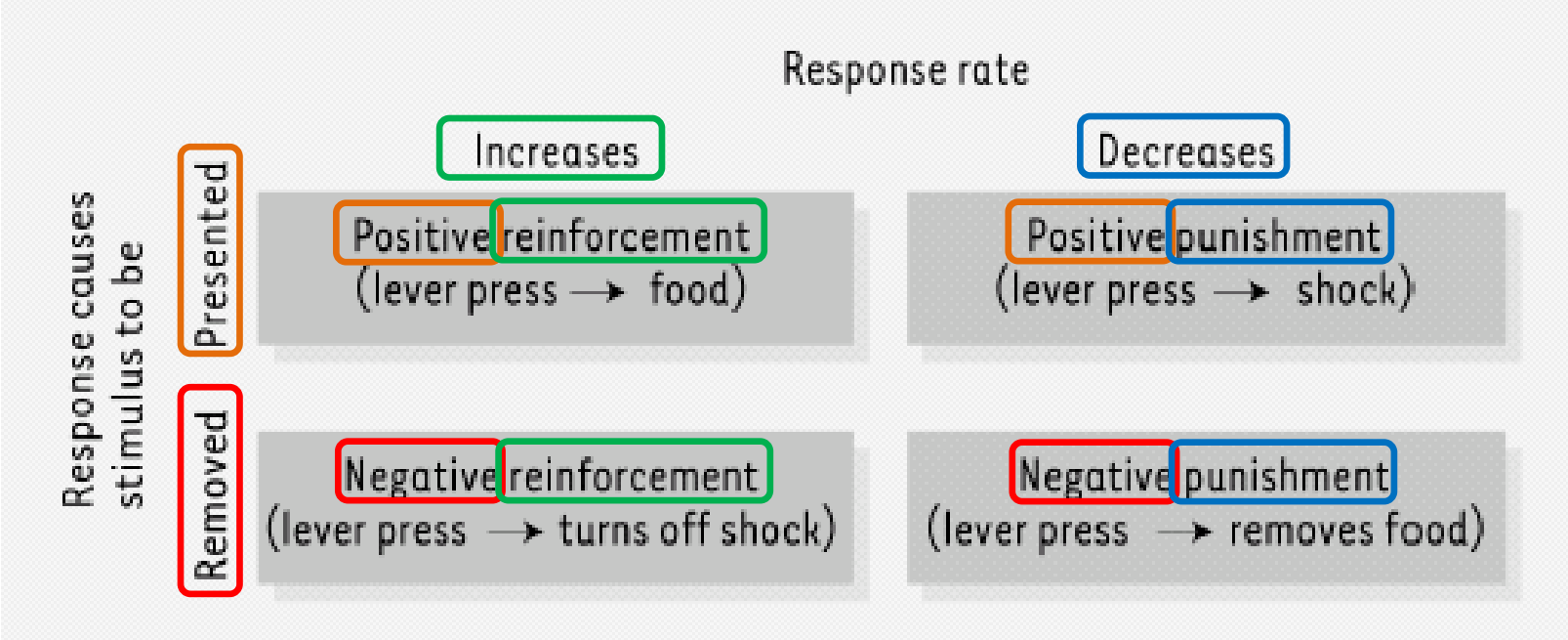
- It produces negative feelings and does not promote new learning

- It may indeed teach the recipient to use punishment towards others

- It is useful if behaviour is dangerous and must be changed/suppressed quickly

Basic Principles of Learning: Operant Conditioning

Punishment & Reinforcement



Basic Principles of Learning: Operant Conditioning

How could principles of Classical Conditioning apply to changing children's behaviour? (No guarantee that this works!)

Basic Principles of Learning: Operant Conditioning

- Reinforce alternative behaviour that is incompatible with the undesirable behaviour (e.g. respond to normal voice only, not to screaming)

- Identify the crucial reinforcer (maintaining the behaviour) and stop reinforcing the problem behaviour (extinction)

- Reinforce the non-occurrence of the undesirable behaviour

- Remove the opportunity for positive reinforcement

- Use strongly reinforcing stimuli, but use variety (e.g. praise, privileges)

- Immediate reinforcement after the preferred behaviour

- Start with reinforcing all the time, switch to intermittent

- Encourage self-reinforcement through pride and a sense of self-control

Basic Principles of Learning: Operant Conditioning

Learned Helplessness

Martin Seligman

- He investigated the effects of exposure to uncontrollable shock on escape/avoidance learning in dogs

- 1/3 of dogs exposed to unavoidable shock failed to learn to avoid or escape from an unpleasant or aversive stimulus

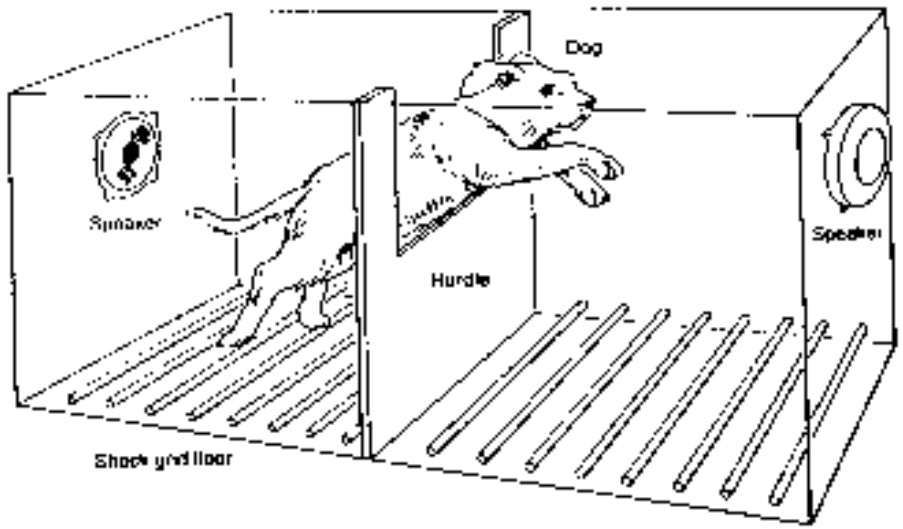
Shuttle Box

first phase: Classical Conditioning

- shock paired with light

second phase: Operant Conditioning

- learn to jump when light



Maier & Seligman (1976). *J Exp Psychol: Gen*

Basic Principles of Learning: Operant Conditioning

Learned Helplessness

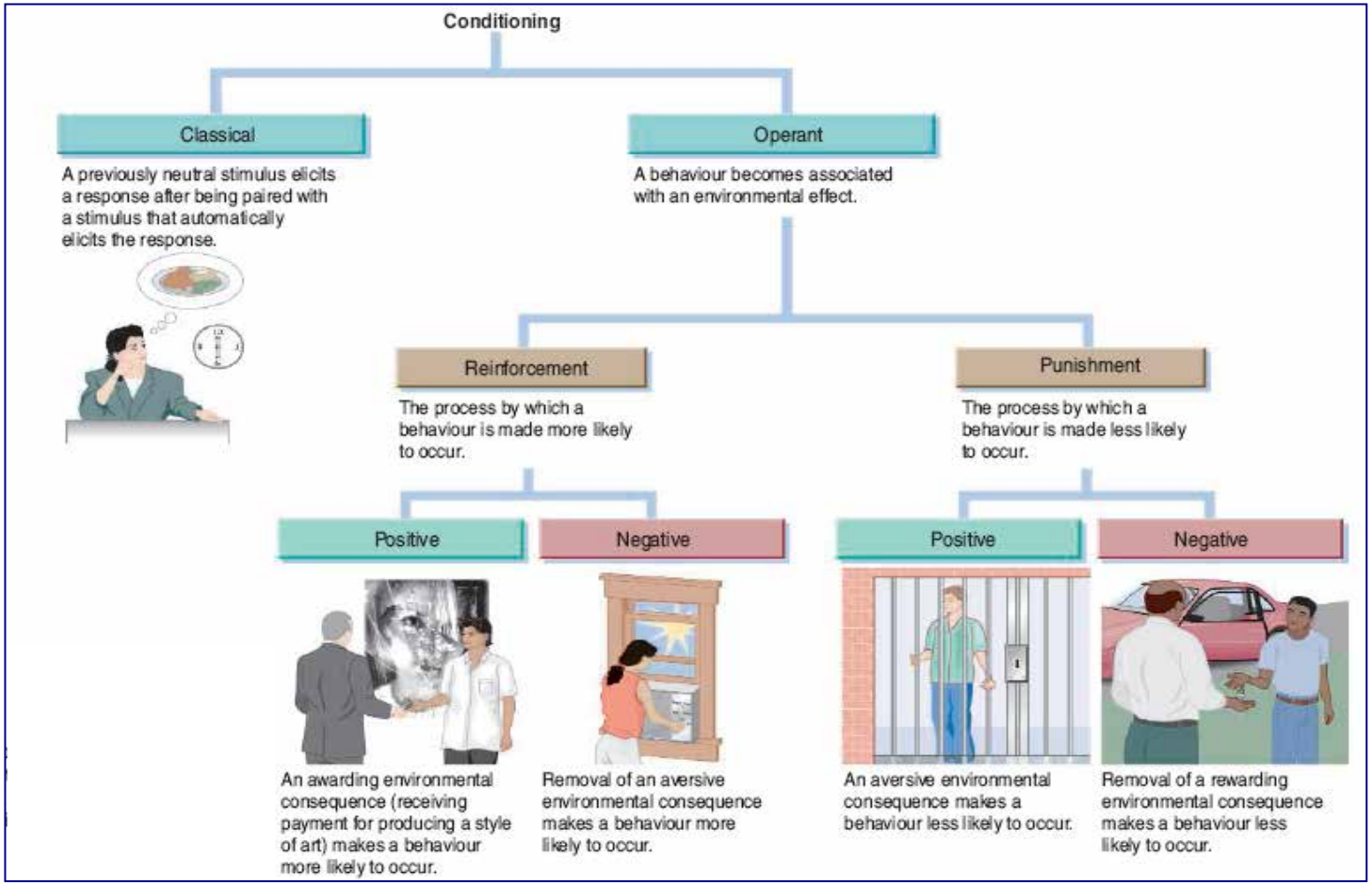
- Learned helplessness might explain behaviour after *abuse* and in *depression*

- When the traumatic event first occurs it causes a heightened state of emotionality, which has been called "fear“

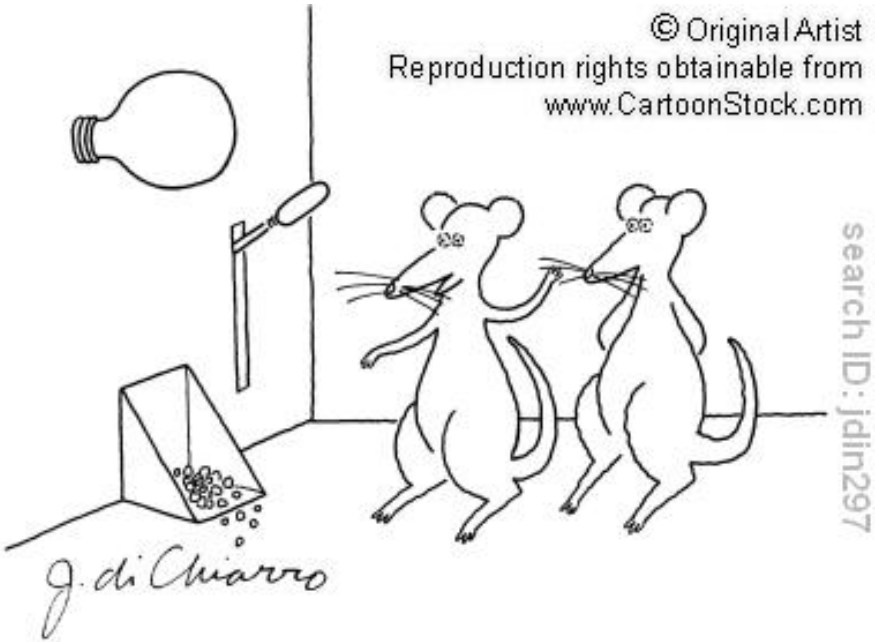
- Fear continues until the subject learns that he can or cannot control the trauma

- “If subject learns that he cannot control the traumatic event, fear decreases and is replaced with depression.” (Seligman, 1979)

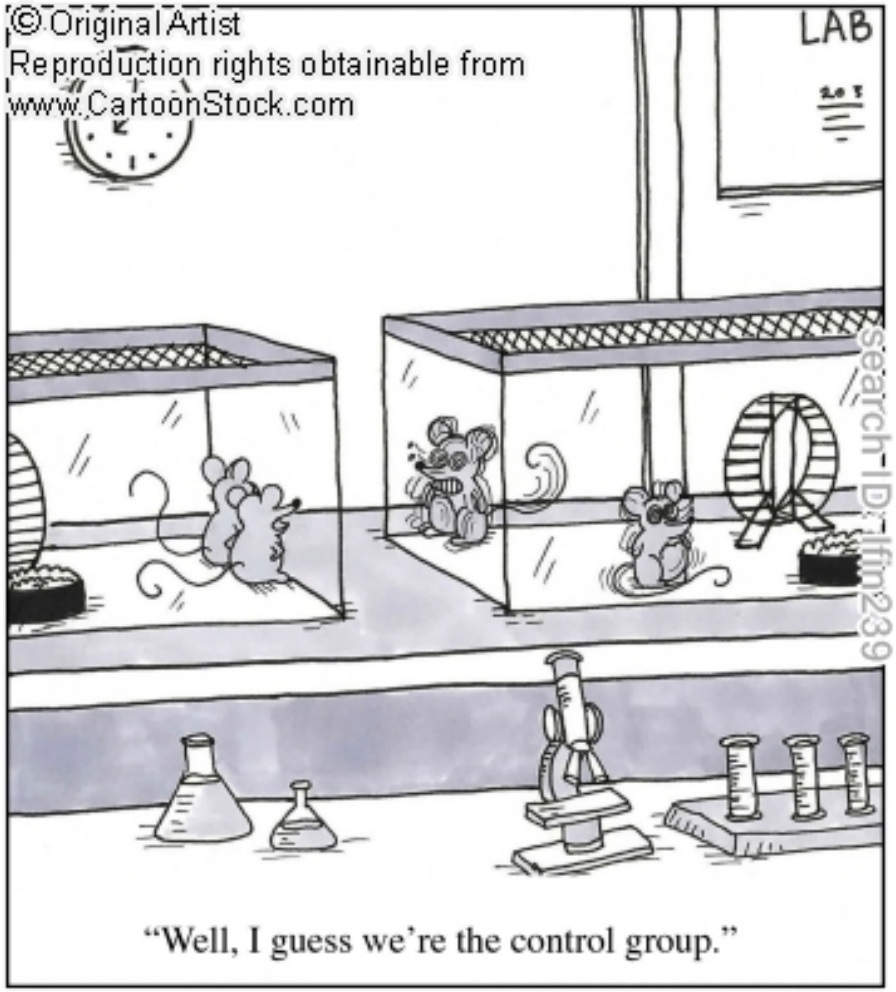
Basic Principles of Learning: Classical and Operant Conditioning - Overview



Basic Principles of Learning: Classical and Operant Conditioning - Overview



"The light goes on. I pull the lever. The food comes. It's a full life."



Classical Conditioning in humans

- J.B. Watson applied conditioning methods to psychology and founded the Behaviourist school of psychology in the U.S (1913)

- *“Give me a dozen healthy infants… and my own specified world to bring them up in and I’ll guarantee to take any one at random and train him to become any type of specialist I might select – doctor, lawyer, artist….even beggar man and thief, regardless of his talents, tendencies, abilities, vocations and race of his ancestors”.* (J.B. Watson, 1919)

- All human behaviour can be understood as the result of conditioning and learning
- Behaviour reflects the influence of past experiences and environmental influences
- Watson also claimed that talent, personality, and intelligence were not inherited

Classical Conditioning in humans

“Little Albert” – Conditioning an infant

- Human *emotions* can be thought of as reflexive responses

- *fear response* triggered by a set of specific stimuli, e.g. sudden loud noise or sudden dropping motion

- at nine months of age Little Albert showed no fear of a tame white rat

- fear response triggered by banging steel bar loudly behind his head when ever the rat was around

John B. Watson and associate conducting an experiment

Classical Conditioning in humans

“Little Albert” – Conditioning an infant

- They repeatedly paired a loud noise with presence of the rat (2x in initial session, 5x a week later)

- This elicited extreme fear response to the white rat alone (formerly neutral)

- Watson et al. observed generalisation to other furry animals, and Santa’s white beard

- They report no attempt to extinguish the response

Watson & Reynor, 1920

Classical Conditioning in humans

“Little Albert” – Conditioning an infant

before conditioning:

UCS (loud noise) ⟶ UCR (fear)

during conditioning:

NS (rat) + UCS (loud noise) ⟶ UCR (fear)

after conditioning:

CS (rat) ⟶ CR (fear)

If you want to know more:

Abramson, L.Y. & Seligman, M.E. (1978). Learned helplessness in humans: critique and reformulation. Journal of Abnormal Psychology, 87, 49-74.

Maier, S.F. & Seligman, M.E. (1976). Learned helplessness: Theory and evidence. *Journal of Experimental Psychology: General, 105,* 3-46.

Thorndike (1932). *The Fundamentals of Learning*, AMS Press Inc.