Lecture 4
Learning to predict events

Monday

8/8/2022

- Reaching for your phone when you hear the same ringtone
- Fear of needles (vaccination, blood test)
- Disliking a subject because of bad teaching
- Wild animals trained to dislike a certain type of meat

Ian Pavlov

Saliva measuring apparatus

- Pavlov was originally studying effects of salivation on digestion (Nobel Prize 1904)

- He showed that salivation was necessary to start the process of digestion in the stomach

- He also started to test salivation to different types of food and stimuli

- Sound+food → salivation

- Sound → salivation (accidental discovery)

Basic Concepts of Classical Conditioning

- **Unconditioned stimulus (US):** a cue that has some biological significance and that, in the absence of prior training, naturally evokes a UR

- **Unconditioned response (UR):** the naturally occurring response to an unconditioned stimulus (US)

- **Conditioned stimulus: (CS)** a cue that is paired with an unconditioned stimulus (US) and comes to elicit a CR

- **Conditioned response (CR):** the trained response to a conditioned stimulus (CS) in anticipation of the unconditioned stimulus (US) that the CS predicts

CONDITIONING

Pavlov's Dog Experiment

BEFORE CONDITIONING

Unconditioned stimulus — Unconditioned response

Neutral stimulus — No response

DURING CONDITIONING

Food + Bell — Unconditioned response

AFTER CONDITIONING

Conditioned stimulus — Conditioned response
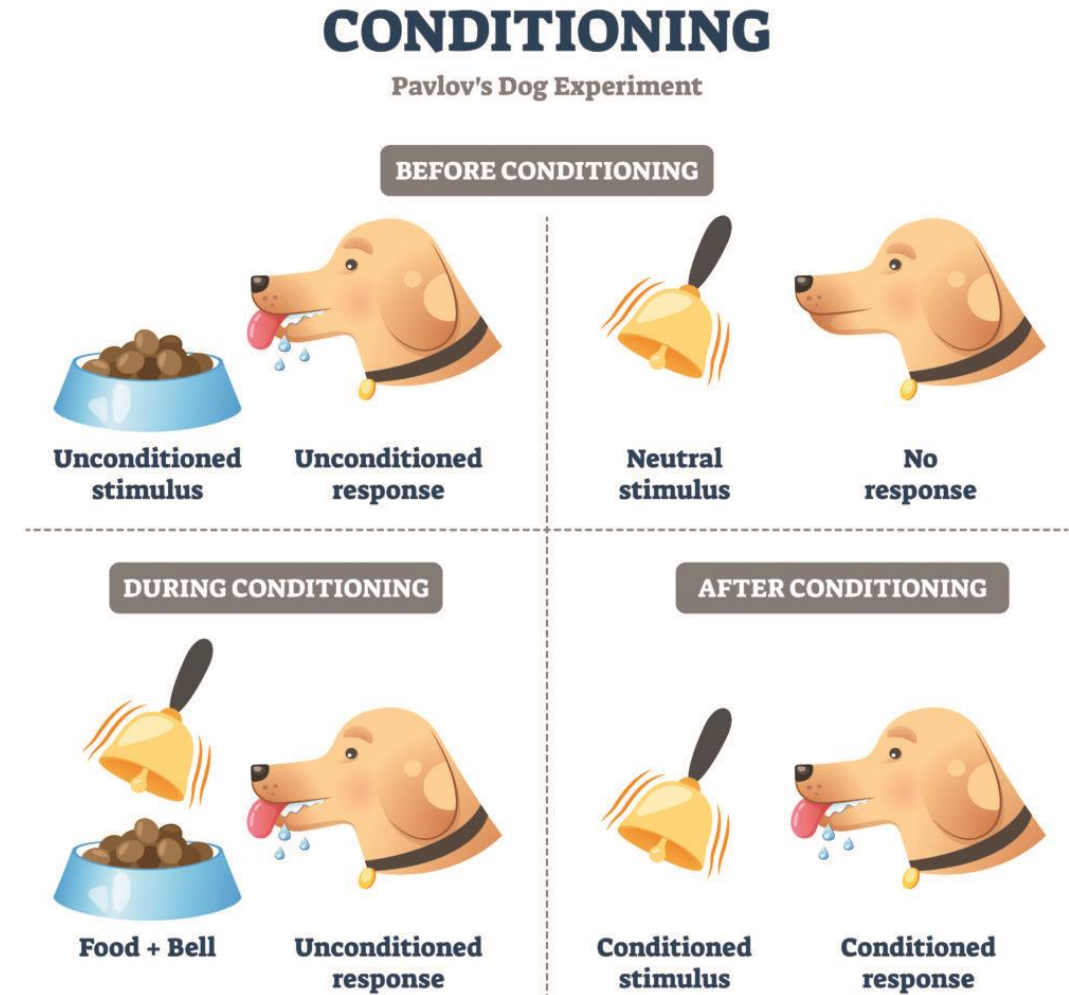
What Is Classical Conditioning?

- **Classical (Pavlovian) conditioning:** a form of learning in which an animal acquires the expectation that a given stimulus predicts a specific upcoming important event

Appetitive and Aversive Conditioning

- **Appetitive conditioning:** conditioning in which the US is a desirable event

- E.g. food,

- **Aversive conditioning:** conditioning in which the US is a disagreeable event

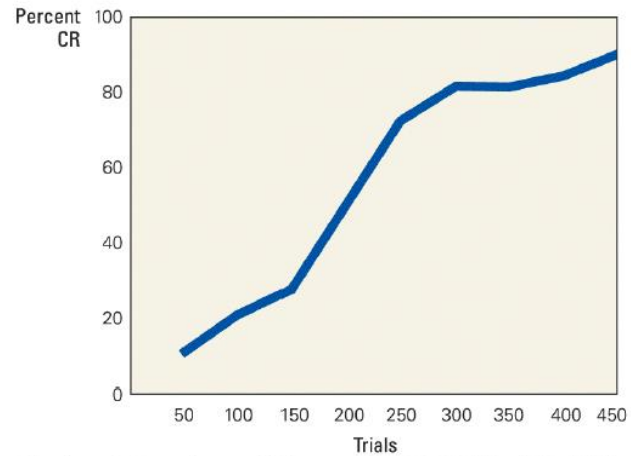- E.g. eyeblink conditioning

- E.g. fear for insects, spiders, phobias

FIGURE 4.5 Eyeblink conditioning in humans and rabbits (A) In human eyeblink conditioning, a tone CS is delivered through headphones. The US is a puff of air delivered through the rubber tube. The eyeblink CR is recorded by EMG electrodes placed above and below the eye. (B) In rabbit eyeblink conditioning, a similar rubber tube delivers the airpuff US to the rabbit in the restraining acrylic glass case; a photobeam measures the CR and UR.

A: Mark Gluck; B: Richard F. Thompson
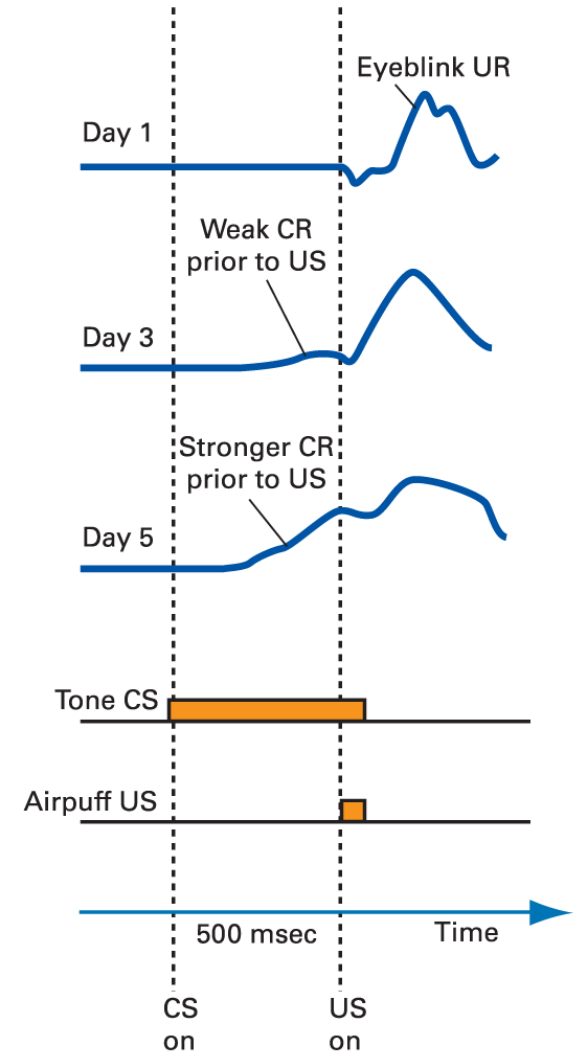

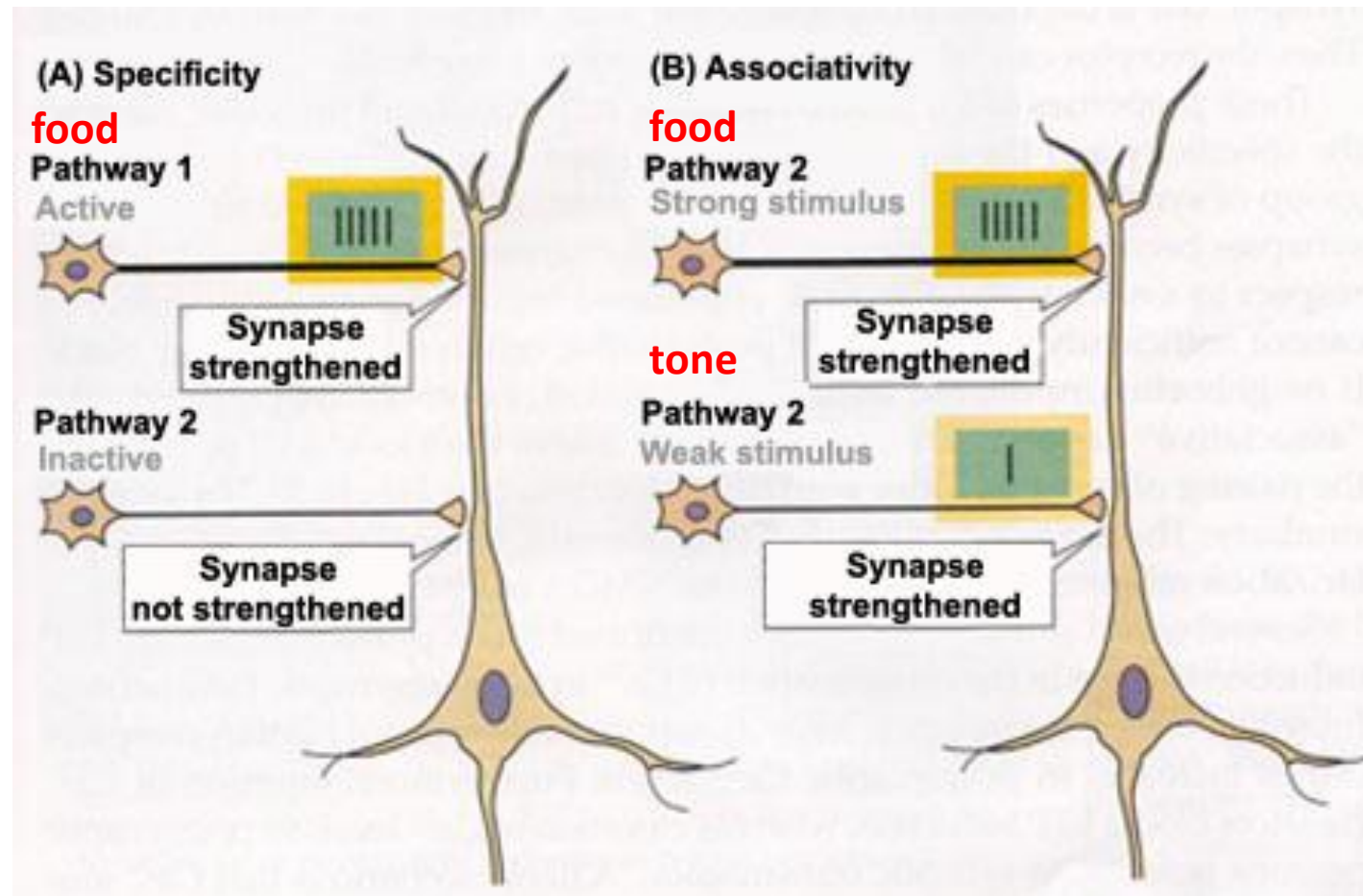**A** Rabbit eyeblink conditioning

B Human eyeblink conditioning
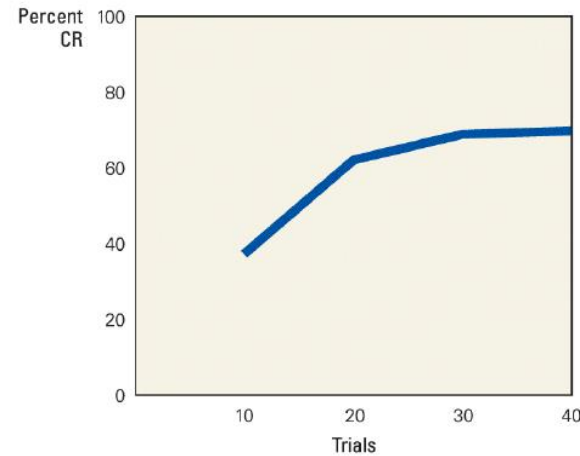
(A) A learning curve showing the percentage of CRs in rabbits across blocks of training trials. (B) Analogous learning curve for human eyeblink conditioning. Although these curves are qualitatively similar, they reflect different training regimes, since the rabbits are usually trained in blocks of 1-hour trial sessions on successive days, whereas humans are trained in a single hour-long session.

Airpuff → eyeblink
Tone → Airpuff → eyeblink
Tone → eyeblink

Gluck et al., *Learning and Memory*, 4e,
© 2020 Worth Publishers

Hebb's Law

(A) Specificity

food
Pathway 1
Active

Synapse strengthened

Pathway 2
Inactive

Synapse not strengthened

(B) Associativity

food
Pathway 2
Strong stimulus

Synapse strengthened

tone
Pathway 2
Weak stimulus

Synapse strengthened

Conditioned Compensatory Response (CCR)

- E.g. swimming pool overflow

- E.g. Context - Adrenaline – heart rate experiment in dogs (Subkov & Zilov, 1937).
  - dogs' heart rate increased less and less with each subsequent injection – _tolerance_

  - _Homeostasis_ - the researchers placed their dogs on injection stands, where the dogs normally received the drug injection, but they administered a neutral, inert substance rather than the adrenaline. The researchers observed that this caused the dogs' heart rate to decrease.

  - _CCR -_ Apparently, the various cues (the stand, the injection) that predicted the adrenaline injection triggered a conditioned compensatory response that lowered the dogs' heart rate in anticipation of the adrenaline's causing an increase in heart rate.

- Body's response to drugs
  - Body adapts to the dose of the drug - **Homeostasis -** The tendency of the body (including the brain) to gravitate toward a state of equilibrium or balance
  - The same quantity now does not give the same effect - **Tolerance** - A decrease in reaction to a drug such that larger doses are required to achieve the same effect.

# CS, US, UR/CR – defined by the roles the cues play in a particular learning situation

- Cigarette Smoke(US) → headache (UR)
- Party → smoke → headache
- Party (CS) → headache (CR) (anticipating smoke)

- Boss harasses (US) → anxiety-smoking (UR)
- Meetings → boss harasses → smoking
- Meetings (CS) → smoking (CR) [anticipating the boss's harassment]

Extinguishing an Old Association

1. What if the boss stops harassing during meetings ? (someone filed a complaint)
    How long will it take to stop smoking?

    Association becomes dormant

-   **Extinction:** in classical conditioning, the process of reducing a learned response to a stimulus by ceasing to pair that stimulus with another, previously associated stimulus
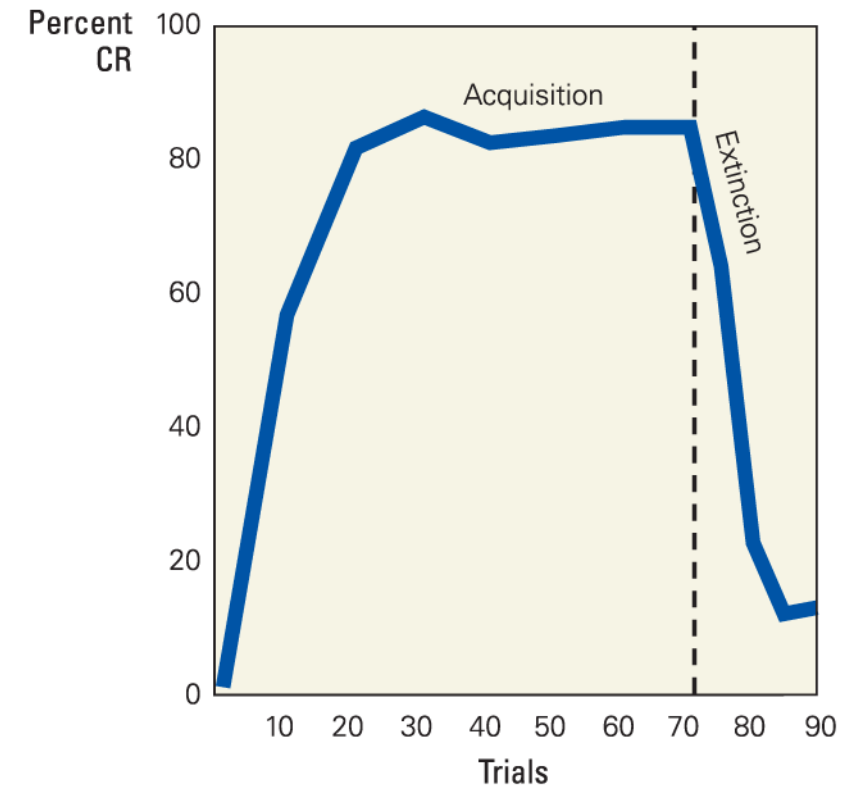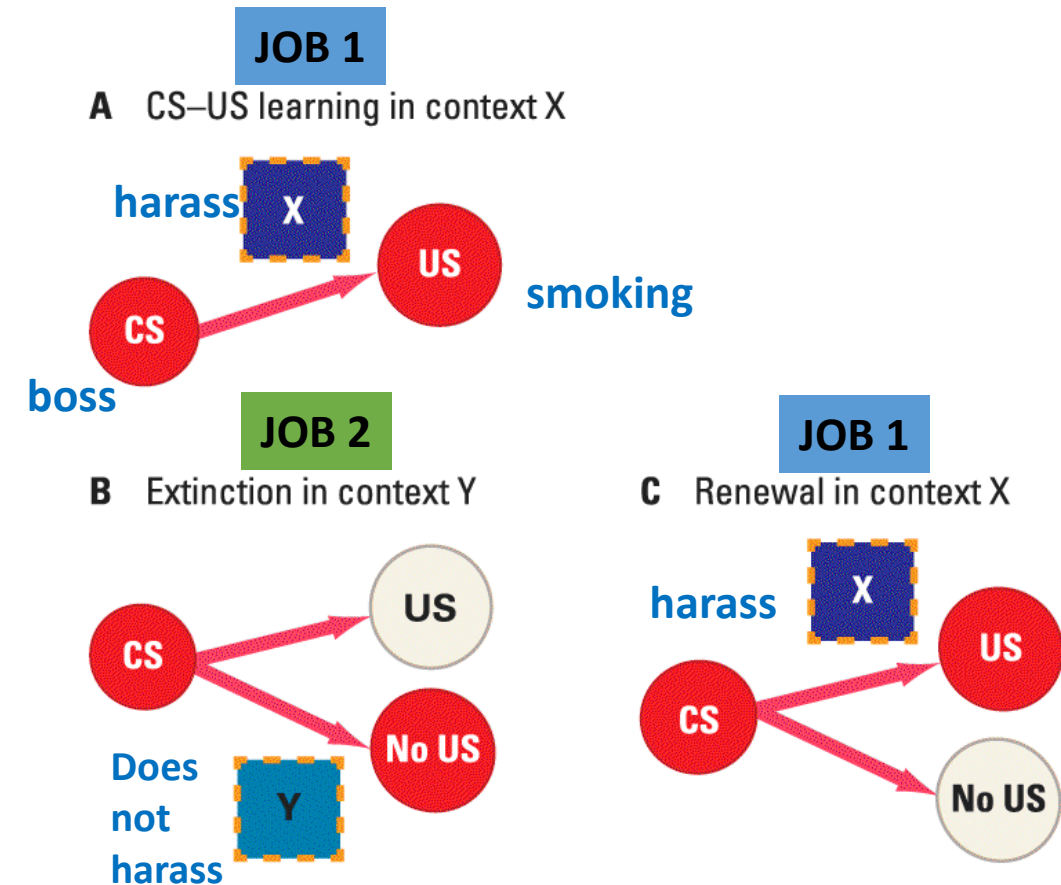

Gluck et al., *Learning and Memory*, 4e, © 2020 Worth Publishers

Extinction

2. What if the employee changes the job?

- Smoking stops/reduces

- Has the brain unlearned the association?
  - No, the original association is still there (memory trace)
  - The association (X) is suppressed (inhibited)
  - Relearning occurs– makes another association (Y)
  - Employee visits old office or meets the ex-boss – smoking behaviour reinstates – **spontaneous recovery** of the association

JOB 1

A   CS–US learning in context X

harass   X   US   smoking

CS

boss

JOB 2

B   Extinction in context Y

CS   US   No US

Does not harass   Y

JOB 1

C   Renewal in context X

harass   X   US

CS   No US

Gluck et al., *Learning and Memory*, 4e, © 2020 Worth Publishers

- Real life examples of extinction?

Rapid reacquisition

E.g. in the new office, if a colleague is uncooperative and prevents you from working efficiently – smoking returns very rapidly

The Informational Value of Cues

- Humans and animals are sensitive to the informational value of cues in determining which associations they do or do not learn

- Contiguity → closeness in time and space
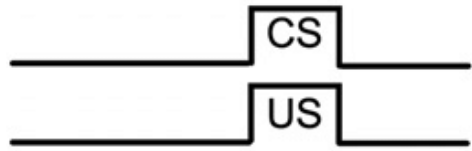- is necessary for learning a new association, such as that between a CS and a US
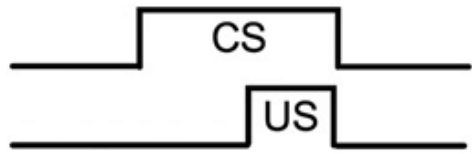
Delay
- Does not require the hippocampus to remember the CS
- Mid-brain+cerebellum needed
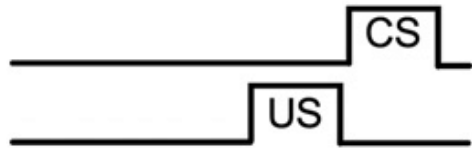- Most effective
- CS predicts US
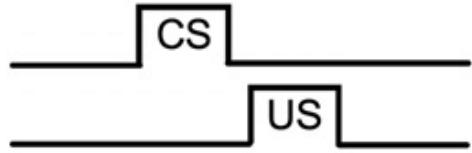
Trace
- Requires the hippocampus to remember the CS
- CS predicts US

Simultaneous
Not predictive
Weak association

Backward
Not predictive
Weak association

Time ⟶

Highway Analogy for Time and Classical Conditioning

Delayed   Trace   Simultaneous   Backward