Cognition: Methods and Models

PSYC 2040

L4: Associations

Part 2

logistics: class survey (February: 1 point)

- https://forms.gle/8KSgcRyE7o2h4VLU8
  - link also on Canvas (under class surveys)
- due Feb 26 (so we can talk about it in class on Feb 28)
- 1 point that counts towards your final points/grade
  - submit on Canvas
- I value your feedback
- anonymous survey! please be honest and reflective
- you will get a code at the end of the survey (on the thank you screen)
  - copy-paste this code on Canvas to get credit

logistics: final project

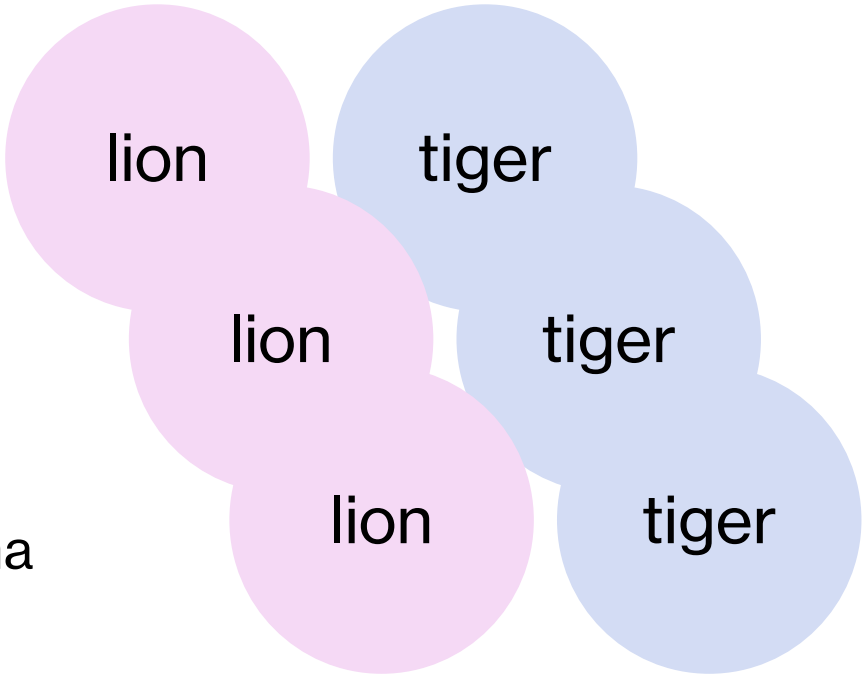
- schedule project meeting before milestone 2 OR 3
  - https://calendly.com/abhilasha-a-kumar/30min
- milestone #2 due Feb 19, 2023 (midnight)
- what's due?
  - jointly select an instance of cognition (+ film/podcast/dataset)
  - find and read one review article (per group)
  - submit 250-word reflection (individually, on the same article)
  - fill out self/peer assessment
  - submit individually on Canvas

project milestones overview

milestone #1: project & partner selection	milestone #2: instance of cognition	milestone #3: article QALMRI	milestone #4: project plan/outline	milestone #5: project first draft	milestone #6: final submission
Feb 12 individual reflection, jointly written contract	Feb 19 joint selection, individual reflection	Mar 5 jointly written QALMRIs of articles	Apr 2 jointly written plan/outline for project	Apr 30 jointly created first draft	May 14 jointly created final project

recap: Feb 14, 2023

- what we covered:
  - origins of associationism
  - Cattell's reaction time studies
  - Thorndike's puzzle boxes
- your to-dos were:
  - *finish:* L4 (Associations) chapter
  - *schedule*: group project meeting with Abhilasha
  - *work on:* project milestone #2
  - *look at:* L4 writing assignments



conceptual question #models

- “Towards the end of the chapter, Crump says that associative learning has succeeded in creating mathematical process models of the association formation process. I am curious what these models look like, how they were derived, and what their applications are.”

today's agenda

- Pavlov's classical conditioning paradigm
- Rescorla-Wagner model of conditioning

review: associations so far

- we learned how the idea of association is fairly old and dates back to philosophers, who came up with certain laws/principles
- psychologists arrived on the scene and began to evaluate some claims about associations
- Cattell investigated seeing/naming times as well as cued associates
- Thorndike investigated associative learning in animals
- the focus was on (1) what associations do people have, and (2) what was the nature of associative learning, through experiments that provided insight into mental processes

conceptual question #imitation

Does the fact that humans are able (and often) learn via imitation support the view that humans and animals have largely differing cognitive processes, as Thorndike's cats, dogs, and chicks were unable to learn through imitation? Does this inability apply only to more tactile tasks like escaping from a box? Does this inconsistency have to do with varying memory processes of events as opposed to differing learning styles (the non-human animals may remember differently)? Is this difference significant enough to indicate evolutionarily that most of our cognitive processes developed after humans split from non-human animals?

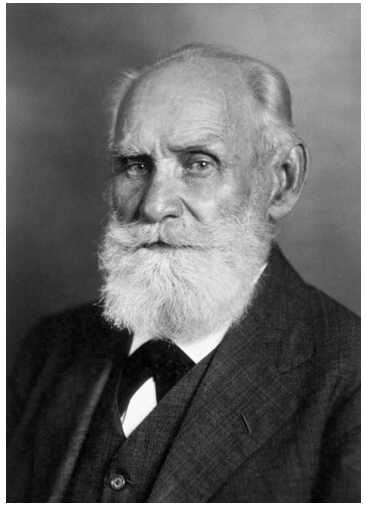
BENNETT G. GALEF, JR.
Department of Psychology
McMaster University
Hamilton, Ontario, Canada L8S 4K1

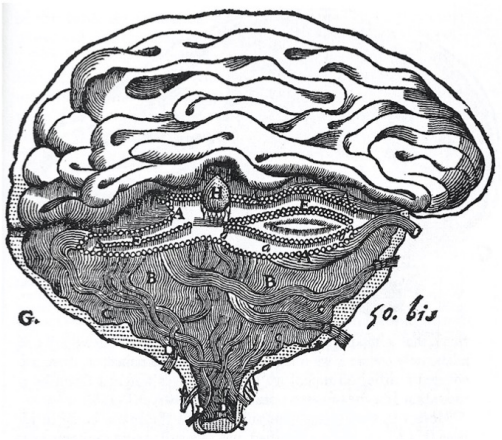
During the past decade, researchers working in a variety of subdisciplines within anthropology, psychology, and biology have made substantial progress in their study of imitative and nonimitative forms of social learning in animals. Nonimitative social learning is now known to play an important role in reproduction, food acquisition, and predator avoidance in a range of vertebrate species. Evidence is also available that not only great apes but also some birds and nonprimate mammals can learn by imitation.

Social Learning and Imitation

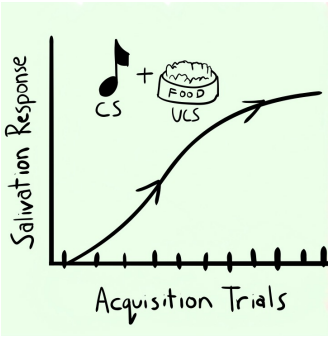
Pavlov: physiology > psychology

- Pavlov was skeptical of psychology and viewed learning from a physiological perspective
- cared about measurable phenomena such as behavior, but also physical secretions
- inspired by Descartes, a dualist who separated the body (physical) and soul (mental)
- Descartes "garden & pipes" analogy and idea of "reflexes" inspired Pavlov's work on understanding how different stimuli produced "reflexes"/responses

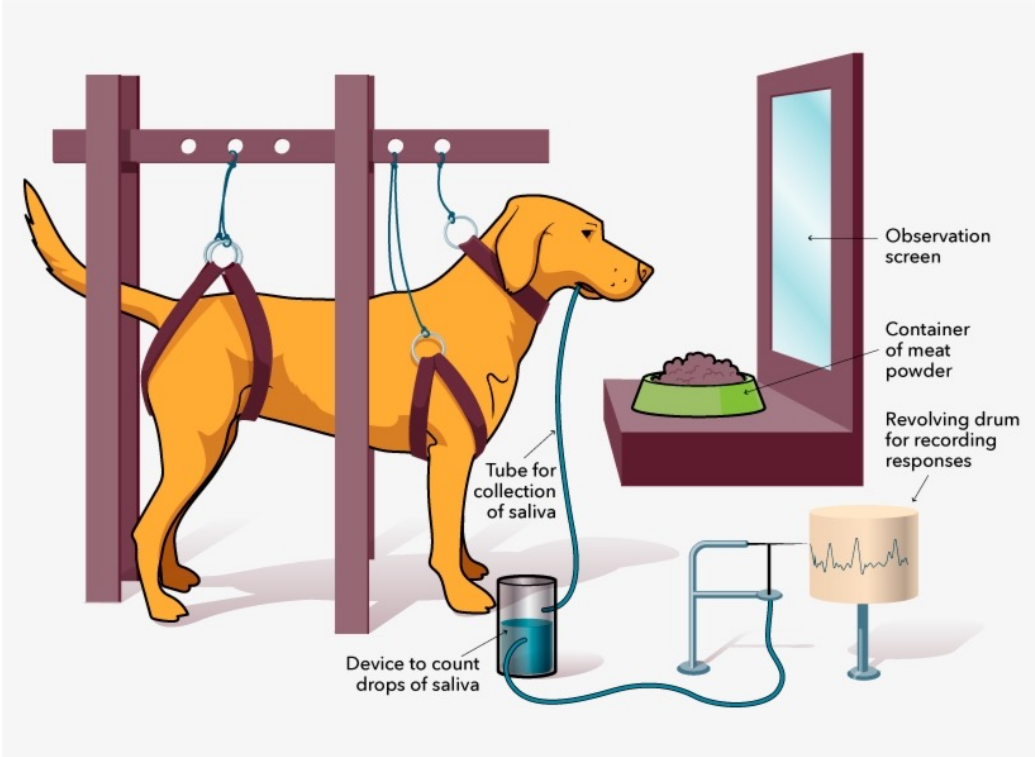




simple acquisition and conditioning

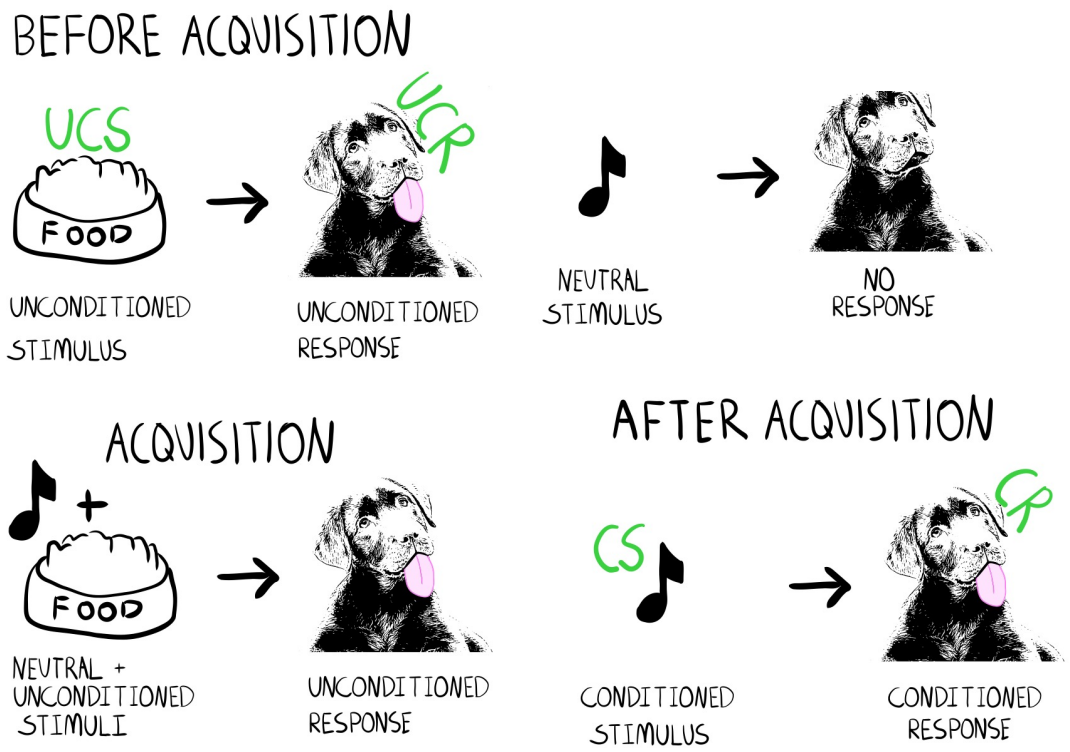


- a dog was given several "acquisition trials"
- on each trial, a perceptual stimulus (tone) + reward (meat powder) were presented
- meat powder naturally caused the dog to salivate, the tone did not
- over time, the dog started to salivate to the sound of the tone



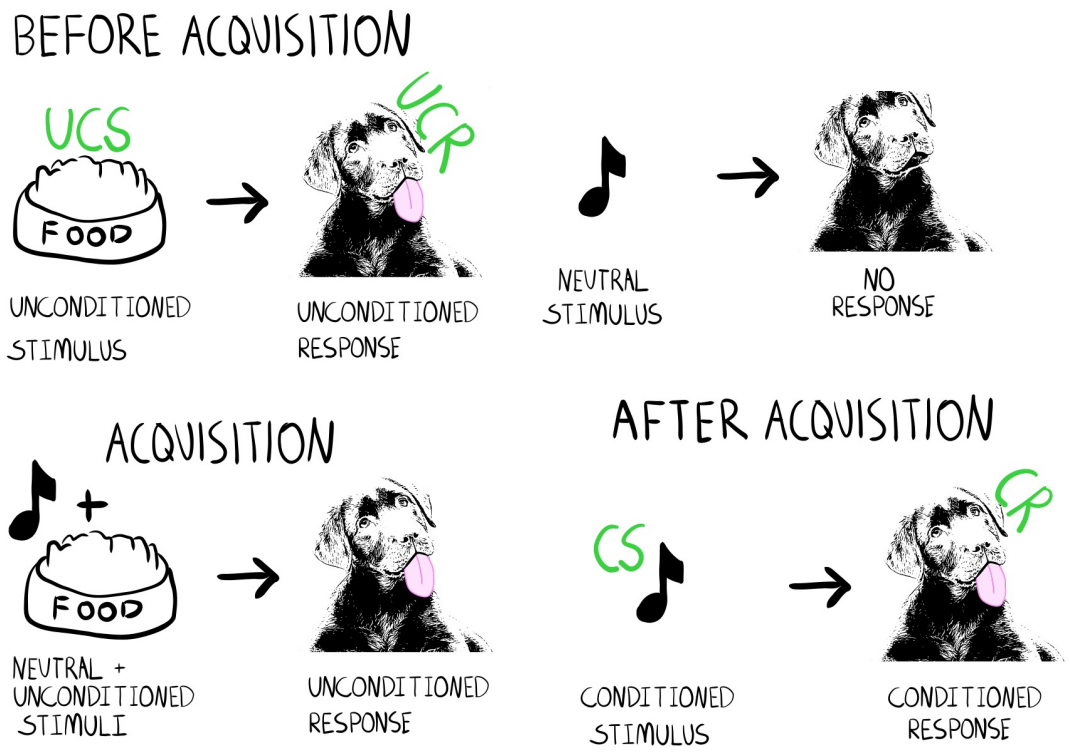
terminology

- unconditioned stimulus (UCS)
  - evokes response without prior learning
- neutral stimulus (NS)
  - does not evoke a response
- unconditioned response (UCR)
  - default response to UCS
- conditioned stimulus (CS)
  - begins to trigger the unconditioned response
- conditioned response (CR)
  - newly learned response



terminology

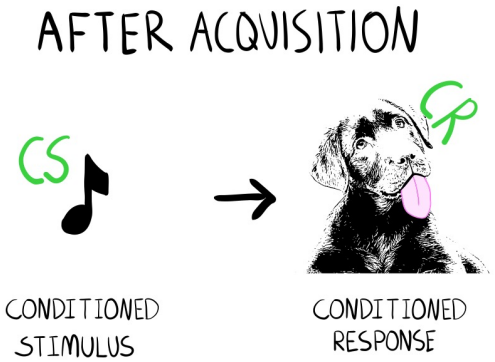
- unconditioned stimulus (UCS)
  - evokes response without prior learning: **food**
- neutral stimulus (NS)
  - does not evoke a response: **tone**
- unconditioned response (UCR)
  - default response to UCS: **salivation**
- conditioned stimulus (CS)
  - begins to trigger the unconditioned response: **tone**
- conditioned response (CR)
  - newly learned response: **salivation**



Kahoot: identify the terms!

- you will be presented scenarios and then asked to identify different aspects of the stimuli/responses through the lens of classical conditioning
- pair up with whoever you're sitting next to
- log on to www.kahoot.it and enter the PIN
- winning team gets...

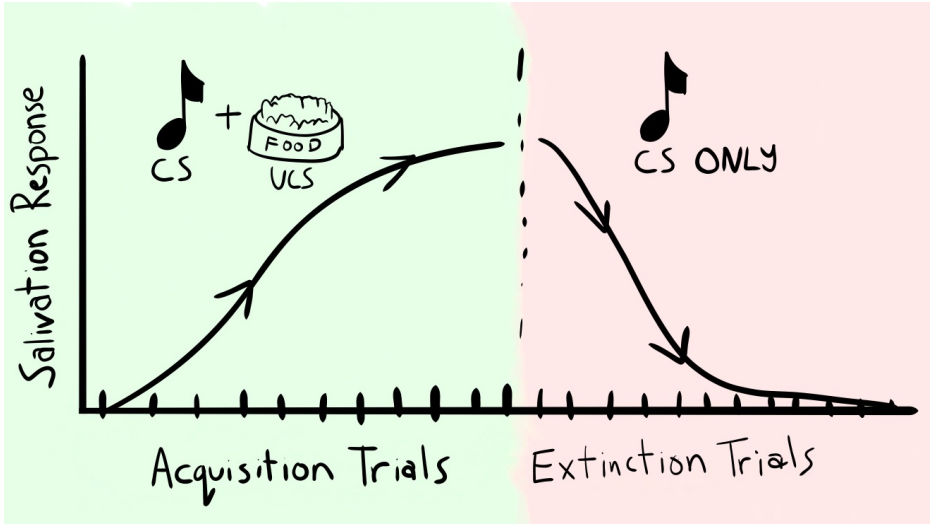
what is being learned here?



- the animal is learning an association
  - between the unconditioned stimulus (food) and conditioned stimulus (tone)
  - learning the association leads to a response
- but what does this mean?
  - does hearing the tone make the dog expect food?
  - was a mental image of food created, therefore leading to salivation?
  - did the tone directly get permanently associated with salivation?
  - could this association be unlearned and then relearned?
- each of these questions may need to be further examined

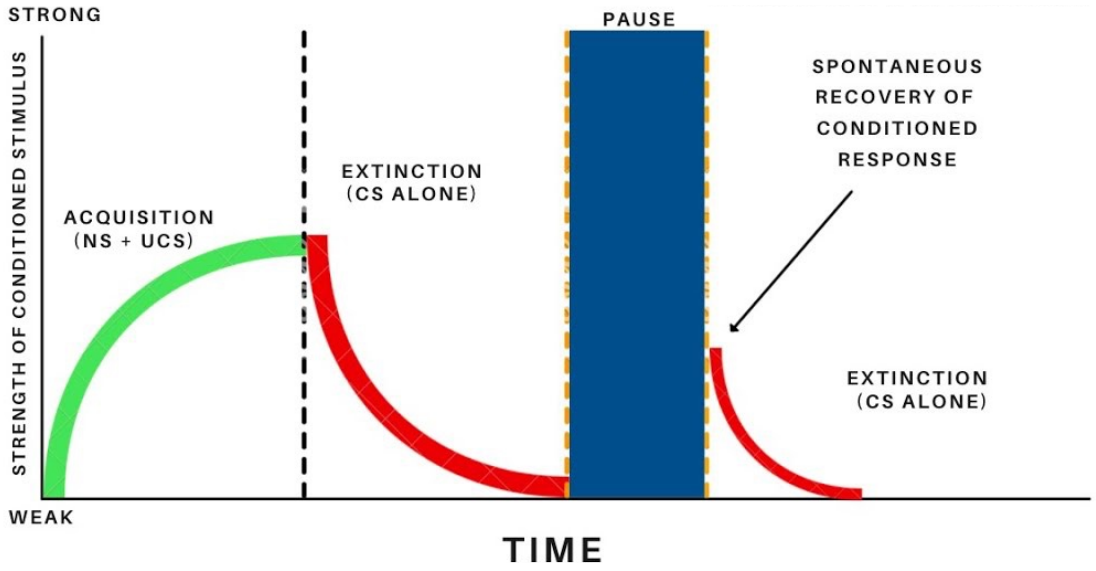
extinction

- Pavlov found that if the conditioned stimulus (tone) is presented alone without a reward (food), the dog starts to salivate less over time upon hearing the tone
- but what does this mean?
  - was the original association unlearned or weakened?
  - did the dog learn to suppress this association?



spontaneous recovery

- Pavlov also found that an "extinct" conditioned stimulus (tone) could evoke the conditioned response (salivation) at a later time
- complicates the "unlearning" explanation of extinction



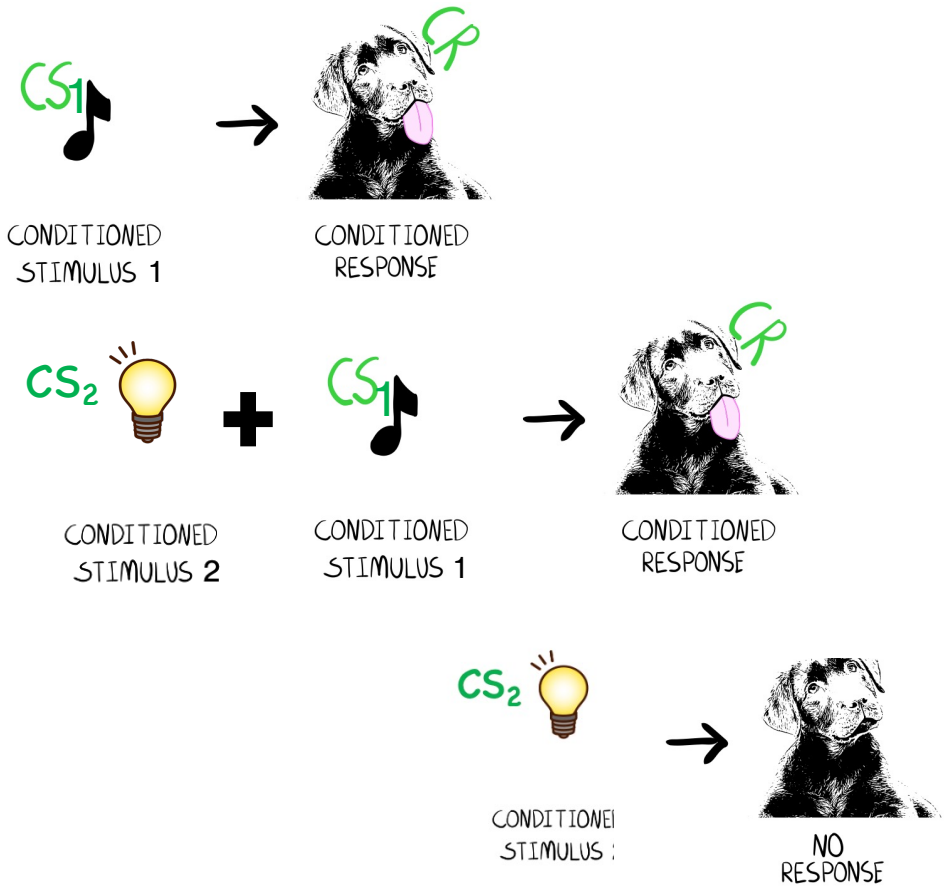
conceptual questions #recovery

“Pavlov's concept of spontaneous recovery seems quite applicable to any field of habit. What role does it play in addiction with relapse, especially when individuals are introduced to environments similar to those in which they have used in the past? It seems like it could be implicated in this even if new habits have been built over old ones, similar to the extinction process. How can this phenomenon be avoided through deeper habit-building or classical conditioning?”

“The textbook discussed how an association can be severed in the extinction phase but spontaneous recovery can make it seem like the association reappears randomly. This lead me to think about how does this show up in people who suffer from dementia? During moments where they recognize someone or something that they had not been able to do previously and seems so out of the blue, is that underlying process an example of spontaneous recovery?”

blocking

- Kamin (1969) discovered that when a second conditioned stimulus (CS_2) is presented in the presence of an already conditioned stimulus (CS_1), this stimulus does not trigger the conditioned response (CR), i.e., this association is “blocked”



some questions about association

- so far, we've seen:
  - people and animals have associations
  - you can learn associations
  - some associations are stronger than others
- but...how do we learn these associations??
  - is it simply if A co-occurs with B?
  - then why not learn the association of walking with food?
  - why does blocking happen?

a model of Pavlovian conditioning

- Robert Rescorla and Allan Wagner proposed the RW-model in 1972 that framed the problem of associative learning as that of prediction
- the broad idea was that associative learning is about how surprised we are by an event, i.e., we are predicting what will happen next and when our predictions don't line up with what happens, we update our associations

$$\Delta v = \alpha\ (\lambda - V_{total})$$

Δv: change in association between CS/UCS

α: learning rate (0 to 1)

λ : max learning possible for US (0 to 1)

V_{total}: sum of all associative strengths

λ - V_{total}: prediction error

a model of Pavlovian conditioning

- imagine that you are the dog in Pavlov's experiment
- in the RW model, you are learning an association (Δv) between the conditioned (tone) and unconditioned stimulus (food)
- you start by predicting whether or not you get a reward (food) when the tone is played
- initially, because there is no association between the tone and food (V_{total}=0), your predictions will be poor (high prediction error: $\lambda - V_{total}$)
- but as you start accumulating more evidence and learn to associate the tone and food, your prediction error will decrease and you will start to show the conditioned response

$$\Delta v = \alpha (\lambda - V_{total})$$

Δv: change in association between CS/UCS

α: learning rate (0 to 1)

λ : max learning possible for US (0 to 1)

V_{total}: sum of all associative strengths

$\lambda - V_{total}$: prediction error

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2$, $\lambda = 1$

- we start with 0 associative strength ($V_{total} = V_{old}$)

Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2$, $\lambda = 1$

- we start with 0 associative strength ($V_{total} = V_{old}$)
- compute the prediction error ($\lambda - V_{total}$, which will be highest when there is no association)

Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$
1	0	1	.2	0.0 + 0.2 = 0.20

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2$, $\lambda = 1$

- we start with 0 associative strength ($V_{total} = V_{old}$)
- compute the prediction error ($\lambda - V_{total}$, which will be highest when there is no association)
- update the learned association by adding the change in association (Δv) to previous association strength (V_{old}): $V_{old} + \Delta v$

Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$
1	0	1	.2	0.0 + 0.2 = 0.20

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2, \lambda = 1$

- we start with 0 associative strength ($V_{total} = V_{old}$)
- compute the prediction error ($\lambda - V_{total}$, which will be highest when there is no association)
- update the learned association by adding the change in association (Δv) to previous association strength (V_{old}): $V_{old} + \Delta v$
- repeat the process with the new $V_{old} = V_{total}$

Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$
1	0	1	.2	0.0 + 0.2 = 0.20
2	0.2	0.8	.16	.20 + 0.16 = 0.36

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2$, $\lambda = 1$

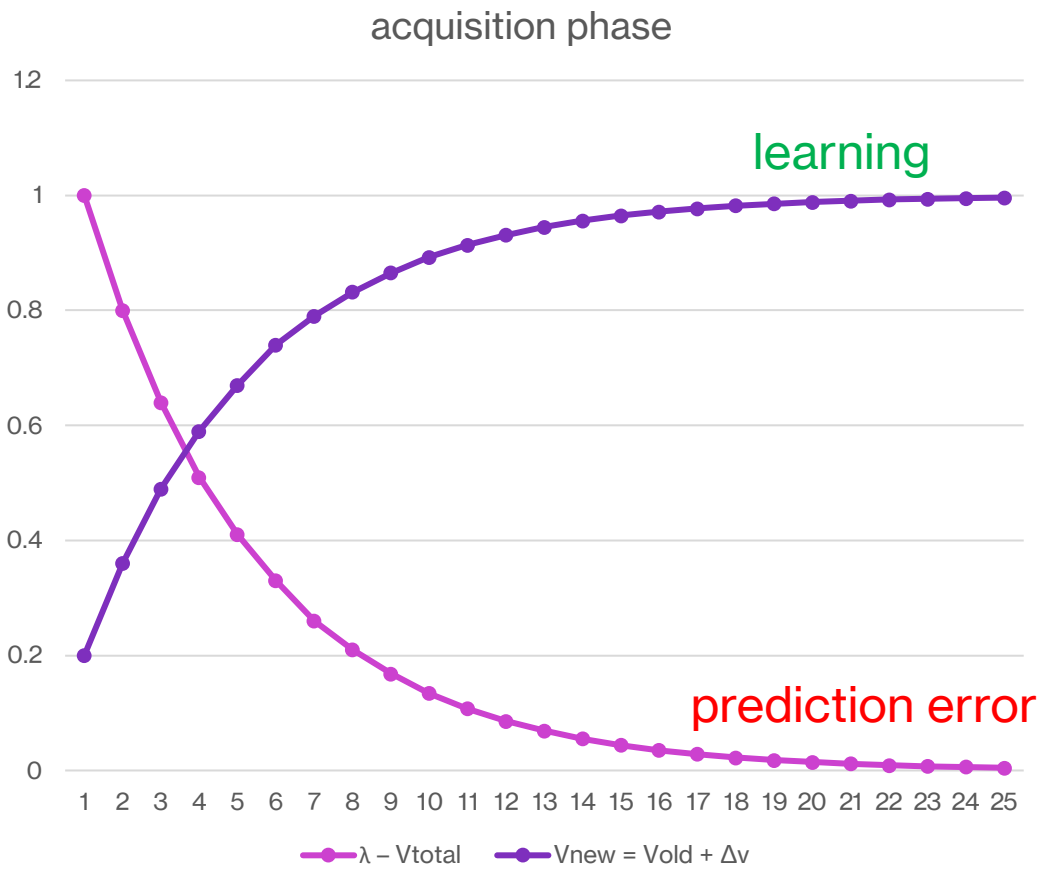
- we start with 0 associative strength ($V_{total} = V_{old}$)
- compute the prediction error ($\lambda - V_{total}$, which will be highest when there is no association)
- update the learned association by adding the change in association (Δv) to previous association strength (V_{old}): $V_{old} + \Delta v$
- repeat the process with the new $V_{old} = V_{total}$
- over time, our prediction error decreases and our learned association (V_{new}) increases

Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$
1	0	1	.2	0.0 + 0.2 = 0.20
2	0.2	0.8	.16	.20 + 0.16 = 0.36
3	0.36	0.64	.128	.36 + .128 = 0.49
4	0.49	0.51	.10	.49 + .10 = 0.59
5	0.59	0.41	.082	.59 + .08 = 0.67
6	0.67	0.33	.066	.67 + .07 = 0.74

an example of RW model

$$\Delta v = \alpha (\lambda - V_{total})$$

$\alpha = 0.2, \lambda = 1$

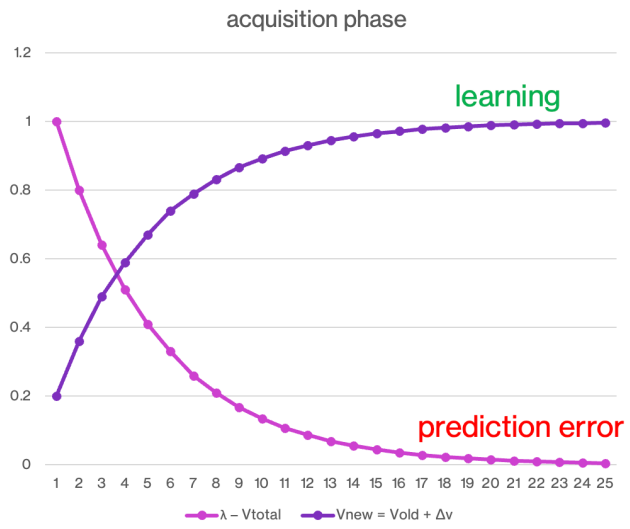


Trial	V_{old}	$\lambda - V_{total}$	Δv	$V_{new} = V_{old} + \Delta v$
1	0	1	.2	0.0 + 0.2 = 0.20
2	0.2	0.8	.16	.20 + 0.16 = 0.36
3	0.36	0.64	.128	.36 + .128 = 0.49
4	0.49	0.51	.10	.49 + .10 = 0.59
5	0.59	0.41	.082	.59 + .08 = 0.67
6	0.67	0.33	.066	.67 + .07 = 0.74

exercise: explain + ask (RW model)

- pair up
- one person explains the model, another asks questions
  - explainer: whoever's home is closest (in miles) to Brunswick
  - questioner: whoever's home is farthest (in miles) to Brunswick
- debrief

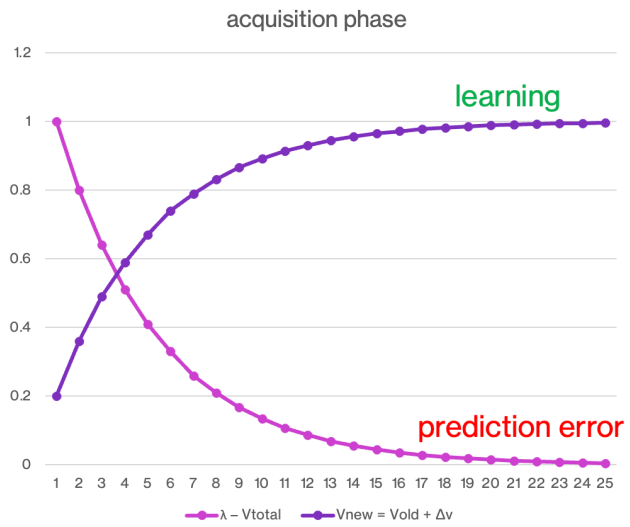
$$\Delta v = \alpha (\lambda - V_{total})$$



why the RW model was important

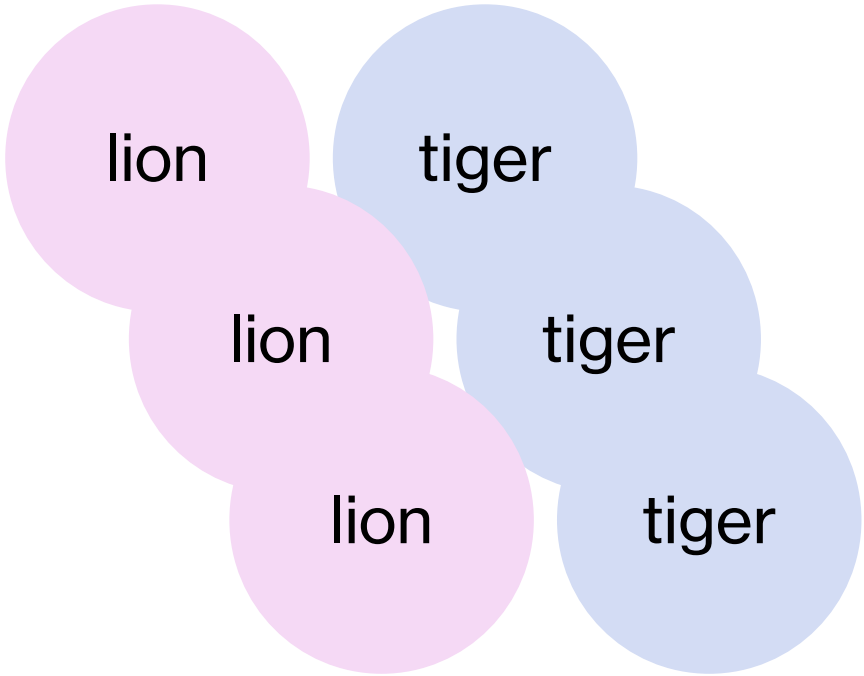
- reframed association as a prediction problem
  - raises the question of whether all learning is predictive
  - a tension between pure association vs. prediction
  - recent language models (e.g., ChatGPT) are all prediction-based
- was able to account for blocking
  - one writing assignment this week dives deep into RW-model
  - another asks you to write a QALMRI (potential practice for milestone #3)
- had some limitations/revisions:
  - spontaneous recovery was hard to explain
  - latent inhibition (stimulus without reward leads to slower/no learning)
- more broadly, computational/mathematical models help clarify theoretical ideas and make specific predictions

$$\Delta v = \alpha (\lambda - V_{total})$$



big takeaways

- association is a fundamental idea in the study of cognition with roots that go back to before cognition was an established field
- classical conditioning is a type of associative learning paradigm; one model (RW) of classical conditioning reframed learning association as learning from prediction errors
- we will revisit association at several points this semester (e.g., language, memory, etc.), but also touch on other big ideas in the field about how to think about cognition



conceptual questions #instincts

- One of Thorndike's questions for further research was whether or not animals "can override instinctual behavior through learned associations"(5.3.4). I am curious what areas of research have delved into this question in humans. Are there "knee-jerk" reactions we can overcome by learning from our environment? What instincts are so hardwired that they cannot be unlearned?

next class

- **before** class:
  - *fill out*: class survey
    - https://forms.gle/8KSgcRyE7o2h4VLU8
  - *schedule*: group project meeting with Abhilasha
    - https://calendly.com/abhilasha-a-kumar/30min
  - *submit:* project milestone #2
    - email me with questions/ideas if your meeting is later!
  - *finish:* L4 quiz + writing assignments
  - *start:* L5 (behaviorism) chapter
- **during** class:
  - is it all about behavior? are mental processes irrelevant?