Cognition: Methods and Models

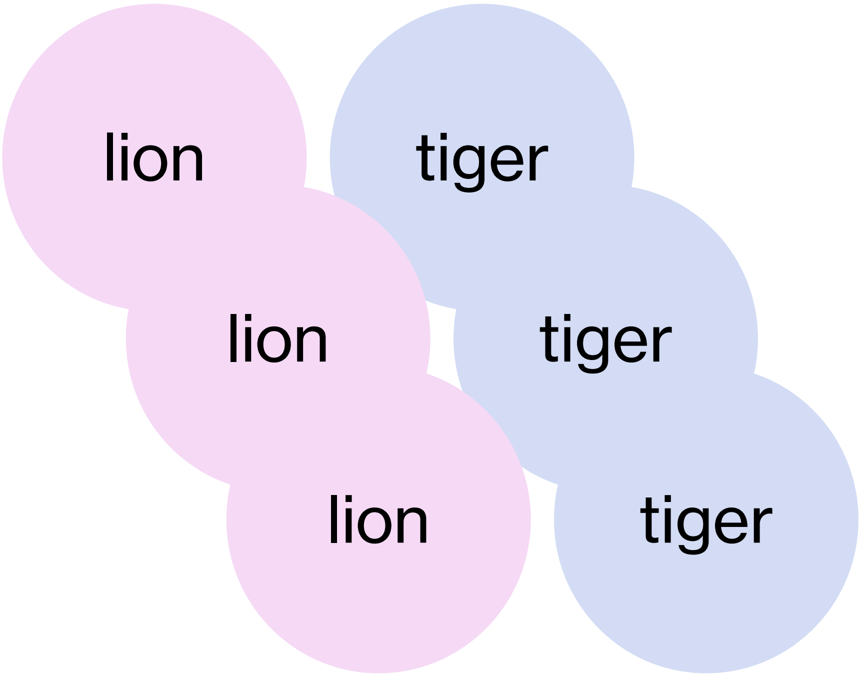
PSYC 2040

L4: Associations

Part 2

recap

- what we covered:
  - origins of associationism
  - Cattell's reaction time studies
  - Thorndike's puzzle boxes
  - associative learning today
- your to-dos were:
  - *finish:* L4 (Associations) chapter
  - *explore:* L4 writing assignments



today’s agenda

- applications of associative learning
  - broader real-life examples
  - Pavlov’s classical conditioning paradigm
- understanding mechanisms
  - Rescorla-Wagner model of conditioning

applications of associations

- consumer behavior
- understanding implicit biases
  - Implicit Association Test
- understanding negative associations
  - phobia treatment
  - addiction/substance abuse
- risk perception
- language learning (ChatGPT-esque)
- behavior change/conditioning

Project Implicit

Unconscious mood-congruent memory bias in depression.

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Watkins, Philip C. Vache, Karen Verney, Steven P. Muller, Stephanie Mathews, Andrew

Citation

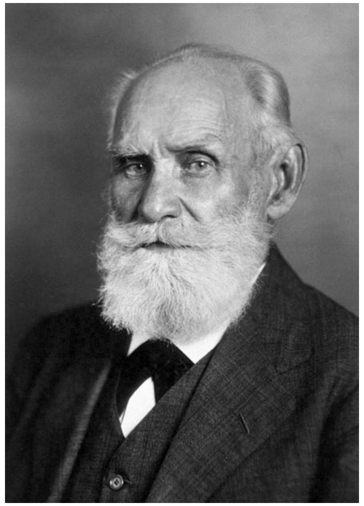
Watkins, P. C., Vache, K., Verney, S. P., Muller, S., & Mathews, A. (1996). Unconscious mood-congruent memory bias in depression. *Journal of Abnormal Psychology, 105*(1), 34–41. https://doi.org/10.1037/0021-843X.105.1.34

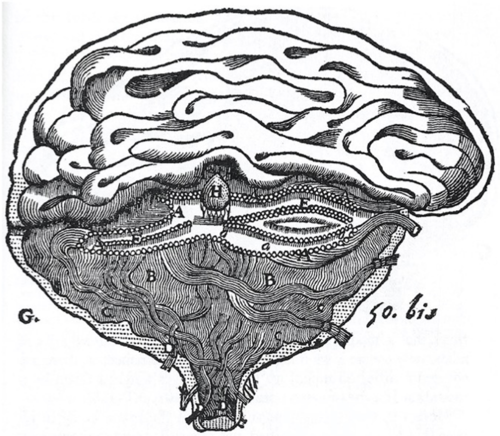
Abstract

The purpose of this study was to investigate an unconscious or implicit mood-congruent memory (MCM) bias in clinical depression. Many studies have shown an explicit memory bias, but no study has yet found an implicit MCM bias in clinical depression. The authors compared depressed and control group participants on a conceptually driven implicit memory test. After studying words of positive, neutral, and negative affective valences, participants produced free associations to various cues. Implicit memory or priming was demonstrated by the production of more studied than unstudied words to the association cues. Depressed participants showed more priming of negative words, whereas controls showed more priming of positive words, thus supporting the MCM pattern. Also, no implicit memory deficit was found in depressed participants. These findings are discussed in the context of several prominent theories of cognition and depression. (PsycInfo Database Record (c) 2022 APA, all rights reserved)

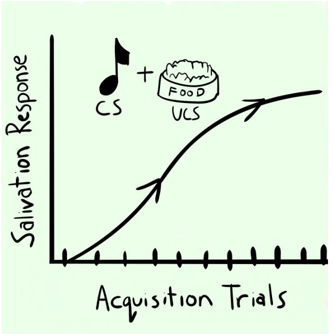
Pavlov: physiology > psychology

- 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

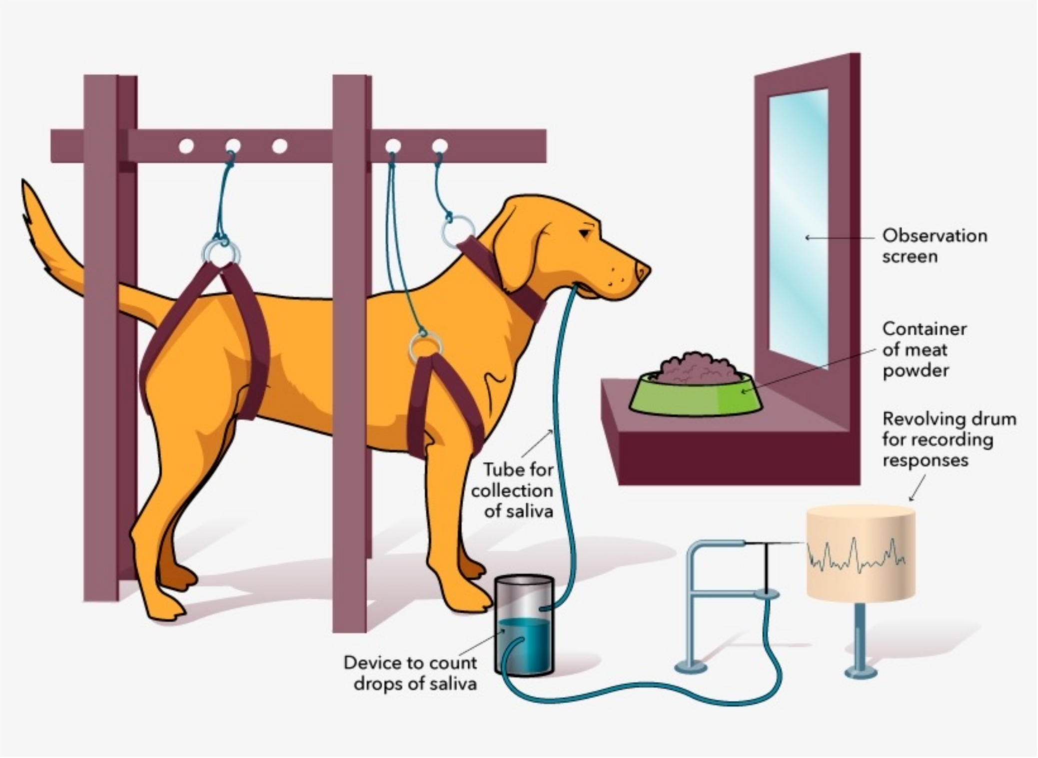




simple acquisition and conditioning

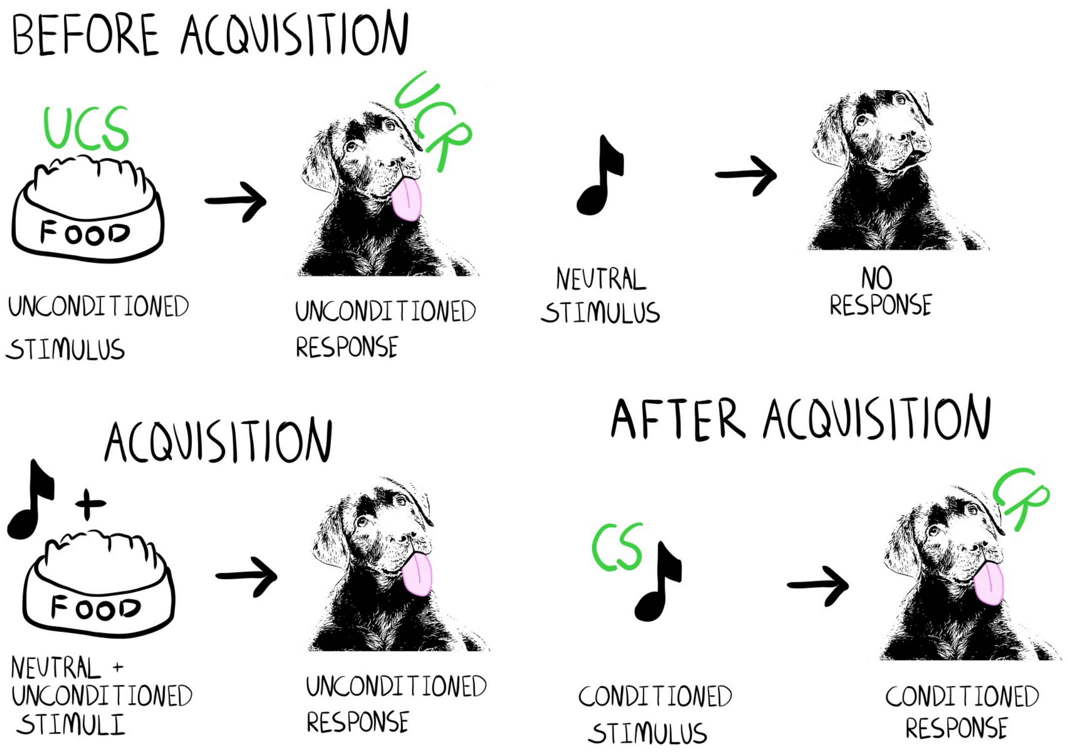


- a dog was given several "acquisition trials"
- on each trial, a perceptual stimulus (tone) + reward (meat powder) were presented
- meat powder naturally caused the dog to salivate, the tone did not
- over time, the dog started to salivate to the sound of the tone



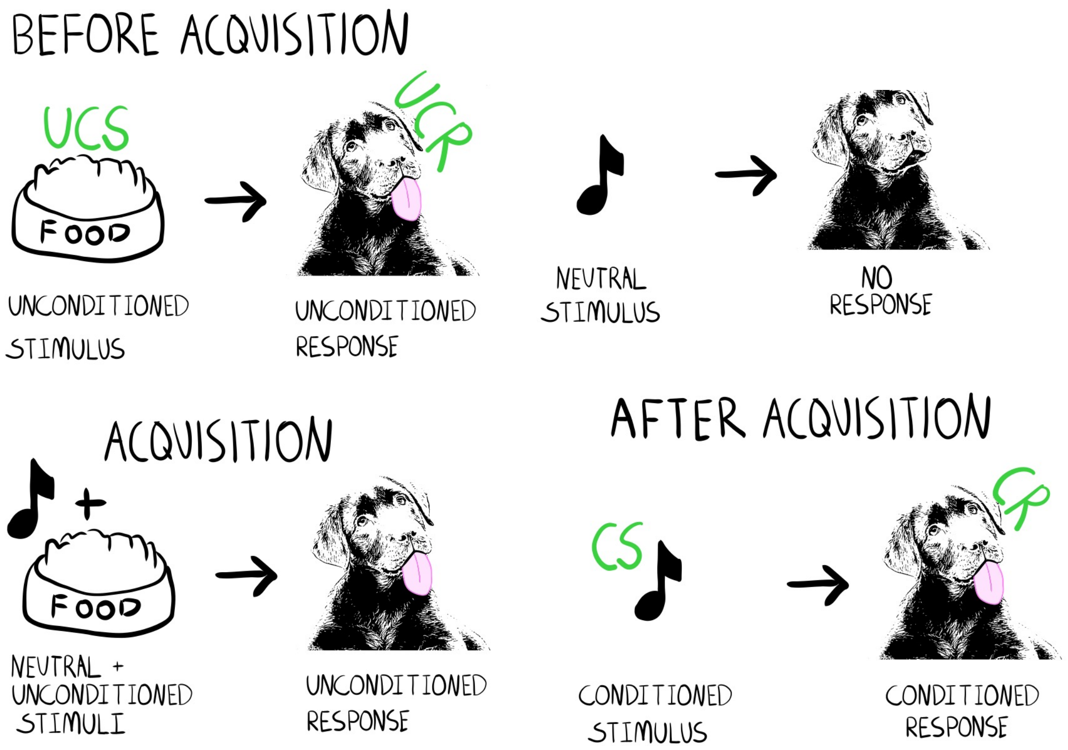
terminology

- 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**



activity: 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

scenario #1

- In Ms. Shah's kindergarten class, the aroma of freshly baked cookies fills the air as she introduces her students to a fun game. She places a colorful jar of cookies on her desk and loudly clears her throat before opening it, revealing the delicious treats inside. Excited giggles fill the room as the children eagerly reach for the cookies. Over the next few days, Mrs. Smith repeats this routine, clearing her throat each time before opening the cookie jar. Soon, she notices that whenever she clears her throat, even without the cookies, the children start to salivate in anticipation of the sweet treats.

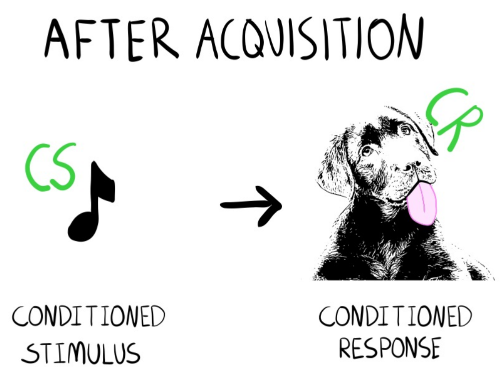
*ChatGPT generated

scenario #2

- Every morning, Tarun wakes up to the sound of his alarm clock ringing. He groggily stumbles out of bed and makes his way to the kitchen, where he begins his morning ritual of brewing coffee. As he starts the coffee maker, the aroma of freshly brewed coffee fills the air. Tom eagerly pours himself a cup and takes a sip, reveling in the rich, bold flavor. Over time, Tom notices that just hearing the sound of his alarm clock ringing triggers a craving for coffee, even before he takes his first sip.

*ChatGPT generated

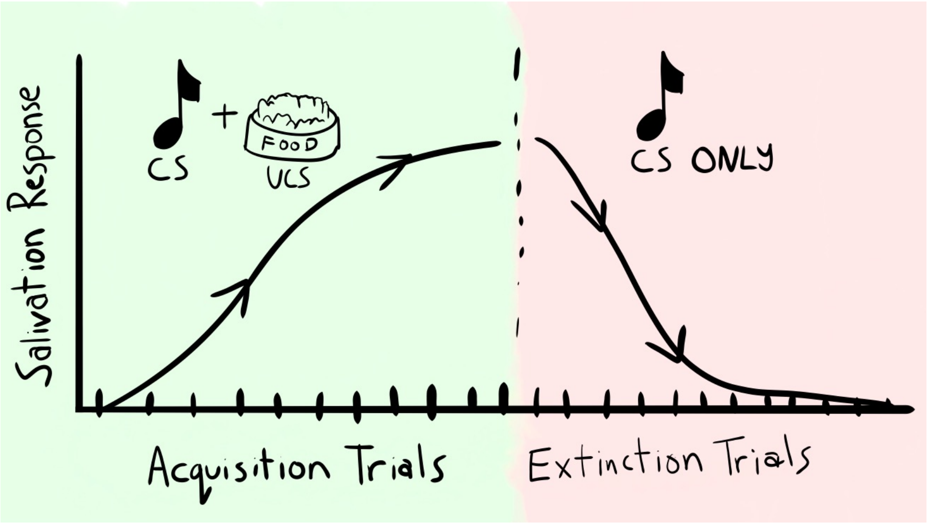
what is being learned here?



- 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

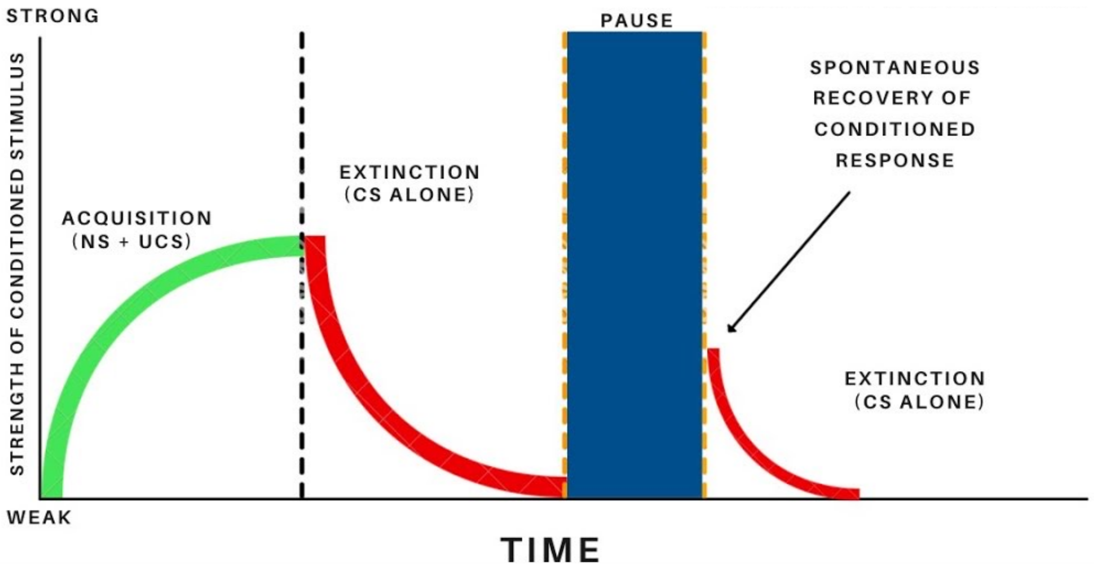
extinction

- 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?



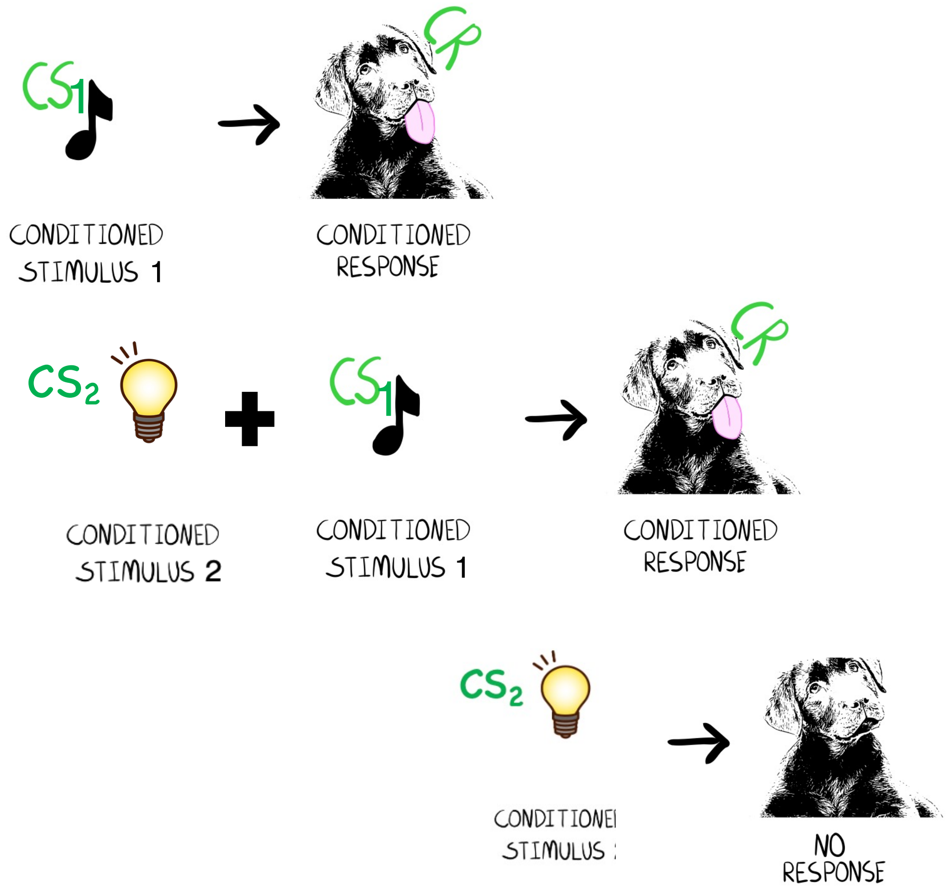
spontaneous recovery

- 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



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

$\lambda - V_{total}$: 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

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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

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

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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

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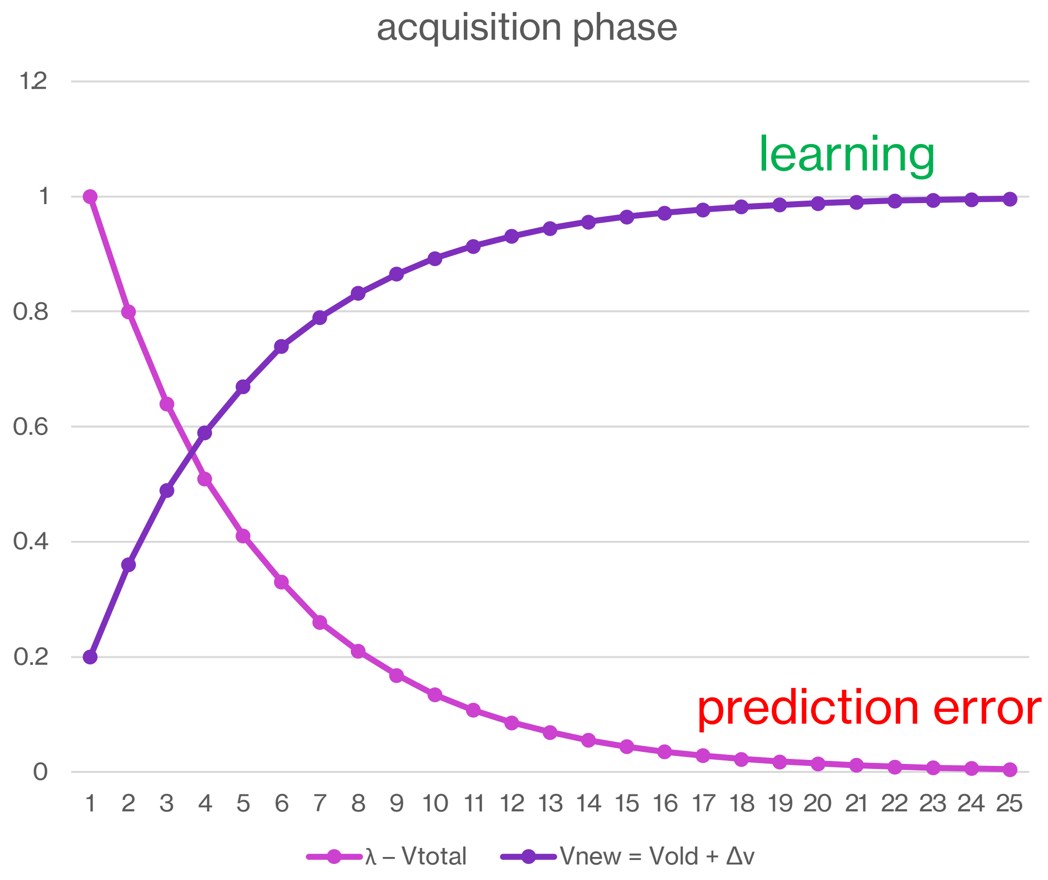
- update the learned association by adding the change in association (Δv) to previous association strength (V_{old}): $V_{old} + \Delta v$
- repeat the process with the new $V_{old} = V_{total}$
- over time, our prediction error decreases and our learned association (V_{new}) increases

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

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

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



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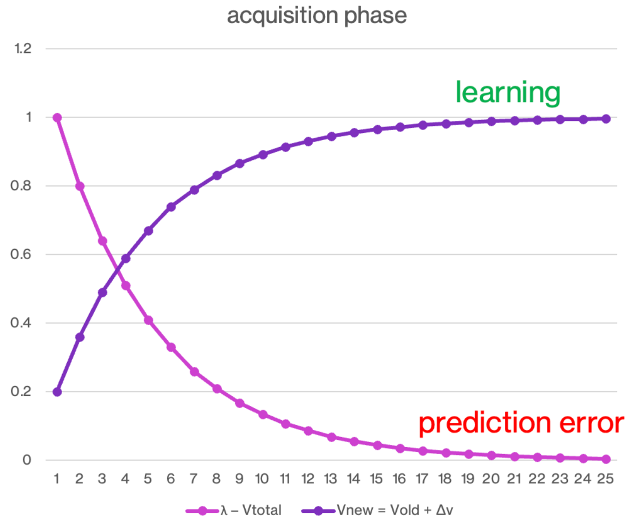
exercise: explain + ask (RW model)

- 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

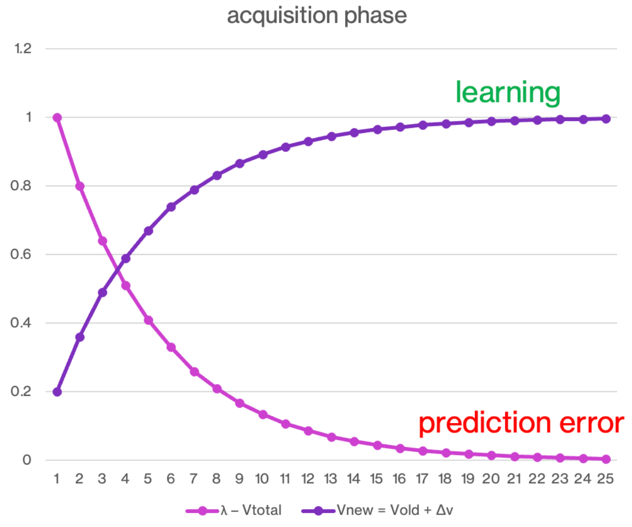
$$\Delta v = \alpha\ (\lambda - V_{total})$$



why the RW model was important

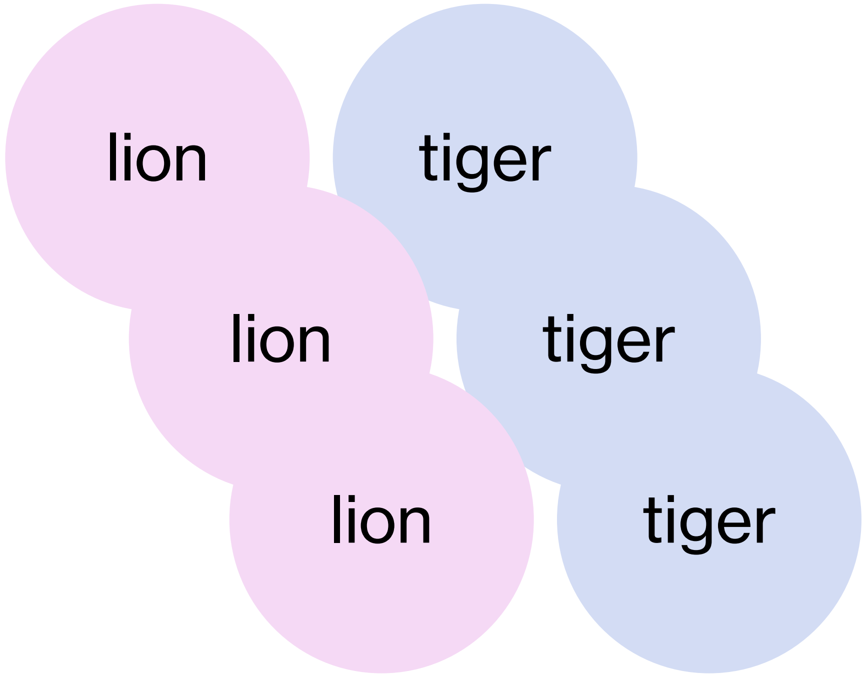
- reframed association as a prediction problem
  - raises the question of whether all learning is predictive
  - a tension between pure association vs. prediction
  - recent language models (e.g., ChatGPT) are all prediction-based
- was able to account for blocking
  - one writing assignment this week dives deep into RW-model
- 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



next class

- **before** class:
  - *finish:* L4 quiz + writing assignments
  - *start:* L5 (behaviorism) chapter
- **during** class:
  - is it all about behavior? are mental processes irrelevant?