L14 - Learning & Attention

Selective Attention

- about prioritising the processing of some stimuli over others
- attention is influenced by salience of stimuli
- derived attention: attention we pay to stimuli according to what we’ve learnt about them (what they mean, consequences etc.)

Lashley (1929)

- subject in an expt. (rats) attend to one property or feature of a stimulus at a given time (selective attention was all or none) e.g. location, texture, smell, size etc.
- the subject only learns about that particular feature it is attending to
- lashley jumping stand: rat is given choice between some features
  • has to make a choice to jump to either 2 platforms
  • cost involved: anxiety —> afraid of heights
  • potential reward in choosing the right option
  • rat is making choice depending on texture of stimulus using its whiskers
  • simultaneous discrimination based on texture
- most early attention was based on discrimination learning

Discrimination and Attention

- phenomena that don't fit well with classical Hull-spence learning theory OR R-W model
- R-W model: non attentional model —> attention you pay to stimuli doesn't change with learning
- intradimensional vs. extradimensional shifts
- easy-to-hard effect
- overtraining reversal effect
Intra-dimensional VS. Extra-dimensional Shift

- stage 1: subject is given discrimination between multiple different stimuli —> stimuli differ in at least 2D
  - US: food delivery after presentation of stimulus is linked to one of the dimensional characters (in this example: blue results in presence of US regardless of shape)
  - animal learns this discrimination over time
- stage 2: given similar discrimination but with different properties
  - new visual stimuli have different features
  - red stimuli are followed by US regardless of shape
- same dimension/property determines whether reinforcement (US) is delivered
  —> this is an intra-dimensional shift
- extra-dimensional shift: the other dimension is now determining factor (e.g. shape - triangle)
- finding: ID shifts are learnt much faster than ED shifts
  - ID shift: animal shows positive transfer towards discrimination involving same relevant features of same dimension (e.g. always testing colour)
  - have learnt to attend more to colour and less to shape
  - ED shift: animals show negative transfer towards learning —> learned to attend to colour so they're expecting the colour to predict US —> produces slower learning when there's a shift to shapes

Easy-to-hard Effect

- gave simultaneous discrimination based on luminance of visual stimuli over each doorway
- initial training phase was either difficult or relatively easy
- test phase: same discrimination was given again
- easy-to-hard: exposure to easier version of the same discrimination ultimately leads to better performance on the more difficult discrimination
- easy discrimination: animal is learning what are the features to attend to and the ones to ignore which it then applies to the test phase OR
- learning strong association between S+ and US and inhibitory learning with S- —> this may generalize to the test phase (doesn't require any attention at all)
- if the generalisation explanation were true —> reverse easy-to-hard: S- should generalise to S+ —> this would make discrimination difficult

findings
- easy: performance is better at the beginning already and they maintain this better responding
- hard: had difficult discrimination already before so they had slow but gradual improvement
- easy-reverse: learn much more rapidly than the hard group and end up performing better (improvement wouldn't be possible if it wasn't for a change in attention)

shows that the easy-to-hard effect is due to an attentional shift NOT due to generalization

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**Overtraining Reversal Effect**
- gave rats discrimination between dark S+ and light S- (difficult visual discrimination)
- looked at how much initial training affected their ability to re-learn the reversal of that discrimination: light S+ and dark S- in test phase
- 2 groups trained with dark S+ and light S-
  - training to criterion: rats were getting 5 in a row correct and were 90% correct
  - once the rats reached this criteria: overtraining —> trained with 150 more correct trials
  - test phase: reversed these stimuli to dark S- and light S+
- findings
• trained to criterion: took 140 trials to reach decent level of performance
• overtrained group: picked up the reversal much more easily in 60 trials
- suggests that extended training improves our ability to switch what you're doing if the same discrimination is being measured
- inconsistent results have been found across different procedures testing this
- this effect mainly occurs when discrimination is difficult and when a large reward is involved

Two-Stage Theories of Learning
Sutherland & Mackintosh (1971)
- Stage 1: selective attention phase
  • stimuli is processed and refined
  • certain stimuli is selected for further processing
  • for each of the various stimulus dimensions: we pull out certain characteristics which are competing for processing and some are chosen
  • consistent reinforcement strengthens a particular analyser: more likely to process that stimuli in the same way you already were
  • inconsistent reinforcement weakens a particular analyser: less likely to process that stimuli in the same way
- Stage 2: S-R learning
  • values that come out of the stimulus processing are associated with responses and outcomes

Explanation for Overtraining Reversal Effect:
- with overtraining: even though an asymptote of learning has been reached —> attention to relevant dimension continues to strength over time
- once discrimination is reversed: overtraining group has stronger and more persistent attention to a particular feature —> learning is fast because animal is still attending to the relevant dimension
—> all of these are ‘old’ theories
Learned Irrelevance

- uncorrelated presentations of CS and US lead to retardation in later conditioning
- presenting CS and US in uncorrelated fashion: it becomes more difficult to learn about that CS in the future
- CS has no information value about US: no evidence of conditioning and you see negative transfer effect in CS’s ability to be conditioned later on
- lower score = stronger learning
- control group: learns association quickly
- CS only: exposed to CS and not US during first phase —> learning slower than control (latent inhibition effect)
- CS/UCS: uncorrelated presentations of tone and shock during first phase —> show resistance to learning (ability to acquire associating between CS and US has been impaired due to learning about them in uncorrelated fashion)

Selective Attention (Mackintosh)

- predictive stimuli gain attention and redundant/irrelevant cues lose attention over time
- every CS has an alpha that reflects salience of CS (but unlike RW model that is a fixed value —> alpha is a changeable value depending on CS’s functional role during training)
- two stimuli in trial: A and X
- attention to A (alpha A) will increase if there is a smaller prediction error for A than there is for X
- A is better predictor of outcome than X —> so attention to A will increase
- if A was poor predictor of outcome: attention to A will decrease

Application to Blocking of Mackintosh Model
- blocking design: A leads to US, then A+B lead to US, then tested on B —> produces poor conditioning on B

- assumption: because A is strong predictor of outcome in first trials and B doesn't have predictive value —> when outcome occurs, prediction error based on A is less than prediction error based on B

- B is redundant (not predicting anything at all) in the beginning

- attention to B decreases —> there is less learning to B

Blocking of Unblocking

- unblocking group (control)
  - phase 1: noise paired with shock
  - no phase 2
  - phase 3: light and noise paired together followed by extra shock (serves as control of normal blocking design because the shock is extra strong so its surprising - some learning should occur)

- test: to reduce attention to light prior to phase 3 so that blocking does not occur

- experiment group: they added a few trials where light and noise lead to same shock before they transitioned to phase 3
  - phase 1: noise is good predictor of medium level of shock
  - phase 2: light and noise with medium shock —> noise is good predictor of shock so attention to light decreases
  - phase 3: light and noise predict extra strong shock —> because you're not attending to the light, you learn much more about the noise

- control group: strong conditioning to light

- experimental group: weak conditioning to light
Learned Predictiveness

- every trial: cue that is predictive and cue that is not predictive
- stage 1
  - A predicts 1, B predicts 2, X and Y are not reliable
  - attention shifts to A and B, decreases away from X and Y
- learned predictiveness: doubles this design
- stage 2: learn new associations with new outcomes —> assumption is that they will be biased to A, B, C, D so higher attention to them even though V, W, X, Y are equally predicting (food allergist example)
- stronger learning for A, B, C, D
- found that AC and BD had stronger learning due to the bias and VX and WY had weak learning (less attention to them)
- previously predicted cues are learned faster than previously irrelevant cues
- assumption: associability of stimuli is a proxy of attention
- blocking designs has similar loss of associability as attention

Negative Transfer

- when US is predicted well —> attention decreases instead of increasing
- learning a reliable relationship between tone and shock in phase 1 —> caused it more difficult to learn association between that tone and shock in phase 2
- tone alone group: suppression ratio decreases
- light and shock group: received training with different US first then light and shock —> showed faster conditioning
- tone shock group: in between —> seems to be slower
Selective Attention (related to negative transfer)
- when consequences of CS are already well known $\rightarrow$ no point in continuing to attend to CS
- better to devote the limited attention resources to other stimuli (that are more uncertain)
- attention and associability of stimuli is proportional to prediction error
  - big error: trial attended to CS more
  - no error: attention to CS drops to 0

Negative or Positive Transfer?
- contradicting?
- but these can be combined
- attention reduces to all stimuli as outcome becomes predictable BUT within trial - more predictive stimuli maintain more attention than the less predictive stimuli
- map onto functional distinction: role of attention plays in learning $\rightarrow$ exploitation vs. exploration
  - attending to predictive stimuli allows you to exploit the info you have about the env
  - attention to uncertain stimuli allows you to seek out more info about the env