

PSYCH 101

Personal Notes

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Module 1: Memory

How has the understanding of memory evolved? (1A)

FORGETTING CURVE - EBBINGHAUS

The "forgetting curve" is a visual model to show the decline of memory retention over time.

BEHAVIOURIST PERSPECTIVE

The "behaviourist" perspective focused only on things that could be observed directly in their investigations, ignoring the mind completely.

COGNITIVE PERSPECTIVE

The "cognitive" perspective was the belief that the brain and mind functioned like the hardware and software of a computer respectively. In particular, they conceptualised memory to have the main processes of ① encoding; ② storage; and ③ retrieval.

ERRORS IN MEMORY (1B)

Note that each time a memory is used, it must be reconstructed in your mind.

This makes it prone to "drift" from the original memory.

OMISSION

The "omission" of a memory involves the loss of details during the reconstruction of it.

SUBSTITUTION

The "substitution" of a memory involves the changing of details of the memory in subtle ways during the reconstruction of it.

INSERTION

The "insertion" of a memory involves the adding of details of the memory that never actually happened during the reconstruction of it.

CONFABULATION

"Confabulation" is a type of memory error in which gaps in a memory are unconsciously filled with fabricated, misinterpreted or distorted information.

SOURCE AMNESIA

"Source amnesia" is the recollection of information from someone else's experience, but mistakenly believing the experience was your own.

LEADING QUESTION

A "leading question" is a question that subtly prompts the respondent to answer in a particular way.

TWO CAR STUDY - LOFTUS & PALMER (1974)

The "two car study" was a classic psychology study that examined the malleability of eyewitness testimony.

Methodology:

- ① Participants watched a video depicting two cars in an accident.
- ② After the video, one group was asked "how fast were the cars going when they contacted each other?"
- ③ The other group was asked "how fast were the cars going when they smashed each other?"
- ④ The researchers found the first group remembered the cars going ~7 mph slower than the second group.
- ⑤ Moreover, after a week, the participants were asked whether they saw any broken glass in the video.
- ⑥ 32% of the participants from the "smashed" group recollect there being some, whereas only 14% of the participants from the "contacted" group did, even though there were no broken glass to begin with.

PROCESSES OF MEMORY

ENCODING (1C)

"Encoding" is the process in which various types of information are converted into neuronal impulses.

PASSIVE ENCODING

We say encoding is "passive" if no effort is invested in remembering the information.

eg watching TV, reading a book

Since passive encoding is shallow, most of the information will be lost or remembered inaccurately.

ACTIVE ENCODING

On the other hand, we say encoding is "active" if effort is expended to process the information for later use.

eg taking notes, studying

Since active encoding requires deeper levels of processing, it is more likely that the recollection of the memory later on will be far more superior.

STRUCTURAL ENCODING

"Structural encoding" is the process where the word is encoded via the physical structure of it.

PHONEMIC ENCODING

"Phonemic encoding" is the process where the word is encoded via the sound structure (ie phonetics) of it.

SEMANTIC ENCODING

"Semantic encoding" is the process where the word is encoded via the meaning of it.

WORD STRUCTURE STUDY - TULVING & CRAIK

(1975)

The "word structure" study examined how some forms of active encoding can lead to deeper processing and better memory reconstruction than others.

Methodology:

- ① the researchers asked participants something about the structure of each word in a list of 60 words.
- ② One group was asked structural encoding questions;
- ③ One group was asked phonetic encoding questions; and
- ④ One group was asked semantic encoding questions.
- ⑤ Afterwards, the researchers recorded how many words the participants could "pick out" from a list of 180 words, 120 of which were similar "distracting" words and the other 60 from the original list.
- ⑥ They found that
 - the structural group could pick ~20% of the words;
 - the phonetic group could pick ~50% of the words; and
 - the semantic group could pick ~80% of the words.

ENRICHMENT TECHNIQUES

"Enrichment techniques" are techniques that can be used to process information even deeper, ultimately leading to better memory recall.

ELABORATION

"Elaboration" is a form of semantic encoding that aids the recall of new information by connecting it to existing information.
eg using metaphors/analogies when explaining a novel concept.

SELF-REFERENT ENCODING

"Self-referent encoding" is a form of semantic encoding that aids the recall of new information by connecting it to oneself.

DUAL ENCODING

"Dual encoding" is a form of semantic encoding that aids recall of information by producing redundant (more than one) codes / pointers.

METHOD OF LOCI

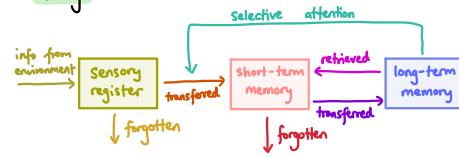
The "method of loci" is a memory technique that works by constructing dual codes via associating information with familiar spatial locations.

STORAGE (ID)

The "storage" of memory describes the process by which information is maintained in memory.

THREE-BOX MODEL

The "Three-Box model" is a method to visualise the "stores" of memory storage.



SENSORY MEMORY

"Sensory memory" refers to the collection of "sensory registers", who hold information from each of the sensory organs.

e.g. eyes, ears etc

Note that only raw sensory information is stored in sensory memory.

Sensory registers typically maintain information for brief periods of time ($\leq 1s$).

DURATION OF VISUAL REGISTER STUDY - SPERLING (1960)

One of Sperling's most notable studies involved measuring the duration of the visual register.

Methodology:

- ① Participants were shown three rows of three letters for $\frac{1}{20}$ of a second.
 - ② This was followed by one of three tones (low, medium or high).
 - ③ If a low tone was played, the participant were to refer to the bottom row of letters, and similarly for if the medium or high tone was played.
 - ④ When the tone played immediately after the array disappeared, participants could confidently recall the cued row of letters.
 - ⑤ This result was observed even when there was a $\frac{1}{4}$ second delay between the array disappearing and the tone.
 - ⑥ However, as the interval continued to increase, accuracy dropped off; eventually, after the interval was ≈ 1 second long, participants could no longer report any of the letters.
- Researchers concluded that information is held in the visual register for $\approx 0.25-0.5$ seconds.

EIDOTIC / PHOTOGRAPHIC MEMORY

A person is said to have "eidetic memory" or "photographic memory" if they can retain information in their visual register for a little longer than usual ($1+$ seconds).

DECAY

"Decay" describes forgetting that occurs simply from the mere passage of time.

SHORT-TERM MEMORY

Some information may be transferred into our short-term memory for further processing, especially if it is the focus of our attention.

INCULCATION

"Inculcation" is the process of repeating something multiple times to remember it better.

DURATION OF SHORT-TERM MEMORY IS LIMITED TO 20s - PETERSON & PETERSON (1959)

A classic study by Lloyd & Margaret Peterson helped to determine the duration of short-term memory.

Methodology:

- ① Participants received an auditory cue that contained three letters followed by three numbers.
- ② Then, they started to count backwards by threes beginning with the numbers in the cue, to prevent them from practising the target information (the letters).
- ③ Once the interval was complete, the participants stopped counting and tried to recall the letters in the cue.
- ④ The proportion of participants who were able to recall the letters dropped exponentially as the interval length increased.
(By 18 seconds, the proportion was practically 0.)

HOW MUCH INFO CAN SHORT-TERM MEMORY HOLD? - MILLER (1956)

In a now legendary study, Miller exposed how much information we can retain in our short-term memories.

Methodology:

- ① Participants were exposed to lists of words.
- ② Then, without any cues, the participants tried to recall as many of the words as possible.
- ③ Results showed they could recall 7 ± 2 words on the list.

CHUNKING

"Chunking" is the process of combining bits of information to create fewer but more meaningful chunks of information.

THEORY OF WORKING MEMORY - BADDELEY (1970s)

Baddeley's Theory of Working Memory expands on the Short Term Memory (STM) model by incorporating conscious processing of info into the model.

In particular, its components are

- ① a "central executive", which monitors;
- ② the "visuo-spatial sketch pad", in charge of visual semantics;
- ③ the "episodic buffer", in charge of episodic long term memory; and
- ④ the "phonological loop", in charge of language.

LONG-TERM MEMORY

Some of the information from the Short-term Memory might be transferred to Long-Term memory, particularly if it has received a deep level of processing.

It is contentious whether Long-term Memory can store information permanently, barring brain damage.

However, most researchers agree the capacity of Long-Term Memory is unlimited.

INACCESSIBLE INFORMATION

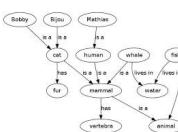
We say information in the Long-term Memory is "inaccessible" if it is still stored, but cannot be retrieved.

UNAVAILABLE INFORMATION

We say information is "unavailable" if it used to be present in Long-term Memory, but has since been lost.

SEMANTIC NETWORK

In Long-Term memory, information seems to be organised in "semantic networks"; ie information networks according to semantic meaning.



SPREADING ACTIVATION

"Spreading activation" describes the process where the priming/activation of a neuron increases the likelihood that connected/adjacent neurons will fire in the network.

PROSPECTIVE MEMORY

"Prospective memory" is a subclass of long-term memory which revolves around the performing of actions in the future. eg picking up groceries on the way home.

RETROSPECTIVE MEMORY

"Retrospective memory" is a subclass of long-term memory which revolves around the memory of the past.

Declarative retrospective memories (or "explicit" retrospective memories) are memories that can be talked about and transferred from one mind to another.

Moreover, declarative retrospective memories can be subdivided further into

① "episodic" memories, or memories of past events/episodes; and

② "semantic" memories, or memories of facts.

On the other hand, "non-declarative" retrospective memories (or "implicit" retrospective memories) cannot be transferred simply by talking about it.

Non-declarative retrospective memories can be sub-divided into

① "procedural" memories (or "muscle" memories); and

② "conditioned" responses (see reading 1).

RETRIEVAL (IE)

"Retrieval" is the process by which information is retrieved from memory.

RECALL

"Recall" is the form of retrieval that requires the respondent to retrieve the information without any cues to help them.
eg short-answer questions

RECOGNITION

"Recognition" is the form of retrieval that requires the respondent to recognise the target information in the presence of distractor information.
eg MCQs

INTERFERENCE

"Interference" is the failure to retrieve target information due to similar pieces of information interfering with each other.

PROACTIVE INTERFERENCE

"Proactive" interference occurs when existing information interferes with our ability to store new information.

RETROACTIVE INTERFERENCE

"Retroactive" interference occurs when new information interferes with our ability to retrieve old information.

THE MEMORY OF CHILDREN - GARVEN, WOOD, MALPASS & SHAW (1998)

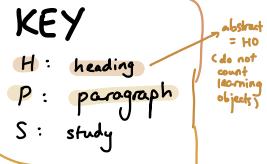
In 1998, a group of researchers constructed a study to investigate the interrogation techniques used by law enforcement officers to solicit false allegations from young children.

Methodology:

- ① Children were visited in their classroom by a man who read them a story, gave them stickers & cupcakes, and then left.
- ② Then, one group were simply asked questions of the things the man did and did not do.
- ③ The other group were asked leading questions in combination with interrogating techniques; for example, the researchers
 - ① repeated questions when no accusation was made;
eg are you sure Manny didn't bump the teacher?
 - ② prefacing a question by indicating other children had made an accusation;
eg other children saw Manny bump the teacher
 - ③ rewarding children for making an accusation;
eg you are a brave boy!
 - ④ acting disappointed when children did not make an accusation; and
eg good boys tell the truth.
 - ⑤ "imagination inflation".
eg imagine Manny had bumped the teacher;
did he use his right or left shoulder?
- ④ The researchers found that using interrogation techniques increased the likelihood that children would answer yes to misleading questions drastically.

The researchers concluded children are a lot more susceptible than adults to techniques that inadvertently create false memories.

Reading 1: Conditioning and Learning



CLASSICAL / PAVLOVIAN CONDITIONING (HI PI)

Q1 "Classical conditioning", or "Pavlovian conditioning", occurs when neutral **stimuli** are associated with psychologically significant **events**. (HI P4)

- eg associating the action of "eating fish" (stimulus) with getting sick (event)

Q2 The effect was studied by Russian physiologist Ivan Pavlov around the turn of the 20th century. (HI P3)

PAVLOV'S DOG (HI P2)

Q1 "Pavlov's dog" was a famous experiment that helped give rise to the classical conditioning theory.

Methodology:

- Pavlov rang a bell, and gave a dog some food; and
- Pavlov repeated action ① multiple times.
- Eventually, the dog treated the bell as a signal for food, and began salivating in anticipation for the treat.

Note: this result has been reproduced in the lab using

- a wide range of signals; and
 - eg tones, light, tastes etc
- paired with many different events.
 - eg drugs, shades, illness etc

CLASSICAL CONDITIONING IN HUMANS (HI P3(1))

Q1 Psychologists often attribute classical conditioning as the cause for many human phenomena.

- eg¹ associating a drug someone has taken with the environment they have taken it;
- eg² associating a stimulus (eg a big beach towel) with an emotional event (eg burst of happiness).

BENEFITS OF CLASSICAL CONDITIONING (HI P3(2))

Q1 Whilst classical conditioning may seem too "simplistic" or "old-fashioned", it is still studied today because

- It is a straightforward test of associative learning that can be used to study other, more complex behaviours; and
- Because classical conditioning is always occurring in our lives, its effects have important implications for understanding normal and disordered behaviour in humans;
- There are many factors that affect the strength of classical conditioning, which warrants research and theory; and
(S: Rescorla & Wagner, 1972; Pearce & Burton, 2001) (H3 P5)
- Behavioural neuroscientists have also linked classical conditioning to the study of many of the basic brain processes involved in learning.
(S: Fanselow & Pouille, 2005; Thompson & Steinmetz, 2009) (H3 P5)

UNCONDITIONED STIMULUS (US) AND RESPONSE (UR) (HI P5)

Q1 We say a stimulus and its associated response are "unconditioned" if the stimulus automatically triggers the response without any kind of teaching or "training".

Q2 In this case, we denote the unconditioned stimulus as "US" and the respective unconditioned response as "UR".

- eg Pavlov's dog (after "training")
 - US = food
 - UR = makes the dog drool

CONDITIONED STIMULUS (CS) AND RESPONSE (CR) (HI P6)

Q1 On the other hand, we say a stimulus and its corresponding response is "conditioned" if the stimulus must be paired with something that does have importance to elicit the response.

Q2 Note that the stimulus must not have any importance to the organism in question in the absence of the thing of importance.

Q3 In this case, we denote the conditioned stimulus as "CS", and the conditioned response as "CR".

- eg Pavlov's dog (before training)
 - before training, bell means nothing to dog
 - but after training, bell causes dog to salivate
 - so CR = salivation, CS = bell

Q4 Note that the unconditioned and conditioned responses (ie UR and CR) are often the same.

- eg¹ US = eating of fast food
CS = seeing fast food logo
* UR = SR = salivating.

- eg² US = waking up early
CS = alarm clock ringing
UR = CR = natural sense of grumpiness

CLASSICAL CONDITIONING HAS MANY BEHAVIOURAL EFFECTS (H2 P1)

Usually, CSs do not elicit only one reflex; they usually trigger a whole system of responses.

For instance, in the presence of a CS, an organism will respond to ready its body for the upcoming food (the US). (S: Timberlake, 2001).

The organism might

- ① start salivating;
- ② elicit the secretion of gastric acids, pancreatic enzymes and insulin to prepare the body for digestion;
- ③ elicit approach behaviour and a state of excitement; and
- ④ even cause them to overeat (ie eat more even if they are full.)

TASTE AVERSION CONDITIONING (H2 P3)

"Taste aversion learning" is the phenomenon where a taste (CS) is paired with sickness (US), and causes the organism to reject and dislike that taste in the future.

eg a person who gets sick after too much tequila might acquire a profound dislike of the taste/odor of it.

FEAR CONDITIONING (H2 P4)

"Fear conditioning" is the phenomenon where a CS is associated with an aversive US (eg pain), which eventually elicits fear/anxiety in the organism when the CS is applied.

eg if an experimenter sounds a tone just before applying a mild shock to a rat's foot, the tone will elicit fear/anxiety after one or two pairings.

Note that fear conditioning creates many anxiety disorders in humans, including phobias and panic disorders.

(S: Mineka & Zinberg, 2006)

CONDITIONED COMPENSATORY RESPONSES (H2 P5)

A "conditioned compensatory response" is a CR that opposes/weakens the strength of the UR, rather than strengthening it.

(S: Siegel, 1981)

eg someone addicted to morphine can increase their pain sensitivity when told that the drug is coming.

Notably, conditioned compensatory responses have many implications for drug use: for example,

① they tell us a drug user's "tolerance" will be highest in the presence of cues associated with the drug; and

- cues elicit compensatory responses that weaken the drug's effect
- so, overdoses are usually not due to a dosage increase, but rather by taking the drug in an unfamiliar place.

(S: Siegel, Hansen, Krauk & McCull, 1982)

② they may also cause discomfort, thus motivating the drug user to continue usage of the drug to reduce them. (H2 P6)

- eg heightened pain sensitivity, decreased body temperature

CLASSICAL CUES MOTIVATE ONGOING OPERANT BEHAVIOUR (H2 P7)

Another effect of classical cues is that they can motivate ongoing operant behaviour.

eg if a rat learnt pressing a lever will give it a drug, in the presence of cues that signal "the drug is coming soon", the rat will work harder to press the lever.

*see next page for definition of operant behaviour

THE LEARNING PROCESS (H3)

BLOCKING (H3 P1)

"Blocking" describes the phenomenon where the association of some CS A with an US blocks/inhibits the association of a novel CS B with that same US.

eg A rat learns to associate the ringing of a bell (CS A) with the presentation of food (US).

Then, a light is added, and the light turning on (CS B) and the bell ringing are both paired with the US.

But the rat fails to "learn" the association between the light turning on and the food presentation, since the previous association of the bell ringing with the food presentation "blocks" the new association.

Blocking occurs because since CS A already predicts the US, it is not "surprising" that the US occurs with CS B.

Note that blocking and other related effects indicate that the learning process tends to take in the most valid predictors of significant events, and ignore the less useful ones. (H3 P3)

PREDICTION ERROR (H3 P2)

A "prediction error" is a discrepancy between what is expected to occur and what actually occurs in a conditioning trial (ie how "surprising" the CR was in response to the CS).

Note that a non-zero prediction error is required for learning, as otherwise the outcome will be "given" and so no new connections need to be formed.

PREPAREDNESS (H3 P4)

"Preparedness" is the idea that an organism's evolutionary history makes it easy to learn a particular association.

eg Rats & humans are naturally inclined to associate an illness with a flavour, rather than with a light/tone.

This is because if we get sick, it most likely stems from a food-related cause; hence, we will more greatly ensure we avoid that food in the future to avoid getting sick.

ERASING CLASSICAL LEARNING (H4)

EXTINCTION (H4 P1)

"Extinction" is the phenomenon where there is a decrease in the strength of a learned behaviour, resulting in the eventual "extinguishing" of the response.

This is accomplished by presenting the CS repeatedly without the US.

Extinction is especially important for psychologists, as it can help eliminate maladaptive and unwanted behaviours.

eg a person with arachnophobia is repeatedly shown pictures of spiders (CS) in neutral conditions, which eventually causes the association of spiders with fear (CR) to extinguish.

SPONTANEOUS RECOVERY (H4 P2)

"Spontaneous recovery" is the phenomenon where following a lapse in exposure to the CS after extinction has occurred, sometimes re-exposure to the CS can evoke the CR again.

eg A student associates the smell of chalkboards (CS) with the agony of detention (CR). However, after years from encountering chalkboards, a sudden whiff of one can trigger the agony of detention again.

The existence of spontaneous recovery tells us that extinction does not necessarily destroy the original learning.

(S: Bouton, 2004)

CONTEXT (H4 P3 (1))

"Context" refers to the stimuli that are in the background whenever learning occurs.

RENEWAL EFFECT (H4 P3 (2))

The "renewal effect" is the phenomenon where if the CS is tested in a new context (ie different room/location), the CR can return even if extinction has already occurred.

These effects have been interpreted to suggest extinction inhibits (rather than erases) the learned behaviour, and this inhibition is mainly expressed in the context in which it is learned.

Note that this does not imply extinction is a bad treatment for behaviour disorders; indeed, clinicians can increase its effectiveness by implementing basic research on learning to help defeat the relapse effects. (H4 P4)

(S: Craske et al., 2008)

INSTRUMENTAL / OPERANT CONDITIONING (HI P7(1))

💡 "Instrumental conditioning", or "operant conditioning", occurs when a behaviour is associated with the occurrence of a psychologically significant event.

💡 This theory was first studied by Edward Thorndike, and later extended by B.F. Skinner.

eg mother tells child "don't make a fuss when we're in the supermarket, and you'll get a treat on the way out".

SKINNER BOX (HI P7(2))

💡 The "Skinner box" experiment is one of the most best-known examples of operant conditioning at play.

💡 In a nutshell, a rat in a lab "learns" to press a lever in a cage to receive food.

OPERANT BEHAVIOUR (HI P7(3))

💡 "Operant behaviour" is any behaviour that is done voluntarily to achieve some set of consequences (ie a "learned" behaviour.)

eg Skinner's box rat flicking the lever to receive food pellets.

THORNDIKE'S LAW OF EFFECT (HI P9(1))

💡 Thorndike's "law of effect" states that when a behaviour has a positive/satisfying effect or consequence, it is more likely to be repeated in the future; and when a behaviour has a negative/painful/annoying effect or consequence, it is less likely to be repeated in the future.

REINFORCERS (HI P8)

💡 A "reinforcer" is any consequence of a behaviour that strengthens the behaviour and/or increases the likelihood it will be performed again.

eg Skinner's box rat
- food pellets are reinforcers
- because they strengthen the rat's desire to engage with the environment in this particular manner (ie flicking the lever)

💡 "Positive reinforcement" is the strengthening of a behaviour by adding a desirable stimulus.

eg receiving a gold star for excellent work

💡 "Negative reinforcement" is the strengthening of a behaviour by removing an aversive stimulus.

eg studying hard so parents will not nag you

PUNISHERS (HI P9(2))

💡 A "punisher" is any stimulus that decreases the strength of an operant behaviour, and/or decreases the likelihood it will be performed again.

💡 "Positive punishment" is the weakening of a behaviour by adding an aversive stimulus.

eg yelling at a naughty child

💡 "Negative punishment" is the weakening of a behaviour by removing a desirable stimulus.

eg taking a naughty child's favourite toy away.

MOST FACTORS THAT AFFECT THE STRENGTH OF CLASSICAL CONDITIONING ALSO AFFECTS THE STRENGTH OF OPERANT CONDITIONING (H5 P1)

💡 Note that most of the things that affect the strength of classical conditioning also affects the strength of operant conditioning.

eg reinforcers/punishers, extinction

INSTRUMENTAL RESPONSES COME UNDER STIMULUS CONTROL (H6)

STIMULUS CONTROL (H6 P1)

💡 "Stimulus control" occurs when an operant behaviour is controlled by a stimulus that precedes it.

eg You only wait for the green arrow, not just the green light, before turning.

💡 In this case, we say that the operant behaviour is "under" stimulus control.

💡 Stimulus-control techniques are widely used in the laboratory to study perception and other cognitive processes in animals. (H6 P3)

DISCRIMINATIVE STIMULUS (H6 P2)

💡 A "discriminative stimulus" is a stimulus that signals whether the response will be reinforced.

💡 Note that a discriminative stimulus usually does not elicit the response directly (which is what a "classical" CS does), but instead "sets the occasion" for the operant response.

eg a canvas put in front of an artist does not elicit painting behaviour, but rather "sets the occasion" for painting to occur.

CATEGORISATION (H6 P4)

💡 "Categorisation" is the sorting of different items into classes or categories.

💡 Stimulus control techniques have also been used to study how animals can learn how to categorise different sets of stimuli.

eg birds in a Skinner box can learn how to peck at different buttons depending on the pictures of flowers, cars, chairs or people shown. (S: Wasserman, 1995)

OPERANT CONDITIONING INVOLVES CHOICE (H7 P1)

E₁: Note that operant conditioning always requires choosing one behaviour over others.

eg rat chooses to press the lever instead of sleeping, etc

E₂: Moreover, the alternative behaviours are each associated with their own reinforcers:

E₃: Then, the tendency for an organism to perform a particular action depends on both the reinforcers "earned" for it, and the reinforcers "earned" for its alternatives.

QUANTITATIVE LAW OF EFFECT (H7 P2)

E₁: The "quantitative law of effect" revolves around the notion that the effects of reinforcing one behaviour depend crucially on how much reinforcement is earned for the behaviour's alternatives.

(S: Herrnstein, 1970)

eg If a pigeon learns that pecking one light will reward two food pellets, whereas the other light only rewards one, the pigeon will peck the first light.
But what if getting to the first light takes more work?

E₃: In general, a given reinforcer will be less reinforcing if there are many alternative reinforcers in the environment.

eg sex/alcohol/drugs are less effective reinforcers if in the presence of family/work achievement/love.

COGNITION IN INSTRUMENTAL LEARNING (H8 P1)

E₁: Modern research have shown that reinforcers can also make animals learn about the specific consequences of each behaviour, and will perform said behaviour depending on how much they currently want/value its consequence.

REINFORCER DEVALUATION EFFECT (H8 P2 (1))

E₁: The "reinforcer devaluation effect" describes the finding that an animal will stop performing an instrumental response that once led to a reinforcer if the reinforcer is made aversive or undesirable.

(S: Colwill & Rescorla, 1986)

GOAL-DIRECTED BEHAVIOUR (H8 P2 (2))

E₁: We say a behaviour is "goal-directed" if it is influenced by the current value of its associated goal.

(S: Dickinson & Balleine, 1994)

HABIT (H8 P3)

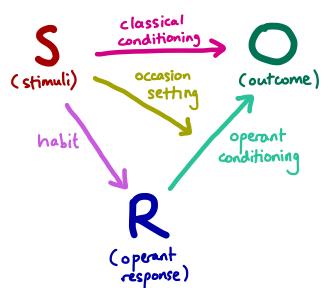
E₁: A "habit" is any instrumental behaviour that occurs automatically in the presence of a stimulus, with the animal's knowledge of the reinforcer's value not being able to influence the behaviour anymore.

E₂: Note that an animal might still persistently perform a habit even if the action is paired with an aversive/negative response (eg sickness.) (S: Holland, 2004)

PUTTING CLASSICAL & INSTRUMENTAL CONDITIONING TOGETHER (H9)

THE SOR MODEL (H9 P2)

The "SOR model" is a method we can use to visualise the connections between classical and operant learning. (H9 P3)



Firstly, the organism will have to learn to associate the response and outcome (ie R-O); this is typically done via operant/instrumental conditioning. (H9 P4)

Secondly, the organism will have to learn to associate the stimulus with the outcome (ie S-O); this is typically done via classical/Pavlovian conditioning. (H9 P5)

Thirdly, the organism will have to learn to associate the stimulus and the response (ie S-R); this is typically achieved via habit formation. (H9 P6)

Lastly, the organism will have to learn the association between the stimulus and the response-outcome connection (ie S-(R-O)); this typically occurs when the stimulus "sets the occasion" for the response-reinforcer link. (H9 P7)

OBSERVATIONAL LEARNING (H10 P1)

"Observational learning" is the process where organisms learn by observing the behaviour of others.

eg children watching children playing the game.

SOCIAL LEARNING THEORY (H10 P2)

"Social learning theory" revolves around the notion that individuals can learn novel responses via observation of key others' behaviours.

(S: Bandura, 1977).

SOCIAL MODELS (H10 P3)

"Social models" are authorities that are the "targets" for observation and who model behaviours.

Note that observational learning hinges on the presence of social models.

PROCESS OF OBSERVATIONAL LEARNING (H10 P4)

In his paper, Bandura highlights four major parts of observational learning:

- ① attention;
 - one must pay attention to learn
- ② retention;
 - one must retain the observed knowledge to learn
- ③ initiation (execution); and
 - one must be able to execute/initiate the learned behaviour
- ④ motivation.
 - one must be motivated to engage in observational learning

BOBO'S DOLL EXPERIMENT (H10 P6)

The "Bobo's doll" experiment was one of the more notable experiments designed to explore observational learning.

(S: Bandura, Ross & Ross, 1961)

Methodology:

- ① Children were to observe an adult social model interact with a clown "Bobo" doll.
- ② For one group, the adult was aggressive towards the doll; and
- ③ for the other group, the adult was neutral towards the doll.
- ④ Afterwards, the children were given a chance to interact with the doll themselves.
- ⑤ The children that were exposed to the adult behaving aggressively towards the doll were more likely to behave aggressively towards the doll themselves, compared to the other group.

The researchers concluded the observations of the adult's social model's behaviour gave the children in the aggressive group a justification to act aggressively towards the doll themselves.

VICARIOUS REINFORCEMENT (H10 P7)

"Vicarious reinforcement" refers to the learning that occurs when subjects observe the reinforcement or punishment of another person.

Note that vicarious reinforcement does play a role in observational learning.

eg In an adaptation of the Bobo doll study, children in the aggressive group were shown to exhibit less aggressive behaviour if they witnessed the adult model getting punished for their adult aggression.

(S: Bandura, Ross & Ross, 1961)

Module 2: Stats and Research Designs

SAMPLING (2A)

POPULATION

The "population" refers to the complete set of data.

SAMPLE

A "sample" is a subset of scores drawn from the population.

MEASUREMENT

"Measurement" is the act of assigning numbers to observations.

e.g. assign 20 to someone's age, assign 1 to represent whether they are male or not.

CONSTANT

We say a set of observations are "constant" if they are uniform.
e.g. "human".

VARIABLE

We say a set of observations are "variable" if they are non-uniform.
e.g. age/sex

QUANTITATIVE

We say a variable is "quantitative" if their values take numerical values.
e.g. age

QUALITATIVE

We say a variable is "qualitative" if their values take on categorical values.
e.g. sex (male/female)

PARAMETER

A "parameter" is a numerical or other measurable factor that describes an aspect of the population.
e.g. population mean = μ

STATISTIC

A "statistic" is a numerical or other measurable factor that describes an aspect of the sample.
e.g. sample mean = \bar{x}

SAMPLING ERROR

"Sampling error" is defined as the discrepancy between a population parameter and its corresponding sample statistic.
e.g. mean: sampling error = |sample mean - pop. mean| = $|\bar{x} - \mu|$.

* note: sampling error > 0 always
(because we take the absolute value!)

MEASURES OF CENTRAL TENDENCY (2B)

MODE

The "mode" is the category that occurs the most frequently from a set of data.

Mode is typically used for categorical data.

MEAN

The "mean" is defined as the mathematical average of all the scores in a set of data.

The mean is calculated via

$$\mu = \frac{\sum x}{n}$$

MEDIAN

The "median" is defined as the middle score (or the midpoint between the two middle scores) in the set of data.

The median is typically used for skewed distributions because it is not as strongly influenced by outlier values.

MEASURES OF VARIABILITY (2C)

"Measures of variability" tell us how spread-out the scores are in a set of data.

MEAN (μ)

The "mean" is defined as the typical score of a set of data, and is calculated by

$$\mu = \frac{\sum x}{N}$$

VARIANCE (σ^2)

The "variance" describes the average amount of squared deviation, and is calculated by

$$\sigma^2 = \frac{\sum (x-\mu)^2}{N}$$

STANDARD DEVIATION (σ)

The "standard deviation" describes the average amount of deviation, and is calculated by

$$\sigma = \sqrt{\frac{\sum (x-\mu)^2}{N}}$$

CORRELATION COEFFICIENT (2D)

E1: The "correlation coefficient", denoted as " r ", is a statistic that describes the strength and direction of the relationship between two variables.

SCATTER PLOT

E2: A "scatter plot" is a graph which plots a set of data by their values of two variables.



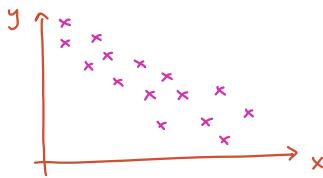
POSITIVE RELATIONSHIP

E3: We say two variables have a "positive relationship" if high values on one variable are associated with high values on the other variable.



NEGATIVE RELATIONSHIP

E4: We say two variables have a "negative relationship" if high values on one variable are associated with low values on the other variable.



STRENGTH OF CORRELATION COEFFICIENT

E5: The value of the correlation coefficient can tell us of the "strength" of the relationship between the two variables.



E6: The greater the magnitude of the correlation coefficient is, the greater the "strength" of the correlation.

INFERRENTIAL STATISTICS (2E)

E1: "Inferential statistics" can be used to compare two sets of scores to determine whether there is a significant difference between them or not.

STATISTICALLY SIGNIFICANT

E2: We say a result is "statistically significant" if its "p-value" is less than 0.05.

E3: This is usually used to verify whether the "difference" between two groups is "real" or not.

E4: Common statistical tests include

- ① the t -test (two groups); and
- ② the F -test (three or more groups).

Reading 2.1: History of Psychology

A PRE-HISTORY OF PSYCHOLOGY (H1)

EMPIRICISM - LOCKE & REID (1700s) (H1 P1)

💡 "Empiricism" is the notion that all knowledge comes from experience.

💡 Empiricism was taught in universities, especially in the faculties of intellect, will and the senses.

(S: Fuchs, 2000)

PHYSIOLOGY & PSYCHOPHYSICS (H2)

NEURAL IMPULSE - HELMHOLTZ (1800s) (H2 P1)

💡 The "neural impulse" is an electro-chemical signal that enables neurons to communicate.

💡 Helmholtz measured the speed of the neural impulse, and through his study of the physiology of hearing/vision he showed our senses can deceive us, suggesting the science of psychology was feasible.

PHYSIOPHYSICS - WEBER & FECHNER (H2 P2)

💡 "Physiophysics" is the study between physical stimuli and the perception of those stimuli.

EXPERIMENTAL PSYCHOLOGY - WUNDT (H2 P3)

💡 "Experimental psychology" is the scientific and empirical approach to the study of the mind.

INTROSPECTION - WUNDT (H2 P4 (1))

💡 "Introspection" is the process where subjects train themselves to offer detailed self-reports of their reactions to various stimuli.

CONSCIOUSNESS (H2 P4 (2))

💡 "Consciousness" is the awareness of ourselves and the environment.

SCIENTIFIC PSYCHOLOGY COMES TO THE UNITED STATES (H3)

STRUCTURALISM - TITCHENER (1900s) (H3 P1 (1))

💡 "Structuralism" was a school of American psychology that sought to describe the elements of conscious experience.

(S: Evans, 1972; Titchener, 1909)

AMERICAN PSYCHOLOGICAL ASSOCIATION (APA) (1892) (H3 P2 (1))

💡 The American Psychological Association (or APA) is a scientific professional organisation of psychologists.

SOCIETY OF EXPERIMENTAL PSYCHOLOGISTS (SEP) (1904) (H3 P2 (2))

💡 The Society of Experimental Psychologists (or SEP) is another scientific professional organisation of psychologists, founded by Titchener.

AMERICAN PSYCHOLOGICAL SOCIETY / ASSOCIATION FOR PSYCHOLOGICAL SCIENCE (1988) (H3 P3)

💡 The American Psychological Society, known today as the Association for Psychological Science, is an international non-profit organisation whose mission is to promote, protect & advance the interests of scientifically oriented psychology in research, application, teaching and the improvement in human welfare.

TOWARD A FUNCTIONAL PSYCHOLOGY (H4)

FUNCTIONALISM - JAMES, HALL & CATTELL (1800s) (CH4 P1)

E₁: "Functionalism" was a school of American psychology that focused on the utility of consciousness.

E₂: Note that it laid the groundwork for the study of animal & comparative psychology.

(S: Benjamin, 2007).

PRINCIPLES OF PSYCHOLOGY - JAMES (1890)

CH4 P2)

E₁: "Principles of Psychology" was one of James' most influential books in psychology, where he argues that consciousness is ongoing and continuous.

E₂: Indeed, according to James, consciousness helped us adapt to our environment, in ways like allowing us to exhibit free will over our choices.

MARY WHITON CALKINS (1900s) (H4 P3)

E₁: Mary Whiton Calkins was one of James' students, who was an accomplished researcher and the first woman elected president of the APA.

(S: Scarborough & Furumoto, 1987)

G-STANLEY HALL (1900s) (H4 P4 (1))

E₁: G-Stanley Hall was a psychology professor who made many notable contributions to the field, including creating the first American psychology journal (the "American Journal of Psychology"), and founding the APA.

FRANCIS CECIL SUMMER (1900s) (H4 P4 (2))

E₁: Francis Cecil Summer was one of Hall's students who became the first African-American to earn a doctorate in psychology.

JAMES MCKEEN CATTELL (1900s) (H4 P5 (1))

E₁: James McKeen Cattell was a psychology academic who worked on the study of individual differences and the belief that mental abilities (e.g. intelligence) are hereditary.

EUGENICS (H4 P5 (2))

E₁: "Eugenics" describes the practice of selective breeding to promote desired traits.

THE GROWTH OF PSYCHOLOGY (H5)

GESTALT PSYCHOLOGY - WERTHEIMER, KOFFKA, KOHLER & LEWIN (1900s) (H5 P1)

E₁: "Gestalt psychology" revolves around the belief that studying the whole of any experience is richer than studying individual parts of that experience.

E₂: The work of Gestalt psychologists most likely played a role in the rise of "cognitive psychology" in America.

*see below for definition of cognitive psychology.

BEHAVIOURISM - WATSON & SKINNER (1900s)

CH5 P2)

E₁: "Behaviourism" is the study of overt and observable behaviour, rejecting any reference to the intangible mind.

E₂: Note that Pavlov (champion of classical conditioning) was also an early influencer of behaviourism in America.

COGNITIVE PSYCHOLOGY - BARTLETT, BRUNER, BROWN & MILLER (1900-2000s) (H5 P3 (1))

E₁: "Cognitive psychology" refers to the study of mental processes.

E₂: The field serves as a successor to Behaviourism, as psychologists began to realise it could not fully explain human behaviour since it rejected mental processes.

CONSTRUCTIVE MIND - BARTLETT (H5 P3 (2))

E₁: The "constructive mind" idea revolves around the notion that people use their past experiences to construct frameworks in which to understand new experiences.

FLASHBULB MEMORY - BROWN (H5 P3 (3))

E₁: A "flashbulb memory" refers to a highly detailed and vivid memory of an emotionally significant event.

TIP-OFF-THE-TONGUE PHENOMENON (H5 P3 (4))

E₁: The "tip-of-the-tongue" phenomenon describes the inability to pull a word from memory even though there is a sensation that that word is available.

THE MAGIC NUMBER SEVEN, PLUS OR MINUS TWO - MILLER (H5 P3 (5))

E₁: "The Magic Number Seven, Plus or Minus Two" is one of the most cited papers in psychology, which posits that the number of bits of information an average human can hold in working memory is 7 ± 2 .

APPLIED PSYCHOLOGY IN AMERICA (H6)

MODERN INTELLIGENCE TESTS - BINET (1857-1911) (H6 P1 (1))

Binet's "modern intelligence test" used tasks of problem solving and reasoning to help identify schoolchildren in need of educational support.

MODERN INTELLIGENT TESTS IN AMERICA - GODDARD (1866-1957), TERMAN (1877-1956) (H6 P1 (2))

The modern intelligence tests by Binet was first introduced in the United States by Goddard & Terman.

NATURE-NURTURE DEBATE (H6 P1 (3))

The "nature-nurture" debate revolves around the strength of the relative contributions heredity and environment play in determining intelligence.

(S: Fancher, 1987)

HUGO MUNSTERBERG (1863-1916) (H6 P2(1))

Hugo Munsterberg made heavy contributions to areas such as employee selection, eyewitness testimony, and psychotherapy.

WALTER D SCOTT (1869-1955) & HARRY HOLLINGWORTH (1880-1956) (H6 P2(2))

Scott and Hollingworth produced original work on the psychology of advertising and marketing.

LILIAN GILBRETH (1878-1972) (H6 P2(3))

Gilbreth helped promote the use of time and motion studies to improve efficiency both in industry and in the home.

eg pop-up trachea, fridge door shelving

CLINICAL PSYCHOLOGY - WHITNER (1867-1956) (H6 P3)

Whitner is responsible for the founding of the first psychological clinic (1896), where he treated children with learning and behavioural problems using his psychological expertise on sensation and perception.

PSYCHOLOGY AS A PROFESSION (H7)

AMERICAN ASSOCIATION FOR APPLIED PSYCHOLOGY (AAAP) (1930s) (H7 P1)

In 1917, applied psychologists organised to create standards for education, training and licensure.

This culminated with the founding of the "American Association for Applied Psychology", or "AAAP", which dealt with the interests of psychologists in education, industry, consulting and clinical work.

EFFECT OF WWII ON APPLIED PSYCHOLOGY (H7 P2 (1))

During WWII, the abundance of the psychiatric casualties of war overwhelmed the mental health industry.

This led to the federal government merging the AAAP & APA, and the focusing of training of professional psychologists.

NATIONAL MENTAL HEALTH ACT OF 1946 (H7 P2 (2))

The "National Mental Health Act of 1946" provided funding to allow the collaboration of the APA, the Veterans Administration and the Public Health Service to develop training programs for clinical psychologists.

BOULDER CONFERENCE ON GRADUATE EDUCATION IN CLINICAL PSYCHOLOGY (1949) (H7 P2 (3))

The "Boulder Conference in Graduate Education in Clinical Psychology", convened shortly after the National Mental Health Act of 1946, launched doctoral training programs in psychology, counseling and school psychology.

SCIENTIST-PRACTITIONER MODEL OF TRAINING (H7 P2 (4))

The "scientist-practitioner" model of training is a model of training that emphasises the development of both clinical and research skills.

PRACTITIONER-SCHOLAR MODEL OF TRAINING (H7 P2 (5))

The "practitioner-scholar" model of training instead focuses on the development of clinical practice.

The model was suggested at the Vail Conference on Professional Training in Psychology in 1973, as an alternative to the "scientist-practitioner" model.

PSYCHOLOGY AND SOCIETY (H8)

SOCIETY OF THE PSYCHOLOGICAL STUDY OF SOCIAL ISSUES (SPSSI) (1936) (H8 P1(1))

The "Society of the Psychological Study of Social Issues", or "SPSSI", supports research and action on a wide range of social issues.

PSYCHOLOGY OF SEX

HELEN THOMPSON WOOLLEY (1874-1947) (H8 P1(2))

In the early 1900s, when women's rights were marginalised, Thompson examined the assumption that women were more overemotional compared to men and found that emotion did not influence women's decisions any more than it did men's.

LETA S. HOLLINGWORTH (1886-1939)

(H8 P1(3))

Hollingworth investigated and found that menstruation did not negatively impact women's cognitive or motor activities.

PSYCHOLOGY OF RACE

MAMIE PHIPPS CLARK (1917-1983) & KENNETH CLARK (1914-2005) (H8 P2(1))

The Clarks studied the ways in which school segregation negatively impacted the self-esteem of African-American children.

BROWN V. BOARD OF EDUCATION (1954)

(H8 P2(2))

In the Supreme Court case of "Brown v. Board of Education", it was ruled that school segregation would end, primarily due to the research of the Clarks.

(S: Guthrie, 2003)

ASSOCIATION OF BLACK PSYCHOLOGISTS (ABPsi) (1968) (H8 P2(3))

The "Association of Black Psychologists", or "ABPsi", helped push for greater advocacy for issues impacting the African American community.

PSYCHOLOGY OF GENDER

THE ADJUSTMENT OF THE MALE OVERT

HOMOSEXUAL - HOOKER (1907-1996) (H8 P3)

"The Adjustment of the Male Overt Homosexual" showed that there were no significant differences in psychological adjustment between homosexual and heterosexual men.

Hooker's research helped to de-pathologise homosexuality, eventually leading to the decision by the APA to remove homosexuality from the Diagnostic and Statistical Manual of Mental Disorders in 1973.

(S: Garnets & Kimmel, 2003)

Reading 2.2: Research Designs

EXPERIMENTAL RESEARCH (H2)

SPENDING & HAPPINESS - DUNN (2008) (H2 P1)

Dunn's study aimed to test the common intuitive idea that we are happier when we spend money on ourselves compared to when we spend it on others.

Methodology:

- ① Dunn gave each of the participants \$20.
- ② The participants were then tasked to spend the money by the end of the day.
- ③ One group was told to spend the money on themselves;
- ④ The other group was told to spend the money on others.
- ⑤ At the end of the day, she measured participants' "levels" of happiness using a self-report questionnaire.
- ⑥ Dunn found the group who had spent the money on others were happier than those who had spent the money on themselves. (H2 P2)

The researchers concluded spending on others causes us to be happier than spending on ourselves. (H2 P2)

INDEPENDENT VARIABLE (H2 P2(1))

The "independent variable" is the variable that is changed / manipulated in the experiment.

eg whether participants spent money on themselves or others in Dunn's study.

DEPENDENT VARIABLE (H2 P2(2))

The "dependent variable" is the variable that is measured in the experiment.

eg participants' happiness in Dunn's experiment.

Importantly, the dependent variable must depend on what happens to the independent variable.

RANDOM ASSIGNMENT (H2 P4)

"Random assignment" is the process of assigning participants to receive different conditions of an experiment by chance.

Random assignment is done to even out any other "external factors" that could otherwise explain the cause of any observable trend between the independent and dependent variables.

CONFOUNDS (H3 P1 (1))

"Confounds" are things that could undermine our ability to draw causal inferences.

eg placebo effect (see below)

PLACEBO EFFECT (H3 P1 (2))

The "placebo effect" occurs when a person, just by knowing that they are receiving special treatment, actually causes changes in behaviour or perception. eg treating someone "special" (ie in an experiment) could make them happier.

PARTICIPANT DEMAND (H3 P1 (3))

"Participant demand" occurs when participants try to behave in a way they think the experimenter wants them to behave.

EXPERIMENTER EXPECTATIONS (H3 P1 (4))

"Experimenter expectations" occurs when the expectations/bias of the experimenter influences the outcome of a study.

DOUBLE-BLIND PROCEDURE (H3 P2)

In a "double-blind procedure", neither the participant nor the experimenter knows which condition the participant is in.

A double-blind procedure can minimise the effects of confounds.

eg placebo effect, experimenter expectation

CORRELATIONAL DESIGNS (H4)

💡 In a "correlational design", we identify patterns of relationships, but cannot infer what causes what.
* see Module 2 for info on scatterplots/correlation coefficient.

💡 Note that correlation does not imply causation, because there may be other factors that explain the correlation.
eg a third variable

QUALITATIVE DESIGNS (HS)

PARTICIPANT OBSERVATION (HS P1)

💡 "Participant observation" is a methodology that involves the researcher embedding themselves into a group in order to study its dynamics.
eg researchers pretending to be cult members to study its dynamics
(S: Festinger, Riecken & Shacter, 1956)

CASE STUDY (HS P2)

💡 In a "case study", specific individuals or contexts are subjected to intensive examination by researchers.
eg intense examination of one person with brain injury.

💡 Sigmund Freud, the father of psychoanalysis, was famous for using this method.

NARRATIVE ANALYSIS (HS P3)

💡 "Narrative analysis" centers around the study of stories and personal accounts of people, groups or cultures.
In this methodology, researchers examine people's personal testimonies in order to learn more about the psychology of those individuals/groups.

QUASI-EXPERIMENTAL DESIGNS (H6)

💡 In a "quasi-experimental design", assignment to certain conditions is based off existing group memberships rather than random assignment. (H6 P2)
eg single/married, class membership

💡 It is harder to draw causal inferences from a quasi-experimental design, simply because there are numerous other external factors that could explain a trend.
why? → random assignment is not used.

LONGITUDINAL STUDIES (H7)

💡 In a "longitudinal study", the same people are tracked over a period of time (from few weeks to decades) to draw inferences.

eg a German study to determine people who end up getting married start off a bit happier than their peers who never marry, by tracking 20,000 Germans for two decades.

💡 Note that longitudinal studies can be quite costly to conduct, especially if they follow many people for many years.

SURVEYS (H8)

💡 "Surveys" involve using old-fashioned or Internet-based questionnaires to collect information.

HAPPINESS & PROBABILITY PERSON WILL GET INTO HEAVEN - KING & NAPA (1998) (H8 P1)

💡 This study tested the hypothesis of whether happy people were judged as more likely to get into heaven compared to unhappy people.

Methodology:

- ① Participants were presented surveys completed by both happy and unhappy people.
- ② They were then asked who were more likely to go to heaven.
- ③ The researchers found happy people were judged to be more likely to go to heaven than unhappy people.

SMILE INTENSITY OF YEARBOOK PHOTOS & MARITAL STATUS - HARKER & KELTNER (2001) (H8 P2)

💡 In this study, Harker and Keltner examined the smile intensity of women's college yearbook photos.

💡 They found smiling in the photos was correlated with the woman being married 10 years later.

TRADEOFFS IN RESEARCH (H9)

RESOURCE AVAILABILITY (H9 P1)

💡 "Resource availability" (eg cost/resources) may be a primary factor in deciding the method used for a particular study.
eg longitudinal studies are better than surveys, but they take up a lot more time and resources.

ETHICS OF A STUDY (H9 P2)

💡 The "ethics" of a study is also a primary factor in deciding the method used for a study.
eg we could not intentionally inflict people with brain injuries to study them.

Module 3:

Evolution and Psychology

HOW DOES EVOLUTION WORK? (3A)

UNIQUENESS / VARIATION

The principle of "uniqueness / variation" revolves around the fact that individuals differ from each other in terms of their characteristics.

HEREDITY

The principle of "heredity" revolves around the fact that DNA can be passed from parent to offspring, and yet an offspring's characteristics are usually different from their parents.

RECOMBINATION

"Recombination" occurs when the parent's individual DNA is "scrambled" up when making gametes (ie sperm/egg cells) and is then mixed together with their mate's DNA during sex.

Note that recombination is a possible reason why the offspring's characteristics differ from the parents.

MUTATION

"Mutation" refers to the random mistakes that are made in the copying of DNA during cell replication.

Note that mutation is also a possible reason why the offspring's characteristics differ from the parents.

ADAPTIVE RADIATION

"Adaptive radiation" refers to the phenomenon where species change overtime in response to the selective forces present in their environment.

eg Darwin's finches.

EXTINCTION

"Extinction" occurs when a species disappears.

SPECIATION

"Speciation" occurs when a new species is created.

ADAPTATION

"Adaptation" describes the observation that species are usually well-suited for their environment.

UNBIAS OF EVOLUTION

Note that evolution is a "mindless" process, and as such has no "goal", nor a preference for one species over another.

THE RISE OF PRIMATES - 140MYA

Primates first evolved on a single landmass that included both Africa and South America.

The African ancestors gave rise to the "Old World Monkeys" and "Great Apes".

The South-American ancestors gave rise to the "New World Monkeys".

Note that all primates exhibit "shared behaviour" because we all descend from a common ancestor.

SEPARATION OF CHIMPS/BONOBOES FROM HUMANS - 7MYA

Chimpanzees and humans "separated" about 7 million years ago.

Note that we share many common features with chimps/bonobos because they are our closest ancestors.

AUSTRALOPITHECINES (LUCY) - 4MYA

"Australopithecines" were the first hominids that were bipedal (walked on two legs).

HOMO HABILIS / HANDY MAN - 2MYA

"Homo habilis", or the "handy man", was the first hominid to leave evidence of stone tool use in the archeological record.

FLAKING

"Flaking" is a technique where one stone is used to shear off a flake of another stone to produce a sharp edge.

Flaking was primarily used by Homo habilis to create stone tools.

ACCUMULATION OF KNOWLEDGE / CULTURE - 1.5MYA

Humans began to transmit, tinker and improve technology across generations around 1.5 million years ago.

Note that this "accumulation of knowledge" seems to be unique to humans.

SOCIAL LEARNING

"Social learning" is the process of learning from peers.

Note that social learning has been observed in species other than humans.

MODERN HUMANS - PRESENT DAY

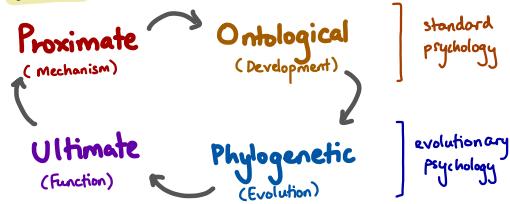
Modern humans are less physically robust than ancestral hominids, but have much larger brains.

The increase in our brain's computational power explains the massive acceleration of current culture and technology.

ACCOUNTING FOR BEHAVIOUR (3B)

FOUR LEVELS OF EXPLANATION - TINBERGEN (1963)

The "four levels of explanation" can help us analyse and evaluate different behaviours.



PROXIMATE / MECHANISM

The level of "proximate", or "mechanism", focuses on how the behaviour works.

e.g. how hormonal differences between men and women help motivate sexual behaviour.

ONTOLOGICAL / DEVELOPMENT

The level of "ontological", or "development", focuses on how the behaviour changes across the lifespan.

e.g. how boys & girls experience different socialisation practices during childhood.

PHYLOGENETIC / EVOLUTION

The level of "phylogenetic", or "evolution", focuses on how the behaviour changes across generations.

e.g. how socialisation of boys/girls stems from unequal parental investment in the ancestral environment.

ULTIMATE / FUNCTION

The level of "ultimate", or "function", focuses on what the behaviour does.

e.g. men and women pursue different sexual strategies to achieve reproduction.

STANDARD APPROACH

In the "standard approach" to psychology, psychologists primarily focus on the proximate and ontological levels of behaviour.

SINGLE DOMAIN-GENERAL INFORMATION PROCESSOR

A "single domain-general information processor" describes the concept that the mind processes all information equally well (to produce different behavioural outputs.)

EVOLUTIONARY APPROACH

In the "evolutionary approach" to psychology, psychologists focus on the "phylogenetic" and "functional" levels of behaviour.

MULTIPLE DOMAIN-SPECIFIC INFORMATION PROCESSORS

The "multiple domain-specific information processors" analogy describes the mind constituting of several specialised "processors", each designed to solve a particular type of problem.

e.g. a "language acquisition processor" that specialises in answering language-related problems.

Note that domain-specific processors may have been adaptive in the past, but not in the current day.

e.g. eating sugar was a plus in ancient times, but is a detriment if consumed in current times.

HOW IS EVOLUTION APPLIED IN PSYCHOLOGY? (3C)

IMPACT OF OUR ANCESTRAL ENVIRONMENT ON BEHAVIOUR

E1: The evolutionary approach suggests that humans should only have mental adaptations for problems that occurred in our ancestral environment.

E2: Moreover, we should also be able to solve problems for which we are mentally adapted to better than problems for which we do not.
eg the "Four card problem"

THE 4-CARD PROBLEM

E1: The "4-card" problem shows how problems that we are mentally adapted to are easier than problems to which we are not.

E2: Methodology:

① Participants were given two similar problems, which asked which cards participants needed to flip over to verify a given statement.

② The first problem:

"if a card shows an even number on one face, then its opposite face is blue".



③ The second problem:

"if a person is drinking alcohol, then this person is at least 19 years of age".



④ Researchers found that only <10% of the participants got the first question correct (it was blue and 8), whereas nearly everyone got the second question correct (it was 16 and beer).

CHEATER DETECTION MENTAL ADAPTATION - COSMIDES & TOOBY

E1: The "cheater detection mental adaptation" theory attempts to explain the discrepancy in the % of people that could answer each problem in the 4-card problem.

E2: The first problem is of logic, which does not map onto "common" problems of survival or reproduction in our ancestral past; hence, we are not mentally "adapted" to solve such problems.

E3: On the other hand, the second problem is of a "social contract", where the one shown was the idea of "permissions"; ie who is able to engage in a behaviour and who is not.

E4: Then, since the violation of social contracts in the ancestral environment compromised survivability and reproduction, evolution "adapted" us to detect "cheaters" who break said contracts.

SEXUAL SELECTION

INTRA-SEXUAL SELECTION

E1: "Intra-sexual selection" is a form of sexual selection where individuals of the same sex compete with each other for access to members of the opposite sex.

eg physical competitions between male deer.

E2: Note that organisms who "win" said competitions get to mate, so it follows from heredity that traits that help organisms win these competitions are passed down to their offspring.

eg bigger antlers/size help male deer win the competitions, so these are passed down to their offspring.

INTER-SEXUAL SELECTION

E1: "Inter-sexual selection" is a form of sexual selection where members of one sex choose members of the other sex based on desirable characteristics.

eg colourful tails for peacocks

PARENTAL INVESTMENT THEORY

PARENTAL INVESTMENT

"Parental investment" refers to any expenditure (ie time/energy/resources etc) that benefits an offspring, and simultaneously reduces the parent's ability to invest in other aspects of fitness (eg mating).

PARENTAL INVESTMENT THEORY - TRIVERS (1976)

1: "Parental investment theory" posits that there exists differences in the degrees to which males and females of a given species are obligated to invest in offspring.

At the minimum,
 ① males are "obligated" to invest sperm; whilst
 ② females are "obligated" to invest eggs.

Moreover,

- ① the sex that makes the larger obligatory investment will be "choosier" when selecting a mating partner; whereas
- ② the sex that makes the smaller obligatory investment will compete for access to the sex that makes the larger investment.

WHY ARE WOMEN "CHOOSIER" THAN MEN?

1: Women are "choosier" than men in regards to sex because they make a larger obligatory investment to their offspring.

2: In particular, this is because

- ① fertilisation of the egg occurs inside the female; and
- ② women are compelled to continuously invest in the offspring or else risk losing the initial "investment".

SEAHORSES: WHY THE FEMALE IS NOT ALWAYS THE "CHOOSIER" SEX

1: Note that in seahorses, females deposit their eggs into the male's pouch where they are fertilised, carried and cared for by the male until the offspring are ready to disperse.

2: As such, since the males have to make a larger investment in their offspring, they are choosier than the females, and in fact the females compete for the males.

PARENTAL INVESTMENT THEORY APPLIED TO HUMAN MATING PSYCHOLOGY

Since women invest more in reproduction, parental investment theory helps explain some of these differences between the sexes in regards to sex-related traits; in particular,

- ① women are choosier (ie more discriminating) than men;
- ② men tend to have more partners (over time) than women;
- ③ men tend to be ready sooner for sex than women; and
- ④ men tend to exhibit a greater interest in casual sex compared to women.

SEXUAL SELECTION IN HUMAN MATING - BUSS & SCHMITT

In this study, male and female undergraduates were asked to rate the probability of consenting to sexual intercourse after different time intervals.

The researchers found that women indicated they would need ~6 months to consent, whereas men indicated they would only need ~1 week.

SHORT/LONG-TERM SEXUAL STRATEGIES - BUSS & SCHMIDT

In this similar study, male and female undergraduates were asked how many sexual partners they would ideally like to have across different time intervals.

The researchers found that

- ① in the short-term (1 month), men indicated they would like at least one sexual partner, whereas women indicated they would want fewer than one sexual partners.
ie many women did not know anyone who they wanted to have sex with.
- ② in the long-term (lifetime), men indicated they would like ~18 sexual partners, whereas women would like around 5-10 sexual partners.

Reading 3.1: Neurons

DISCOVERY OF THE NEURON - CAJAL (1911)

Cajal postulated that the nervous system consisted of discrete, individual neurons, which make up the structure and functionality of said system.

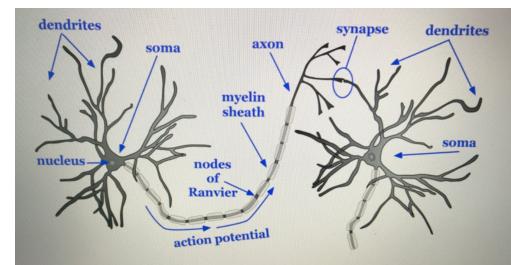
He made this conclusion based on his drawings of Golgi-stained tissue.

This opposed the leading theory at the time proposed by Gerlach, which stated the nervous system consisted of a continuous network of nerves.

Nevertheless, Cajal and Golgi shared the 1906 Nobel Prize in Medicine for their work on the nervous system.

STRUCTURE OF THE NEURON

Note that the human brain consists of ~ 100 billion neurons.



SOMA

The "soma" is the cell body of the neuron, which contains the genetic information of the neuron, and directs protein synthesis.

DENDRITES

"Dendrites" are "processes" that extend out of the soma, which act as the neuron's source of input from other neurons.

NUCLEUS

The "nucleus" contains the genetic information of the neuron, directs protein synthesis and supplies the energy/resources the neuron needs to function, and is located in the soma.

ACTION POTENTIAL

"Action potential" is an important signal that is used as the primary method of communication between neurons.

AXON

The "axon" acts as the neuron's main source of output, which consists of a process that extends far away from the soma and carries an action potential to another neuron.

SYNAPSE

The "synapse" is where the axon of one neuron comes in close contact with the dendrite of another neuron.

PRESYNAPTIC

We say a neuron, or part of a neuron, is "presynaptic" if it is sending the signal.

POSTSYNAPTIC

We say a neuron, or part of a neuron, is "postsynaptic" if it is receiving the signal.

MYELIN SHEATH

The "myelin sheath" is an insulating substance that covers the axon to allow signals to travel quickly between one neuron to another.

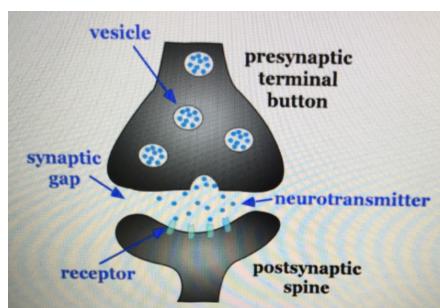
SPINES

"Spines" are protrusions on the dendrites of a neuron that form synapses with the terminal buttons of the presynaptic axons.

TERMINAL BUTTON

The "terminal button" is the part of the end of the axon that forms synapses with the spines on the dendrites of other neurons.

Note that synapses form between the presynaptic terminal button and the postsynaptic spine.



SYNAPTIC GAP

The "synaptic gap" is a ~5nm space between the presynaptic terminal button and the postsynaptic dendritic spine.

NEUROTRANSMITTERS

"Neurotransmitters" are chemical substances that are released by the presynaptic terminal buttons and that act on the postsynaptic spines.

They accomplish this by binding to "receptor sites" in the spine, activating ion channels.

SYNAPTIC VEHICLES

"Synaptic vehicles" are groups of neurotransmitters packaged together and located within the terminal button.

TYPES OF BRAIN CELLS

SENSORY NEURONS

"Sensory neurons" are neurons that help us receive information about the world around us.

MOTOR NEURONS

"Motor neurons" allow us to initiate movement and behaviour, which ultimately allows us to interact with the world around us.

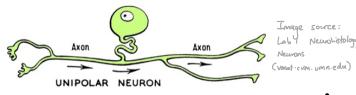
INTERNEURONS

"Interneurons" are neurons that process the sensory input from our environment into meaningful representations.

These then allow us to plan the appropriate behaviour responses, and subsequently to use our motor neurons to execute said responses.

UNIPOLAR NEURONS

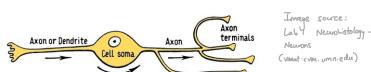
"Unipolar neurons" consist of one axon and no dendrites.



Consequently, they are ideal for just relaying information forward.
eg - communicating body temperature from the spinal cord to the brain

BIPOLAR NEURONS

"Bipolar neurons" consist of one axon and no dendrites.



Bipolar neurons are involved in sensory perception.
eg - perception of light in the retina of the eye.

MULTIPOLAR NEURONS

"Multipolar neurons" consist of one axon and many dendrites.



Multipolar neurons are used in applications involving the communication with many other neurons.
eg - communicating sensory/motor information in the brain

PYRAMIDAL NEURONS

"Pyramidal neurons" are a type of multipolar neuron that has a triangular/pyramidal soma, and is one of the most prominent neurons in the nervous system.

GLIA CELLS

OLIGODENDROGLIA

"Oligodendroglia" are glia cells that form myelin sheaths by wrapping around axons many times.

MICROGLIA

"Microglia" are glia cells that regulate brain development, maintain neuronal networks, and facilitate injury repair.

ASTROCYTES

"Astrocytes" are glia cells that provide nourishment to neurons and provide a barrier between nervous tissue and the bloodstream.

COMMUNICATION BETWEEN NEURONS

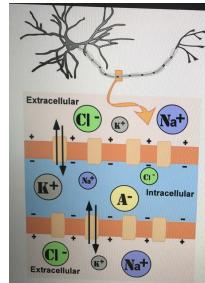
RESTING MEMBRANE POTENTIAL

INTRACELLULAR

"Intracellular" refers to anything inside the cell.

EXTRACELLULAR

"Extracellular" refers to anything outside the cell.



CELL MEMBRANE

The "cell membrane" is a bi-lipid layer of molecules that separates the cell from the surrounding extracellular fluid.

ION CHANNELS

"Ion channels" are proteins that span the cell membrane which form channels that specific ions can flow between the intracellular and extracellular spaces.

DIFFUSION

"Diffusion" is the force on molecules to move from areas of high concentration to areas of low concentration.

ELECTROSTATIC PRESSURE

"Electrostatic pressure" refers to the force which is produced when two ions of like charge repel, and two ions of opposite charge attract.

EQUILIBRIUM POTENTIAL

"Equilibrium potential" is the voltage at which the force of diffusion is equal to and opposite the force of electrostatic pressure.

At this voltage, no ions flow through the ion channels.

RESTING MEMBRANE POTENTIAL

"Resting membrane potential" refers to the potential difference between the "baseline" electrical charge inside the cell compared to the baseline electrical charge outside the cell.

The membrane potential of a neuron at rest is $\sim -70 \text{ mV}$.

EFFECTS OF DIFFUSION & ELECTROSTATIC PRESSURE ON DIFFERENT IONS

ANIONS (A^-)

Anions are highly concentrated inside the cell, so they contribute to the negative charge of the resting membrane potential.

Moreover, anions cannot pass through any ion channels; thus, their concentrations are not affected by diffusion and electrostatic pressure.

POTASSIUM (K^+)

Potassium ions remain in high concentrations inside the cell, and can permeate through the cell membrane.

Diffusion "pushes" K^+ outside the cell because it is highly concentrated inside the cell.

However, electrostatic pressure pushes K^+ back inside the cell because the positive charge of K^+ is attracted to the negative charge inside the cell.

CHLORIDE (Cl^-)

Chloride ions remain in high concentrations outside the cell, and can also permeate through the cell membrane.

Diffusion "pushes" Cl^- inside the cell because it is highly concentrated outside the cell.

However, electrostatic pressure pushes Cl^- back outside the cell because the negative charge of Cl^- is attracted to the positive charge outside the cell.

SODIUM (Na^+)

Sodium ions are of high concentration outside the cell, but they are not as permeable through the cell membrane.

Diffusion "pushes" Na^+ inside the cell because it is of high concentration outside the cell.

Moreover, electrostatic pressure also pushes Na^+ inside the cell because the positive charge of Na^+ is attracted to the negative charge inside the cell.

SODIUM-POTASSIUM PUMP

A "sodium-potassium pump" is an ion channel that uses the neuron's energy (ATP) to pump 3 Na^+ ions outside the cell in exchange for bringing 2 K^+ ions inside the cell.

Sodium-potassium pumps help remove the small amounts of Na^+ inside the cell.

ACTION POTENTIAL

HODGKIN & HUXLEY

Hodgkin & Huxley helped pioneer the general model of electrochemical transduction by studying the axons of giant squids, for which they won the Nobel Prize in Medicine in 1963.

ACTION POTENTIAL

"Action potential" is a transient "all-or-nothing" electrical current that is conducted down the axon when the membrane potential reaches the threshold of excitation.

DEPOLARISATION

"Depolarisation" occurs when the resting membrane potential (-70mV) of a cell shifts to a more positive direction.

HYPERPOLARISATION

"Hyperpolarisation" occurs when the resting membrane potential of a cell shifts to a more negative direction.

THRESHOLD OF EXCITATION

The "threshold of excitation" is the minimum membrane potential that must be reached in order to initiate an action potential.

The threshold of excitation is typically around -50mV.

EXCITATORY POSTSYNAPTIC POTENTIALS (EPSPS)

"Excitatory postsynaptic potentials", or "EPSPs", are depolarising currents that cause the membrane potential to become more positive and closer to the threshold of excitation.

INHIBITORY POSTSYNAPTIC POTENTIALS (IPSPS)

"Inhibitory postsynaptic potentials", or "IPSPs", are hyperpolarising currents that cause the membrane potential to become more negative and further away from the threshold of excitation.

PROCESS OF ACTION POTENTIAL CREATION

At any one time, each neuron receives hundreds of inputs from the cells that synapse with it.

These inputs can either be EPSPs or IPSPs.

The inputs then collectively "sum" together to create a net input.

If the sum of these inputs is large enough to raise the membrane potential past the threshold of excitation, the cell sends an action potential.

IONOTROPIC RECEPTORS

"Ionotropic receptors" are ion channels that open to allow ions to permeate the cell membrane only under specific conditions, such as the presence of a neurotransmitter or a specific membrane potential.

PROCESS OF ACTION POTENTIAL TRANSFER

When an action potential is created, it travels down the axon, away from the soma, until it reaches the end of the axon (ie the terminal button).

At the terminal button, the action potential triggers the release of neurotransmitters from the presynaptic terminal button into the synaptic gap.

In turn, these neurotransmitters cause EPSPs and IPSPs in the postsynaptic dendritic spines of the next cell by binding with ionotropic receptors in a "lock-and-key" fashion.

These EPSPs/IPSPs summate in the same fashion as described before, repeating the cycle again.

VOLTAGE-DEPENDENT

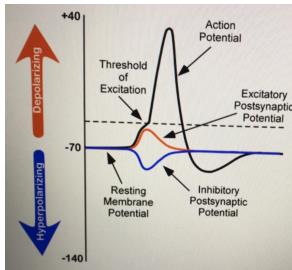
We say an ion channel is "voltage-dependent" if it only allows some ions to enter or exit the cell upon reaching a particular membrane potential.

REFRACTORY

We say an ion channel is "refractory" if it cannot reopen again until after the cell returns to the resting membrane potential.

ROLE OF Na^+ & K^+ IN ACTION POTENTIAL

The ions Na^+ and K^+ play a role in action potential as well.



Process:

- ① When a cell depolarises and reaches the threshold of excitation, a voltage-dependent Na^+ ion channel opens.
 - these are usually closed in resting membrane potential.
 - ② Accelerated by diffusion and electrostatic pressure, this causes Na^+ to rush into the cell, creating a net intracellular positive charge ($\sim +40\text{mV}$). (ie the "rising" / "depolarising" phase of the action potential).
 - even under normal circumstances, Na^+ is already "pushed" inside the cell by diffusion & electrostatic pressure (see earlier)
 - but since Na^+ cannot really permeate the cell membrane, the concentrations of Na^+ outside the cell still remain high.
 - ③ Then, the Na^+ channels become refractory; this forces the action potential to only move down the axon, away from the soma.
 - ④ As the cell becomes more depolarised, a voltage-dependent K^+ channel now opens up.
 - ⑤ Again, accelerated by diffusion and electrostatic pressure, this causes K^+ to be pushed out of the cell.
 - because K^+ concentration is high inside the cell
 - and the presence of Na^+ produces a net positive charge inside the cell.
 - ⑥ This movement causes the cell potential to "fall back" to the resting membrane potential. (ie the "falling" / "hyperpolarising" phase of the action potential).
 - ⑦ A short hyperpolarisation occurs, partially due to the closing of the K^+ channels.
 - ⑧ Then, electrostatic pressure continues to push K^+ out of the cell, and sodium-potassium pumps push Na^+ out of the cell.
 - ⑨ Eventually, the cell returns to its resting membrane potential, and the excess K^+ diffuse away.
- ⑩ Note that this whole process/exchange occurs in less than 1ms.
- ⑪ Also note that only ion channels in very close proximity to the action potential are affected.

NODES OF RANVIER

"Nodes of Ranvier" are gaps in the myelin sheaths that facilitate the generation of a fast electrical impulse along the axon.

SALTATORY CONDUCTION

"Saltatory conduction" is the process in which an action potential "jumps" actively between successive nodes of Ranvier, accelerating the transmission of it.

Na^+/Ca^+ CHANNELS \rightarrow EPSP

Neurotransmitters that activate Na^+ or Ca^+ channels cause an EPSP to occur in the dendrite of the post-synaptic cell.

NMDA RECEPTORS

"NMDA receptors" are receptors that are activated in the presence of glutamate (the main excitatory neurotransmitter in the brain).

K^+/Cl^- CHANNELS \rightarrow IPSP

Neurotransmitters that activate K^+ or Cl^- channels cause an IPSP to occur in the dendrite of the post-synaptic cell.

GABA RECEPTORS

"GABA receptors" are receptors that are activated by gamma-aminobutyric acid (GABA) (the main inhibitory neurotransmitter in the brain.)

REUPTAKE

"Reuptake" is the process in which neurotransmitters that do not bind to receptors are taken back into the presynaptic terminal button.

Reading 3.2: The Nervous System

Researchers have observed that the brains of many animals resemble humans.

e.g. apes, monkeys, humans

However, they have found that the neurons of humans are more complex than in other species.

i.e. we have more dendrites, etc. This allows our behaviours to be more intricate and complex, even when compared to apes.

Indeed, as our nervous system got more complex as humans evolved, our material culture became more sophisticated and advanced.

e.g. Homo habilis (2mya) only used stone tools; Homo sapiens (us) erected cities, constructed the written language, etc

ONTOGENY / DEVELOPMENT OF THE NERVOUS SYSTEM

ECTODERM

The "ectoderm" is the outermost layer of a developing fetus.

During development, the ectoderm is where nervous tissue emerges from.

NEURAL TUBE

The "neural tube" is the precursor to the central nervous system which forms in the embryo during development.

Note that this tube is hollow.

ROSTROCAUDAL (HEAD-TO-TAIL)

PLANE

The "rostrocaudal plane" is a front-back plane used to identify anatomical structures in the body and brain.

* rostral = "head", caudal = "tail"

NEURAL INDUCTION

"Neural induction" is the process in which the neural tube is formed in the embryo using nervous tissue from the ectoderm.

Note that the tube "sows" itself in the rostrocaudal direction.

SPINA BIFIDA

"Spina bifida" is a pathological condition that occurs when the neural tube does not close at the "tail" of the rostrocaudal plane (i.e. "caudally").

In this case, the lumbar and sacral segments of the spinal cord are disrupted.

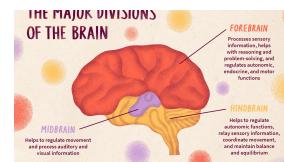


Image source:
Divisions of the Brain: Forebrain, Midbrain & Hindbrain
(ThoughtCo.)

FOREBRAIN

The "forebrain" is the part of the nervous system that contains the cerebral hemispheres, thalamus and hypothalamus.

MIDBRAIN

The "midbrain" refers to the most forward-most part of the brainstem.

Note that the midbrain is smaller than the forebrain and hindbrain because of the non-uniform proliferation of neurons and glia cells during development.

HINDBRAIN

The "hindbrain" is the part of the nervous system that contains the medulla oblongata, the pons and the cerebellum.

CEPHALISATION

"Cephalisation" occurs when the neural tube "balloons up" at the rostral end, in turn forming the forebrain, midbrain, hindbrain and spinal cord.

NEUROBLASTS

"Neuroblasts" are brain progenitor cells that asymmetrically divide into other neuroblasts or nerve cells.

NEUROEPITHELIUM

The "neuroepithelium" refers to the lining of the neural tube.

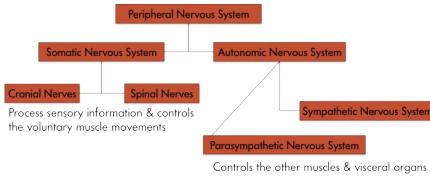
NEURAL CREST

The "neural crest" refers to the set of primordial neurons that migrate outside the neural tube and give rise to sensory and autonomic neurons in the peripheral nervous system.

Note that the neural crest is generated by the neuroepithelium.

STRUCTURE OF THE NERVOUS SYSTEM

THE PERIPHERAL NERVOUS SYSTEM



AUTONOMIC NERVOUS SYSTEM

The "autonomic nervous system" is a part of the peripheral nervous system that connects to glands and smooth muscles.

SYMPATHETIC NERVOUS SYSTEM

The "sympathetic nervous system" is a division of the autonomic nervous system that generally engages in "fight or flight" functions.

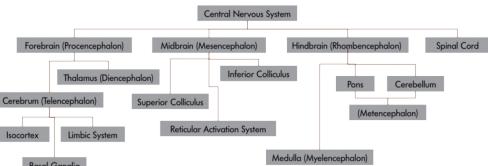
PARASYMPATHETIC NERVOUS SYSTEM

The "parasympathetic nervous system" is a division of the autonomic nervous system that generally engages in "rest and digest" functions.

SOMATIC NERVOUS SYSTEM

The "somatic nervous system" is a part of the peripheral nervous system that uses cranial and spinal nerves in volitional actions.

THE CENTRAL NERVOUS SYSTEM



CEREBRUM / TELENCEPHON

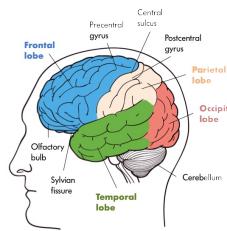
The "cerebrum", or "telencephalon", consists of the left and right hemispheres of the brain that sits on the top of the nervous system and engages in a variety of higher order functions.

SULCUS / SULCI

"Sulci" are crevices/fissures formed by convolutions in the brain.

GYRUS / GYRI

"Gyr" are bulges that are raised between or among fissures of the convoluted brain.



CENTRAL SULCUS

The "central sulcus" divides the hemisphere into the frontal and parietal-occipital lobes.

LATERAL SULCUS

The "lateral sulcus" divides the temporal lobe below the frontal and the parietal lobes.

TEMPORAL LOBE

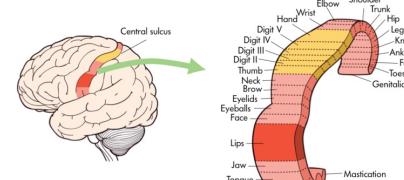
The "temporal lobe" is the area of the cerebellum that lies below the lateral sulcus.

Note the temporal lobe contains auditory and olfactory (smell) projection regions.

PRIMARY MOTOR CORTEX / PRECENTRAL GYRUS

The "primary motor cortex", or "precentral gyrus", is a strip of cortex just in front of the central sulcus that is involved in motor control.

Note that different areas of the primary motor cortex control different regions of the body.



MAGNIFICATION FACTOR

The "magnification factor" is the cortical space projected by an area of sensory input (e.g. mm of cortex per degree of visual field.)

Magnification factor helps to codify the fact that some body parts on the primary motor cortex occupy more space on the strip than other body parts. e.g. fingers, thumbs, lips.

PARIETAL LOBE

The "parietal lobe" is an area of the cerebrum just behind the central sulcus that is engaged with somatosensory (touch, pain etc) and gustatory (taste) sensation.

PRIMARY SOMATOSENSORY CORTEX

The "primary somatosensory cortex" is a strip of cerebral tissue just behind the central sulcus engaged in sensory reception of bodily sensations.

All spinal and some cranial nerves send sensory signals from skin and muscles to the primary somatosensory cortex.

SECONDARY SOMATOSENSORY CORTEX

The "secondary somatosensory cortex" is the part close to the lower end of the strip of cerebral tissue that is responsible for taste experiences from the tongue, pharynx, epiglottis, etc.

WERNICKE'S AREA

The "Wernicke's area" is a language area in the temporal lobe where linguistic information is comprehended.

BROCA'S AREA

"Broca's area" is a region in the frontal lobe where speech information is processed.

ARCUATE FASCICULUS

The "arcuate fasciculus" is a fiber tract that connects the Wernicke's and Broca's speech areas.

AGNOSIAS

An "agnosia" is an inability to recognise objects, words or faces.

Agnosias are caused by damage to the Wernicke's area.

PRIMARY AUDITORY CORTEX

The "primary auditory cortex" is a region in the temporal lobe which is involved in processing auditory information.

PREPYRIFORM CORTEX

The "prepyriform cortex" is a region near the temporal lobe responsible for the processing of olfactory (smell) information.

OCCIPITAL LOBE

The "occipital lobe" is the back part of the cerebrum, which houses the visual areas.

THALAMUS

The "thalamus" is the part of the diencephalon (forebrain) that acts as a gateway for incoming and outgoing information.

LATERAL GENICULATE NUCLEUS (LGN)

The "lateral geniculate nucleus", or "LGN", is a nucleus in the thalamus that is innervated (supplied with nerves) by the optic nerves and sends signals to the visual cortex in the occipital lobe.

TRANSDUCTION

"Transduction" is a process in which physical energy is converted into neural energy.

VISUAL SENSE & PATHWAYS

When images form on the retina, they are transduced into neural language and handed down to the visual cortex for further processing.

Then, in the visual cortex, all the individual attributes/features of the image are decomposed and processed by different visual cortical modules.

e.g. color, texture, orientation

These attributes are then recombined to give rise to the singular perception of the image in question.

LIMBIC SYSTEM

The "limbic system" is a loosely defined network of nuclei in the brain involved in learning and emotion.

HIPPOCAMPUS / HIPPOCAMPI

The "hippocampus" is a nucleus inside the temporal lobe involved in learning and memory.

FORNIX / FORNICES

"Fornices" are nerve fiber tracts that connect the hippocampus to mammillary bodies.

CINGULATE GYRUS

The "cingulate gyrus" is a medial cortical portion of the nervous tissue that is a part of the limbic system, that is involved in attention and emotions.

GLOBUS PALLIDUS

The "globus pallidus" is a nucleus in the limbic system that is involved in motor movements and their coordination.

HYPOTHALAMUS

The "hypothalamus" is a part of the diencephalon (forebrain) that regulates endocrine hormones with the pituitary gland.

SUPERIOR & INFERIOR COLICULI

The "superior and inferior colliculi" are regions in the midbrain which process visual and auditory information.

SUBSTANIA NIGRA

The "substantia nigra" is the region of the midbrain responsible for Parkinson's disease.

PONS

The "pons" is a bridge that connects the cerebral cortex with the medulla, and reciprocally transfers information back and forth between the brain and spinal cord.

The pons also processes sensory and motor information using the cranial nerves.

MEDULLA OBLONGATA

The "medulla oblongata" is an area just above the spinal cord that processes breathing, digestion, heart and blood vessel function, swallowing and sneezing.

CEREBELLUM

The "cerebellum" is a nervous system structure behind and below the cerebrum, that controls motor movement coordination, balance, equilibrium and muscle tone.

GRAY MATTER

"Gray matter" composes the back/cortex of the cerebrum and consists of the cell bodies of the neurons.

WHITE MATTER

"White matter" represents the regions of the nervous system that comprises of the axons of the nerve cells.

STUDYING THE NERVOUS SYSTEM

IMMUNOCYTOCHEMISTRY

"Immunocytochemistry" is a method of staining tissue, including the brain, using antibodies to isolate specific neurons for observation.

LESION STUDIES

"Lesion studies" are surgical methods in which a part of an animal's brain is removed to study its effects on behaviour or function.

EVENT-RELATED POTENTIALS

"Event-related potentials" are a physiological measure of large electrical change in the brain produced by sensory stimulation or motor responses.

COMPUTERISED AXIAL TOMOGRAPHY (CAT)

"Computerised axial tomography", or "CAT", is a scanning technique that uses X-rays to capture many pictures of the brain and combines them into a 3D model of it.

MAGNETIC RESONANCE IMAGING (MRI)

"Magnetic resonance imaging", or "MRI", uses large magnets toobble/precess hydrogen nuclei to capture images of the brain.

POSITRON EMISSION TOMOGRAPHY (PET)

"Positron emission tomography", or "PET", is an invasive procedure that captures brain images with positron emissions from the brain after the individual has been injected with radio-labelled isotopes.

Module 4: Visual Perception

SENSATION & PERCEPTION (4A)

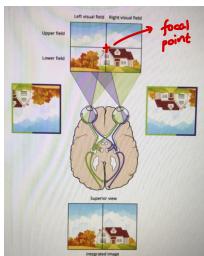
SENSATION

💡 "Sensation" is the process of detecting physical energy in our environment.
eg eyes collect information about light waves.

TRANSDUCTION

💡 "Transduction" is the process of converting sensory information into action potentials.
This is done so that the brain can process sensory information.

EXAMPLE: FROM THE VISUAL FIELD TO THE OCCIPITAL LOBE



- 💡 Process:
- ① Light from the left visual field is collected by the right side of the retina in both eyes.
 - ② Similarly, light from the right visual field is collected by the left side of the retina in both eyes.
 - ③ The left visual field then crosses over to the right side of the brain, and the right visual field crosses over to the left side of the brain.
 - ④ Lastly, visual centres in the occipital lobe work together to integrate information from the two fields, and flip the image right side up.

PERCEPTION

💡 "Perception" is the process of giving sensory input meaning, via our brains creating an internal mental representation of the outside world.

💡 Note that our perceptions are usually just illusions.
eg a rose is not "red", but rather "red" is a perception created by our brain whenever our senses encounter 700nm wavelengths in the visual field.

💡 We also have strong evidence that our perceptions are similar amongst humans, since

- ① our tastes in music/fashion etc. are "consistent"; and
- ② our sensory and perceptual systems are the products of evolution.

SYNTHEΣIA

💡 "Synesthesia" is a neurological condition in which stimulation of one sensory modality can cross over and lead to a perception in another modality.
eg "grapheme-colour synesthesia": when different letters/numbers become associated with different colours.

PROPERTIES OF WAVES (4A)

LIGHT

ADDITIVE MIXING

💡 "Additive mixing" occurs when lights are mixed together, leading to more complex stimuli.
* "RGB" diagram.

SUBTRACTIVE MIXING

💡 "Subtractive mixing" occurs when colours are mixed together, leading to less complex stimuli.
* "RBY" diagram

WAVELENGTH → HUE

💡 The "wavelength" of the light wave determines the "hue" of the wave, or the "color" of the wave.
eg red, blue, green etc

AMPLITUDE → BRIGHTNESS

💡 The "amplitude" of the light wave determines the "brightness" of the wave, with greater amplitudes corresponding to brighter colours.

COMPLEXITY → SATURATION

💡 The "complexity" of the light wave determines the "saturation" of the wave, with a higher wave complexity corresponding to a lower saturation.

SOUND

FREQUENCY → PITCH

💡 The "frequency" of a sound wave determines its pitch (in Hz).
* humans are most sensitive to frequencies in 1000-4000 Hz.
* but we can hear frequencies in 20-20000 Hz.

AMPLITUDE → LOUDNESS

💡 The "amplitude" of a sound wave determines its "loudness" (in dB).
* 2B is on a "logarithmic scale"

"COMPLEXITY" → TIMBRE

💡 The "complexity" of a sound wave determine its "timbre", or the number of frequencies it has.

COLOUR PERCEPTION (4B)

TRICHRAMATIC (3 COLOUR) / YOUNG-HELMHOLTZ THEORY

"Trichromatic (3 colour) theory" describes what happens in the retina, where the photoreceptor cells are located.

RODS

"Rods" are photoreceptor cells located in the periphery of the retina that are highly sensitive to light, making them great for seeing in low illumination environments, but are insensitive to colour.

* there are ~120M rods in the retina.

CONES

"Cones" are photoreceptor cells located in the "fovea" area (center) of the retina, which have high acuity and are sensitive to different wavelengths of light, but have relatively low sensitivity to light itself.

* there are relatively 7-8M cones in the retina.

Cones can be subdivided further into red, blue and green ones, which each respond most sensitively to their respective "color" of light.

* the strengths of the firings of the cones determines the color being looked at.

* Also, note for any color, at least 2 cones are firing.

DICHROMATIC COLOUR DEFICIENCY

"Dichromatic colour deficiency" occurs if an individual only possesses 2 of the 3 types of cones, making them "colourblind" (ie unable to distinguish between certain hues of colour.)

* we can check for colour blindness using the "Ishihara" test.

OPPONENT PROCESSING THEORY

"Opponent processing theory" describes how colour is perceived in the brain, by describing "antagonistic" cell pairs; where the stimulus of one cell inhibits the stimulation of its paired cell.

eg red/green

OBJECT PERCEPTION (4C)

BOTTOM-DOWN PROCESSING

"Bottom-down" processing consists of putting smaller "pieces" together to make larger ones.

Process:

- ① First, you detect the specific features of the stimulus;
eg object is small, white, walks on 4 legs
- ② Then, you combine these features into more complex forms; and
eg infer animal based on characteristics
- ③ Lastly, you recognise the stimulus.
eg recognise object is a dog.

TOP-DOWN PROCESSING

In "top-down" processing, we instead use strategies shaped by evolution/our experiences to infer characteristics about stimuli.

Process:

- ① First, we formulate the perceptual "hypothesis" about the nature of the stimulus as a whole.
eg at a dog park, you expect to see dogs.
- ② Then, we select and examine features to check our hypothesis.
eg any four-legged animals would be "identified" as dogs.
- ③ Finally, we recognise the stimulus.

FEATURE DETECTORS

"Feature detectors" are cells found in the visual cortex that respond maximally to certain types of stimuli.

eg a cell that fires rapidly when it detects a vertical line in the visual field.

GESTALT PRINCIPLES OF TOP-DOWN PROCESSING

"Gestalt principles" are perceptual strategies we use to organise and perceive the world.

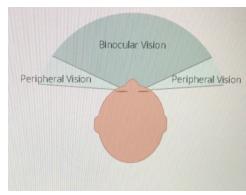
Principles:

- ① Principle of figure or ground
- scenes are divided into either figure or background.
- ② Principle of proximity
- objects positioned closely tend to be grouped together in perception.
- ③ Principle of similarity
- objects resembling each other tend to be grouped in perception.
- ④ Principle of continuity
- objects are perceived as continuous.
- ⑤ Principle of closure
- objects are perceived as completed by filling in "gaps" in the objects.

DEPTH PERCEPTION (4D)

STEREOSCOPIC VISION

- "Stereoscopic vision" describes the ability of the visual brain to register a sense of 3D shape and form from visual inputs.
 - * eg in humans, with two eyes positioned side by side.



RETINAL DISPARITY

- "Retinal disparity" describes the phenomenon where there are discrepancies between the images received by the left and right retinas in minor regions of our vision (our "peripheral" vision).

INTERPOSITION

- "Interposition" is the tendency to perceive blocked objects as more distant than occluding objects.

LINEAR PERSPECTIVE

- "Linear perspective" describes the tendency to perceive depth when two lines are observed to converge.

RELATIVE SIZE

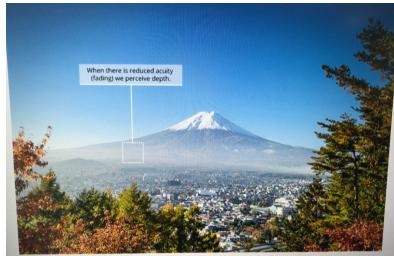
- "Relative size" describes the tendency to perceive smaller objects as further away than larger objects of the same type.

TEXTURE GRADIENT

- "Texture gradient" describes the tendency for the "units" that make up a texture to become more distorted and denser as they recede into the distance.

VISUAL ACUITY

- "Visual acuity" describes the tendency for tiny particles in the atmosphere to create a "fading" effect to occur over large distances.



MOTION PARALLAX

- "Motion parallax" occurs when we perceive distant objects moving more slowly across the horizon than nearby objects when we are in a moving vehicle (eg car).

