Introduction to Cognitive Science 1-Page Document

Highlight the following:

experiments

key terms

other relevant stuff

perspectivation

# **1 - The Science of Cognition**

## Introduction

**Cognitive psychology** is the science of how the mind is organized to produce intelligent thought and how the mind is realized in the brain. Cognitive psychologists strive to understand the mechanisms that make such intellectual sophistication possible. Like wanting to know about the magical tech that gives you netflix to chill with. Moreover they want to create AI with general intelligence as sophisticated as human

* The basic mechanisms governing human thought are important in understanding the types of behavior studied by other social sciences. For example, an appreciation of how humans think is important to understanding why certain thought malfunctions occur (clinical psychology), how people behave with other individuals or in groups (social psychology), how persuasion works (political science), how economic decisions are made (economics) why certain ways of organizing groups are more effective and stable than others (sociology), and why natural languages have certain features (linguistics)
  + Cognitive psychology is thus the foundation on which all other social sciences stand, in the same way that physics is the foundation for the other physical sciences.

## I - **Where and when did cognitive psychology originate?**

1. Nativism vs. Empiricism
   1. Armchair psychology - “**Introspection**”
      1. **Behaviorism**
         1. **Gestalt psychology** (perception, Gestalt principles)
2. The cognitive revolution (1967, 1970, 1973, 1979)
   1. Chomsky VS. Skinner

## II - **How is the mind realized in the body?**

1. Dominant approach: **information-processing approach**
   1. **Sternberg paradigm (1966)**
   2. Chapter 10 - differences between humans and computers thinking
   3. Cognitive science (PC and AI) vs. Cognitive Psychology (exp. techniques)

## III - **Information processing in the brain?**

1. **Neurons** (transmits signals via electrochemical activity - Action potential)
   1. Communicate with Neurotransmitters in **synapses** between terminal buttons and dendrites. Body = soma, Extending from soma = axon (insulated **myelin**)
   2. More meaning = more active areas (Mazoyer et al., 1993)
      1. cognition is achieved through large patterns of neural activity

2. **Spinal cord, Neocortex, occipital lobe, parietal lobe**, **temporal lobe (Wernicke’s area** (Semantic)),  **frontal lobe(Broca** - Syntax), **prefrontal cortex, , hippocampus, Basal Ganglia ------ (topographic organization (Somatosensory cortex)**

* 1. (Tootell, Silverman, Switkes, & DeValois, 1982) - Monkey and bullseye

## III - **What are the methods for studying the brain?**

1. Electroencephalography (**EEG**) → patterns of electric potential on the scalp
   1. Event-related potentials (**ERP**) → measurement of change in electrical activity → averaged EEG responses aligned to a particular stimulus, good temporal resolution, difficult to locate
2. Magnetoencephalography (**MEG**) → measure magnetic fields produced by electrical activity in the brain
3. Positron emission tomography (**PET**) → radioactive tracer injected → good information about location of neural activity
4. Functional magnetic resonance imaging (**fMRI**) → metabolic rate or blood flow in the brain (the more blood flow → more activation in that part of the brain)
5. Transcranial magnetic stimulation (**TMS**) → coil placed on head → pulses delivered to region

## Conclusion

As a general overview, this chapter serves as a foundation to the rest of the chapters that in turn will focus on different aspects of cognition, such as memory, attention and what we today believe about visual perception.

# **2 - Perception**

## Introduction

As described in ch 3 on attention, the brain has lots of sensory modalities with their own set of serial bottlenecks. But interestingly enough 50% of brain power is diverged to the Visual Modality. What kind of system needs this much energy to function? Let’s have a look: We will be looking firstly at the **Early phase – shapes + objects extracted from visual field** and thereafter **Late phase – shapes + objects are recognized**

## I - Visual perception - Bottom up processing

1. **Early phase** 
   1. Light → lens → iris → vitreous humor → retina + **fovea**
   2. Photoreceptor cells (Roughly 120 mio pr. eye) --> bipolar --> ganglion cells
      1. On-center & Off-center
   3. Optic nerve → optic chiasm → visual cortex - Ventral/i and Dorsal/ii pathway
      1. “What” – Temporal lobe – semantic pathway - recognition of objects
      2. “Where” – Parietal lobe – spatial processing+coordinating vision/action
2. **Late phase**
   1. The visual cortex – **topologically mapped**
      1. Hubel and Wiesel (1962) - Cat (Bar and Edge detectors)
      2. Hypercolumns (Hubel and Wiesel) → 2mm by 2mm
      3. Livingstone and Hubel (1988) → Feature maps → 32→ Binding prob.
3. Models on Depth and Patterns
   1. **Texture gradient**, **Stereopsis**, **Motion parallax**
   2. David Marr (1982) → 21/2 D sketch → 3D
   3. **Gestalt principles**: Proximity,Similarity,Good continuation,Closure/good form
      1. Palmer (1977) Exp. Participants could recognize part more rapidly, when following gestalt principles
4. Patterns
   1. Template matching model (wrong theory!)
   2. Feature analysis (wrong)
   3. Object Recognition (wrong)
   4. Recognition by components Biederman(1987)(old/wrong/simplified!)- 36geons
5. **Only bottom up models → Remember that Fusiform gyrus also exists**

## II - Speech recognition - Bottom up processing

1. Feature analysis for speech as well -Phonemes
   1. **coarticulation** (Liberman, 1970)
2. **Categorical perception**:
   1. Studdert-Kennedy (1976) → People are very poor at discriminating between a pair of /b/’s or a pair of /p/’s -artificially manipulated until it was a B and not P
   2. - e.g. Emotions in faces + Russian blue experiment (siniy + goluboy)

## III - Context – top-down processing

1. Selfridge (1955) - Same stimulus in different contexts (“the cat”)
2. Word superiority effect - Word context can be used to supplement feature information
3. Massaro (1973) – **Fuzzy logical model of perception (FLMP**): a mathematical model of how stimulus and context combines to create our perception
4. Phoneme restoration effect - Eel experiment, Warren (1970)
5. **Change blindness** - Door experiment, McConkie & Currie, 1996

## Conclusion

- e.g. agnosia (inability to process sensory information) → Proof of different steps:

- apperceptive (problems in early processing) associative (problems in pattern recognition)

# **3 - Attention and performance**

## **Introduction**

We get simultaneous input from our perceptual systems, such as visual and auditory systems, from all over the place, but since our cognitive resources are limited, we cannot attend to everything in parallel.

Thus, attention is defined as selectively concentrating on one aspect of the environment while ignoring other things. Later on, I'll continue into performance. Performing tasks require monitoring and attention as well, unless they become automatized so that central cognitive control is no longer needed.

## I - Information processing

1. Brain parts involved
   1. A lot of processing is done before we are conscious of the things we are perceiving (see ch 2)
   2. Modes of attention => g**oal-directed** (top-down) and **stimulus driven** (bottom-up)
      1. The cocktail party effect
2. **Serial bottlenecks**
   1. A point in which it is no longer possible to do everything in parallel
   2. **Early-selection** (**filter** + **attenuation**) / **late-selection theories**
      1. dichotic listening task (in favor of early selection)

## II - Visual attention

1. Neural basis of visual attention
   1. Enhancement of cortical signals corresponding to attended location
   2. Contents: Fusiform face area / Parahippocampal place area
2. Importance of visual features (see ch 2)
   1. Visual search (look for distinctive features) (K/O)
   2. Binding problem => feature-integration theory: attention is needed for binding
      1. Illusory conjunctions Treisman 1995
3. Allocating attention
   1. Parietal cortex:
      1. Left -> local features of objects
      2. Right -> spatial attention, global patterns
   2. **Visual neglect** (Robertson and Lamb, 1991)
   3. **Inhibition of return** (flicker experiment by Tipper, Driver and Weaver 1991)

## III - Central attention and performance

1. **Perfect time sharing** >< **central bottleneck** (driving example, ch 9)
2. Prefrontal sides of executive control
   1. **ACC**: conflicts, correlation: performance on stroop ~ age/practice
   2. **DLPFC**: intentions, behavior
3. Automaticity (ch 9)
   1. The stroop effect (cognitive dissonance)

## **Conclusion**

Earlier on, it was thought that we couldn't attend to something if we weren't conscious of it. But as Anderson indicates us in this chapter, a lot of information is processed at an unconscious level, and attention can be divided into several parts: attention allocated in perceptual processing, attention in executive control and attention in response generation. There are several processing systems in the brain for processing this information, and bottlenecks can occur in all of them. So, attention can be described as a combination of processing systems competing about the limited information-processing resources.

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# **4 - Mental Imagery**

## I - **Mental imagery**

*The processing of perceptual-like information in the absence of an external source.*

* Debate: An **epiphenomenon**?
* Verbal imagery >< Visual imagery - (jingle/spatial - Roland and Friberg (1985))
  + Same distinguishable brain areas active as when we *actually* perceive something
  + Verbal: the what-pathway, prefrontal cortex (Broca’s + Wernicke’s areas)
  + Visual: the where-pathway, parietal cortex, occipital cortex, temporal cortex
    - * Either seeing or imagining faces and houses.
        + Fusiform face area (FFA) for faces/expert details (ch 9)
        + Parahippocampal place area (PPA) for houses
        + → SAME areas active for imagery, just weaker signal!

BUT still just an epiphenomenon? NO!:

Kosslyn et al. (1999), TMS to primary visual area 17 → longer RT answering questions using mental imagery

* **Mental rotation**
  + Bigger angle of disparity → longer RT. Linear relation, both in 2D and 3D! (Shepard & Metzler, 1971) → imagery as an analogue simulation of real life
* Spatial encoding (shapes) >< Linear encoding (words) (see Santa, 1977)
* Interference effects (Brooks, 1968)
  + suggest overlapping in cognitive function in imagery and perception

## II - Representations of space

* **Egocentric** >< **Allocentric**
  + Language-dependent - language shapes our cognitive system
    - Dutch >< Tenejapans: see drawing, turn around, draw it - does the drawing turn with you or not?
* **Cognitive maps**

Mental representations of locations in space

* + **Route maps** (action-based) >< **Survey maps** (spatial information)
    - Taxi drivers: larger hippocampi (learned survey maps) compared to bus drivers (simple route maps)
      * hippocampus also important in memory! (ch 6+7
      * Expertise (ch 9)

## Conclusion

Perception and imagery are two overlapping, but not identical processes. Same distinctions and same active brain areas. Sometimes loss of one means loss of the other - sometimes not. Probably not an epiphenomenon.

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# **5 - Representation of Knowledge**

## Introduction

What is knowledge? Knowledge is representations equal to memories. It filters away the insignificant details and context → semantic memory. The prefrontal regions, posterior regions and the “what”-pathway (the semantic pathway) is involved in the abstraction of knowledge.

## I - Verbal information

* Left prefrontal region
* People are able to remember meaning of sentences, but not style (if that is not their goal, however possible if attended) → experiment by Warner: cued or not cued
* **Propositional analysis** → what to remember in a complex sentence
  + relation (verbs, adjectives) + argument (subject)

## II - Visual information

* Right prefrontal region
* Better than verbal → shown either pictures or sentences → visual memory best (Shephard)
* Memory is best with meaning → seeing a drawing with or without meaning → best with meaning (Bower) + washing machine (Bransford) → simple **mnemonic technique**

## III - Symbol systems

* **Amodal symbol system/amodal hypothesis** → not associated with a particular modality
* **Perceptual symbol system/Multimodal hypothesis** (extension of the “**dual-code theory**”) → specific to particular modality (visual, auditory, etc.)
  + Evidence for perceptual: Stanfield experiments with “eagle in the sky” + nail to wall or floor, view a picture of a nail either horizontally or vertically → if the nail was oriented the same way as they read → faster RT

## IV - **Embodied Cognition**

* fMRI study → listening to verbs as “kick” → activation in relative motor cortex
* Multimodal >< Amodal
  + knowledge in multiple modalities >< meaning not in particular modality

## V - Conceptual knowledge: Categories

* Posterior regions, the temporal cortex
* Positive effects = generalize, predict, negative = stereotyping → girls + math skills
* Semantic networks, **schemas**, **scripts** 
  + experiment with office room (Brewer, 1981) → effects of schemas in memory
* Degree of category → cup or bowl? → allow variation in the category (ch 2)
* **Abstraction theories** >< **Exemplar theories**
  + abstract general properties >< only the specific instances

## Conclusion

Knowledge is abstraction → examples with face recognition, word (regardless of font), dogs

* Girl with perfect memory couldn’t abstract

# **6 - Human Memory: Encoding and Storage**

## **Introduction**

Hippocampus is one of the most important regions in the brain when it comes to human memory – it stores all new and permanent memories. The prefrontal regions of the brain are involved in the encoding of new memories and can retrieve old memories.

## **I – Visual sensory memory (iconic)**

* **Whole report procedure** >< **partial-report procedure** (Sperling 1960: visual arrays of letters)
* Information held in the **visual sensory memory**
  + - If attended → able to report it, if not information is lost

## **II – Auditory sensory memory (echoic)**

* Able to report auditory stimulus with accuracy if probed soon after onset
* Memory last up to 10 seconds (experiment: Sams, Hari, Rif and Knuutila)

## **III – Short- & long-term memory**

* Attended at sensory store → short-term memory → rehearsed → long-term memory
* Shallow (fragile memory) >< **deep attentive processing** (durable memory)
* Retrieval from long-term memory (**ACT theory**)
* **Activation** → depends on base-level activation + activation from associations (Anderson, p 133-134) + **associative spreading**
* **Spreading activation** = presented items through related network memories
  + (fan effect - chapter 7)
* Practice = memory strength → **Power law of learning**  (Pirolli and Anderson)

## **IV – Working memory**

* Frontal cortex → important for working memory tasks
  + Monkeys & food exp. → cue, delay, response → monkeys with lesions → can’t perform task (Goldman-Rakic, 1987)
* **Central executive** → “mothership” → retrieves information + controls attention
* **Phonological loop** → Verbal information
* Articulatory loop (“inner voice” – rehearse + speech – Broca’s area)
* Phonological store (“inner ear” – store information – parietal-temporal region)
* **Visuospatial sketchpad** → rehearsing visual information
* e.g. multiplication problem - can be solved phonologically or visually

## **V – What influences memory?**

* (meaningful) **elaborate processing** → better memory (lawyer) Bower (1973)
  + The PQ4R-method → preview, questions, read, reflect, recite, review + **method of Loci**
* Incidental & intentional learning → intention not important → process is! Hyde and Jenkins (1973)
* **Flashbulb memories** → burned into memory → can be influenced by media + memories change every time we retrieve them → Amygdala might burn stuff into you better (p. 147)
* Creates complications with Childmolestation cases in psychology → Chapter 7

**Conclusion**

A lot goes on in our mind when we try to either remember something or retrieve memories.

# **7 - Human Memory: Retention and Retrieval**

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## Introduction

## Our mind and brain contain several representations of the real world of different times and events, that can be called memories. But how do we recall things? Some researchers claim that no memories are really forgotten, others argue that interfering memories really suppress former memories. In addition, it seems that context also plays a role in retrieval of memories.

## I - Theories of forgetting

# Memories aren't really forgotten (Nelson, 1971: 43-dog) - recognition easier than recalling

# **Decay theory** of forgetting

# **Power law of forgetting** (cf. Power law of learning, ch 6)

# **Interference theory** of forgetting (Lewis & Anderson 1976: Napoleon sentences)

# Inhibitory explanation (probably not true): retrieval-induced suppression (red-blood-strawberry)

## II - Factors affecting recall

# The **fan effect** spreads activation → harder to retrieve

# The protecting effect of meaningful redundancy → easier to retrieve (Mozart, Paris)

# Inferences / plausible retrieval (pregnant Nancy story - Black, 1979)

# Elaboration (based on *meaning*)

# False memories (**Deese-Roediger-McDermott paradigm,** word lists **-** Deese, 1959)

* + 1. False memory syndrome -> childhood sexual abuse (Schacter, 2001)

# The effects of context (e.g. prompts)

# Level of association => **encoding specificity principle** (divers, Godden 1975)

# **Mood congruence** + **state-dependent learning** (e.g. intoxicated)

## III - Implicit (non-declarative) VS. explicit (declarative) memory

# Different brain parts activated

# Hippocampus (temporal lobe): permanent storage of new memories

# Prefrontal regions: creation of new memories, procedural memory

# Basal ganglia: procedural memory

# **Amnesia** (damage to hippocampal regions) - sometimes caused by **Korsakoff syndrome**

* 1. **Retrograde**: loss of former memories (HM)
  2. **Anterograde**: inability to create new memories (patient HM, Clive Wearing)

1. **Dissociations** = different tests of memory show different results
   * 1. Argues for different memory systems (episodic, semantic, procedural)
     2. Amnesic patients still show priming effects, + procedural knowledge, Clive and piano

## Conclusion

Memory can be divided into declarative memory that we can explicitly recall and non-declarative memory to which we don't have conscious access. First, events are stored as episodic memories but then abstracted to context-free semantic facts that may slightly become more and more implicit knowledge.

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# **8 - Problem Solving**

## Introduction

This chapter focuses on human problem solving. In problem solving it is most to reach your goal-state. To due this the prefrontal cortex is important due to the fact that it is important in maintaining goal structures. This cortex is large in humans compared to other species which, could indicate that problem solving is somehow unique for humans.

## I - Human problem solving

1. **Well- and ill defined problems** 
   1. Maze >< “Remember to be happy”
2. The **problem space** → **initial state, intermediate state, goal state** (the eight puzzle)

## Il - Operators

1. Acquiring **operators** → **search** (**trees**) → discovery (cat in box), direct specification (pyramid problem), examples (pyramid problem)
   1. **analogy** → used in Raven's Matrices
2. Selecting operators → **backup avoidance**, **difference reduction/hill climbing** (hobbits and orcs), **means-ends analysis** (General Problem Solver by Newell & Simon),
   1. The Tower of Hanoi: often difference reduction → means-ends analysis
3. Representation of problem → important it is correct (checkerboard problem)
   1. **Functional fixedness** → “the candle problem” and “the two-string problem”

## Ill - **Set effects**

1. Definition: Unable to see simpler solution due to previous solutions that has worked (**Einstellung effect**) → Luchins: experiment with jugs, learned hard solution
2. **Incubation effect** → go away from problem → “forget” inappropriate ways of solving problems (cheap-necklace problem)
3. **Insight problem** → sudden “aha”-experience -> Heightened activity in prefrontal cortex

## Conclusion

In conclusion, it is shown that humans might have some unique ways to solve problems such as the use of analogy. However, human problem solving is not perfect and can be affected by set effects.

# **9 - Expertise**

## Introduction

Humans are a unique species: behavioral plasticity → becoming experts. Expertise is basically the use of memory in problem solving.

## I - Skill acquisition

* Quantitative brain changes: more expertise = more efficiency = less activation
* Qualitative: 3 stages of skill acquisition (a gradual process!):
  + **cognitive stage** (declarative encoding of the skill)
  + **associative stage** (errors eliminated, connections strengthened)
  + **autonomous stage** (automated and rapid)
    - **proceduralization:** declarative → procedural memory (ch 6+7)
* **The power law of learning**
  + Skill improves as a power function of practice (practice becomes less efficient over time)

## II - Novices vs. experts

* **Tactical learning** (“the foot soldier”)>< **Strategic learning** (“the army general”)
* Differences in problem perception: recognizing the surface >< underlying structure
  + Experiment by Lesgold → lung problem = tumor >< collapsed lung
* Pattern learning and memory - **chunking**
  + Recalling chess board positions: experts superior only for actual positions
    - (also greater activation in the FFA (ch 4) + (ch 6+7 for chunking + better recall for meaningful problems!))
  + → experts remember more + larger patterns. Improved storage + retrieval.
* Innate talent? (ch 14)

## III - Practice and transfer

* **Doctrine of formal discipline** (early 1900)
  + The faculty view. Esoteric subjects discipline the mind. Transfer = broad.
* **Theory of identical elements** (Thorndike, 1906)
  + Transfer = only mediated by identical elements. Overly narrow definition.

Bottom line:

* **Deliberate practice** is crucial!
* Positive transfer = narrow (only if same knowledge, BUT Brazilian street vendors, no transfer)
  + correct problem representation (ch 8) + encoding context...
* Negative transfer = very rare (only the Einstellung effect, functional fixedness, ch 8)

## Conclusion

*“No pain, no gain” -* Practice is important for expertise.

Also important uniquely human attributes to become an expert: higher order problem-solving skills (ch 8), reasoning (ch 10), decision making (ch 11), and communication by language.

# **10 - Reasoning**

Introduction

According to Anderson, there is a paradox in human reasoning: human reasoning is judged deficient when using standards of logic and mathematics, but AI systems built on these standards is also seen deficient compared to human reasoning and lack common sense. A lot of research is thus done to analyze the complexities included in human reasoning.

I -Different reasoning types

1. **Deductive reasoning** (certainty)
   1. **Conditional statements**: if **antecedent**, then **consequent**
      1. **Modus ponens** (T→ T), **modus tollens** (F ← F)
         1. Fallacies: **affirmation of the consequent** (T ← T), **denial of the antecedent** (F → F)
   2. Quantifiers
      1. All, no => universal statements
      2. Categorical syllogism (2 premises + conclusion)
2. **Inductive reasoning** (probabilistic conclusion) (1, 2, 4 - next number? Could be many!)
3. **Abductive reasoning** (‘the grass is wet, it must have rained’)

## II - Factors affecting reasoning

1. Content, additional material => rich understanding of the real world (library example, Byrne 1989)
   1. **Wason selection task** >< **Permission schema** (social norm)
   2. Optimal behavior
      1. Assumption that properties are rare => low probabilities, thus people don't check the "uninformative logically correct answers" - (car lights example)
2. Interpretation (maths problem VS real-world situation)
   1. Applies on if statements and logical quantifiers
   2. True conclusion VS valid syllogism
3. **Atmosphere hypothesis** (not always true)
4. **Mental model theory** (Johnson-Laird: “some of the squares have bold borders”)
   1. Brain: Right hemisphere of the frontal cortex active in visual tasks (also takes part in processing of mental images)
      1. whereas opposite true for arithmetic calculations

## III - Hypotheses (inductive reasoning)

1. Formation: **attribute identification** (relevant features) + **rule learning** (how the features are connected)
2. (Bruner, 1956) Testing:
   1. Conservative focusing
   2. **Confirmation bias**: looking only for positive instances (or protect one's theory from disconfirmation in science)

IV - Dual-process theories

1. **Type 1**: rapid and automatic processes; rely on associations between situations and actions
2. **Type 2**: slow, deliberative

* Can’t be ‘proofed’/falsified… not very good theory - applies to everything!

Conclusion

When discussing human reasoning, it is important to take into account the fact that it usually takes place in a complex world. So, judging human reasoning only by logical standards might lead to inappropriate conclusions in the real world. What appears efficient in the laboratory might be deficient in the real world and vice versa.

# X - Emotion

## Introduction

Emotions have an evolutionary function of guiding our behaviour, and they are now taking the stage in cognitive science as a huge topic of interest. Emotions are a way of tagging stimuli with certain response. For example, fear can be linked to seeing a snake and trigger an action response of flighting away. It is debated to which extent emotions are especially human, and what is the cause and effect (bodily change VS subjective feeling).

## I - Different approaches to emotions

1. Emotions are multi-faceted: (4) **hedonic value**, 'feeling state', external outcomes (**expressions**), action responses => Conscious + unconscious
   1. Problem of measuring: subjective/physical/behaviour
2. Behavioristic account: Survival value, rewarding/punishing
3. Guiding (social) behaviour: **Mentalizing**, **mirroring** → communicative function
4. **Somatic marker hypothesis** → rationality coloured by emotion (cf. Decision-making chapter 11)

## II - Theories of emotion

1. Early theories
   1. Darwin: many expressions common with animals (innate)
   2. Freud: id, ego, super-ego
2. **James-Lange theory**: expression => emotion ("self-perception of bodily changes produces emotional experience")
   1. Controversial: adrenaline (Schachter) >< forced smile
3. **Cannon-Bard theory**: emotional perception => bodily reaction
   1. Hypothalamus = centerpiece of emotions (ANS regulation)
4. Contemporary view: different types of emotions have different neural substrates
   1. Ekman: 6 basic emotions
   2. Russell, Feldman-Barret: core affect (linked to limbic structures)
      1. Linked with: executive control, language, theory-of-mind…
   3. Rolls (behavioristic): dimensions of reward and punishment + context

## III - Emotional body

1. Subcortical **Papez circuit**: cingulate cortex, hippocampus, hypothalamus, anterior nucleus of the thalamus
   1. **Limbic system**: papez + amygdala, orbitofrontal cortex
   2. Old view: thought to be an “emotional brain”
2. **A**utonomic **N**ervous **S**ystem mediates changes in the body (e.g. skin conductance)
3. **Amygdala**: learning the emotional value of stimuli, especially fear
   1. **Kluver-Bucy syndrome**
   2. Learning + storing the *conditioned* fear response (mice, lights and shocks, Ward 2012)
   3. Pop-out effect (snakes), slow and fast route
4. **Insula**: disgust (also moral disgust); interoception: monitoring the internal state of the body
5. **Orbitofrontal cortex**: computing the *current* value of a stimulus; Reversal learning and extinction (Chocolate | Wine: subjective value)
6. Lateral prefrontal cortex, ventromedial prefrontal cortex
7. **Anterior cingulate (ACC)**: is an action rewarded or punished; output of bodily responses; pain
8. **Ventral striatum** @basal ganglia: connecting the orbitofrontal cortex, basal ganglia and thalamus
   1. Nucleus accumbens: **dopamine** (prediction of reward)

## Conclusion

All in all, emotions are an interplay of brain and body. Categorical distinctions: Innate or constructed from different combinations of building blocks of other kinds of core processes? Emotional brain as such does not exist, but certain parts do have a special role in emotional processing: Not a one-to-one mapping between brain structure and emotions. Cognition (thoughts, beliefs, apparaisal..) plays a role.

# **11 - Decision Making**

## Introduction

People's lives are full of decisions in incomplete and uncertain conditions, and in contrast to purely logical reasoning, decisions in real life have consequences. In addition, people's understanding of probabilities and past experiences do shape our decision making processes.

## I - Probabilistic judgement

1. **Bayes theorem** - a prescriptive model >< descriptive model (how people actually do)
   1. **Base-rate neglect** (cancer example) => people weigh the evidence too much
   2. **Conservatism** (blue and red chips, Ward Edwards 1968) = the tendency to underestimate (accumulating) evidence
2. Availability of examples
   1. Implicit knowledge: **probability matching** (training on diseases + symptoms, Glue and Bower 1988)
   2. Effect of recalling relevant information (k words): availability bias, priming
   3. **Gambler's fallacy**: "law of averages" (coin, heads and tails, Tversky 1974)
   4. **Recognition heuristic** (size of German cities, Goldstein, 1999)

## II - Decision-making under uncertainty

1. Expected values (probability x value) >< subjective utility (relative discounts on prices)
   1. Associated with **subjective probability** >< objective probability
   2. **Loss aversion** - we weigh losses heavier
2. **Framing effects** (Asian disease problem - saved >< killed) + (child custody - award >< deny)
3. Importance of justifying actions

## III - Brain parts

1. **Ventromedial prefrontal cortex**: motivational balance, emotional regulation, social sensitivity (reflective processing of reward)
   1. (Phineas Gage, **Iowa gambling task**)
   2. integrating the probability of reward with its magnitude
2. Parietal cortex: cold calculation (math)
3. Subjective utility related to dopamine neurons in basal ganglia (cf. Emotions) (reflexive processing of reward)
   1. FRN: "heart has to learn" (p 277-278)
   2. Magnitude of reward

## IV - Maximizers and satisficers (Schwartz)

1. **Maximizers** seek and accept only the best (grocery shopping: a great deal of time and effort on the search)
   1. >< **satisficer** (the best people can do?, “good enough”)
   2. being a maximizer is correlated with being unhappy BUT they do not show that being a maximizer causes unhappiness
2. Regret, "if only.." => maximizers always believe there could be something better they wanted to reach
3. Maximizing (search for the impossible) >< perfectionism (knows when goals are unrealistic)

## Conclusion

Humans are special in decision making because of the greatly developed prefrontal cortex: it allows people to reason in a reflective way and not simply follow more primitive systems that also monitor behavior.

# **x 14 - Individual Differences in Cognition**

## Introduction

What is intelligence? bla bla nature vs. nurture. A mix! <https://www.youtube.com/watch?v=cMefRjbEuZY>

## I - Early development

* Delay of human development
  + large birth canal, pliable skull, brain volume doubles in 1 year. Neurons decline.
* Piaget’s 4 stages of development (BUT a gradual process!)
  + **Sensory-motor stage, preoperational stage, concrete-operational stage, formal-operational stage**
    - Learning the principle of **conservation**, can be tested:
      * Object permanence with doll behind screen + rows of coins + liquids in jars
    - Neo-Piagetian theory: is the key simply a growing working memory capacity? (harder juice problems require more memory, p 347, Case)

In the brain

* → age 2: mostly “thinking better” (10x more synaptic connections), plasticity, **myelination** (faster signals)
* After age 2: mostly “knowing better” (semantic memory, facts)
* Age-related decline: relatively minor - disorders are the problem (e.g. Alzheimer’s)

## The Empiricist-Nativist debate

* Nature?
  + Biology contributes: age-related decline in working memory, steeper drop-off for remembering more premises (Salthouse, page 352)
  + **Behavioral genetics** and the concept of **heritability** (twin studies + adoption studies)(BUT *small differences grow on you!*)
* Nurture?
  + Mental rotation: children and adults on the same learning curve (Kail, 1988)
  + Are children just universal novices? (expertise) + (memory for meaning)

soccer experts remember the most of a soccer story, age irrelevant (p 349)

Information processing gets faster with age - but because of practice or biology?

## III - **Psychometric tests** and Intelligence

* **IQ**: general intelligent performance. Normally distributed.
  + e.g. Raven’s progressive matrices (non-verbal, abstract reasoning)
* **The Flynn effect** + the effect in reverse? (Børge Priens prøve, declining scores)
* **Factor analysis:** correlations between tests. Multidimensional space.
  + → probably around 3 factors. Verbal, reasoning, spatial.
  + (old theory: Spearman’s *g*, a single dimension of intelligence) - not true!
* **Crystallized** (acquired) **>< fluid intelligence** (reasoning/novel domains)**.**

## Conclusion

No single dimension of intelligence. A mix of nature and nurture. Different brain regions specialized for different functions. Practice → faster rate of processing → more effective, less metabolic expenditure.