Center of Functionally Integrative Neuroscience
Aarhus University/ Aarhus University Hospital - DENMARK

Introduction to Cognitive Science
12. Summary

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Exam questions

1. Please give a summary of chapter 1 (Introduction to Cognitive Psychology) in Goldstein & van Hoof, including illustrative experimental examples.

2. Please give a summary of chapter 2 (Cognitive Neuroscience) in Goldstein & van Hoof, including illustrative experimental examples.

3. Please give a summary of chapter 3 (Perception) in Goldstein & van Hoof, including illustrative experimental examples.

4. Please give a summary of chapter 4 (Attention) in Goldstein & van Hoof, including illustrative experimental examples.

5. Please give a summary of chapter 5 & 6 (Memory systems) in Goldstein & van Hoof, including illustrative experimental examples.

6. Please give a summary of chapter 9 (Knowledge) in Goldstein & van Hoof, including illustrative experimental examples.

7. Please give a summary of chapter 12 (Problem Solving) in Goldstein & van Hoof, including illustrative experimental examples.

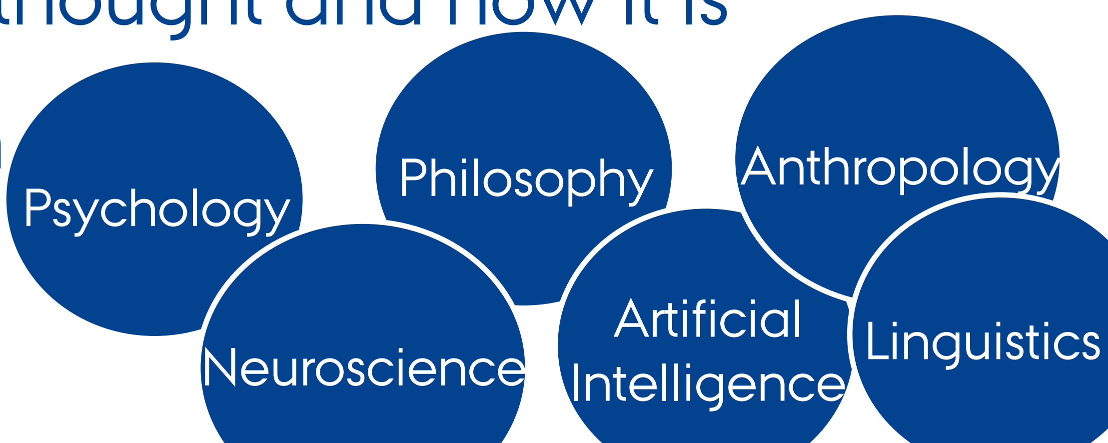
8. Please give a summary of chapter 13 (Judgment, Reasoning and Decisions) in Goldstein & van Hoof, including illustrative experimental examples.

9. Please give a summary of chapter 16 (The Social and Emotional Brain) in Ward, including illustrative experimental examples.

The Science of Cognition

WHAT IS COGNITIVE SCIENCE?

- The science of how the mind is organized to produce intelligent thought and how it is realized in the brain



Interdisciplinary

The Science of Cognition

Philosophy — Identifies the questions to ask

Anthropology — Describes the progression of societies and cultures

Neuroscience — Studies biological mechanisms of the physical brain

Psychology / Linguistics — Examine mental processes and behaviors

Artificial Intelligence — Uses computational modelling to understand and replicate mental processes

Preface to CogSci 1800-1940

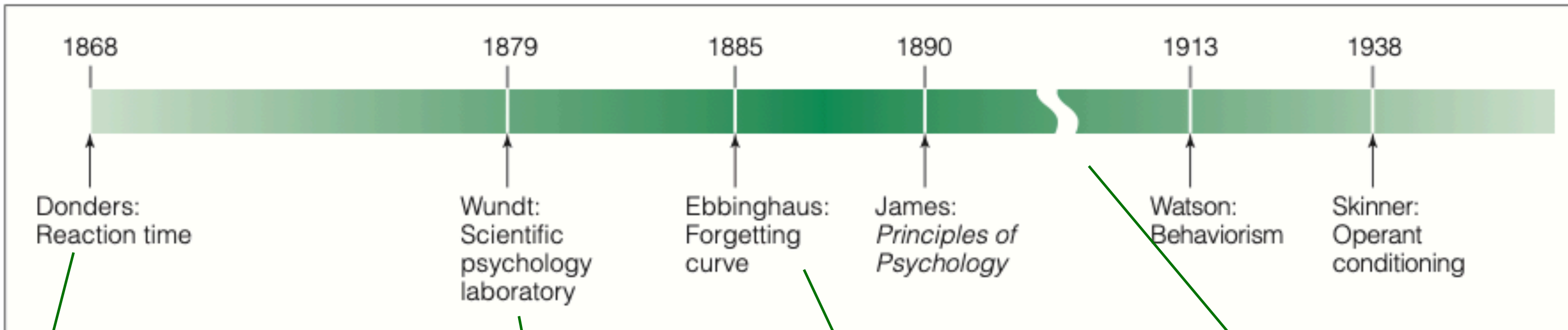
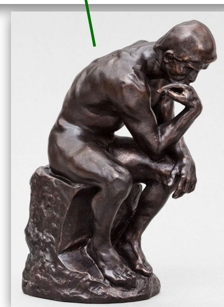
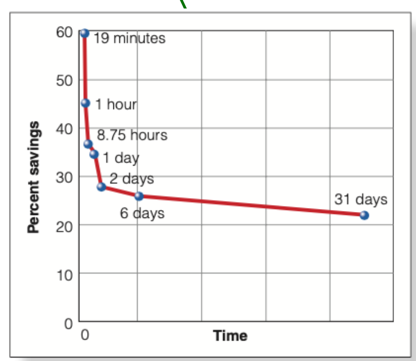
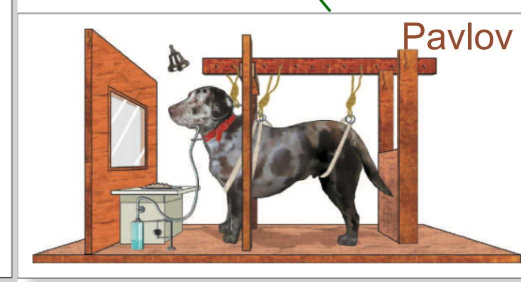
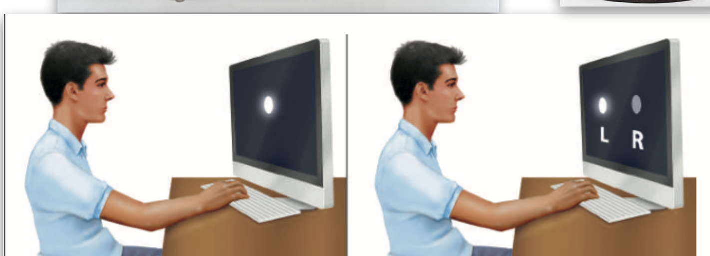


Figure 1.6 Time line showing early experiments studying the mind in the 1800s and the rise of behaviorism in the 1900s.







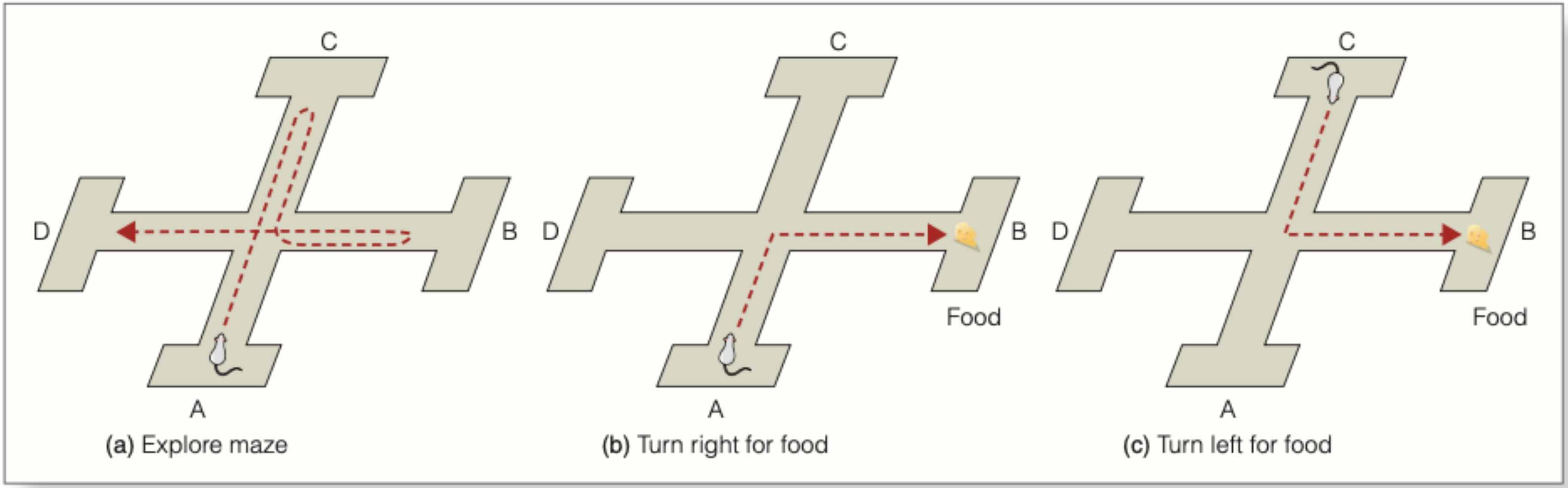


(a) Press J when light goes on.

(b) Press J for left light, K for right.

(Goldstein & van Hoof 2021, p. 5-10)

Tolman opens the black box



➤ **Figure 1.7** Maze used by Tolman. (a) The rat initially explores the maze. (b) The rat learns to turn right to obtain food at B when it starts at A. (c) When placed at C, the rat turns left to reach the food at B. In this experiment, precautions are taken to prevent the rat from knowing where the food is based on cues such as smell.

(Goldstein & van Hoof 2021, p. 11)

The cognitive revolution

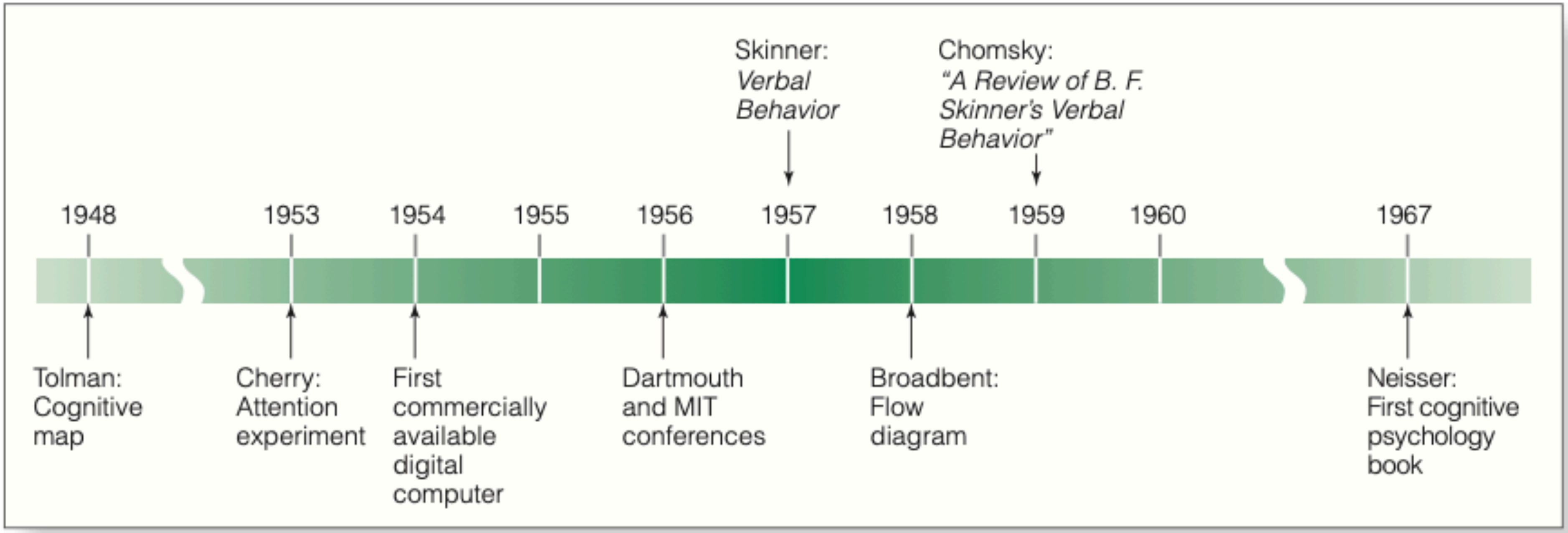


Figure 1.9 Time line showing events associated with the decline of the influence of behaviorism (above the line) and events that led to the development of the information-processing approach to cognitive psychology (below the line).

(Goldstein & van Hoof 2021, p. 14)

Process models

- Boxes and arrows have been an important part of the Cognitive Science toolbox.

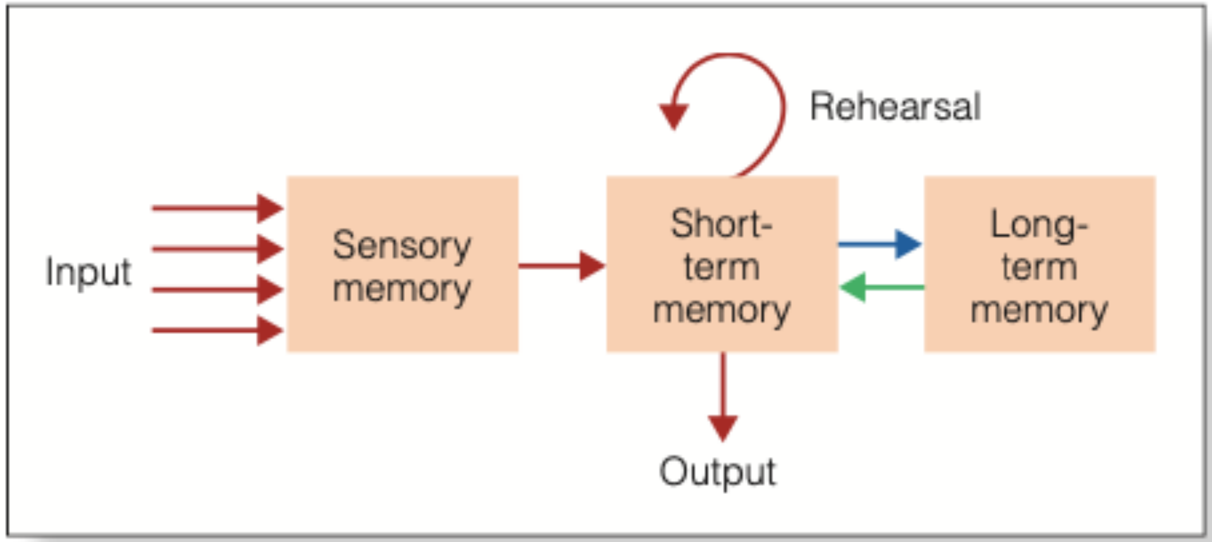
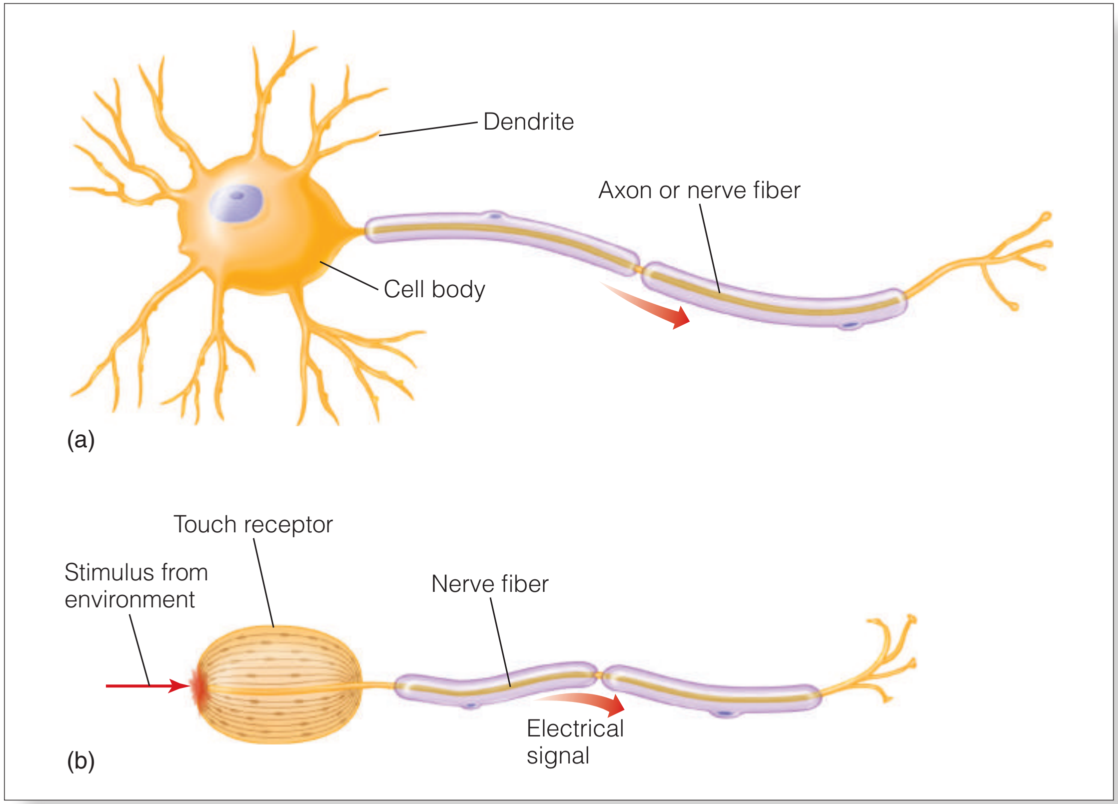


Figure 1.10 Atkinson and Shiffrin's (1968) model of memory. See text for details.

(Goldstein & van Hoof 2021, p. 16)

Chapter 2: Cognitive Neuroscience

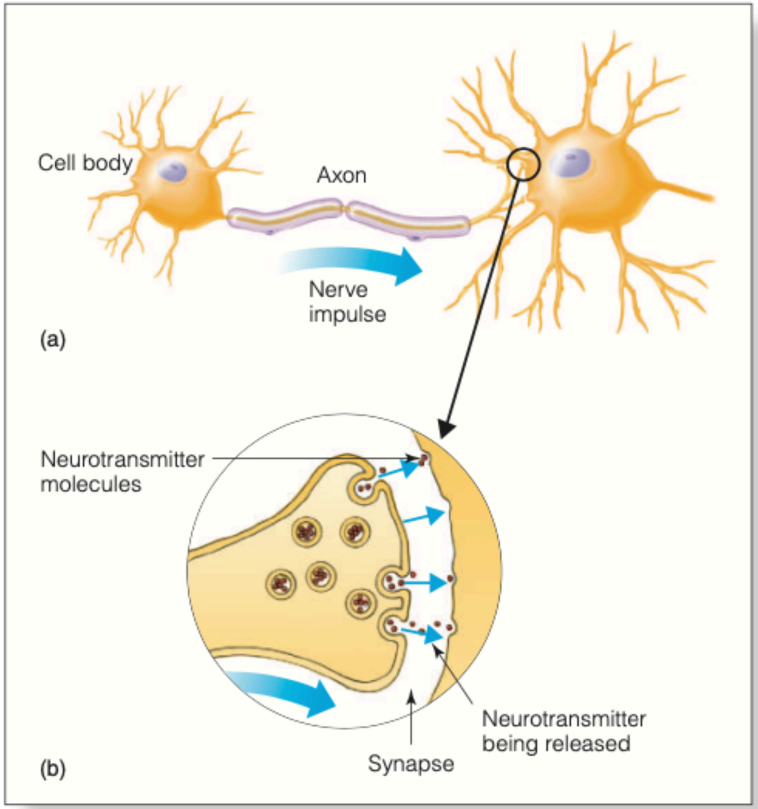
Neuronal structure



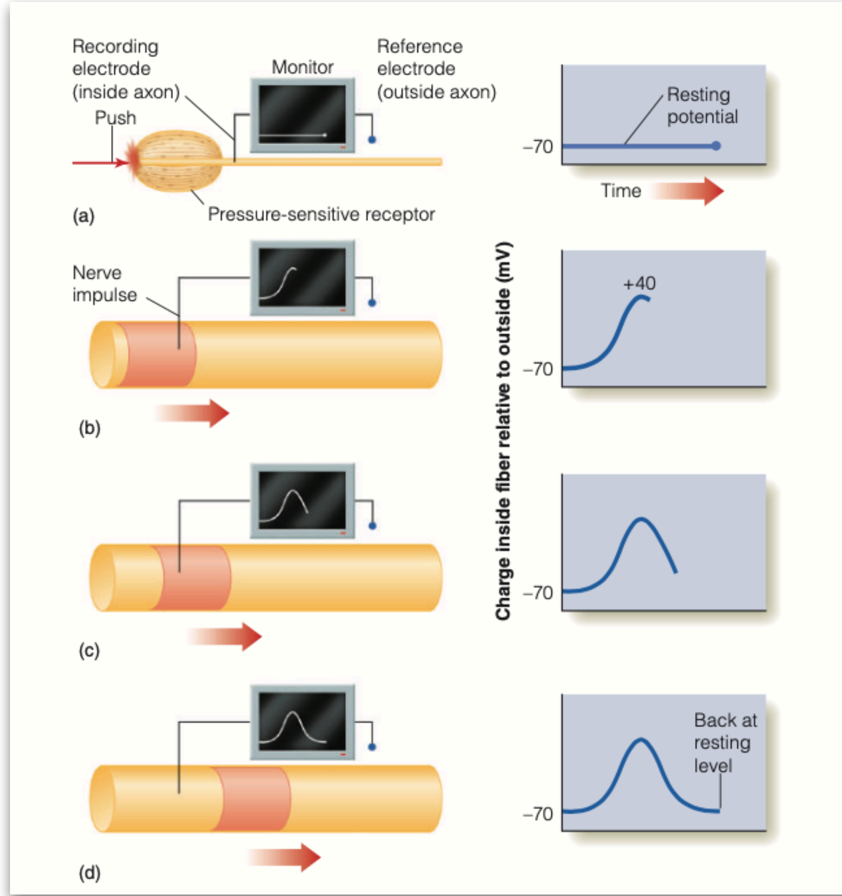
➤ **Figure 2.3** (a) Basic components of a neuron in the cortex. (b) A neuron with a specialized receptor in place of the cell body. This receptor responds to pressure on the skin.

(Goldstein & van Hoof 2021, p. 26)

Neural transmission

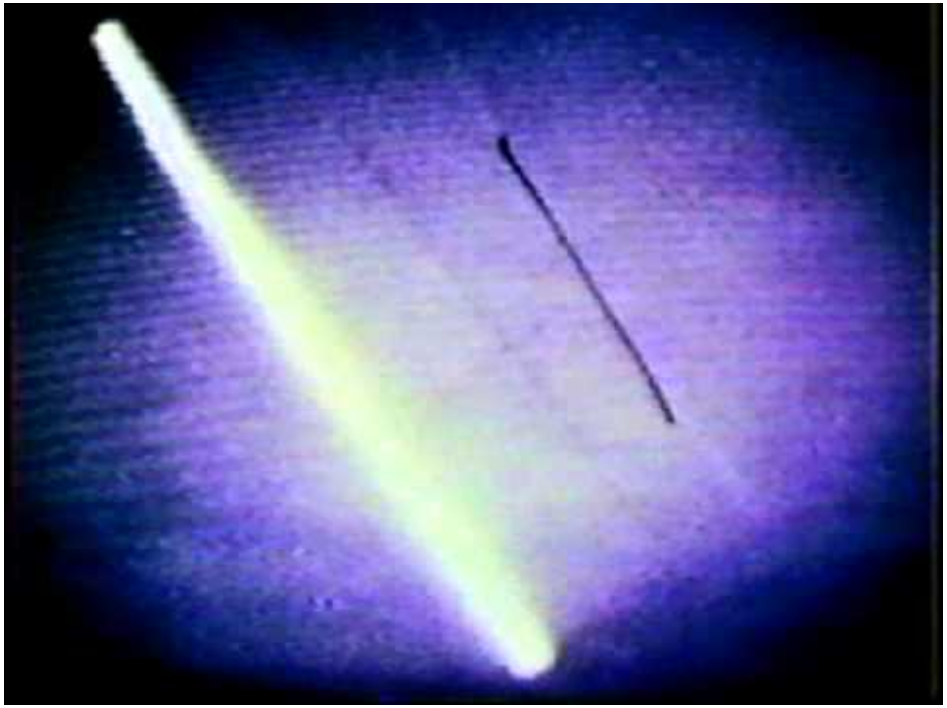


➤ **Figure 2.4** (a) Neuron synapsing on the cell body of another neuron. (b) Close-up of the synapse showing the space between the end of one neuron and the cell body of the next neuron, and neurotransmitter being released.

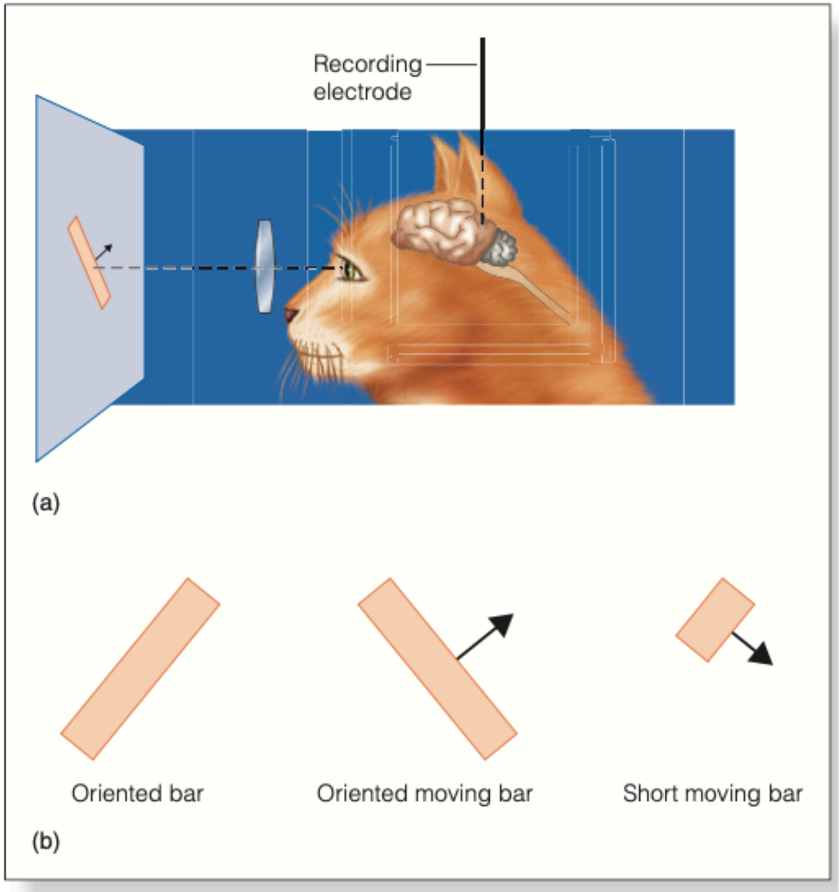


(Goldstein & van Hoof 2021, p. 28-29)

Neural representation: Feature detectors

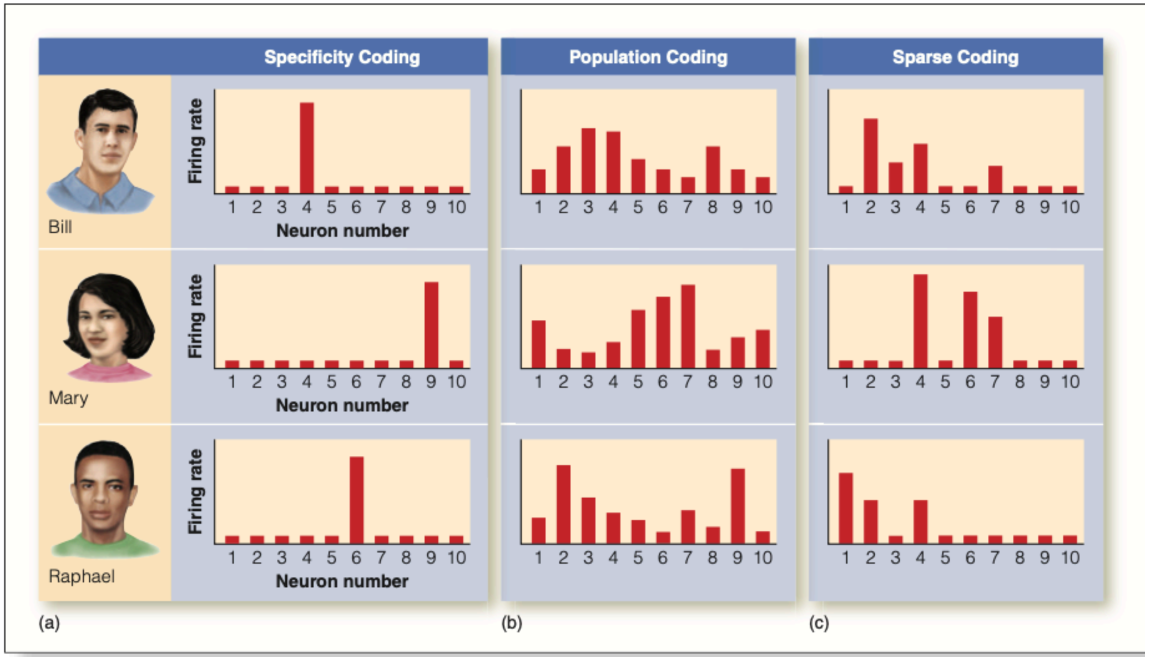


https://www.youtube.com/watch?v=8VdFf3egwfg

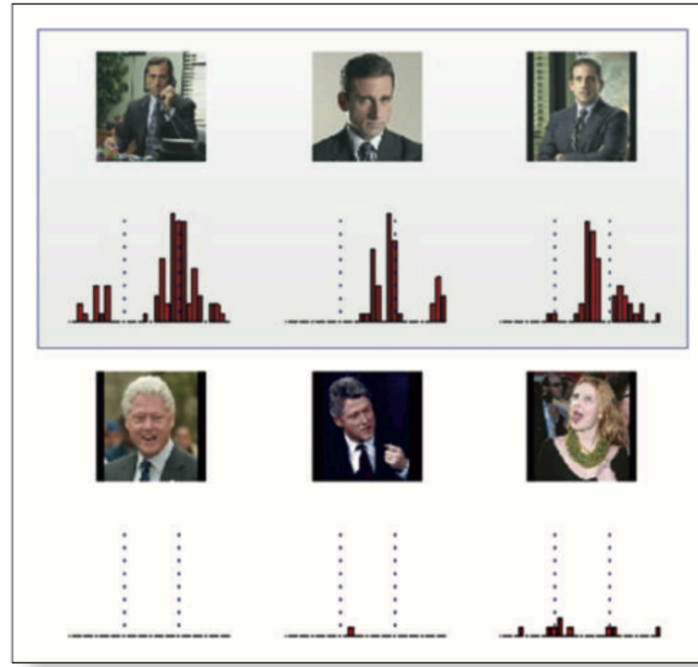


(Hubel & Wiesel 1959: Goldstein & van Hoof 2021, p. 32)

Neural representation: Types of coding



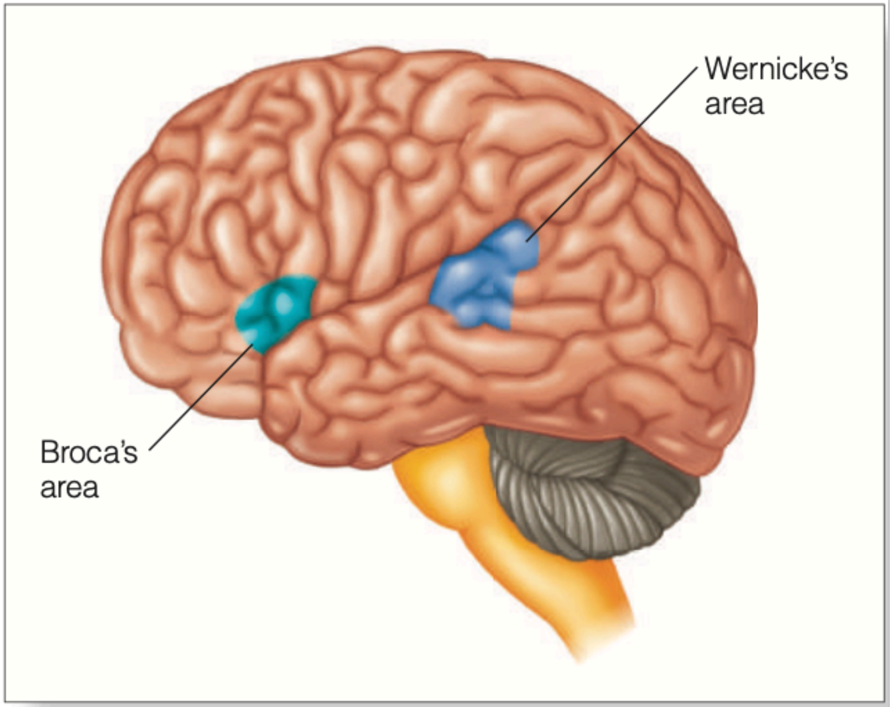
➤ **Figure 2.14** Three types of coding: (a) Specificity coding. The response of 10 different neurons to each face on the left is shown. Each face causes a different neuron to fire. (b) Population coding. The face's identity is indicated by the pattern of firing of a large number of neurons. (c) Sparse coding. The face's identity is indicated by the pattern of firing of a small group of neurons.



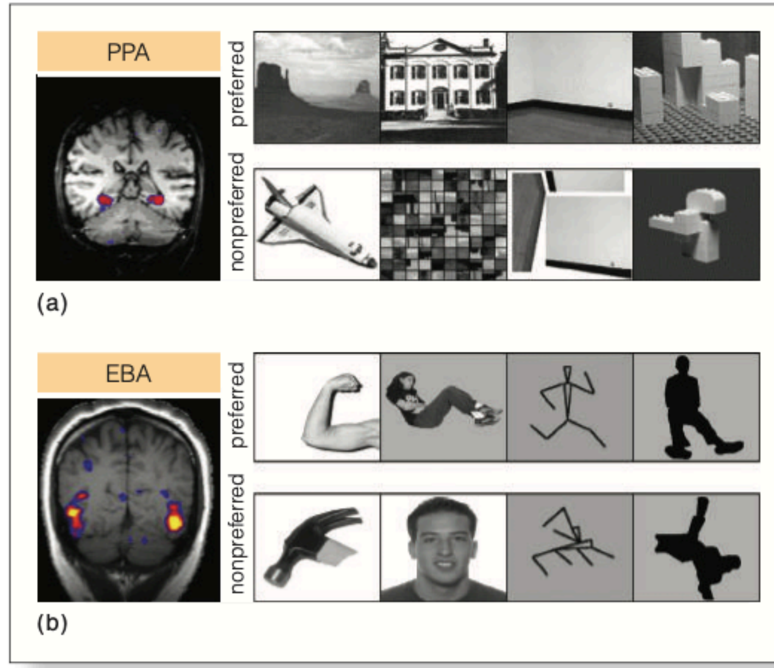
➤ **Figure 2.15** Records from a neuron in the temporal lobe that responded to different views of Steve Carell (top records) but did not respond to pictures of other well-known people (bottom records). (Source: Quiroga et al., 2008)

(Goldstein & van Hoof 2021, p. 35)

Neural macro-scale representation: Localisation



➤ **Figure 2.16** Broca's area, in the frontal lobe, and Wernicke's area, in the temporal lobe, were identified

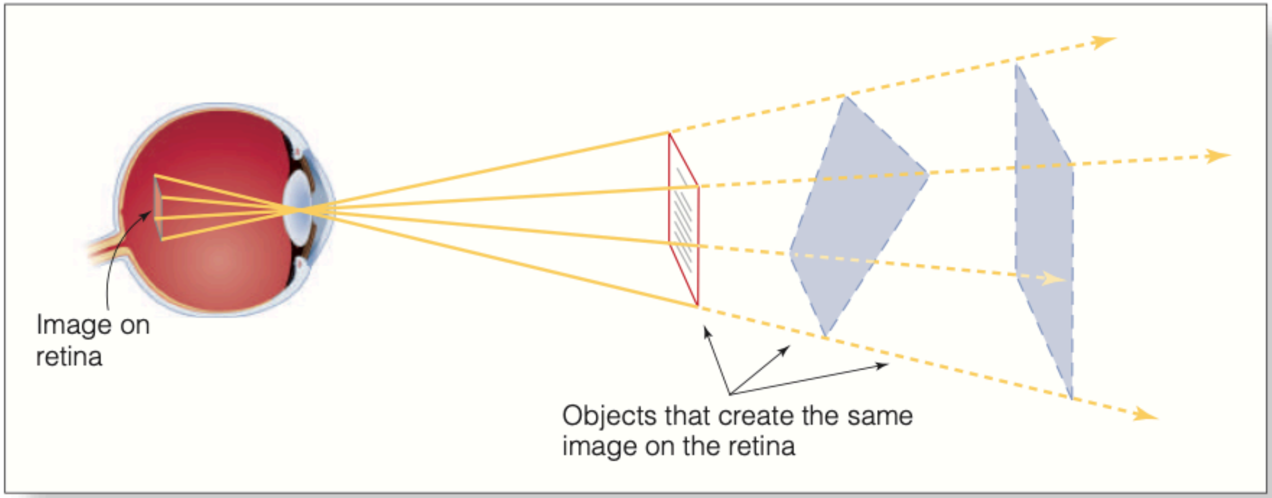


➤ **Figure 2.18** (a) The parahippocampal place area (PPA) is activated by places (top row) but not by other stimuli (bottom row). (b) The extrastriate body area (EBA) is activated by bodies (top) but not by other stimuli (bottom).
(Source: Chalupa & Werner, 2003)

(Goldstein & van Hoof 2021, p. 37-41)

Chapter 3: Perception

Challenges for vision: The inverse problem

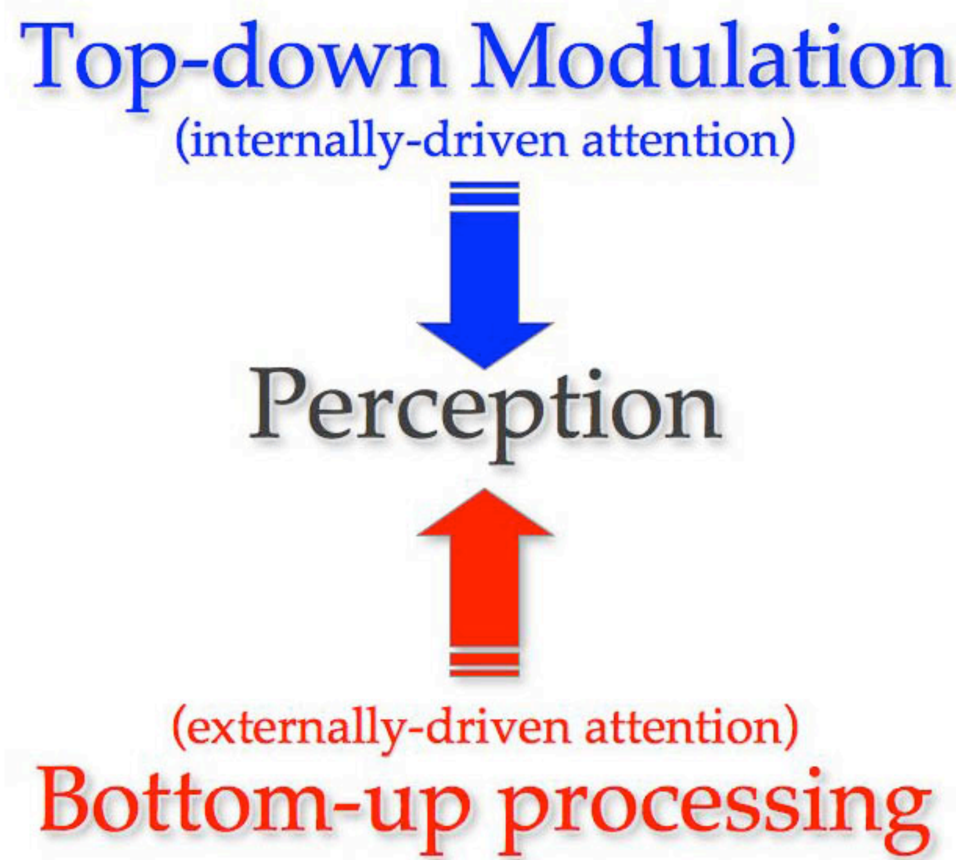


➤ **Figure 3.7** The projection of the book (red object) onto the retina can be determined by extending rays (solid lines) from the book into the eye. The principle behind the inverse projection problem is illustrated by extending rays out from the eye past the book (dashed lines). When we do this, we can see that the image created by the book can be created by an infinite number of objects, among them the tilted trapezoid and large rectangle shown here. This is why we say that the image on the retina is ambiguous.

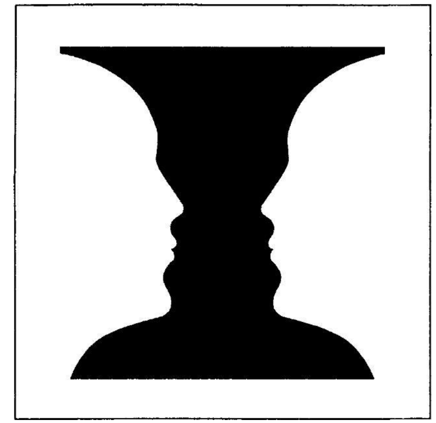
- There is an infinite number of ways for 3D->2D projection

(Goldstein & van Hoof 2021, p. 55)

Top-down vs Bottom-up



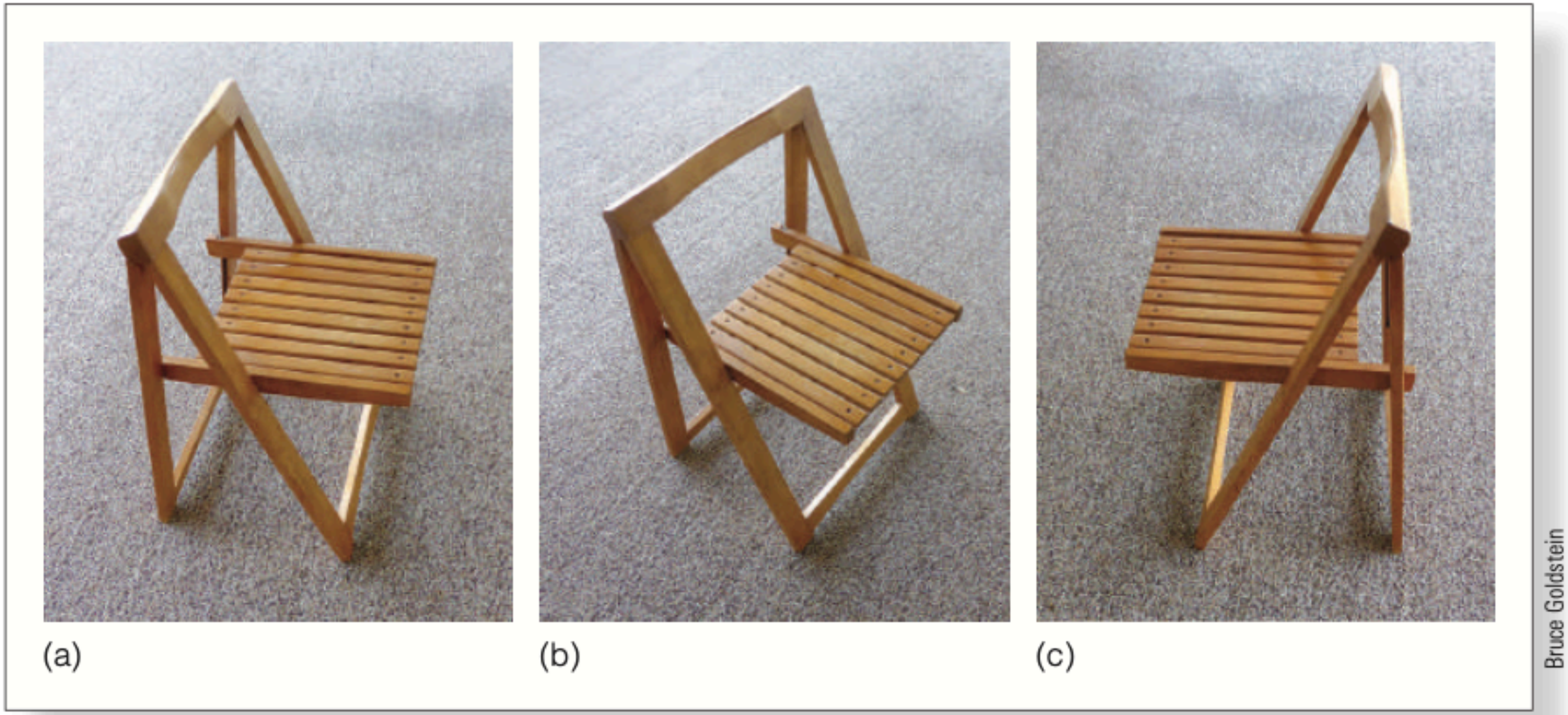
Figure/ground principle



Rubin's faces/vase

(Goldstein & van Hoof 2021, p. 58)

Challenge for perception: View point dependency

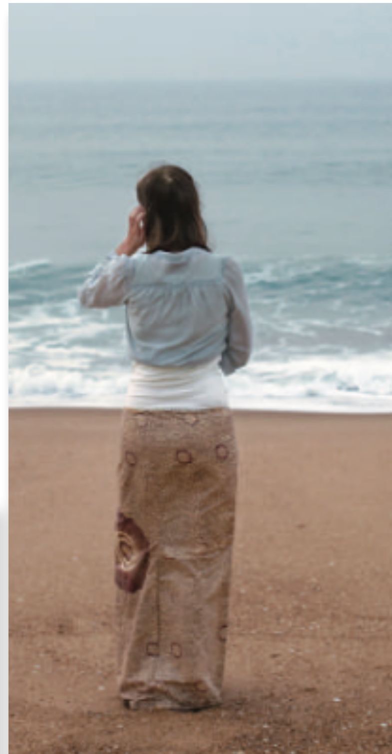


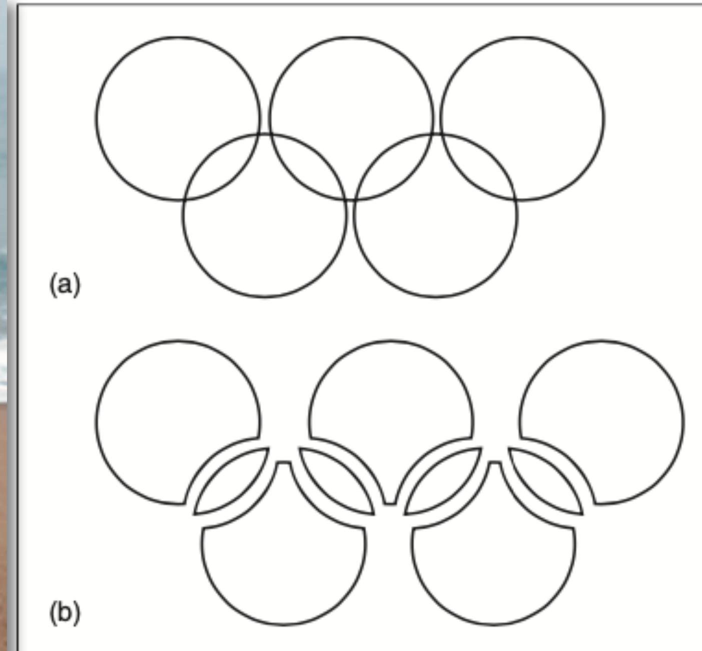
➤ **Figure 3.10** Your ability to recognize each of these views as being of the same chair is an example of viewpoint invariance.

(Goldstein & van Hoof 2021, p. 57)

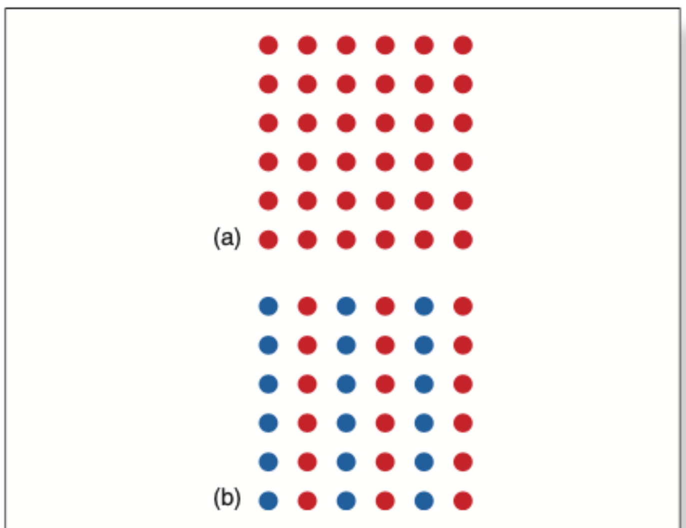
Gestalt principles

- Principle of
  - Figure/Ground
  - Continuation
  - Good figure/closure
  - Similarity
  - Common region
  - proximity

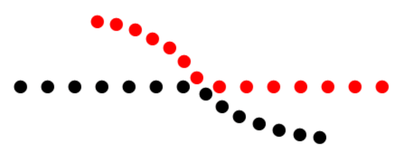




➤ **Figure 3.19** The Olympic symbol is perceived as five circles (a), not as the nine shapes in (b).



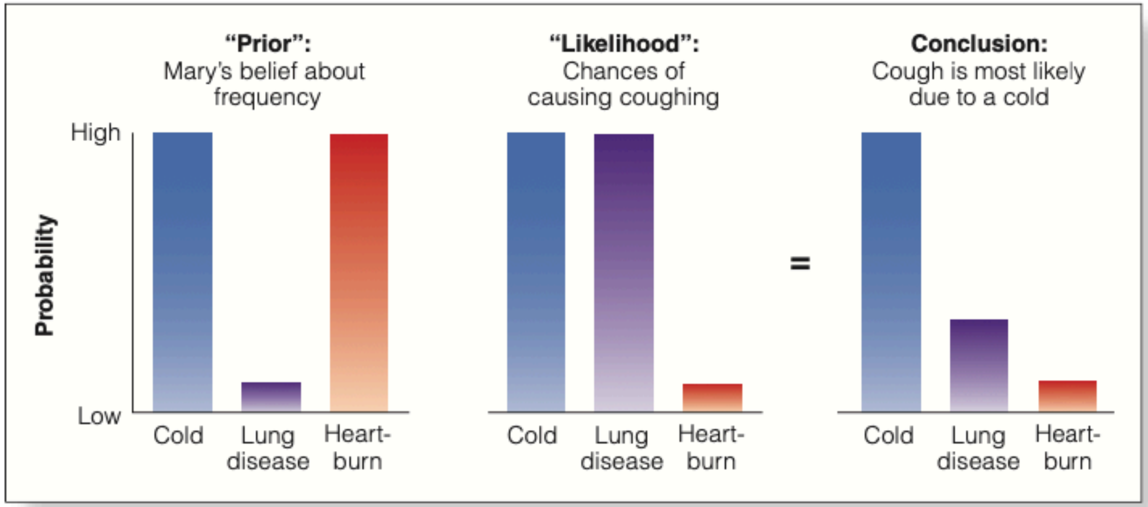
➤ **Figure 3.20** (a) This pattern of dots is perceived as horizontal rows, vertical columns, or both. (b) This pattern of dots is perceived as vertical columns.



(Wertheimer 1912; Goldstein & van Hoof 2021, p. 65

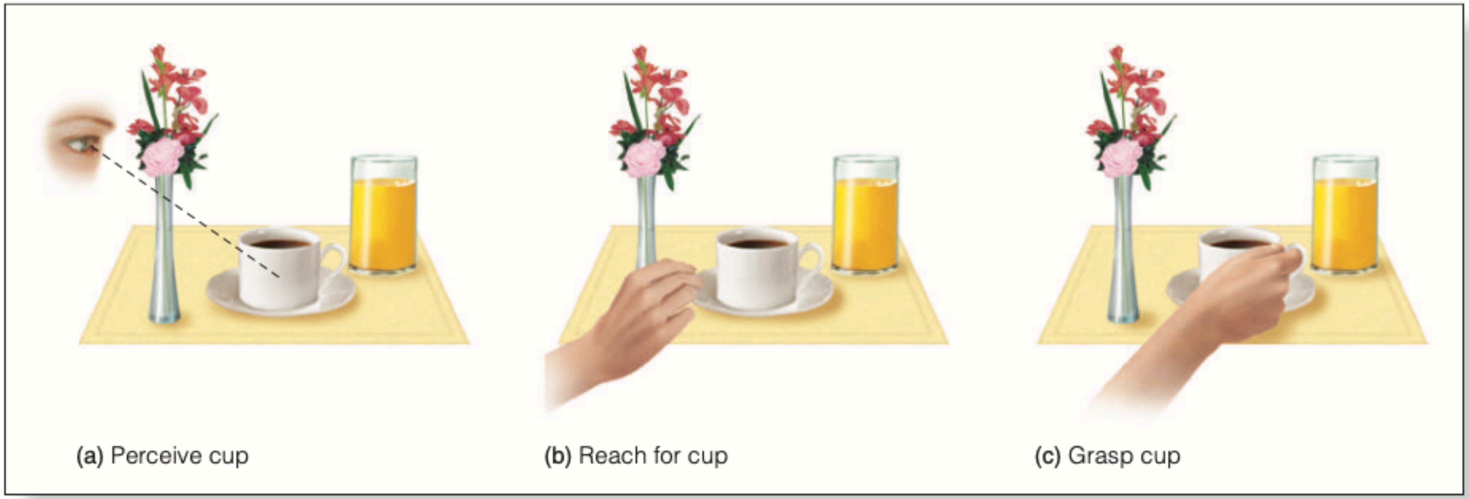
Bayesian inference

➤ **Figure 3.24** These graphs present hypothetical probabilities to illustrate the principle behind Bayesian inference. (a) Mary's beliefs about the relative frequency of having a cold, lung disease, and heartburn. These beliefs are her *priors*. (b) Further data indicate that colds and lung disease are associated with coughing, but heartburn is not. These data contribute to the *likelihood*. (c) Taking the priors and likelihood together results in the conclusion that Charles's cough is probably due to a cold.

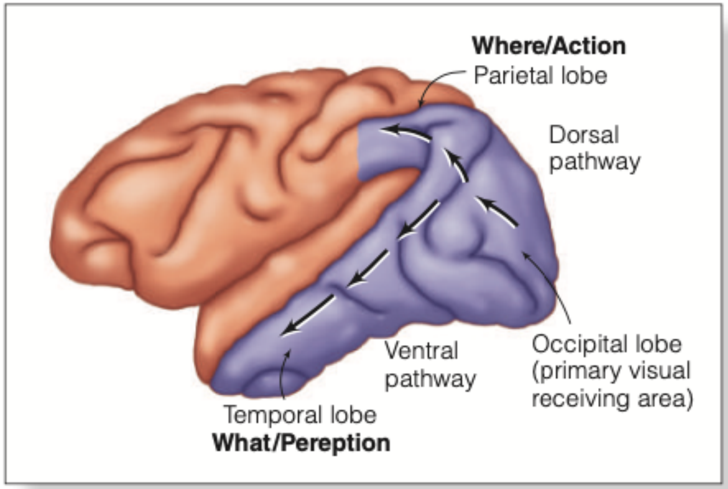


(Goldstein & van Hoof 2021, p. 69)

Perception for recognition or action



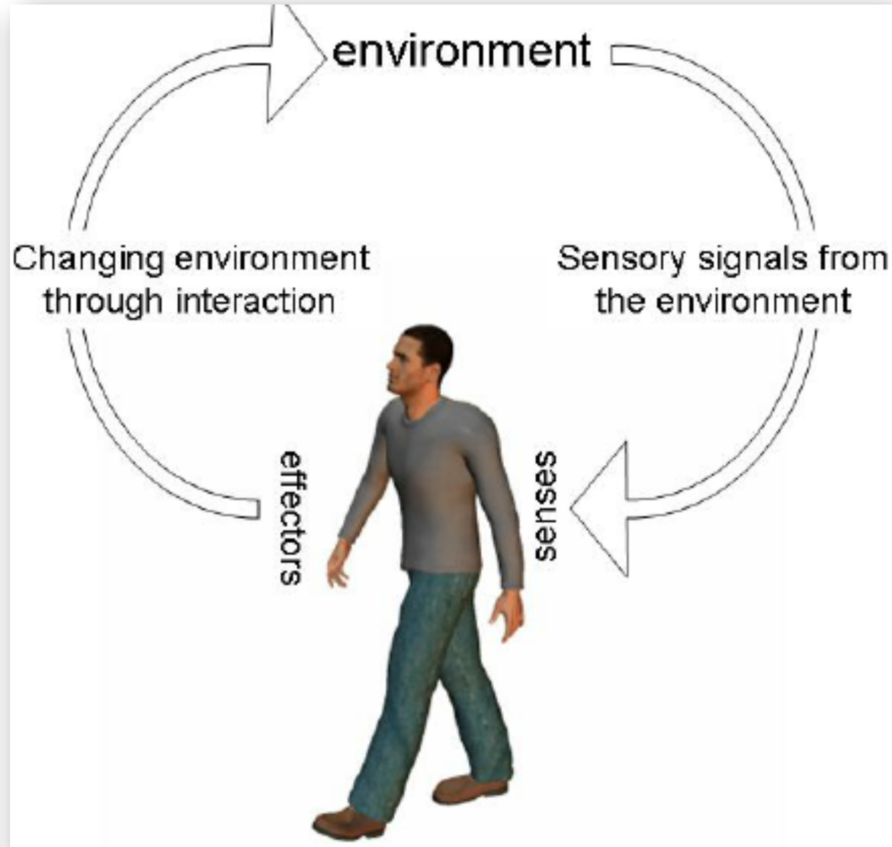
➤ **Figure 3.29** Picking up a cup of coffee: (a) perceiving and recognizing the cup; (b) reaching for it; (c) grasping and picking it up. This action involves coordination between perceiving and action that is carried out by two separate streams in the brain, as described in the text.



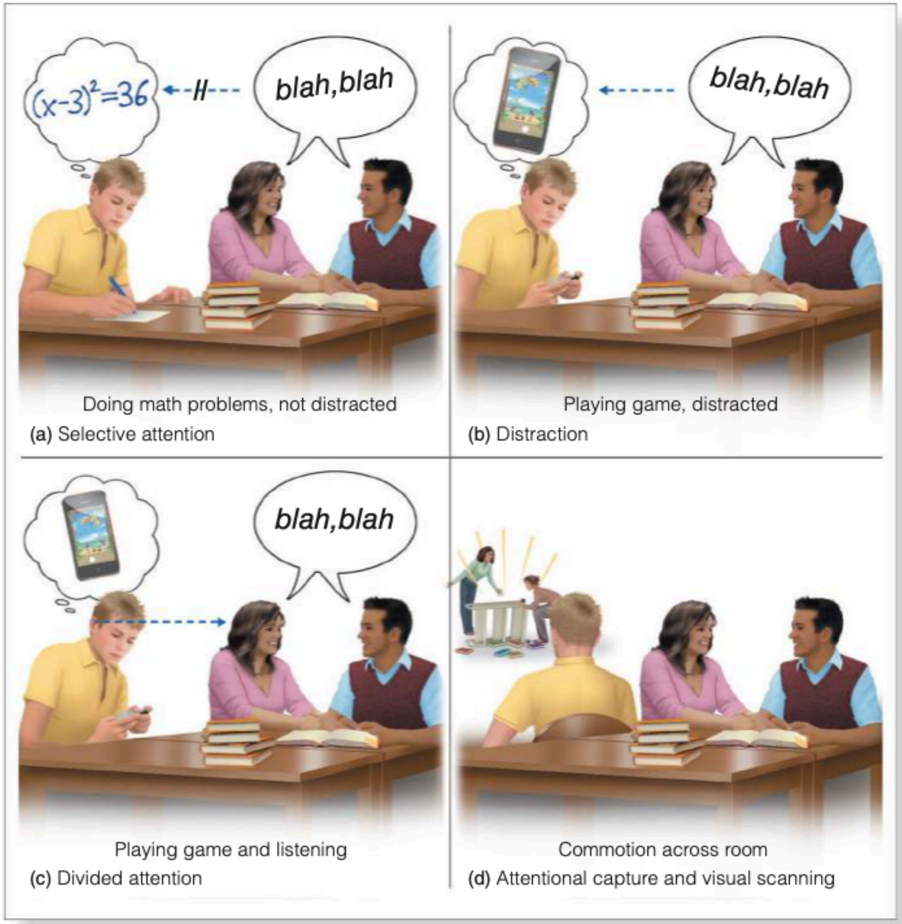
(Goldstein & van Hoof 2021, p. 76-79)

Perception/Action cycle!

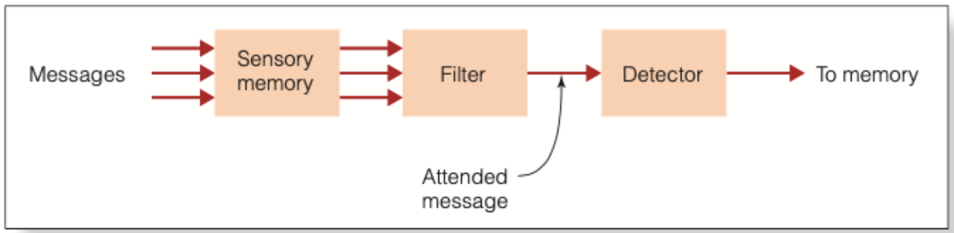
- Classic cognitive science thinks in terms of linear connections
  - Perception -> Representation ->
  - Action
- Probably cognition is a feedback control system
  - A loop!



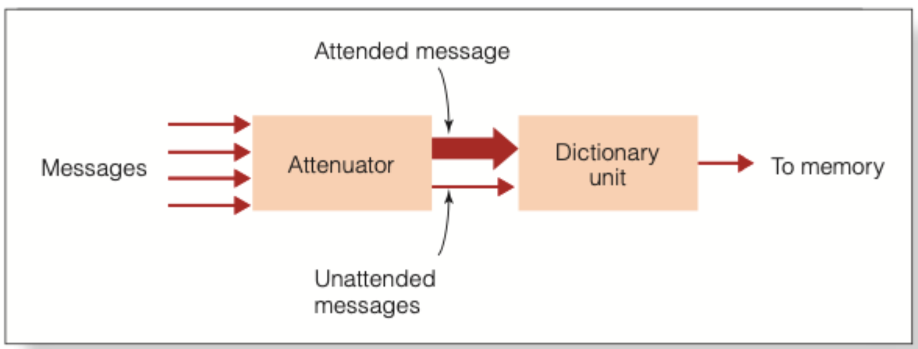
Chapter 4: Attention



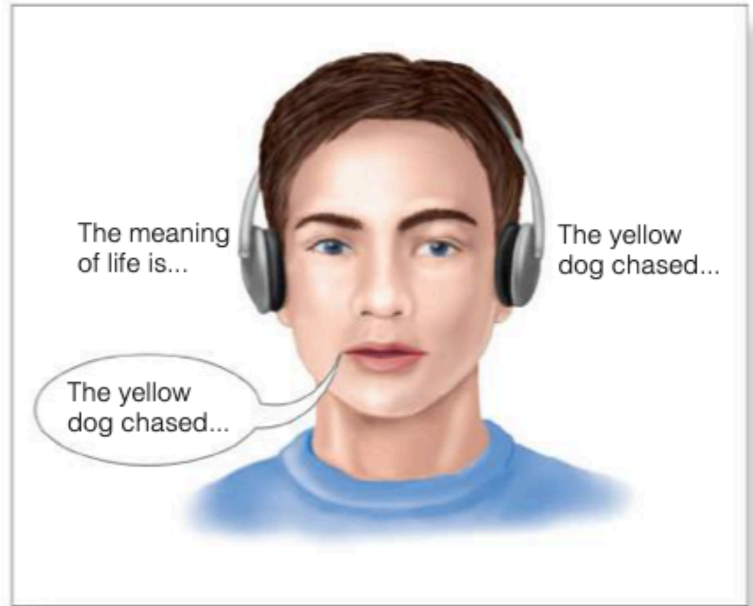
Attention as selection



➤ **Figure 4.3** Flow diagram of Broadbent's filter model of attention.



➤ **Figure 4.5** Flow diagram for Treisman's attenuation model of selective attention.

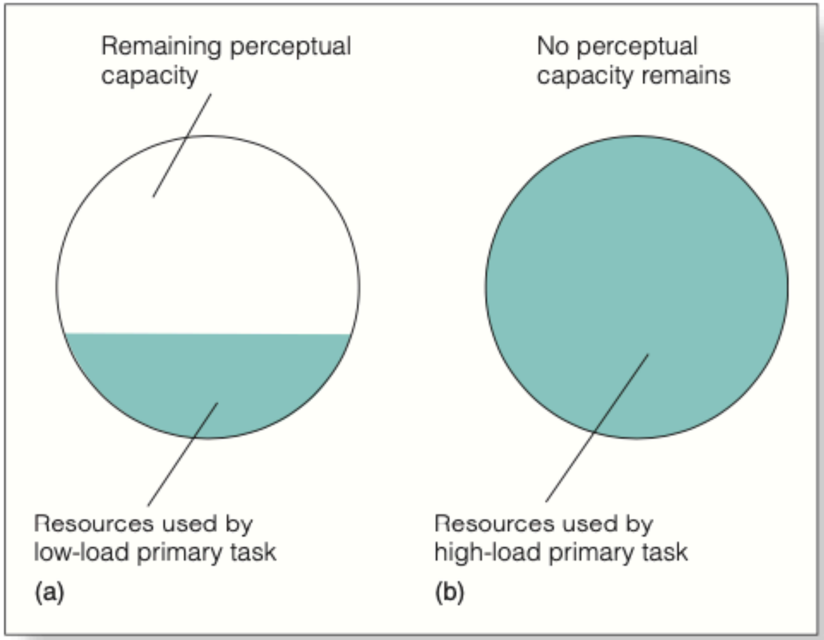


➤ **Figure 4.2** In the shadowing procedure, which involves dichotic listening, a person repeats out loud the words that they have just heard. This ensures that participants are focusing their attention on the attended message.

- Broadbent's filter model
- Treisman's attenuation model

(Goldstein & van Hoof 2021, p. 89-92)

Attention as limited resource: load theory



➤ **Figure 4.8** The load theory of attention: (a) Low-load tasks that use few cognitive resources may leave resources available for processing unattended task-irrelevant stimuli, whereas (b) high-load tasks that use all of a person's cognitive resources don't leave any resources to process unattended task-irrelevant stimuli.

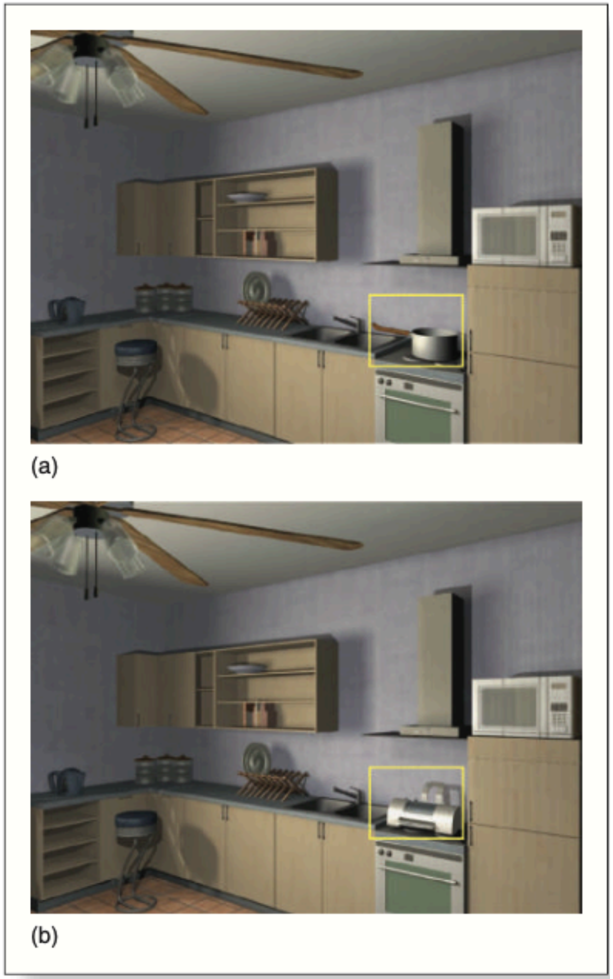
(Goldstein & van Hoof 2021, p.96)

Bottom-up: Stimulus salience

➤ **Figure 4.13** The red shirt is visually salient because it is bright and contrasts with its surroundings.

(Goldstein & van Hoof 2021, p.103)

Top-down: Contextual knowledge

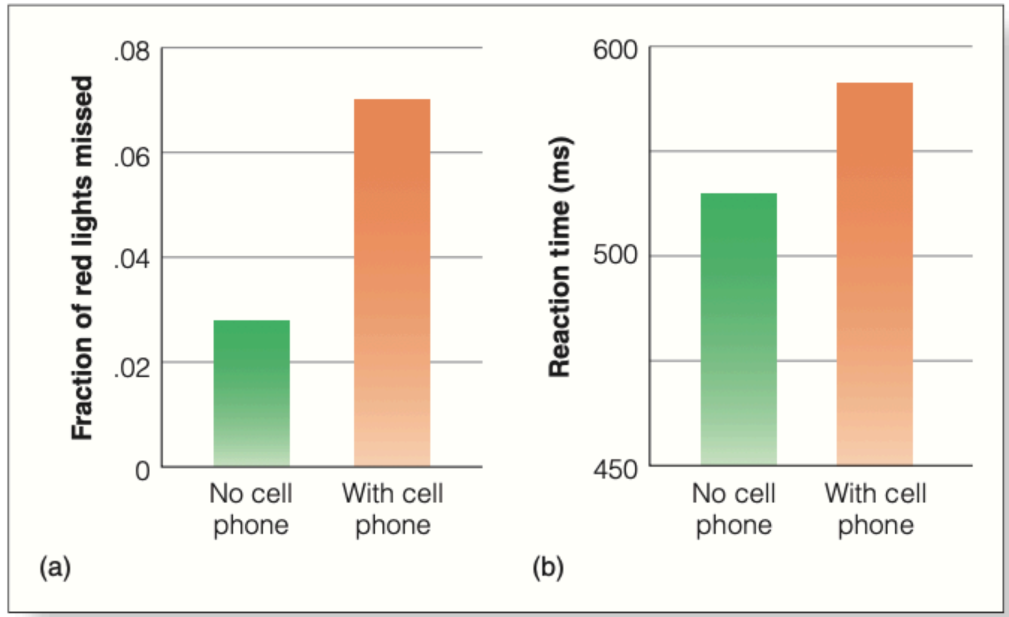


(Goldstein & van Hoof 2021, p.104)

➤ **Figure 4.14** Stimuli used by Võ and Henderson (2009). Observers spent more time looking at the printer in (b) than at the pot in (a), shown inside the yellow rectangles (which were not visible to the observers).

Types of attention

- Overt attention
- Covert attention
- Divided attention



➤ **Figure 4.23** Result of Strayer and Johnston's (2001) cell phone experiment. When participants were talking on a cell phone, they (a) missed more red lights and (b) took longer to apply the brakes.

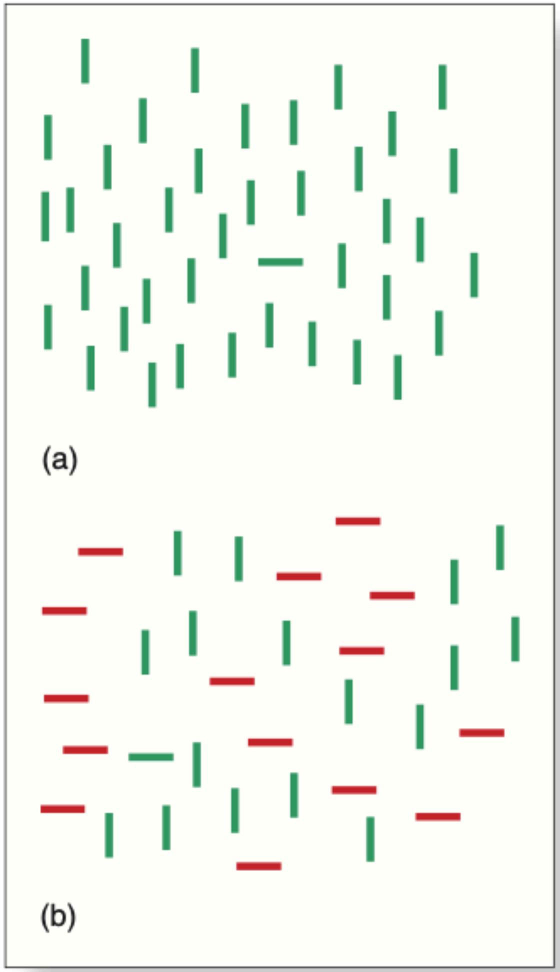
(Goldstein & van Hoof 2021, p.105-109)

Inattentional blindness

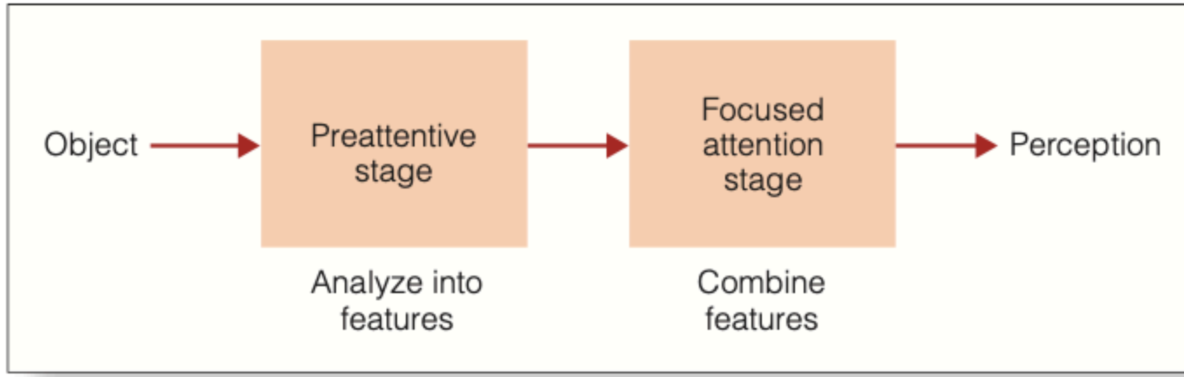
Bruce Goldstein

(Goldstein & van Hoof 2021, p.114-115)

Feature integration theory



➤ **Figure 4.34** Find the horizontal line in (a) and then the green horizontal line in (b). Which task took longer?



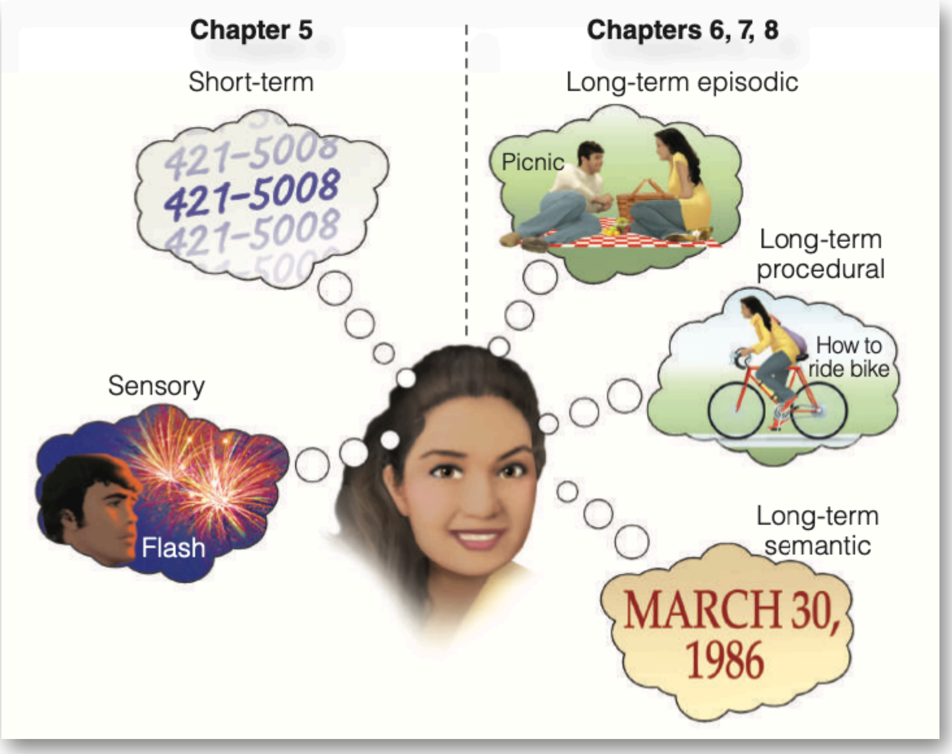
➤ **Figure 4.30** Steps in Treisman's feature integration theory. Objects are analyzed into their features in the preattentive stage, and the features are later combined with the aid of attention.

(Goldstein & van Hoof 2021, p.115-118)

Chapter 5-6: Memory systems

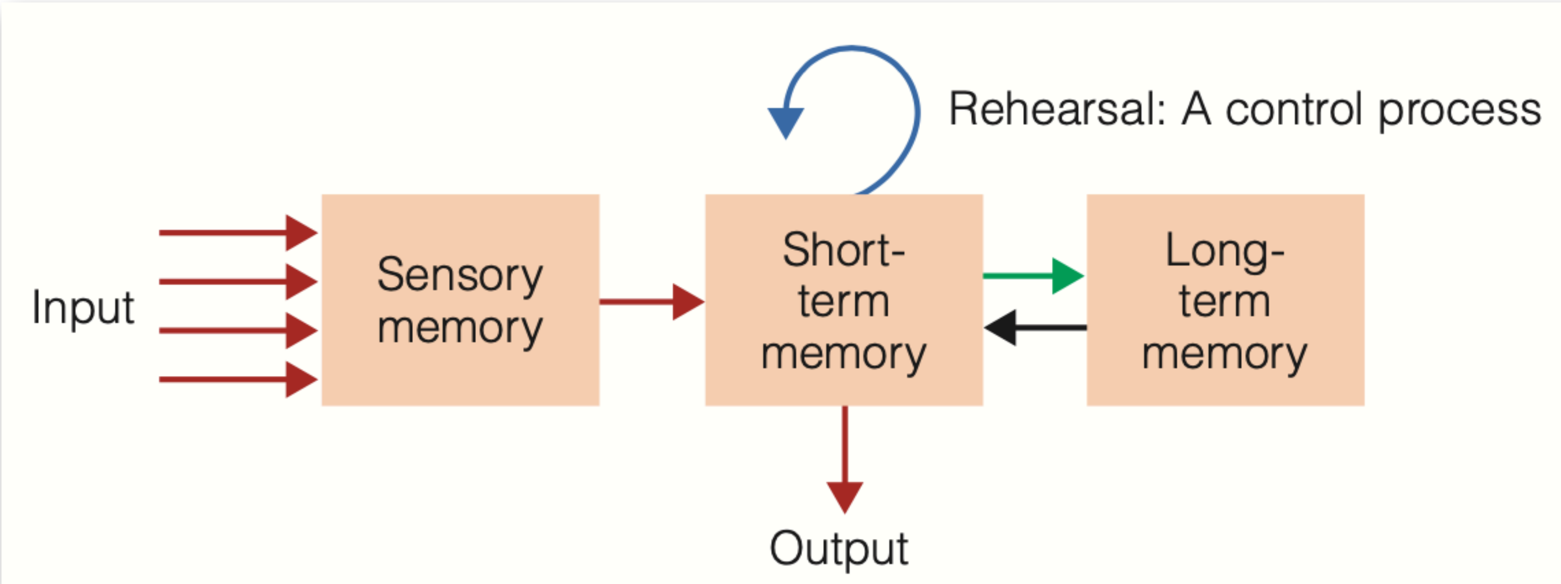
Multiple memory systems

- The cognitive system contains multiple memory systems, defined by their
  - temporal duration (from short to long)
  - quality (episodic, procedural, semantic



(Goldstein & van Hoof 2021, p. 126)

The modal model of memory



- Signals pass through sensory memory, are processed in short-term memory and stored in long-term memory

(Atkinson & Shiffrin 1969; Goldstein & van Hoof 2021, p. 127)

Baddeley's Working memory model 1

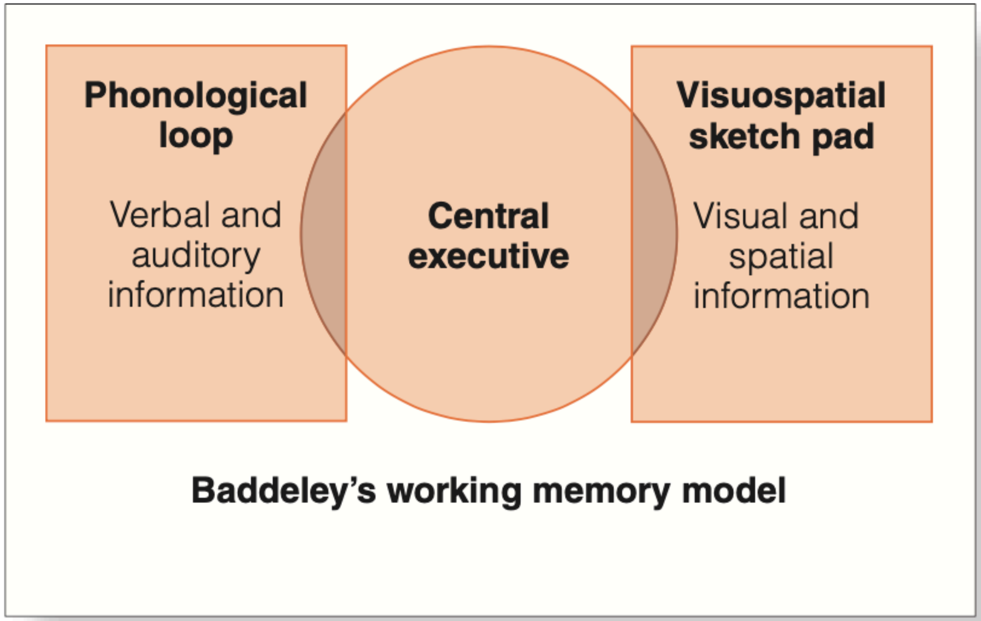
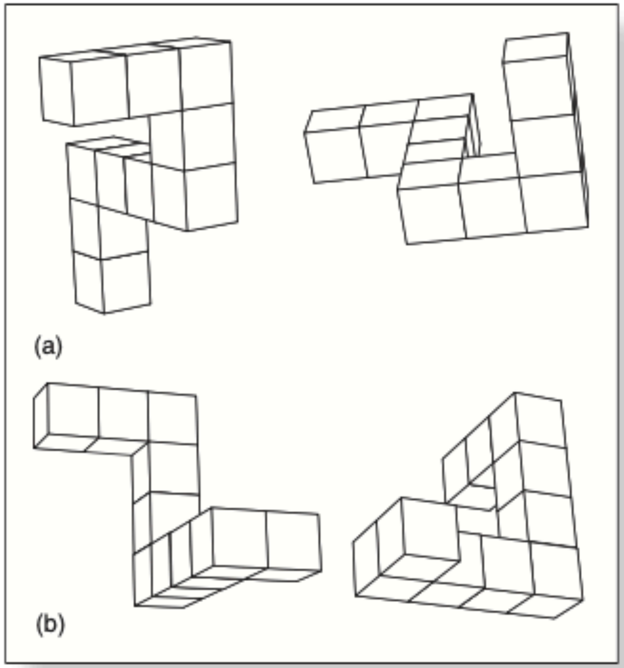


Figure 5.10 Diagram of the three main components of Baddeley and Hitch's (1974; Baddeley, 2000) model of working memory: the phonological loop, the visuospatial sketch pad, and the central executive.

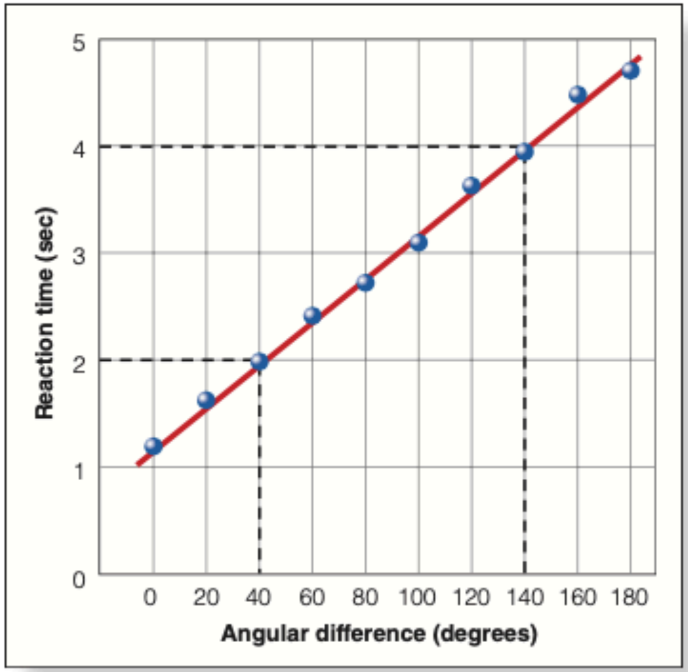
(Baddeley & Hitch 1974; Goldstein & van Hoof 2021, p. 140-141)

Visuospatial sketchpad: Analogical processing



➤ **Figure 5.13** Stimuli for the “Comparing Objects” demonstration. See text for details.

(Source: Based on R. N. Shepard & J. Metzler, Mental rotation of three-dimensional objects, *Science*, 171, Figures 1a & b, 701–703, 1971.)



➤ **Figure 5.14** Results of Shepard and Metzler’s (1971) mental rotation experiment.

(Source: Based on R. N. Shepard & J. Metzler, Mental rotation of three-dimensional objects, *Science*, 171, Figures 1a & b, 701–703, 1971.)

(Shepard & Metzler 1971; Goldstein & van Hoof 2021, p. 145)

Baddeleys's Working memory model 2

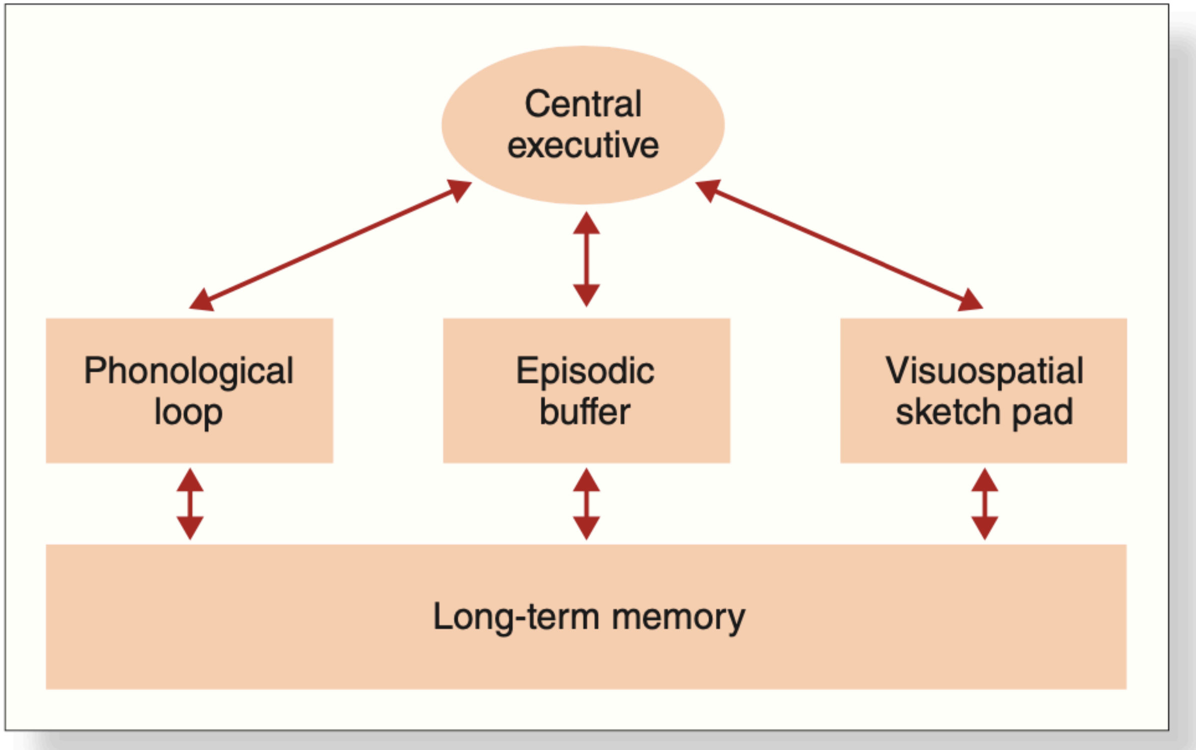
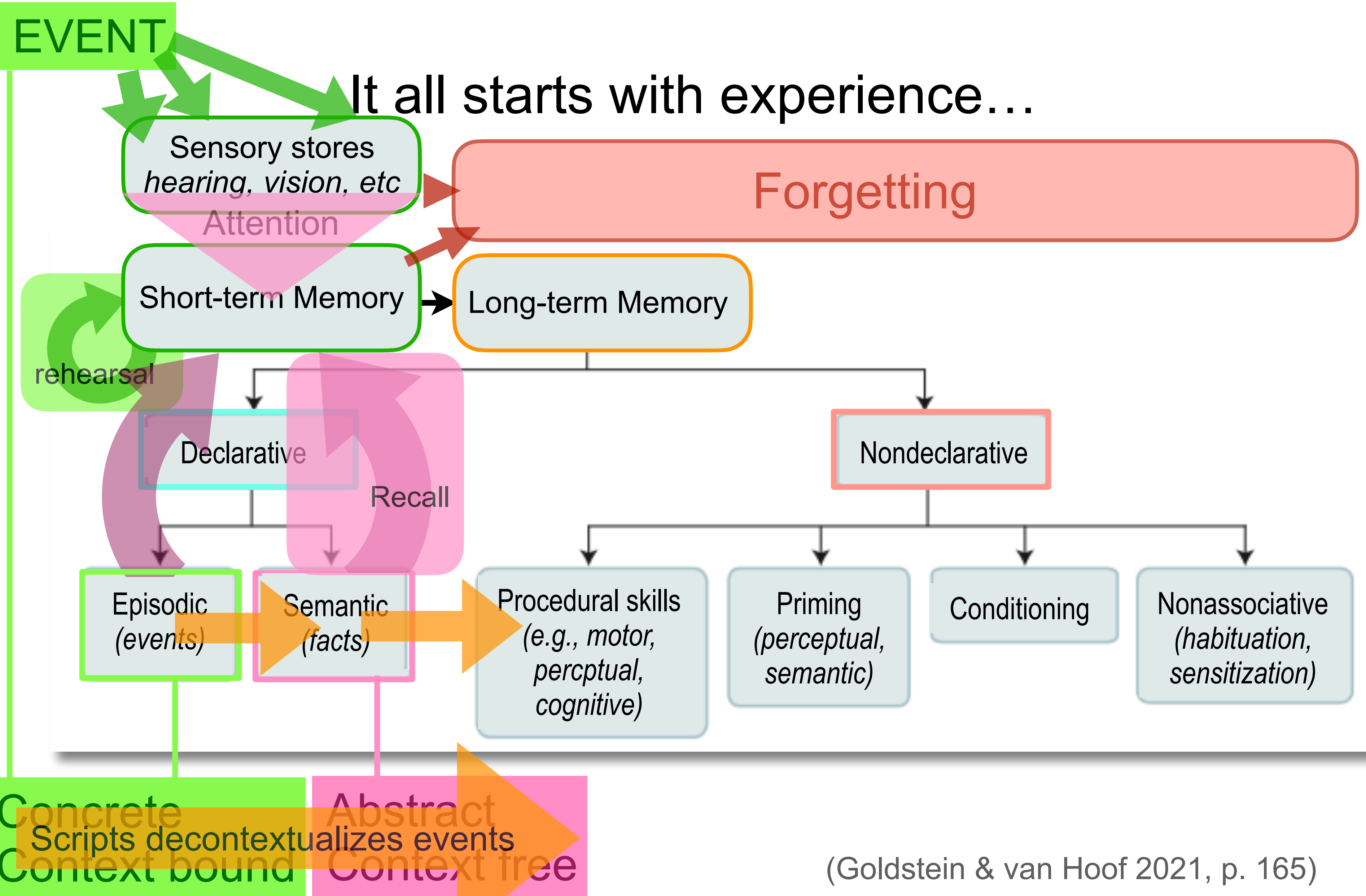


Figure 5.18 Baddeley's revised working memory model, which contains the original three components plus the episodic buffer.

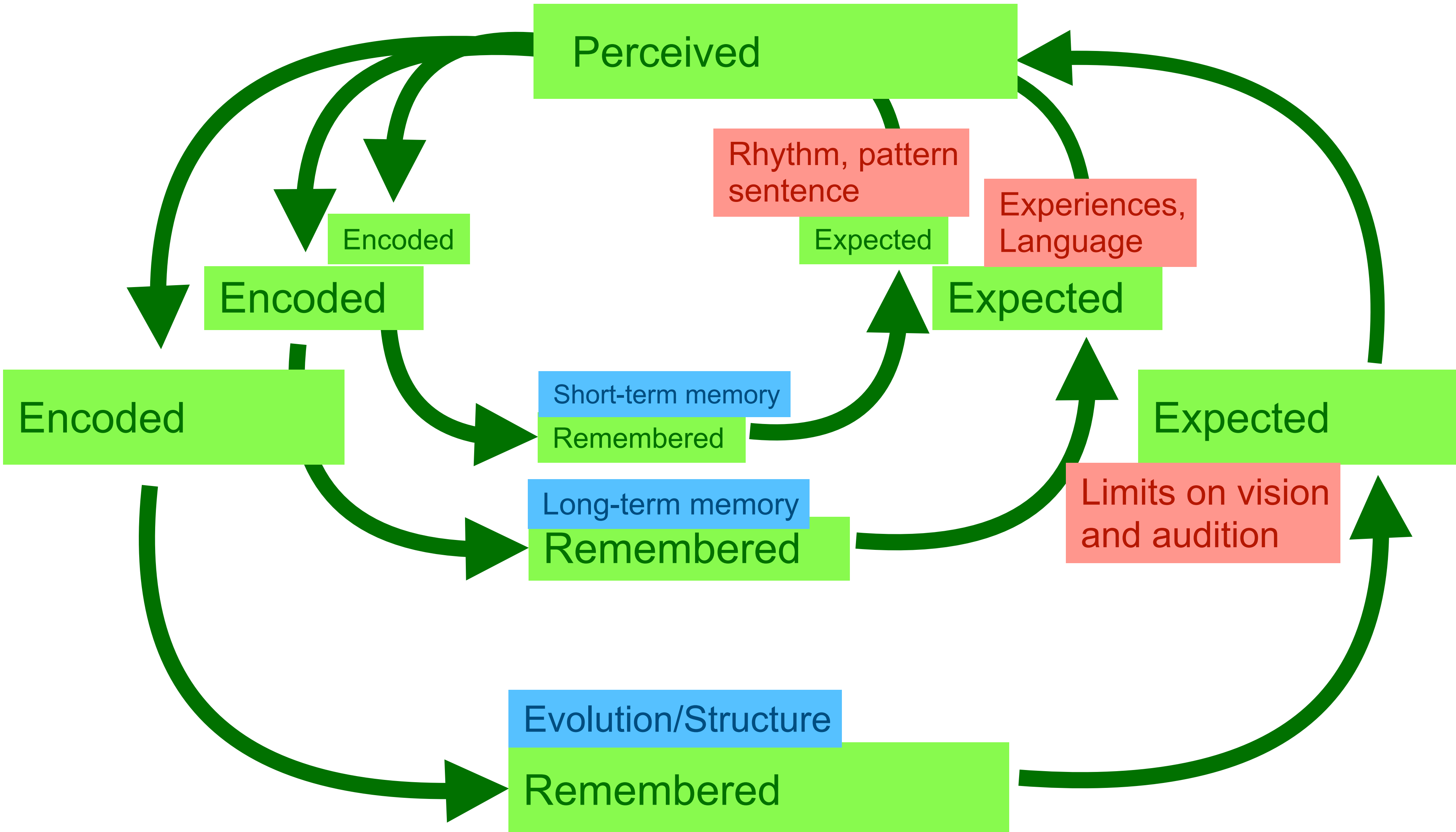
(Baddeley et al. 2009; Goldstein & van Hoof 2021, p. 151-152)

It all starts with experience…



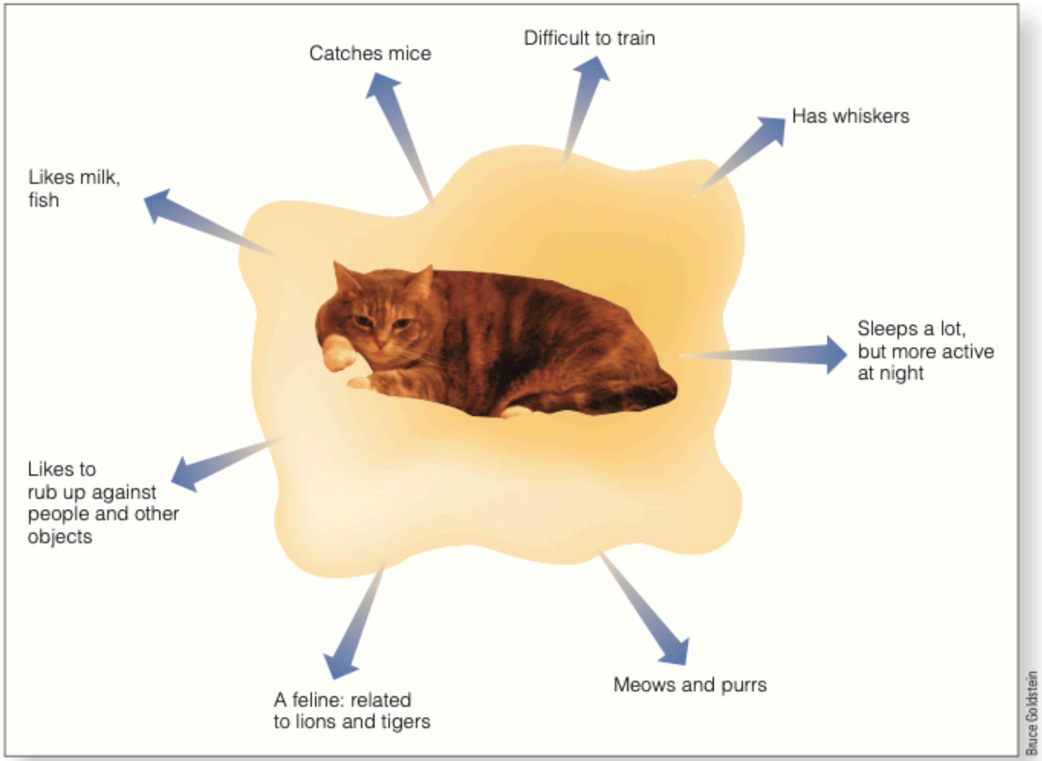
(Goldstein & van Hoof 2021, p. 165)

A loop on multiple time-scales!



Chapter 9: Knowledge

- A.k.a. semantics

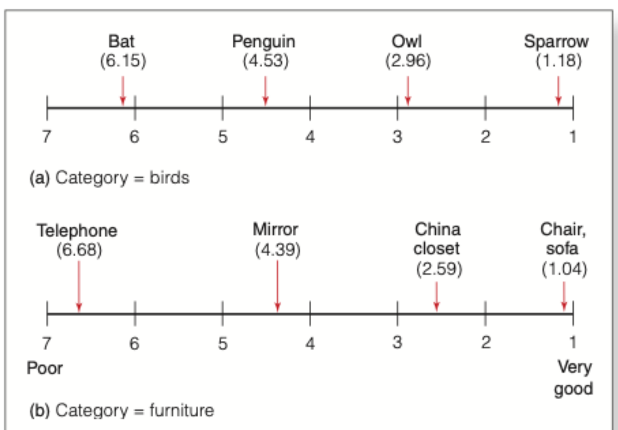


➤ **Figure 9.1** Knowing that something is in a category provides a great deal of information about it.

(Goldstein & van Hoof 2021, p. 263)

Prototypes

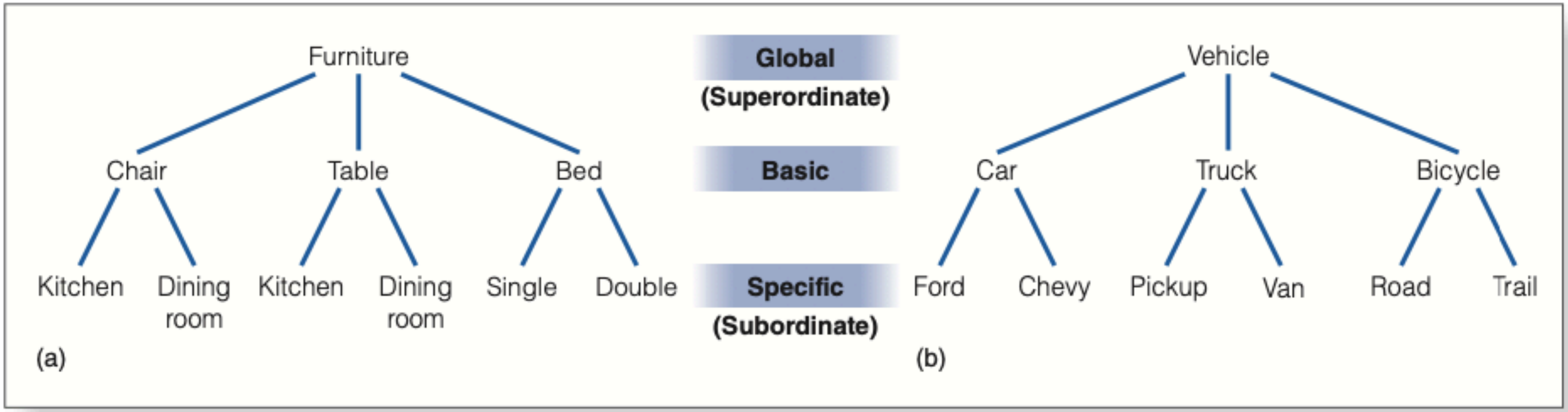
➤ **Figure 9.3** Three real birds—a sparrow, a robin, and a blue jay—and a "prototype" bird that is the average representation of the category "birds."



➤ **Figure 9.4** Results of Rosch's (1975a) experiment, in which participants judged objects on a scale of 1 (good example of a category) to 7 (poor example): (a) ratings for birds; (b) ratings for furniture.

(Rosch 1975; Goldstein & van Hoof 2021, p. 265-266)

Levels of abstraction

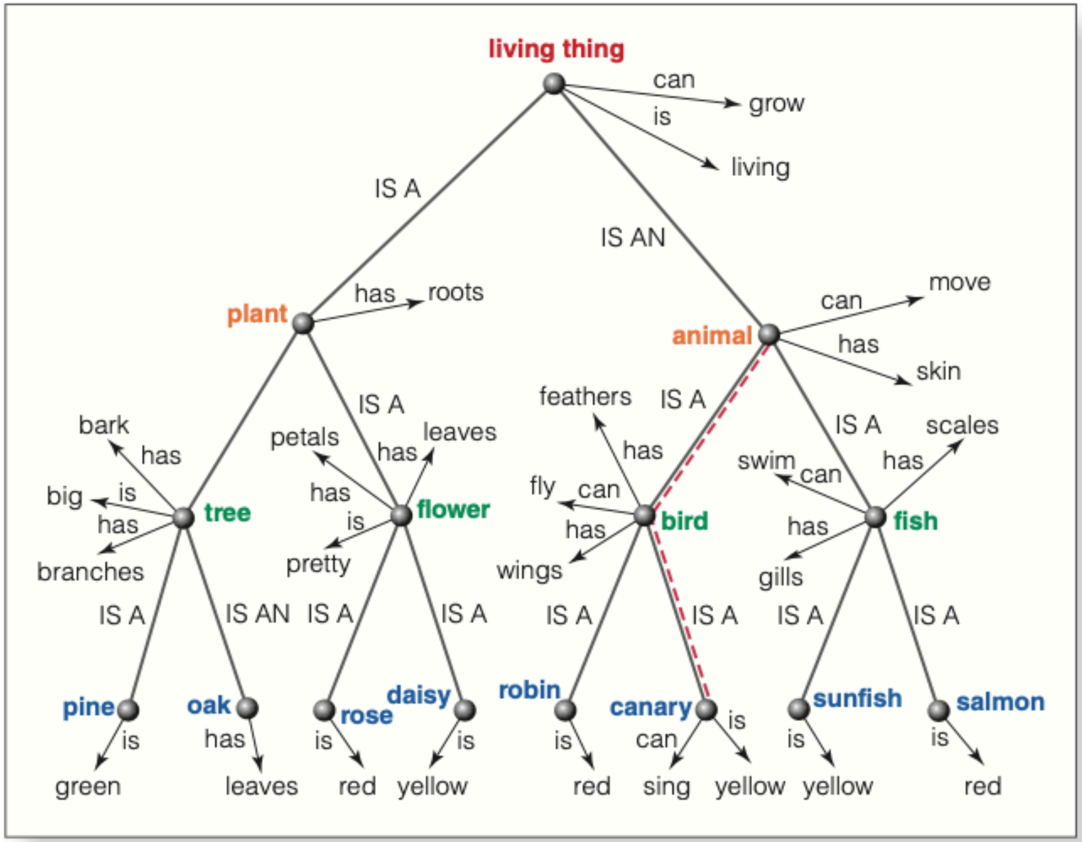


➤ **Figure 9.8** Levels of categories for (a) furniture and (b) vehicle. Rosch provided evidence for the idea that the basic level is "psychologically privileged."

- Basic level: optimal balance between specification and abstraction

(Rosch 1975; Goldstein & van Hoof 2021, p. 273-274)

Collins and Quillian’s semantic hierarchy



➤ **Figure 9.12** Collins and Quillian’s (1969) semantic network. Specific concepts are indicated in color. Properties of concepts are indicated at the nodes for each concept. Additional properties of a concept can be determined by moving up the network, along the lines connecting the concepts. For example, moving from “canary” up to “bird” indicates that canaries have feathers and wings and can fly. The dashed lines indicate the distance in the network from canary to bird and from bird to animal.

(Source: Adapted from T. T. Rogers & J. L. McClelland, 2004)

(Goldstein & van Hoof 2021, p. 278)

Connectionism

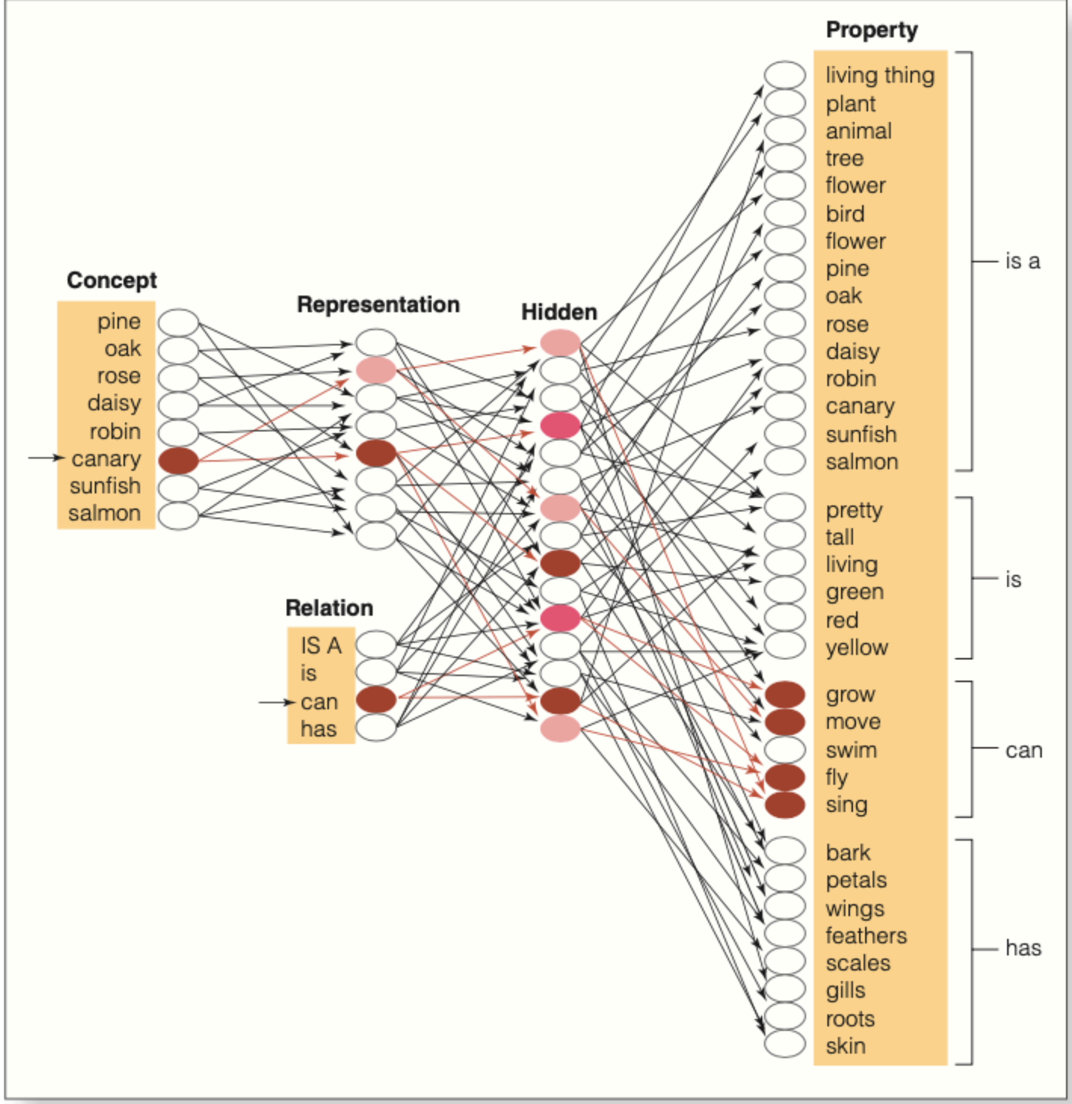


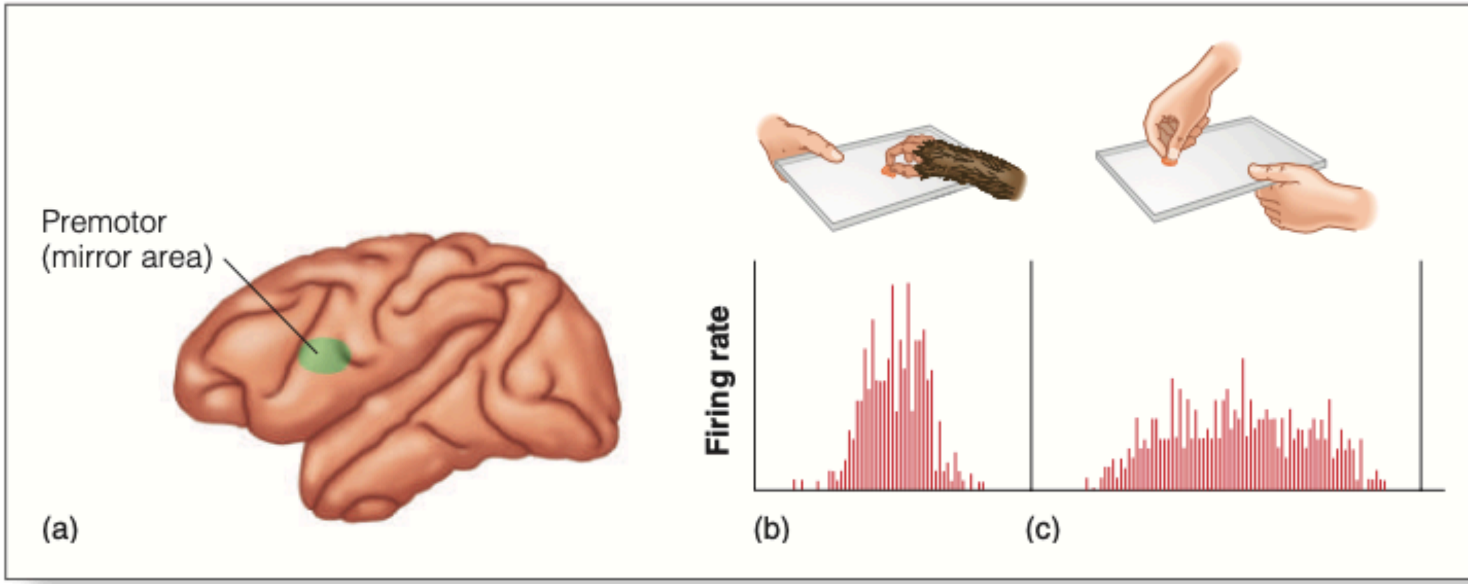
Figure 9.18 A connectionist network. Activation of an item unit ("canary") and a relation unit (*can*) causes activity to travel through the network that eventually results in activation of the property units *grow, move, fly*, and *sing*, associated with "canary can." Shading indicates the activity of the units, with darker shading indicating more activity. Note that only a few of the units and connections that would be activated by "canary" and *can* are shown as being activated. In the actual network, many more units and connections would be activated.

(Source: T. T. Rogers & J. L. McClelland, 2004)

(Goldstein & van Hoof 2021, p. 284)

Cognitive Science
Aarhus University

Embodied representations: mirror neurons

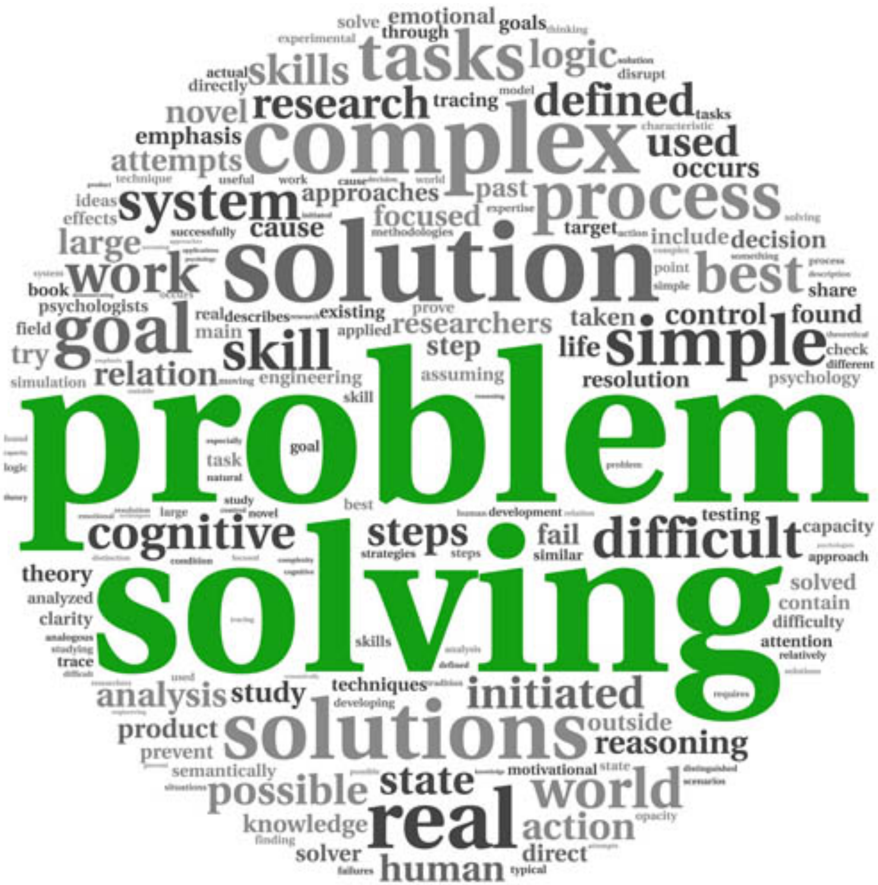


➤ **Figure 3.35** (a) Location of the monkey's premotor cortex. (b) Responses of a mirror neuron when the monkey grasps food on a tray and (c) when the monkey watches the experimenter grasp the food.

(Source: Rizzolatti et al., 2000)

(Goldstein & van Hoof 2021, p. 292)

Chapter 12: Problem solving



What is a problem?

- A problem occurs when there is an obstacle between a present state and a goal

(Goldstein & van Hoof 2021, p. 369)

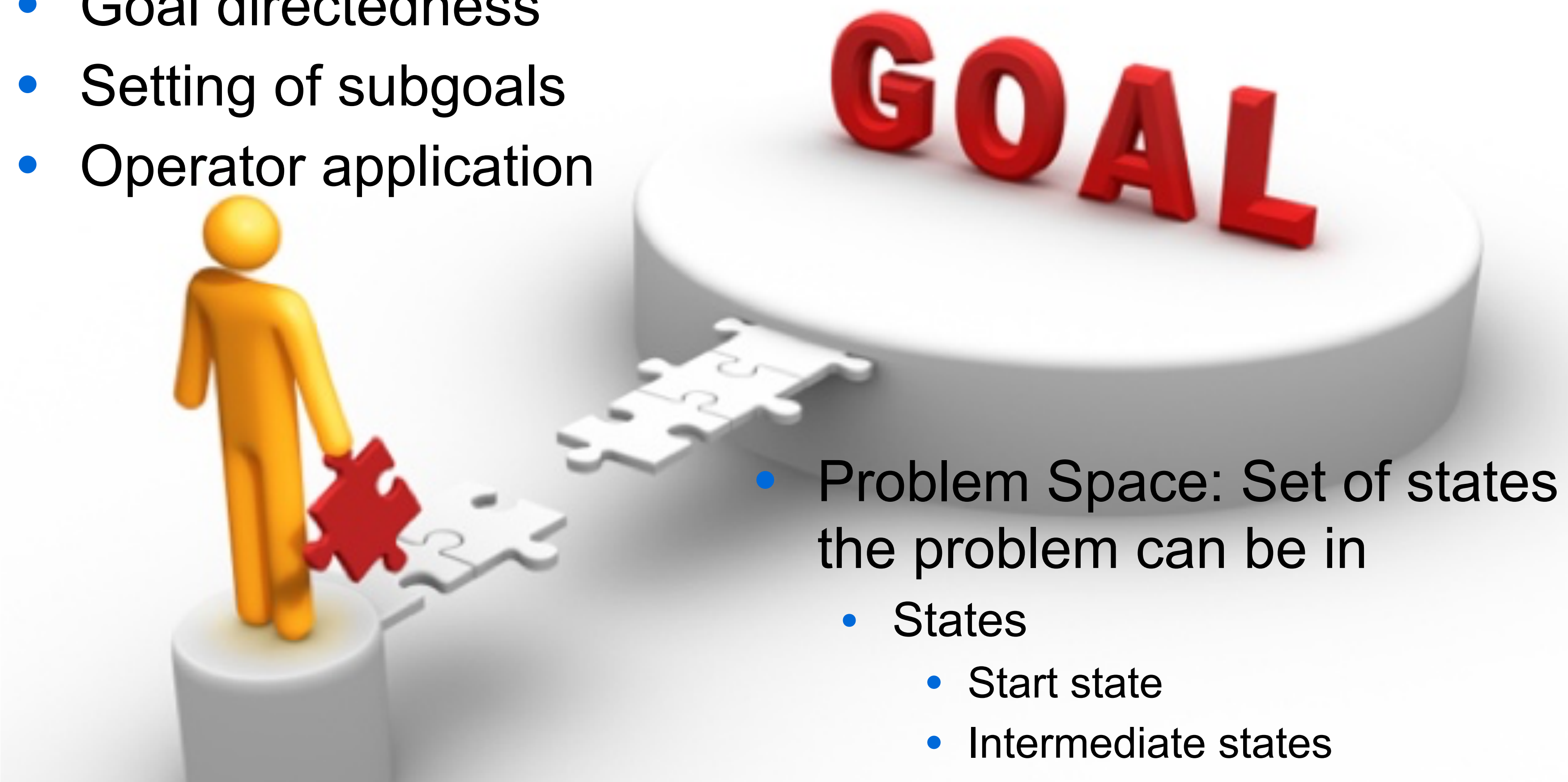
Descriptive and prescriptive approaches

- Descriptive
  - Investigate how cognitive systems solve problems
- Prescriptive
  - Investigate how cognitive systems can optimise problem solving

- Cognitive science covers a middle ground due to its ties with both psychology (primarily descriptive) and computer science (primarily prescriptive)

Characteristics of cognitive problem solving

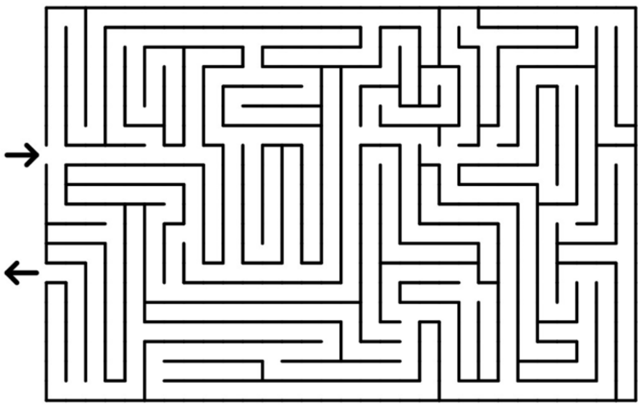
- Goal directedness
- Setting of subgoals
- Operator application



- Problem Space: Set of states the problem can be in
  - States
    - Start state
    - Intermediate states
    - Goal state

(Goldstein & van Hoof 2021, p. 378-)

Well- and Ill-defined problems



- Problems can be classified into two different types (ill-defined and well-defined) from which appropriate solutions are to be made.
  - Well-defined problems have specific goals, clearly defined solution paths, and clear expected solutions.
  - Ill-defined problems are those that do not have clear goals, solution paths, or expected solution.

Problem solving IRL

- Human problems are most often ill-defined.

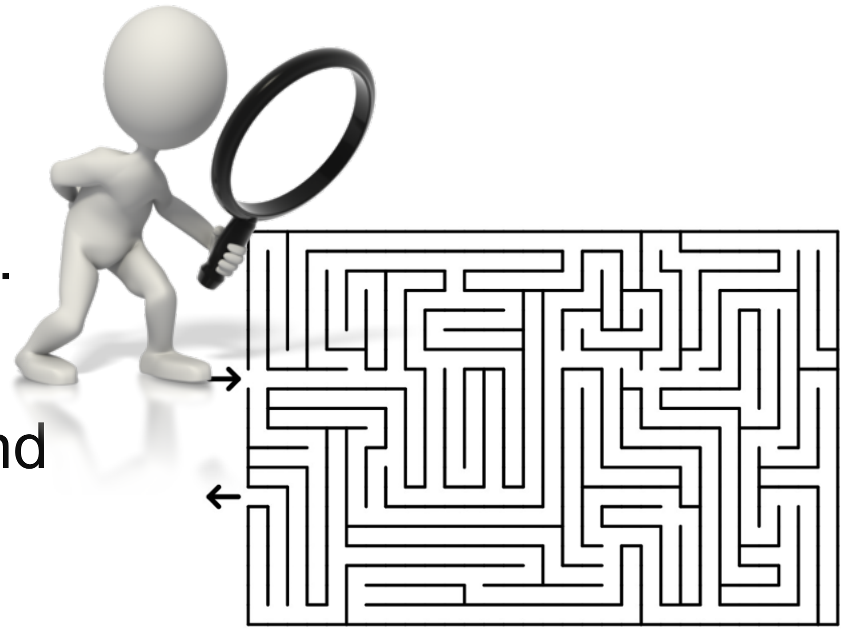
Insight, creativity, fixedness

- Insight learning may be broken down into smaller units.
- What appears to be a very complex solution, may be a combination of simpler learned skills.
- Creativity may be (partly) defined as putting together known skills in a novel fashion.
- Functional fixedness is the inability to apply known skills in novel contexts
  - e.g. Dunckers candle problem

(Goldstein & van Hoof 2021, p. 374-)

The Nature of Problem Solving: Search

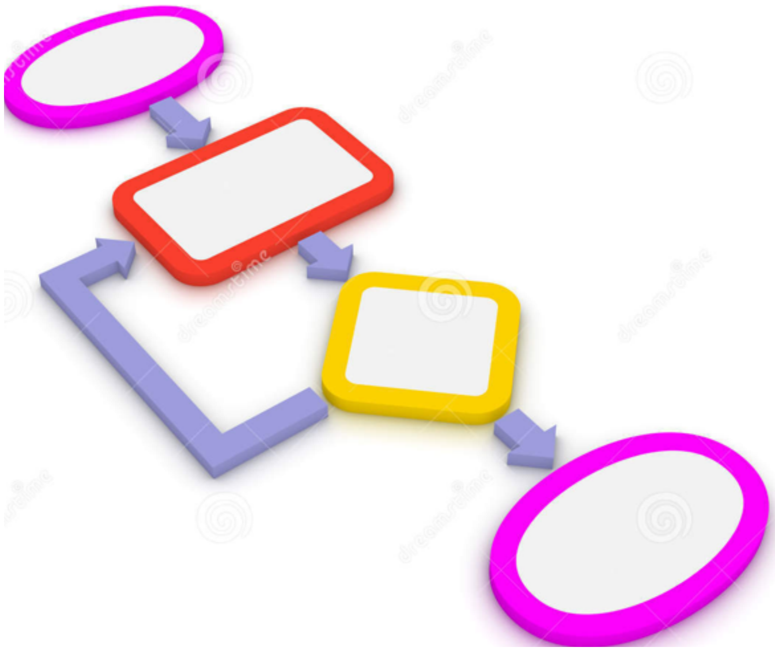
The challenge is to find some sequence of operators in the problem space that leads from the start state to the goal state.



- SEARCH
  - The problem solver must find the path through a maze of states.
  - May involve constructing search trees (set of states that can be reached by applying operator to a start state)

(Goldstein & van Hoof 2021, p. 378-)

Sequence of operations: Algorithm



- An algorithm is an effective method that can be expressed within a finite amount of space and time and in a well-defined formal language for calculating a function. Starting from an initial state and initial input (perhaps empty), the instructions describe a computation that, when executed, proceeds through a finite number of well-defined successive states, eventually producing "output"

- https://en.wikipedia.org/wiki/Algorithm

Take-home messages

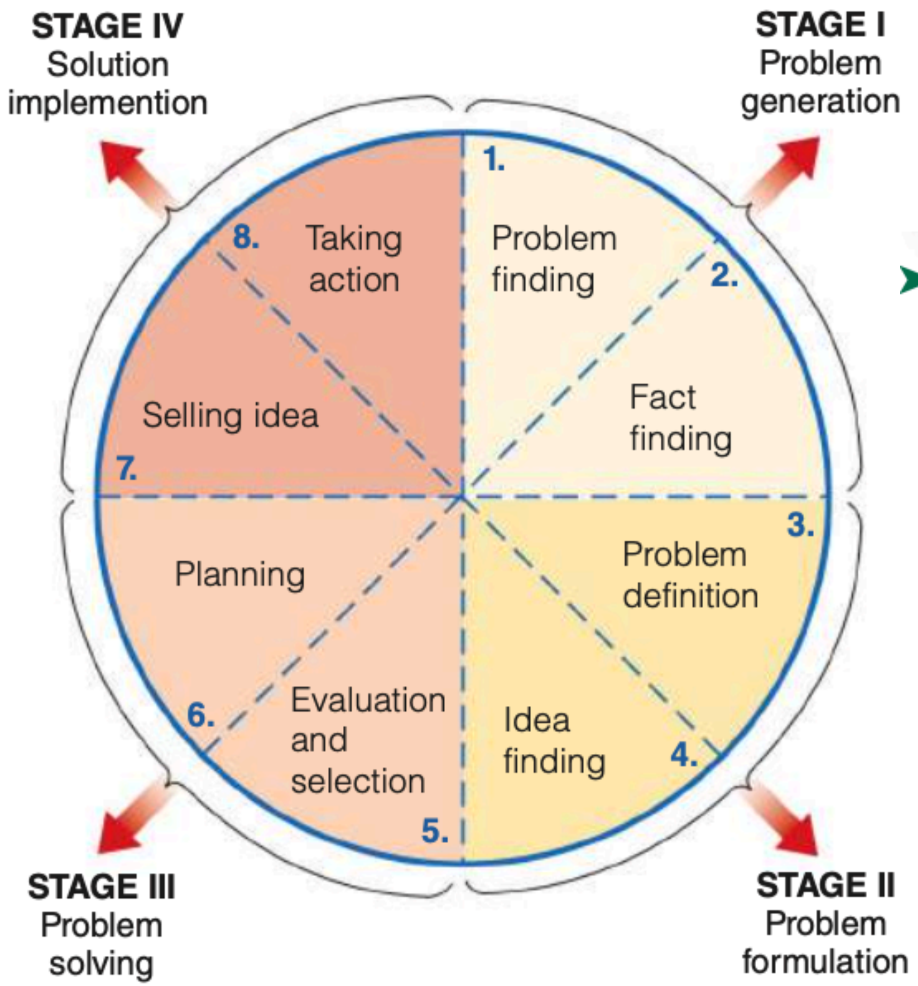
- Cognition as Information-processing forms a link between human problem solving and computation.
- A generalised solution is an algorithm
- Finding the shortest path from initial state to goal state is an optimisation process, i.e. prescriptive

(Goldstein & van Hoof 2021, p. 374-)

What is expertise?

The use of memory in problem solving!

Problem solving as a process



➤ **Figure 12.22** Problem solving process proposed by Basadur et al. (2000). Basadur proposes four steps, each of which is divided into two processes. For example, Stage II, problem formulation, consists of two steps: defining the problem and finding ideas.

(Source: Based on M. Basadur, M. Runco, & L. A. Vega, 2000)

(Goldstein & van Hoof 2021, p. 398)

Chapter 13: Judgment, Reasoning and Problem solving

Certain decisions

Action

Current state → Goal state

If you don't perform the action, you won't attain the goal

Decisions under uncertainty

- Goals

- Be a professor
- Increase wealth
- Prolong life

- Do PhD
- Invest
- Receive a treatment

Decisions under uncertainty are far more common
Two questions for science:
1) How should we use information to make decisions? (Prescriptive models of Judgement)
2) How do we make decisions? (Descriptive and explanatory models of Choice)

Bayes' Rule

Likelihood

How probable is the evidence given that our hypothesis is true?

Prior

How probable was our hypothesis *before* observing the evidence?

$$P(H \mid e) = \frac{P(e \mid H)\,P(H)}{P(e)}$$

Posterior

How probable is our hypothesis given the observed evidence?
(Not directly computable)

Marginal

How probable is the new evidence under all possible hypotheses?
$P(e) = \sum P(e \mid H_i)\,P(H_i)$

Bayesian Inference & Judgement

- ***Rational norm*** for making ***probabilistic inferences***
- ***Prescriptive model*** for reasoning about ***probabilities***
- Prescriptive model for ***judgement under uncertainty***

What about cognition?

- Two common errors of probabilitic reasoning
  - Base rate neglect
    - Failing to take into account how frequent an event is (the prior)
  - Availability heuristic
    - When subjectively estimated probabilities are based on salient cases or examples…

Uncertain decisions

You should be indifferent between the two choices

40% success
p = .4

EV = .4 x 10 = 4

Action

Goal state

$10

Current state

Different Probabilities

Action

Goal state

$20

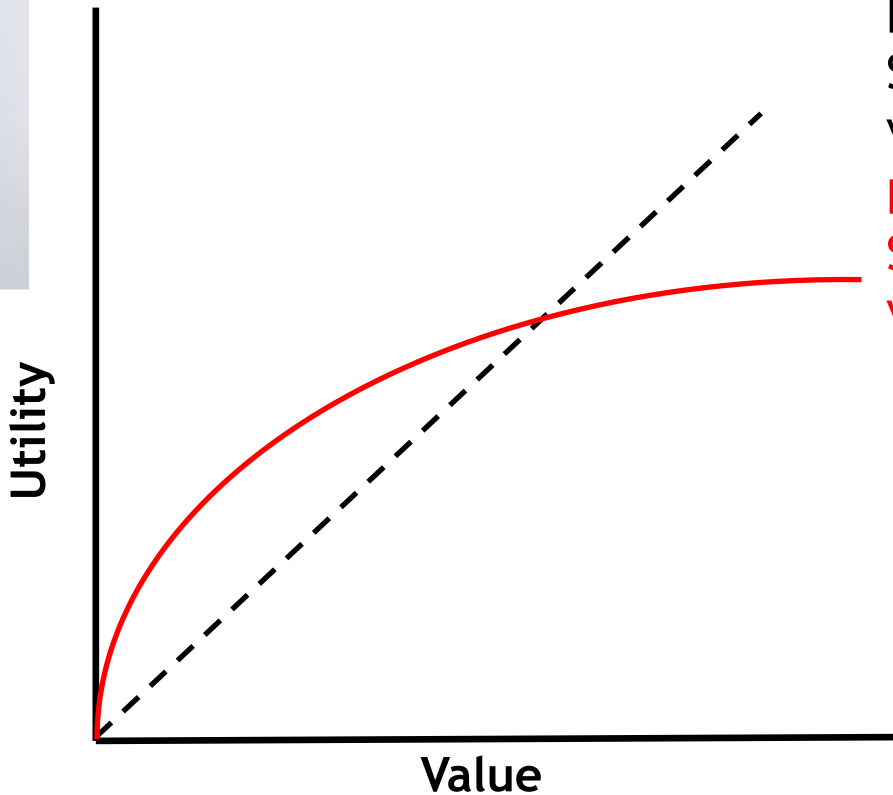
20% success
p = .2

EV = .2 x 20 = 4

YOUR CHOICE WILL DEPEND ON
1) The frame
2) Your endowment
3) Your preference for risk

- Which goal state should I persue with my actions?
- What is the relative **VALUE** of different actions?
- What value should I **EXPECT** from different goal states?
- **EXPECTED VALUE THEORY**

Utility functions

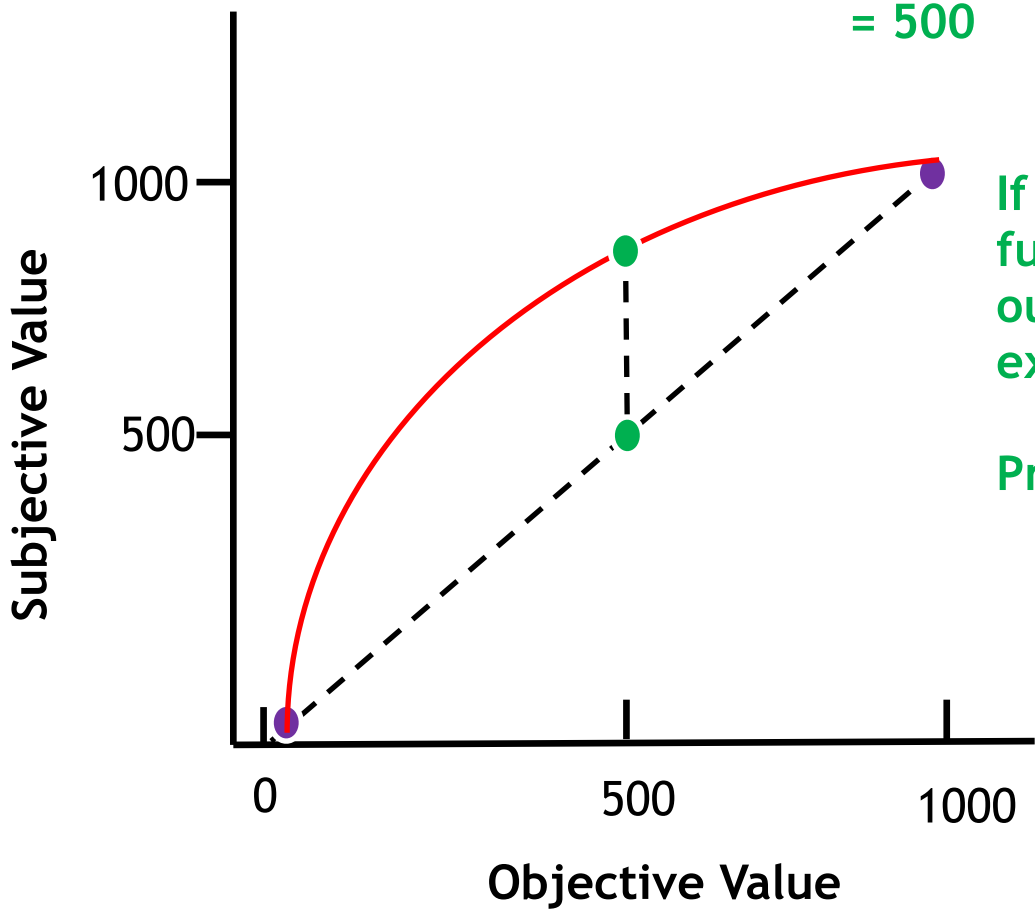


EV Theory Assumption:
Subjective Value = Objective value

EU Theory Assumption:
Subjective Value = f(Objective value)

Risk Aversion

Expected value of the lottery
PA*VA + PB*VB
= (.5*0) + (.5*1000)
= 500



If the point on the utility function for the certain outcome is higher than the expected value of the coin toss

Prefer the sure thing

Value Function

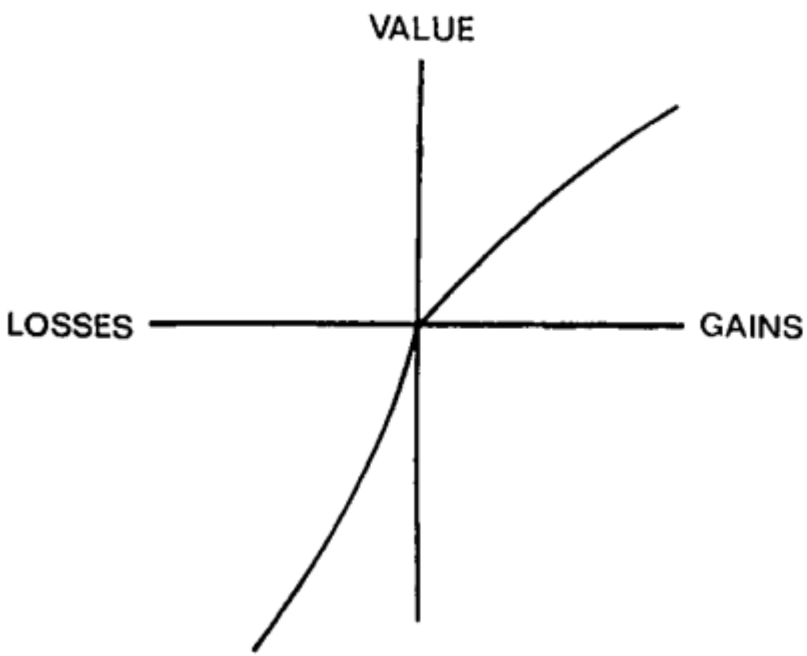


FIGURE 3.—A hypothetical value function

Convex for losses - risk seeking (prefer the risker option, if presented with a chance of a loss)

Also Steeper for losses - loss averse

Concave for gains – risk averse (prefer the surer option, if presented with a chance of a gain)

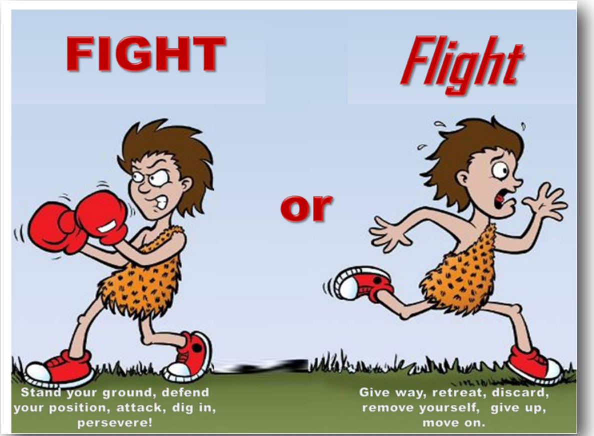
- Win Frame: I know we lost money. But don't pull your investment out of my company! We 're 90% sure we'll make you 1000kr next year! **RISK AVERSE**

- Loss Frame: I know we lost money. But don't pull your investment out of my company! We 're 10% sure we'll get your 1000kr ***back*** next year! **RISK SEEKING**

Chapter 16 (Ward): The Social Brain and Emotion

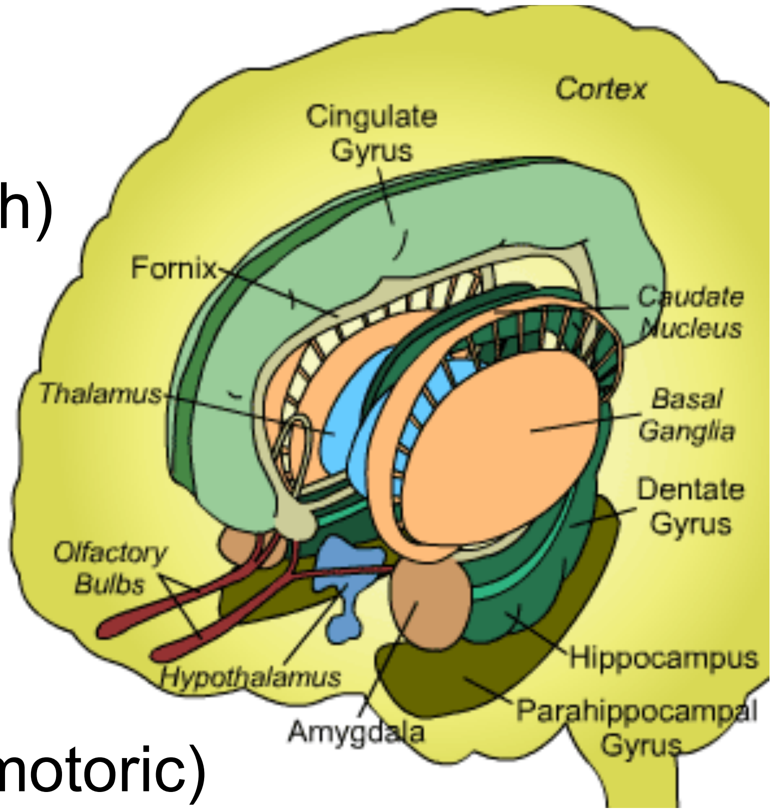
Emotions are Multi-Faceted

- Emotions have an hedonic value, i.e. they are subjectively liked or disliked
- Emotions have a particular 'feeling state' in terms of an internal bodily response (e.g. sweating, heart rate, hormone secretion)
- Emotions elicit particular external motor outcomes in the face and body (expressions). We can use these to infer the feelings of others.
- Emotions trigger action responses (e.g. fight-flight, system 1) and cognitive responses (e.g. increased attention, system 2)



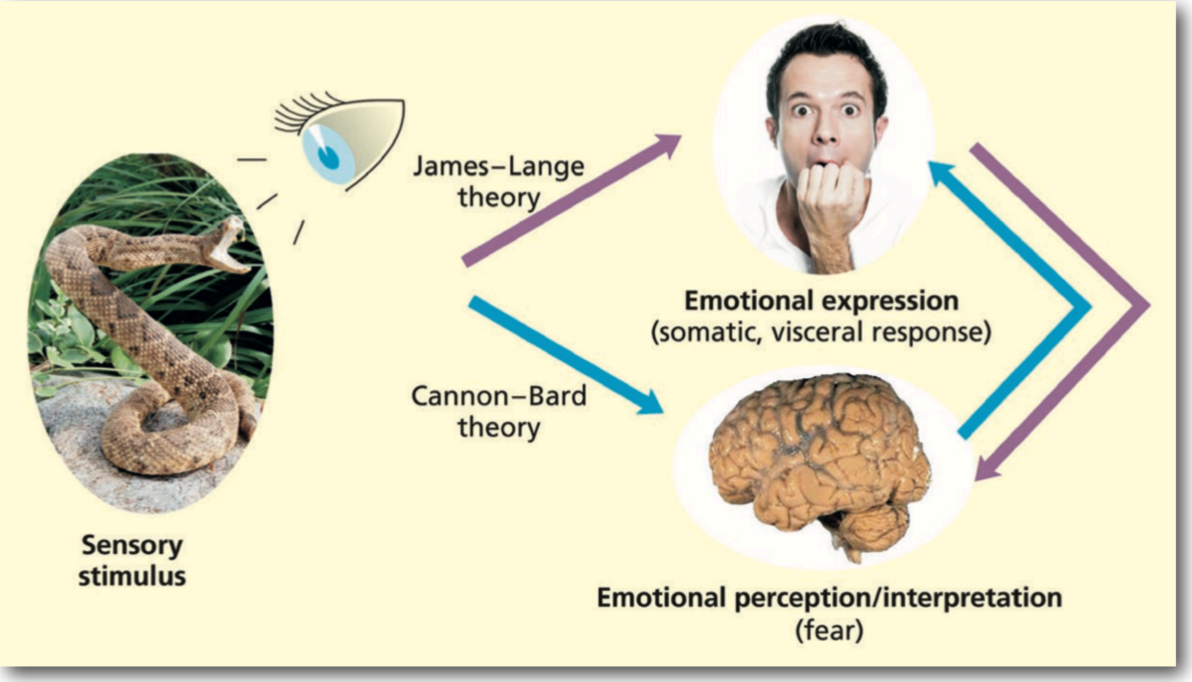
Key brain emotional brain regions

- amygdala
- cingulate cortex
- orbitofrontal cortex (e.g. Kringelbach)
- striatum (dopaminergic regions)
  - nucleus accumbens (ventral striatum)
  - caudate and others (dorsal striatum)
- brain stem
  - ventral tegmental area (dopamine),
  - raphe nuclei (seretonin)
- insula (e.g. taste, smell and gastromotoric)
- hypothalamus (autonomic nervous system)



Stimulus, Experience, or Response?

- James & Lange: The expression *is* the emotion, i.e. without crying, no sadness
- Cannon & Bard: Experience is independent of expression. The activation pattern of the thalamus is thought to play a special role.



Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th edition ed.). Hove: Psychology Press, p. 418

Darwin

- In 1872, Charles Darwin published "*The Expression of the Emotions in Man and Animals*" after 34 years of work on emotion
- It made two important contributions to the field.
  - 1) the notion that animal emotions are homologues for human emotions — an extension of Darwin's work on evolution.
  - 2) the proposal that a limited set of fundamental or 'basic' emotions are present across species and across cultures (including anger, fear, surprise and sadness).

http://darwin-online.org.uk/converted/published/1890_Expression_F1146/1890_Expression_F1146.html

(Dalgleish *Nat. Rev. Neurosci*. 2004, Ward 2021 p. 417)

Six basic emotional expressions

- Anger
- Fear
- Disgust
- Surprise
- Happiness
- Sadness

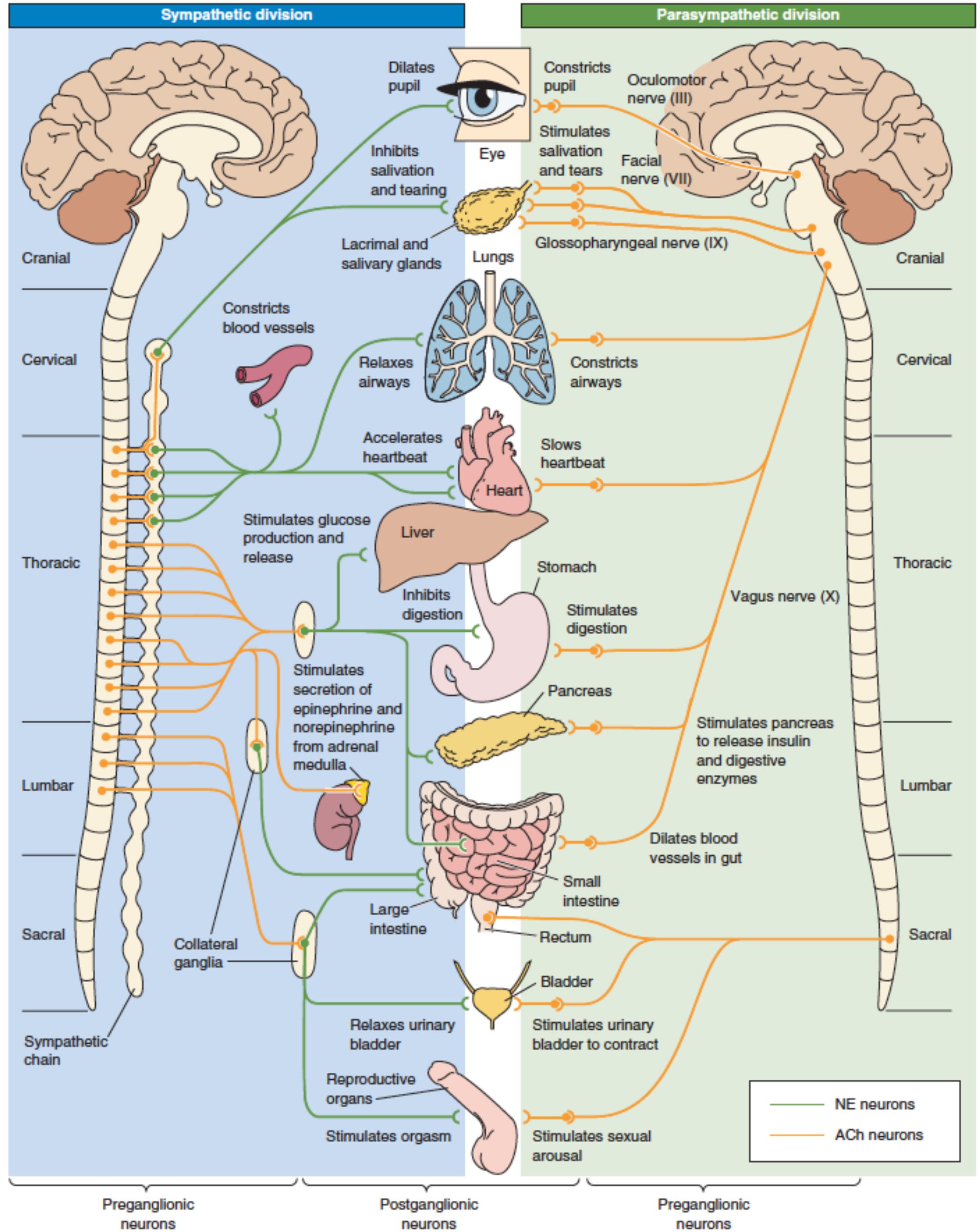
Nine features of basic emotion

TABLE 1
Characteristics which Distinguish Basic Emotions from One Another and from Other Affective Phenomena

	Basic with regard to:	
	Distinctive States	*Biological Contribution*
1. Distinctive universal signals	x	x
2. Presence in other primates		x
3. Distinctive physiology	x	x
4. Distinctive universals in antecedent events	x	x
5. Coherence among emotional response		x
6. Quick onset		x
7. Brief duration		x
8. Automatic appraisal		x
9. Unbidden occurrence		x

Ekman, P. (1992). "An argument for basic emotions." Cognition and Emotion **6**(3/4): 169-200.

The autonomic nervous system (ANS)



Bear, M. F., Conners, B. W., & Paradiso, M. A. (2007). *Neuroscience - Exploring the Brain* (3rd ed., p. 493). Lippincott Williams & Wilkins.

He blushed in anger!
Fear made him pale!

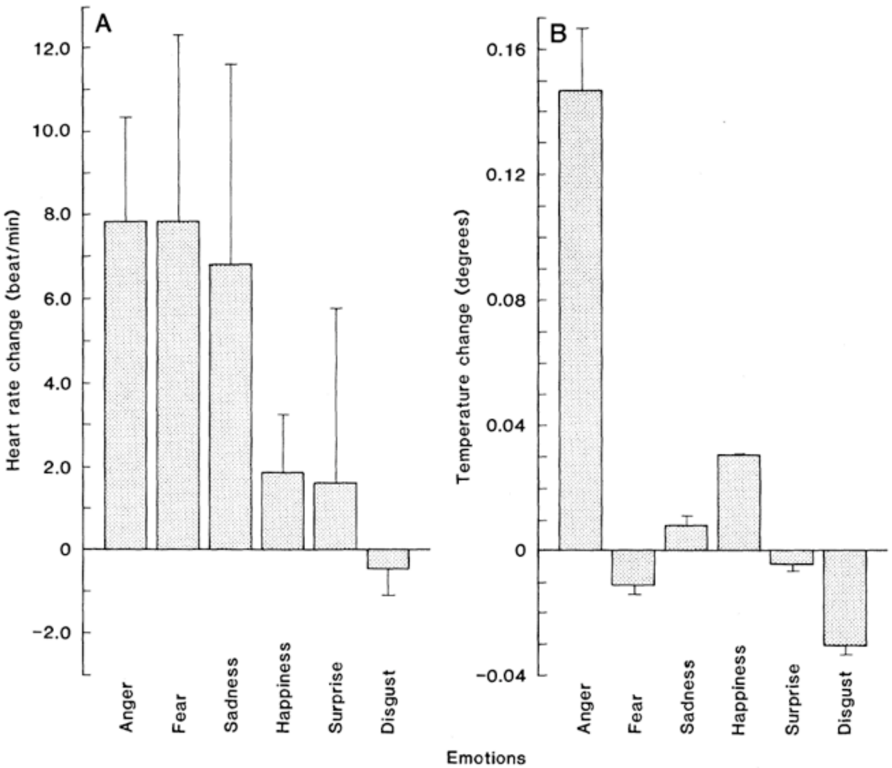
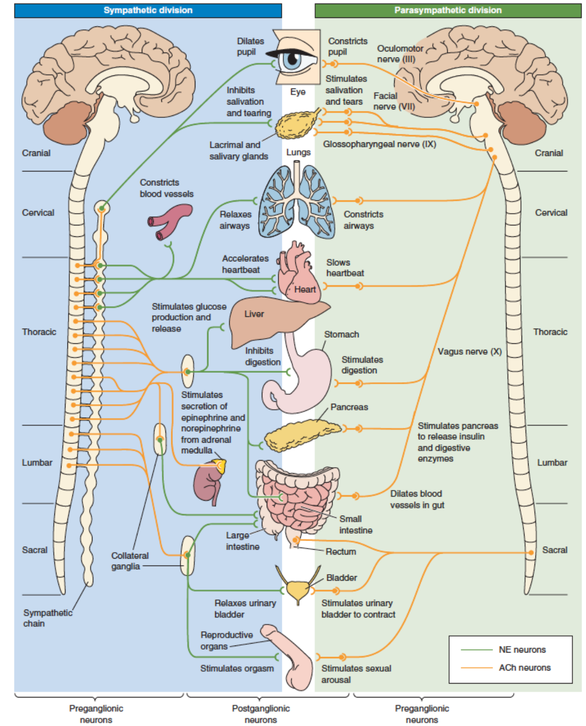
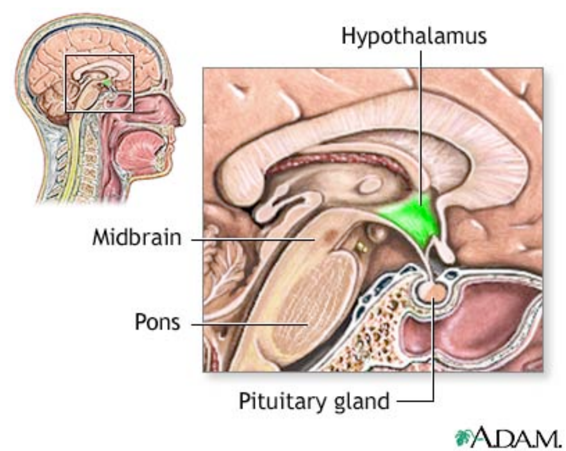


Fig. 3. Changes in (A) heart rate and (B) right finger temperature during the directed facial action task. Values are means ± standard errors. For heart rate, the changes associated with anger, fear, and sadness were all significantly greater ($P < 0.05$) than those for happiness, surprise, and disgust. For finger temperature, the change associated with anger was significantly different ($P < 0.05$) from that for all other emotions.

1209





Ekman et al. 1983

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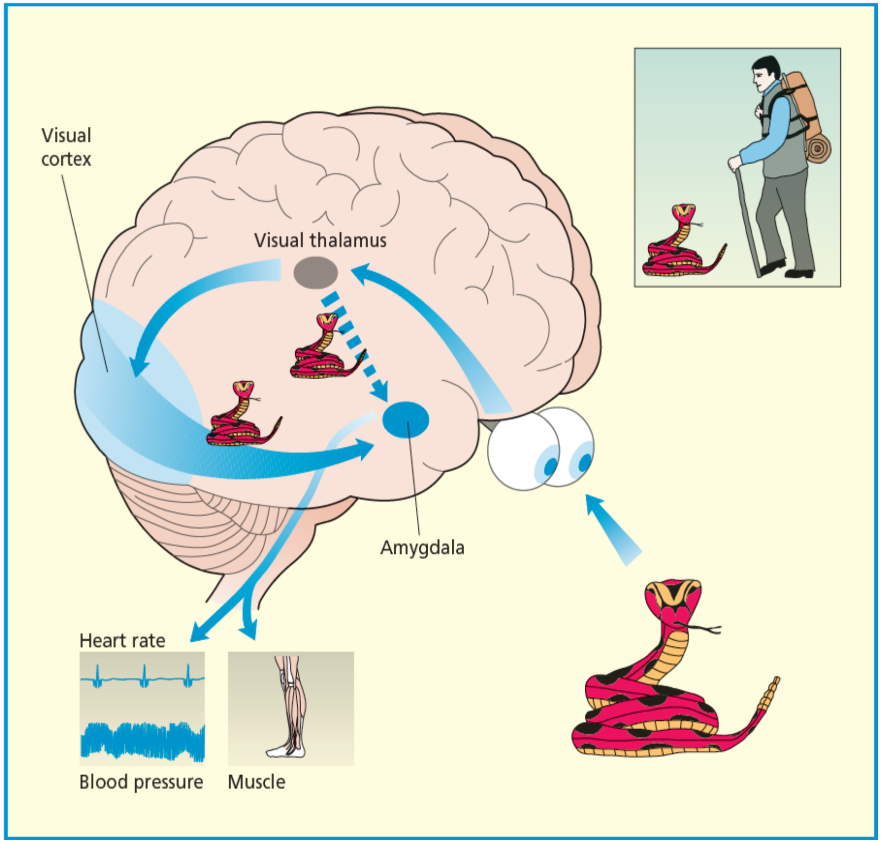
Aarhus University/ Aarhus University Hospital

Cognitive Science
Aarhus University

Fear and anxiety

The Amygdala and Recognition of Fear

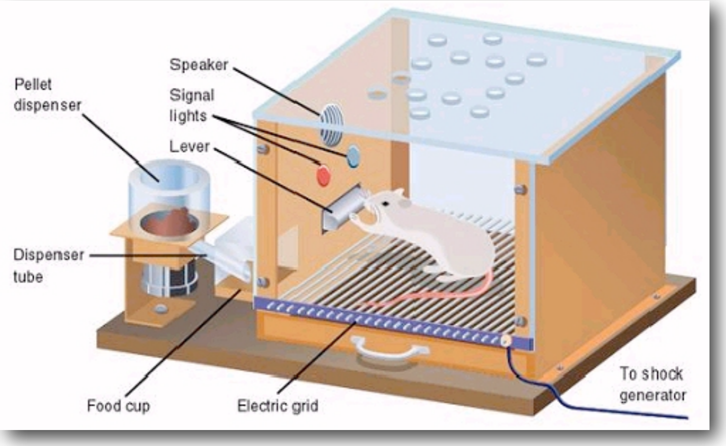
- Le Doux claims that there is a fast route to the amygdala that enables rapid detection of threat
- Some evidence from fMRI that amygdala activated by unconscious presentation of threatening stimuli (although fMRI doesn't provide information about timing)



Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 427). Hove: Psychology Press.

A behaviouristic account of emotion

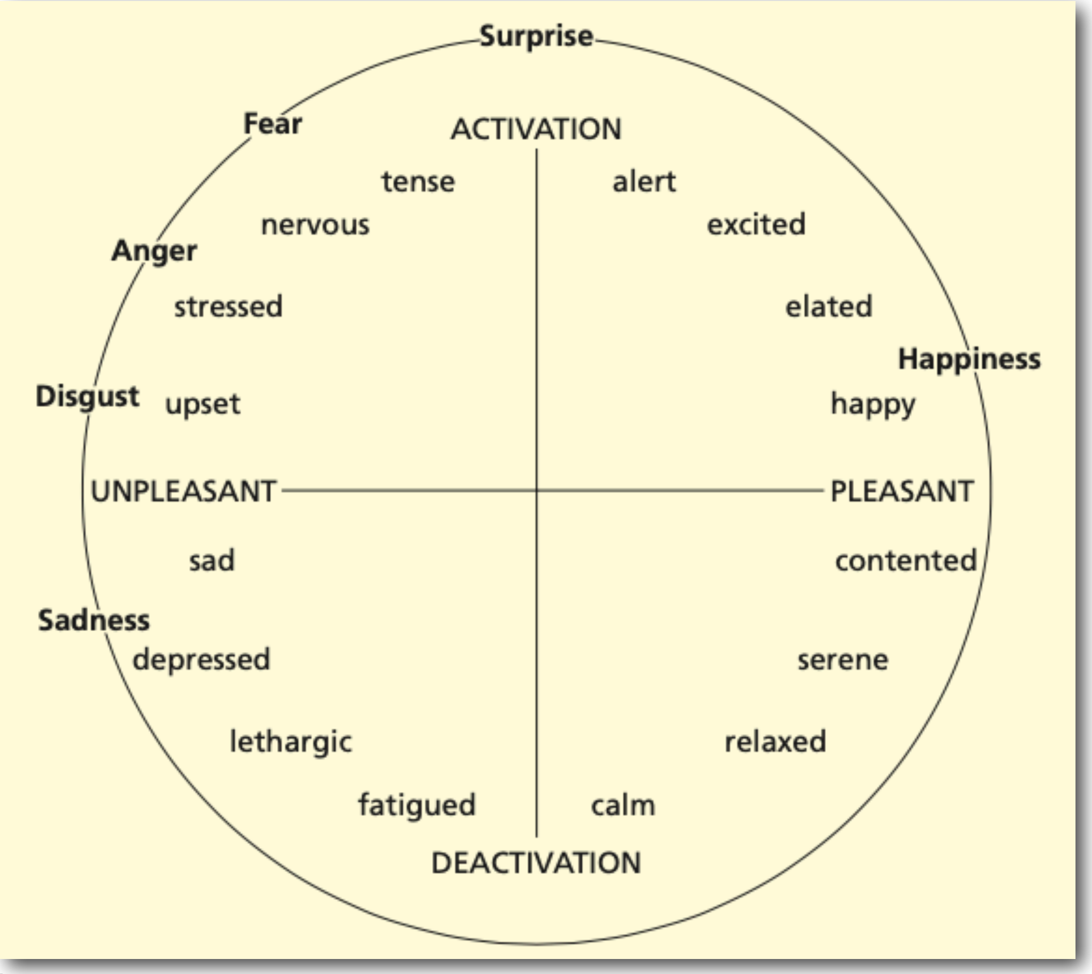
- Emotion = a state associated with stimuli that are
  - rewarding (i.e. that one works to obtain) or
  - punishing (i.e. that one works to avoid).
- These stimuli often have inherent survival value.
- Motivation = states in which rewards are sought and punishers are avoided



Ward, J. (2015). *The Students Guide to Cognitive Neuroscience* (3rd ed., p. 373). Hove: Psychology Press.

Other Approaches

- Two dimensions (Russell & Feldman-Barrett 1999)
  - Unpleasant-Pleasant
  - Deactivation - activation



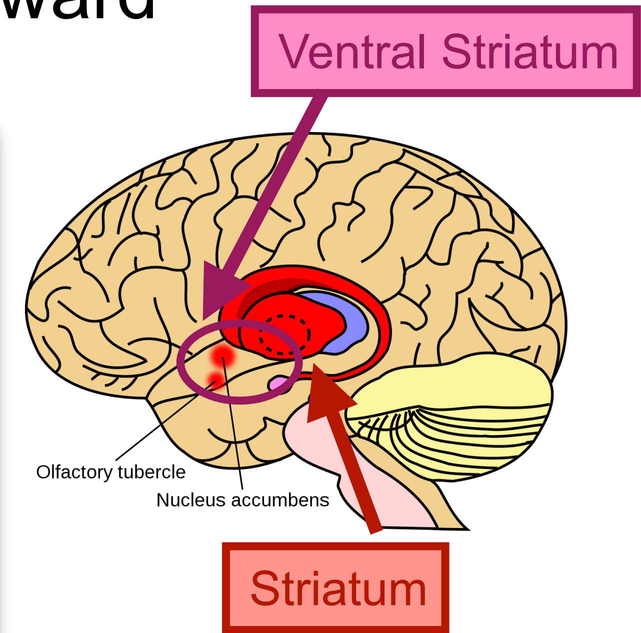
Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 422). Hove: Psychology Press.

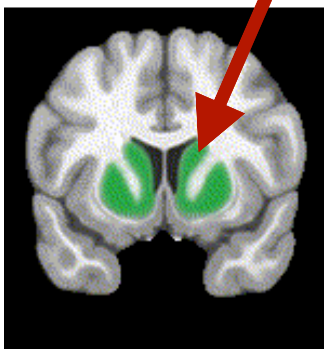
Reward

- Positive reinforcement

Ventral Striatum and Reward

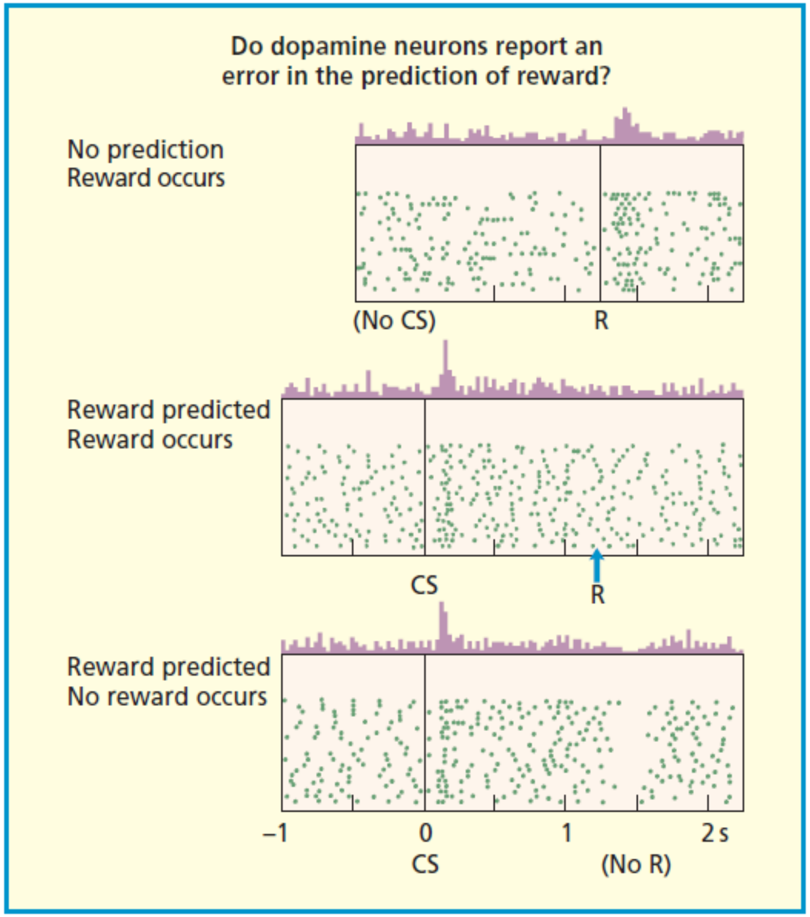
- Increased dopamine release when presented with secondary reinforcers paired with food, or when male rats 'presented' with a female
- In humans, implicated in hedonic aspects of drug use (e.g. cocaine)
- In human fMRI, activity in ventral striatum correlates with level of potential monetary reward



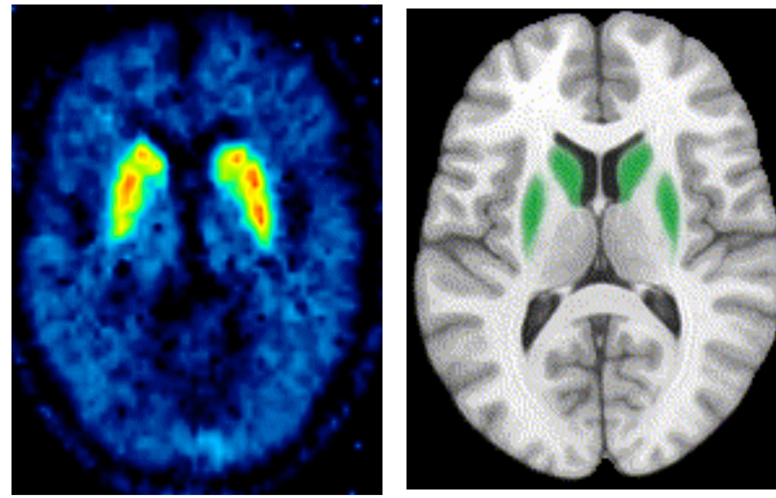


Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 433). Hove: Psychology Press.

Reward or Reward Prediction?



Single cell recordings



PET scan - striatum rich in Dopaminergic neurons

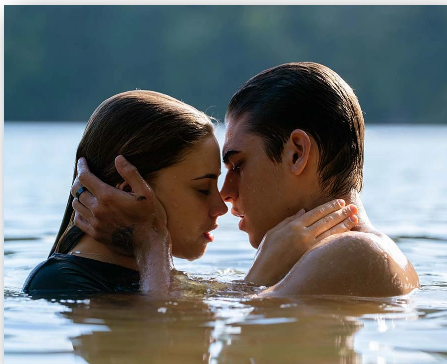
Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 433). Hove: Psychology Press.

Take home messages

- Emotions are IMPORTANT for cognitive science and neuroscience
- Emotion is linked to WHY behaviours and thoughts arise
  - Unconditioned and conditioned reinforcers (needs and dangers)
- Emotion regulation is COMPLEX and involves many interacting processes.
- Emotion is EVERYWHERE in the brain, but tightly coupled to evolutionarily old areas, such as amygdala and hypothalamus
- Much work to be done.

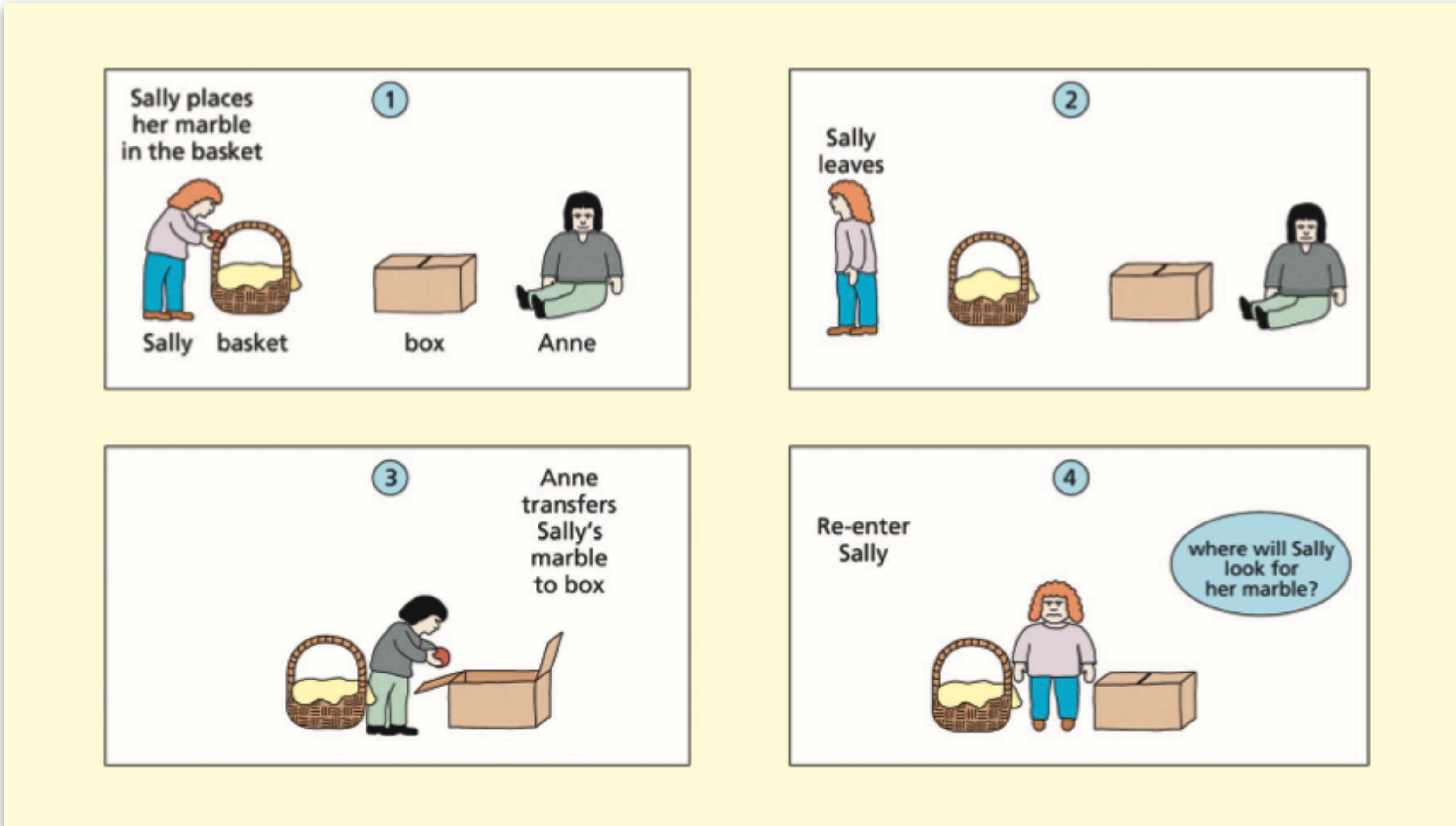
Social cognition

System 1 & 2 empathy



- The purpose of aesthetics has been defined, in part as “the awakening, intensifying, or maintaining of definite emotional states” (Lee 1913 p. 99-100).
- Audiences respond differently to narratives (e.g. thrillers vs. romantic comedies). This may originate in empathic dispositions (e.g. Keen 2006).
- In psychology a distinction between “cognitive” and “affective” empathy has been proposed (Shamay-Tsoory 2009).
- Cognitve empathy is thought to rely on “mentalizing” (Frith & Frith 2007) - the knowledge of other peoples thoughts.
- Affective empathy is thought to rely on automatic emotional contagion (Hatfield et al. 2009) which may rely on the mirror neuron system (Rizzolatti & Craighero 2004).
  - N.B. The mirror neuron theory would propose that cognitive empathy is a function of mirroring as well. But this need not be the case...

Theory of Mind: False belief task



Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 443). Hove: Psychology Press.

ToM deficits in ASD

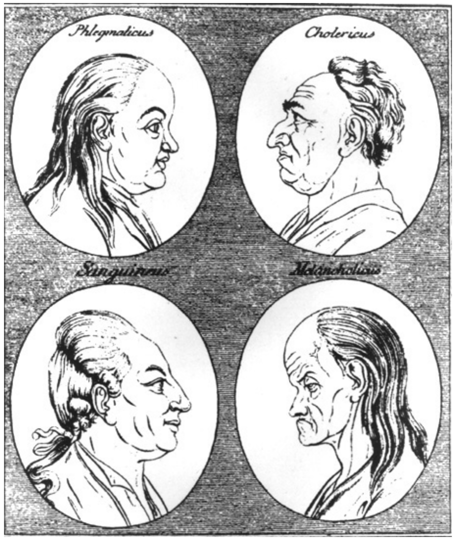
FIGURE 16.18: Children with autism are able to detect which person is looking at them (top), but are unable to infer behavior or desires from eye direction (bottom). For example, they are impaired when asked "which chocolate will Charlie take?" or "which one does Charlie want?".

- Social referencing important for social cognition
- The cooperative eye hypothesis

Ward, J. (2021). *The Students Guide to Cognitive Neuroscience* (4th ed., p. 438). Hove: Psychology Press.

Four temperaments

- Scientists and doctors have pondered over moods and personality profile for 2500 years
- Greek physician Hippocrates (c. 460 – c. 370 BC) described four temperaments as part of the ancient medical concept of humorism, that four bodily fluids affect human personality traits and behaviors.
- Four fundamental personality types:
  - sanguine
  - choleric
  - melancholic
  - phlegmatic.
- Humorism formed medicine for many centuries
- Ideas of stable personality types lives on in personality research
- Humorism is not so far from modern neuroscience, e.g. the idea that depression is caused by an imbalance in serotonin.



THE FOUR TEMPERAMENTS

The Four Humours Theory (Hippocrates & Galen)

Humour	Temperament	Element	Qualities	Characteristic / Personality
Blood	Sanguine	Air	Hot, moist	Courageous, hopeful, amorous
Yellow bile	Choleric	Fire	Hot, dry	Short tempered, ambitious
Black bile	Melancholy	Earth	Cold, dry	Introspective, sentimental
Phlegm	Phlegmatic	Water	Cold, moist	Calm, unemotional

CFIN
www.cfin.au.dk
The Danish National Research Foundation's
Center of Functionally Integrative Neuroscience
Aarhus University / Aarhus University Hospital
DENMARK

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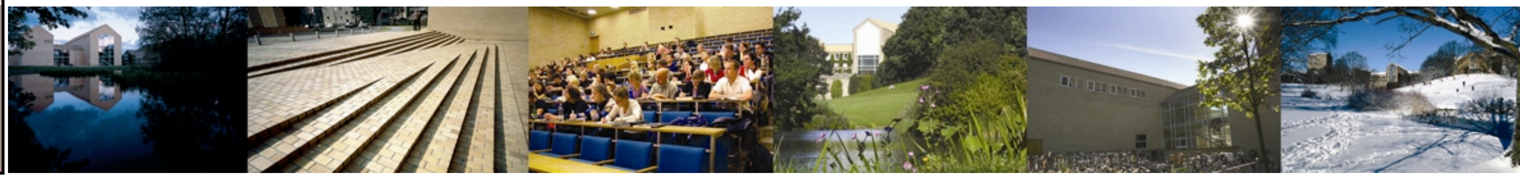
Aarhus University/ Aarhus University Hospital - DENMARK



Introduction to Cognitive Science
12. Summary

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Finding Operators: ANALOGY

- Process by which a problem solver maps the solution for one problem onto a solution for another problem
- Can be used if two problems have different surface, but similar deep structure
- E.g. Gick and Holyoak (1980)
  - Tumor problem
  - Fortress problem

(Goldstein & van Hoof 2021, p. 387-388)

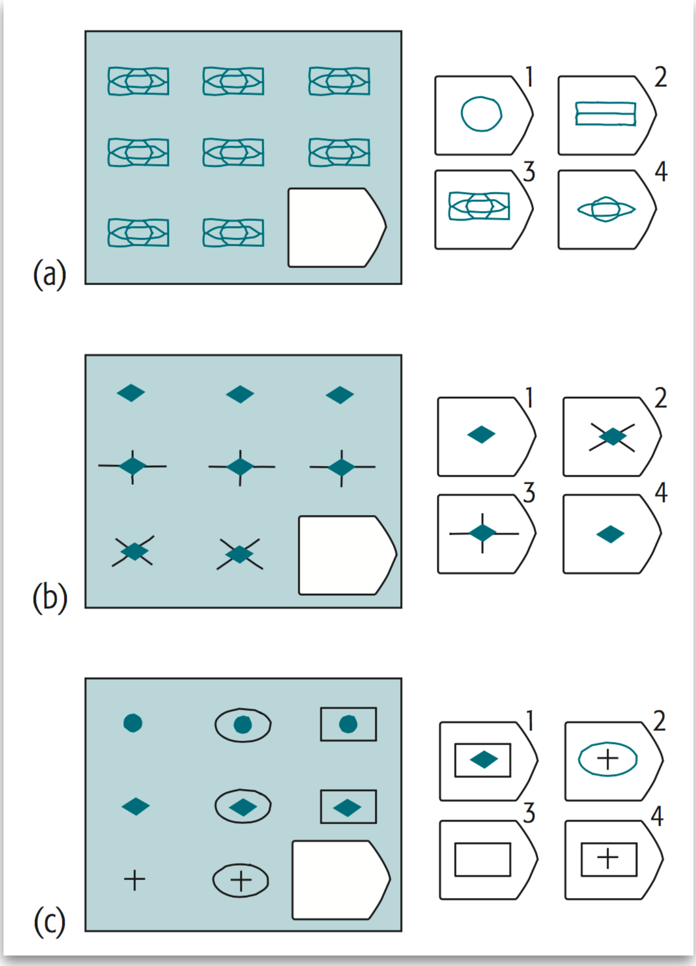
Fun (non)example

https://www.youtube.com/watch?v=pqIZDIxJgXw

The kick…

Difficulties in applying analogies

- Analogy involves noticing that a past problem solution is relevant
  - Participants had to be made aware that the fortress story was relevant for tumor problem
- Then mapping the elements from that solution to produce an operator for the current problem
- Analogical reasoning is used in IQ tests like Raven's progressive matrices



Anderson p. 190-191