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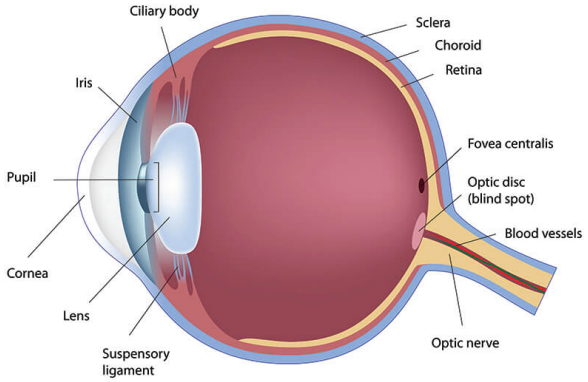
Chapter 3 - Perception

Week	(W3)
Date	
Files & Media	
Literature	
Topic	
Type	Reading

Sensation: information from the environment received by our sensory organs

Perception: experiences resulting from this → what our brain does with that information

- can change based on added information
- can involve a process similar to reasoning or problem solving
- can be based on a perceptual rule
- occurs so rapidly it seems automatic (but it's not)
- occurs in conjunction with action
- involves dynamic processes that accompany and support our actions



- is built on a foundation of information from the environment

Retina: the structure that lines the back of the eye and contains the receptors for seeing

Why human perception is unique/special: Difficulties in designing a “perceiving machine”

- the **image on the retina is ambiguous** as an infinite number of objects can create the same image as e. g. a book
- the perceptual system’s job is to determine the object “out there” that created the image on the retina
- **inverse projection problem**: the task of determining the object responsible for a particular image on the retina (as many possible objects can be associated with with a particular image on the retina)
- **problem of hidden objects**: occurs anytime one object obscures part of another object
  - people easily understand that the part of an object covered continues to exist
- **viewpoint invariance**: the ability to recognize an object seen from different viewpoints
  - computers have a difficulty with this

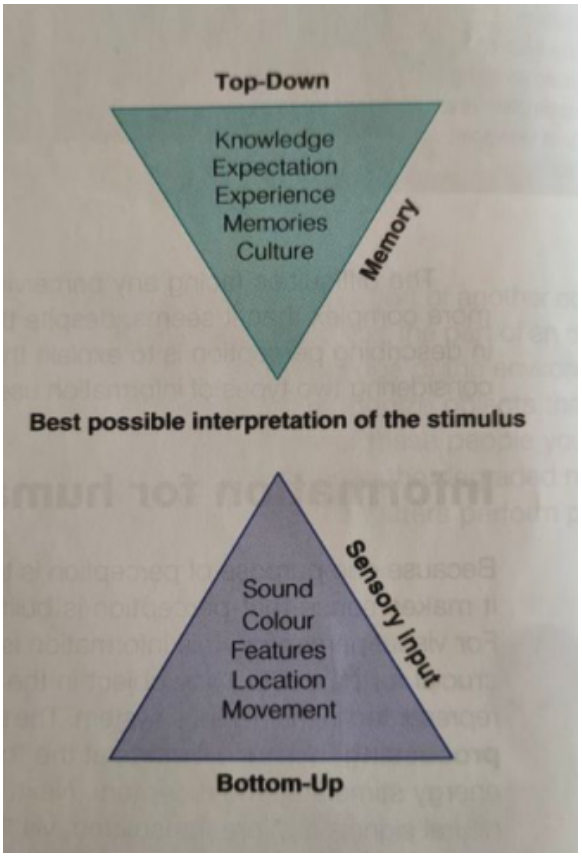
Information for human perception

- perception **is built on a foundation of information from the environment**
  - visual perception → this information = light
  - without light, objects will not be represented in the nervous system - the information from the light entering the eye is crucial
- **bottom-up processing**: the sequence of events from eye to brain
  - starts at the “bottom” of the system, when environmental energy stimulates the receptors
  - the receptors “translate”: environmental energy → neural

signals that are transmitted via the thalamus towards cortical brain areas that will further process and store it

    - perception also involves factors such as:
        - knowledge of the environment
        - expectations people bring into the perceptual situation
        - people's attention to specific stimuli

- This additional information is the basis of top-down processing
- **top-down processing**: processing that originates in the brain, the "top" of the perceptual system



Top-down processing in perception

The role of context in object recognition:

- Oliva and Torralba (2007): "the multiple personalities of a blob" → people perceived the same blob as different things depending on orientation and setting

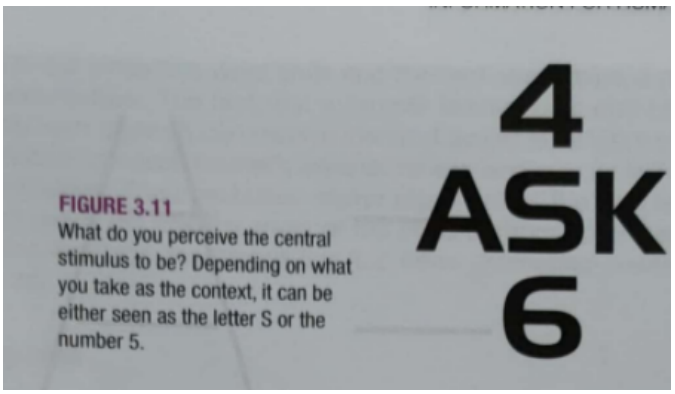
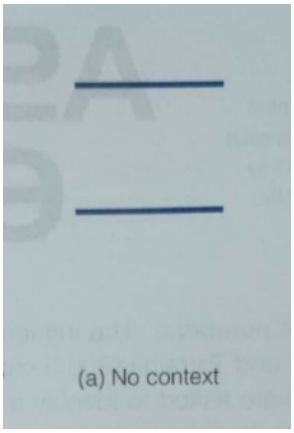
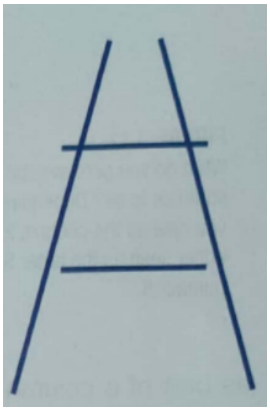


FIGURE 3.11
What do you perceive the central stimulus to be? Depending on what you take as the context, it can be either seen as the letter S or the number 5.

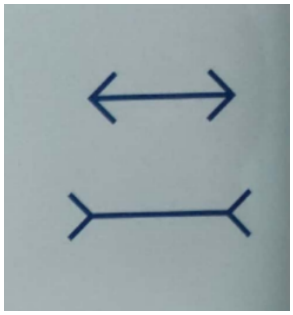
Row or column?

- Rice et al. found participants using body information (hair length, neck, shoulders, height) when facial features were ambiguous
    - they were not aware of using this strategy, claiming they've only relied o facial features
- Calbi et al. → video fragments (positive or negative) affected how participants rated neutral facial expressions





Ponzo illusion



Müller-lyer illusion

- Provided the different context, we perceive these same-length lines to be different

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- When hearing dialogues in a foreign language, it will sound like an unbroken string of sound → sound signal for speech is generally continuous, the breaks in sounds do not necessarily occur between words
- Speech segmentation: someone who knows the language will be able to tell when one word ends and the other begins
- A listener familiar with English and another with Spanish can receive identical sound stimuli but experience different perceptions
    - each listener's experience (or lack of it) with language is influencing their perception
    - continuous sound signal enters ears → triggers signals that are sent towards the speech areas of the brain (bottom-up processing)
    - if a listener understands a language, that knowledge (top-down processing) creates the perception of individual words

Pain

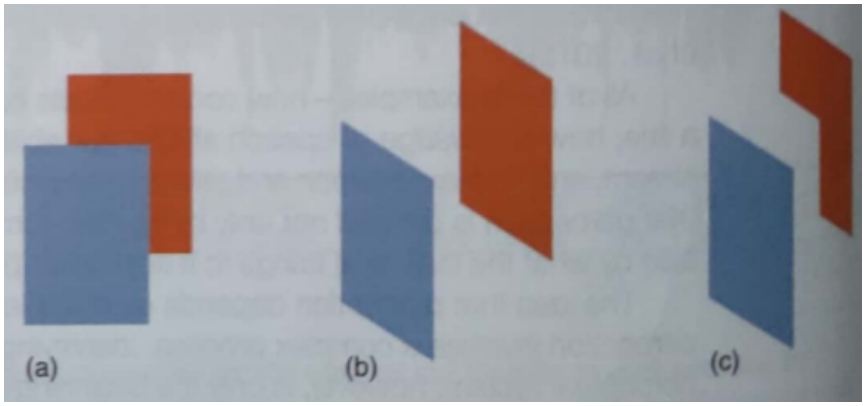
- direct pathway model: pain occurs when nociceptors (receptors in the skin) are stimulated and send their signals on a direct pathway from the skin to the brain - bottom-up process
- further research (60s) has shown that the level and presence of pain is affected by additional factors other than stimulation
  - e. g. runner finishing race with a broken toe
  - feeling the pain only after seeing the wound
- modern research - pain can be influenced by:
  - what a person expects
    - patients with pathological pain getting real relief from taking a placebo
  - where they direct their attention
  - whether distracting stimuli are present
    - the activity of serious gaming could reduce pain behaviour and subjective distress in children undergoing wound care
- **context, knowledge, expectation and attention can influence perception** → illustration of how perception is not only created by signals from the environment but also what the individual brings to it

Four conceptions of object perception

How perceivers use the information? Because the perceptual system does something with it

Helmholtz

- 19th century
- image on the retina is ambiguous: a particular pattern of stimulation on the retina can be caused by a large number of objects in the environment



- How does the perceptual system “decide” that this pattern was created by overlapping rectangles?

Likelihood principle: we perceive the object that is most likely to have caused the pattern of stimuli we have received

- what’s most likely is based on a process called

Unconscious inference: our perceptions are the result of unconscious assumptions/inferences that we make about the environment

- resembles the process of solving a problem, the
  - problem → determining which object has caused a particular pattern,
  - solution → a process of applying the perceiver’s knowledge of the environment in order to infer
- this process **happens rapidly and unconsciously**; even though they feel automatic, they are a result of a rapid process

The Gestalt principles of organization

- ~30 years after Helmholtz’s unconscious inference
- Gestalt psychologists: perception is determined by specific **organizing principles**
- their approach originated as a reaction to Wundt’s structuralism → the whole is more than the sum of its

parts (experience is not just simply adding up elements)

- “gestalt” = “whole”
- They proposed a number of principles of perceptual organization to explain the way elements are grouped together to form larger objects

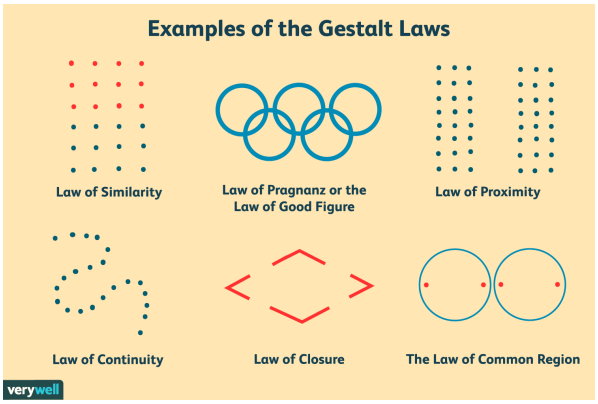
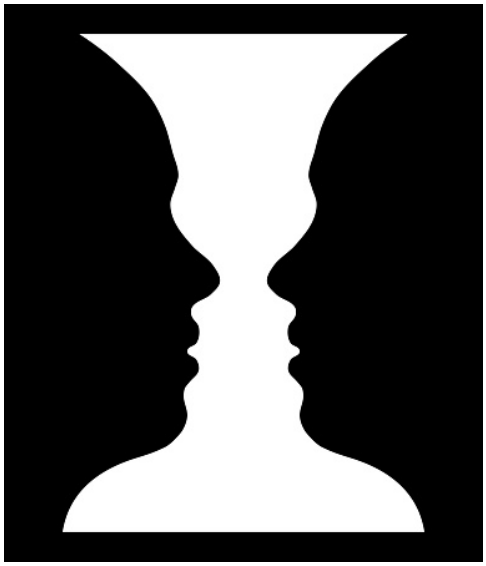


Figure-ground principle

- we perceive something by grouping elements in such a way that a distinction is made between what is in the foreground and what’s in the background



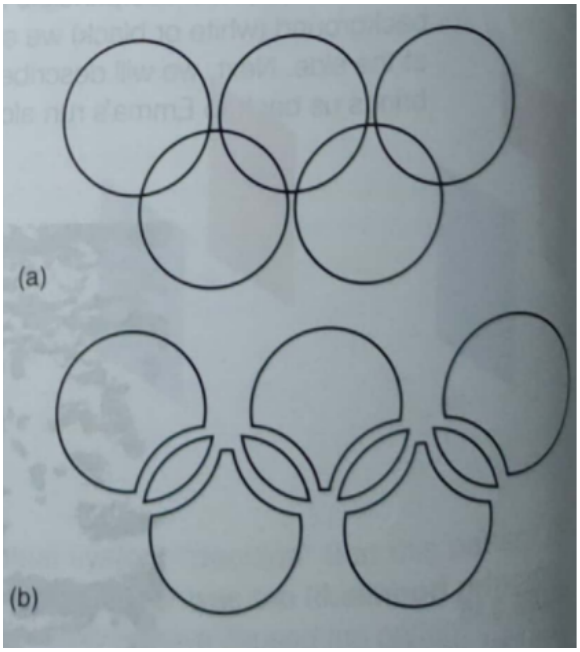
Rubin’s vase

Good continuation

- Points that, when connected, result straight or smoothly curving lines are seen as belonging together, and the lines tend to be seen in such a way as o follow the smoothest path.
- Objects that are overlapped by other objects are perceived as continuing behind the overlapping object

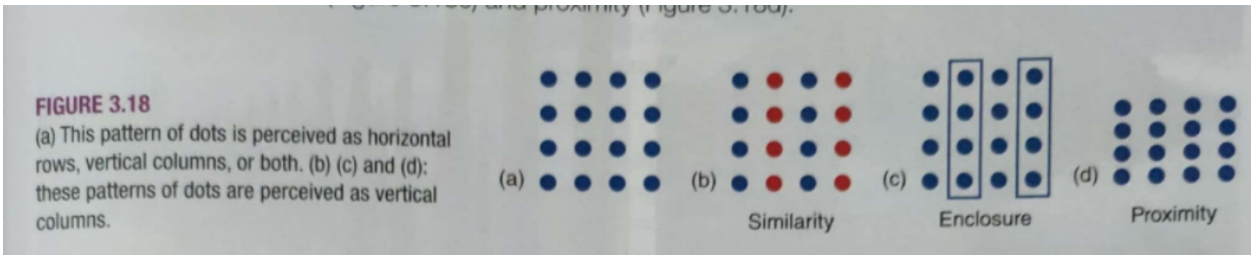
Pragnanz

- law of pragnanz/principle of good figure/principle of simplicity/law of simplicity
- the perceptual field and objects within it will take on the simplest and most encompassing structure permitted by given conditions
- Olympic circles: we see them as circles not like this:



Similarity

- similar things appear to be grouped together (can occur because of size, shape, orientation, enclosure and proximity)



Take-home message (according to Gestalt psychologists)

- visual perception is based on more than just the pattern of light and dark on the retina
- These principles are “intrinsic laws” and are built in to a system
- role of experience is minor compared to the perceptual principles
- in contrast with Helmholtz’s likelihood principle
  - Likelihood principle: we perceive the object that is most likely to have caused the pattern of stimuli we have received

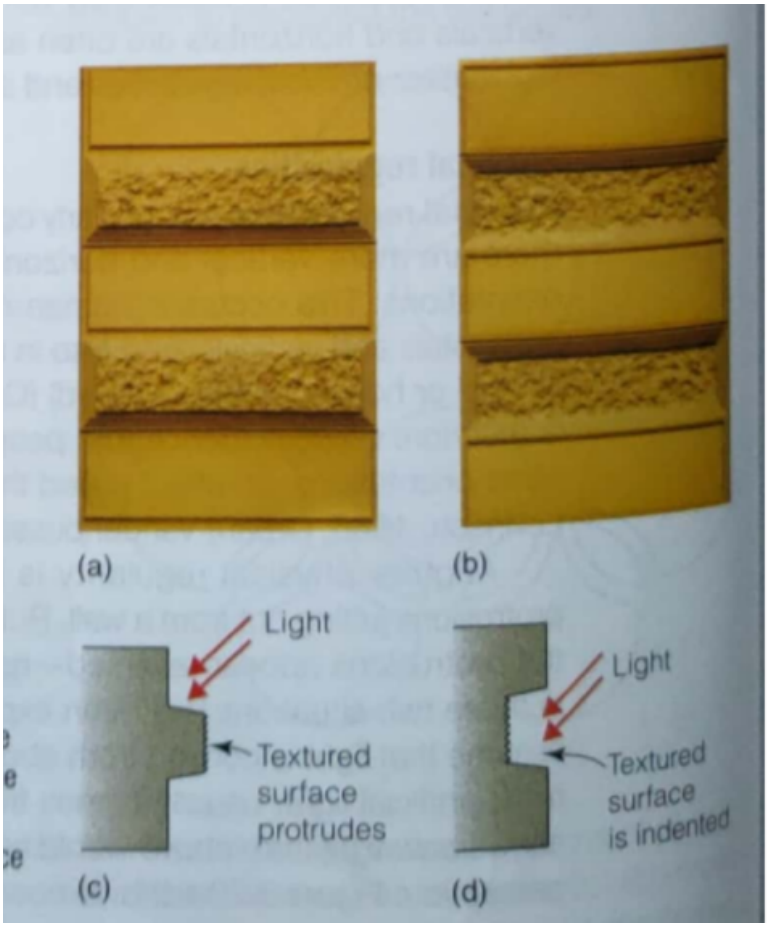
    - what's most likely is based on a process called **Unconscious inference**: our perceptions are the result of unconscious assumptions/inferences that we make about the environment

- Modern psychologists, in agreement of Helmholtz, also see experience as a central component

Regularities in the environment

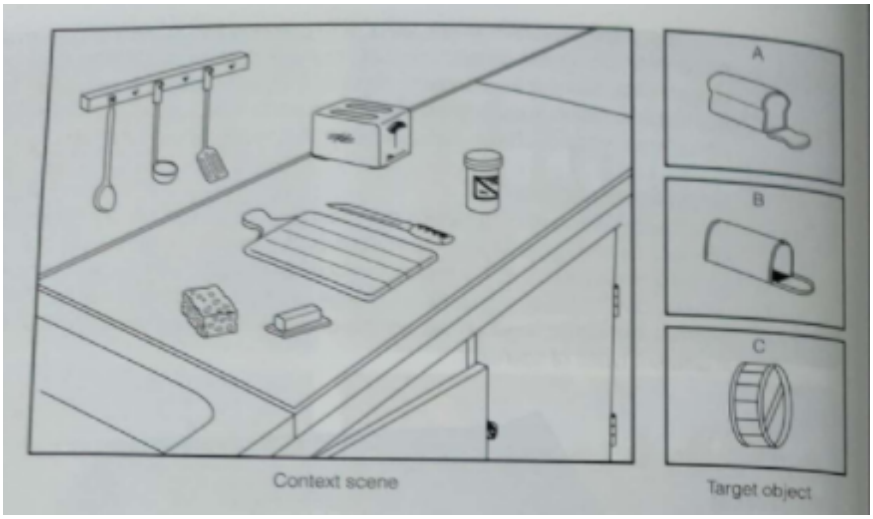
- perception is influenced by our knowledge of regularities in the environment
    - frequently occurring characteristics in the environment → strong influence on what we expect to see
    - e. g. associations like blue - sky, green - grass
- Two types of regularities, physical and semantic
    - **Physical regularities**
        - regularly occurring physical properties of the environment
        - oblique effect: people perceive horizontals and verticals more easily than other orientations - these are more frequent in both human-made environments and nature

        ▼ light-from-above assumption: we usually assume that light is coming from above, bc light in our environment (sun & artificial lights) usually comes from above



- Humans' system is adapted to respond to the physical characteristics of the environment (orientation of objects, direction of light)
- Adaptation also occurs because we've learned about the typical objects occurring in specific types of scenes
- Semantic regularities
  - semantics = meanings of words/sentences (in language)
  - applied to scenes semantics = the meaning of a scene
  - def.: the characteristics associated with the functions carried out in different types of scenes
  - **scene schema**: the knowledge of what a given scene typically contains (e. g. if imagining a lion also imagining savanna, zoo etc, or a lab with a microscope)

▼ Palmer (1975) - context & target pictures



People were more successful in recognizing the bread (scene-appropriate) than the other two objects

- we easily use our knowledge of regularities in the environment to help us perceive, even though we may not be able to identify the specific information we are using
- we unconsciously use this knowledge to help us perceive

Bayesian inference

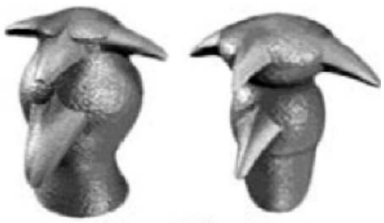
- Helmholtz's idea and regularities in the environment are the bases
- named after Thomas Bayes
- our estimate of the probability of an outcome is determined by 2 factors
  - the prior probability/prior: our initial belief about the probability of an outcome
  - likelihood (of the outcome): the extent to which the available evidence is consistent with the outcome
- **prior * likelihood = P (outcome)**
- people start with a prior probability → use additional evidence to update this initial belief about the probability of a certain outcome → reach a conclusion
- e. g. inverse projection problem → we don't have to rely solely on retinal image as we come to most perceptual situations with prior probabilities based on our past experiences

- used when programming computers

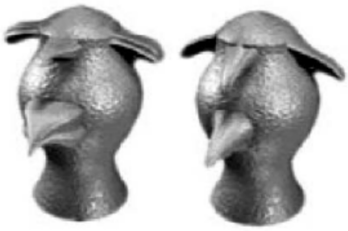
Summary

Experience-dependent plasticity

- kittens raised being surrounded by verticals have more neurons responding to those than to horizontals
- neurons in the FFA can be trained to respond strongly to greebles, birds in bird experts etc. → responds this strongly to faces not only because nature but bc of the lifelong experience we have with faces



Different families



Different individuals

- the brain's functioning can be "tuned" to operate best within a specific environment

Continued exposure to things that occur regularly in the environment can cause neurons to become adapted to respond best to these regularities → neurons reflect knowledge about properties of the environment

Perception is the outcome of an interaction between bottom-up information (from receptors to brain), and top-down information (involves knowledge about the environment or expectations related to the situation.

The interaction between perceiving and taking action

Focusing on the active aspects of perception

We can call it dynamic because:

- involves processes like inference and taking knowledge into account
- it’s closely linked to action

- movement facilitates it → adds complexity; moving reveals aspects of objects that are not apparent from a single viewpoint → provides added information → results in more accurate perception
- continuous coordination between perceiving objects and taking action towards them
- picking up a cup of coffee involves:
  - continually perceiving:
    - the position of the cup
    - of ones hand and fingers relative to the cup
    - calibrating actions in order to accurately grasp the cup &
    - pick it up without spilling coffee

Physiology of perception and action

research in the 80s → **two processing streams in the brain**, one involved in perceiving objects, the other with locating them & taking action towards them

- Ungerleider and Mishkin’s 1992 experiment’s results suggest that the neural pathway that reaches the temporal lobes is playing a role in determining an object’s identity
  - based on the brain parts removed from monkeys and their difficulties in solving the tasks
  - **brain lesioning**: the study of the effect of removing parts of the brain in animals

    ▼ measuring performance before and after the removal of that area/structure

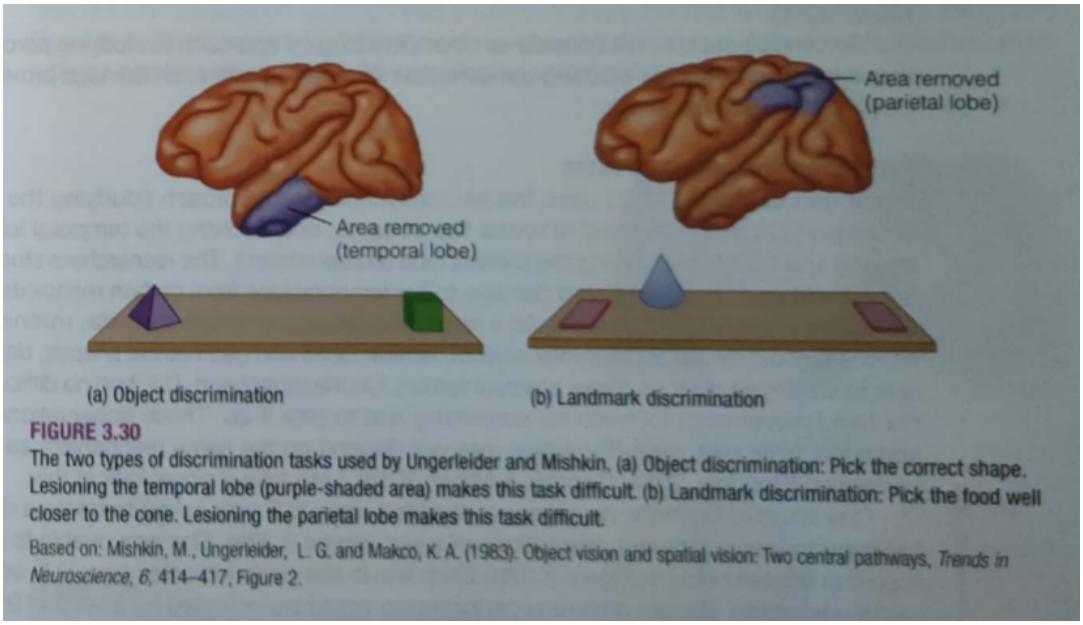
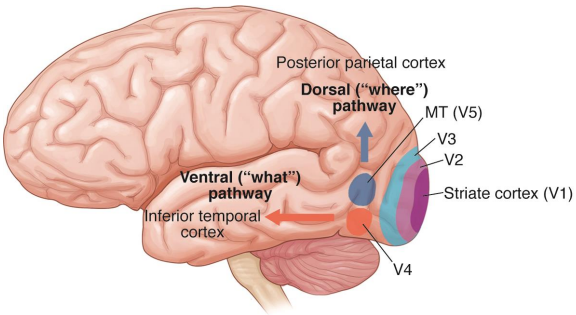


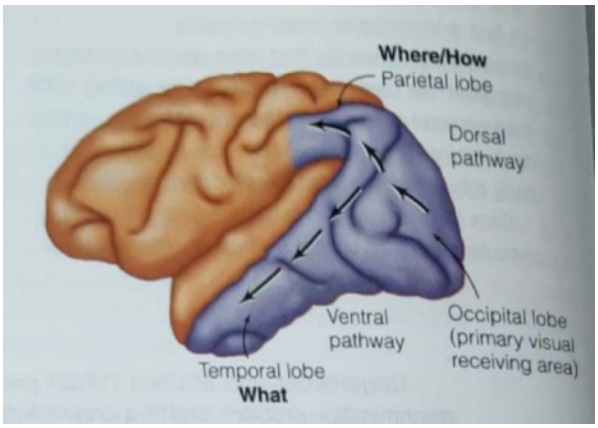
FIGURE 3.30
The two types of discrimination tasks used by Ungerleider and Mishkin. (a) Object discrimination: Pick the correct shape. Lesioning the temporal lobe (purple-shaded area) makes this task difficult. (b) Landmark discrimination: Pick the food well closer to the cone. Lesioning the parietal lobe makes this task difficult.

Based on: Mishkin, M., Ungerleider, L. G. and Makco, K. A. (1983). Object vision and spatial vision: Two central pathways, *Trends in Neuroscience, 6*, 414–417, Figure 2.

Ungerleider and Mishkin (1992)

- the ***what pathway*** **(ventral stream)**: the pathway leading from the striate cortex → temporal lobe
- ***where pathway*****:** striate cortex → parietal lobe; responsible for determining an object's location





other method:

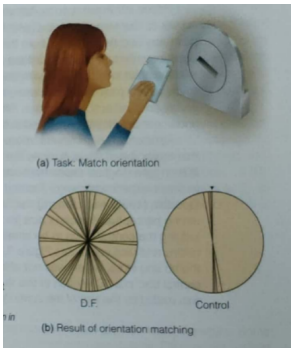
- **neuropsycholgy**: the study of behaviour of people with brain damage

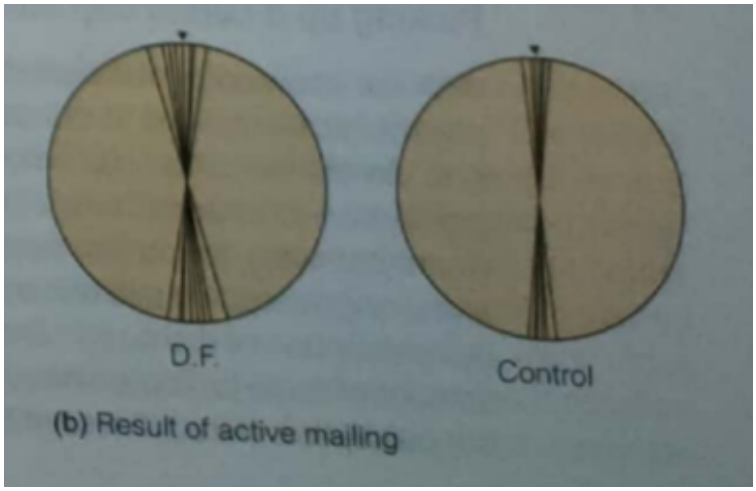
- **what & where pathways can operate independently** (suggested by Goodale, Goodale & Milner, 2018)

- Object and landmark discrimination tasks

Perception and action streams

- Milner and Goodale (1995)
  - **ventral stream**, involving the temporal lobe
  - **dorsal stream**, involving the parietal lobe
  - they studied patient(s) w visual agnosia
  - visual agnosia: the total or partial loss of the ability to recognize and identify familiar objects and/or people by sight (also geometrical objects; despite being able to identify an object's color or visual texture)
  - D. F., a woman with visual agnosia could easily pick up objects → vision-for-perception and vision-for-action may not depend on the same mechanism
  - She could not turn a card to match a slot's orientation, but when she was asked to place the card inside (action was involved), she was able to rotate the card to match the orientation
  - they interpreted these results as evidence for there being one mechanism for judging orientation and another for coordinating vision and action

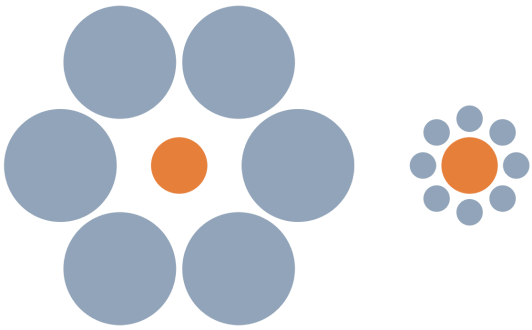




Milner & Goodale:

- **Perception pathway (=what pathway of Ungerleider & Mishkin) - visual cortex → temporal lobe**
- **Action pathway (=where pathway of U & M) - visual cortex → parietal lobe**

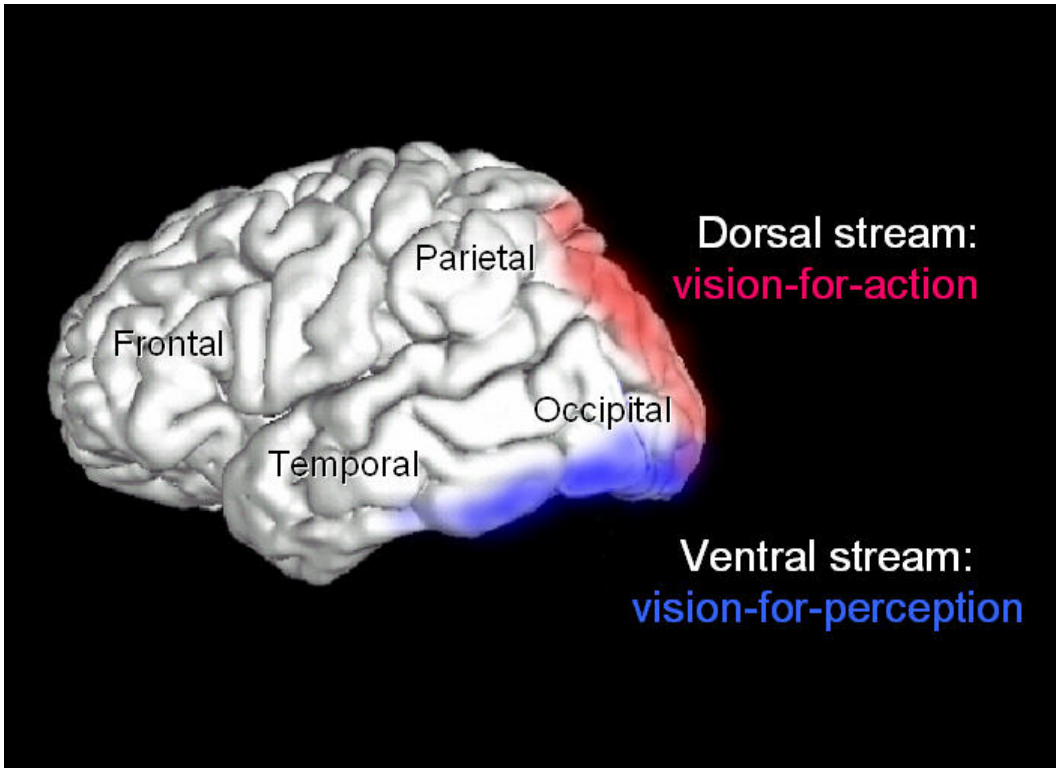
Ebbinghaus illusion



- in the 3D version of this illusion participants opened their hands to the same size for picking up both central items → participants' perception was misled by the size of the surrounding circles, their vision-for-action system was not
- it seems that there is sufficient physiological and behavioural evidence to suggest that **vision is not a unitary system** and that "the visual signals that give us experience of objects and events in the world are not the same ones that control our actions"

A similar coordination occurs between different areas for the sense of hearing

- hearing someone call one's name and turning around to see who said it activates two separate pathways in the auditory system → the auditory what pathway (enables us to hear and identify the sound) and the auditory where pathway (helps locating where the sound is coming from)



There is evidence suggesting that culture also contributes to perception as it influences knowledge and the type of stimuli frequently encountered

Our perceptual systems (even the very basic ones) are largely determined before birth, but are also fine-tuned by our physical and social environment.