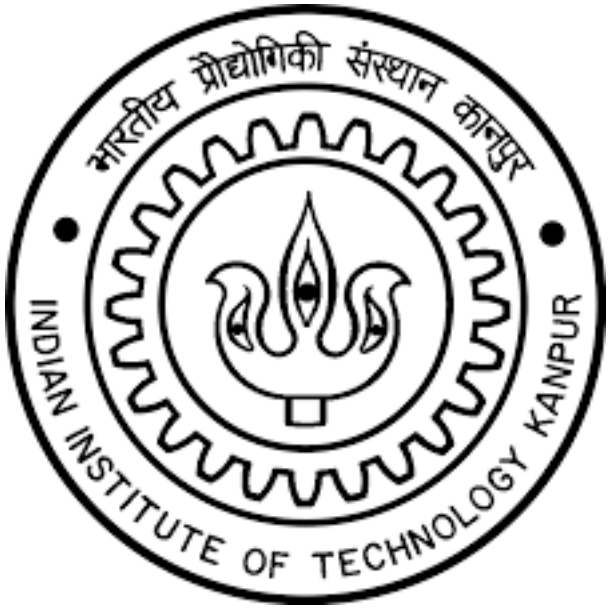

Indian Institute of Technology
Kanpur

In Collaboration
with

National Program on Technology Enhanced Learning (NPTEL)

Presents

Course Title:

Basic Cognitive Processes

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Lecture 18: Approaches to Visual Perception - 1

Approaching Perception: Key Questions

- Before we think of how to describe perceptual processes, it might be important to think of "What is Perception meant for?"
  - is the "goal" of perception **action** or **recognition**?
  - Consider this: If I throw a moving object towards you, What will be your first course of action, evasion or identification of the object?

- there is evidence that perception for action & perception for recognition are **different processes** and may involve **different neural mechanisms** (Milner & Goodale, 1998).

- Another important issue is, whether perception depends upon **bottom - up processing** i.e. the flow of information through the perceptual system starts from the bottom or the sensory receptors and works upwards until an internal representation of the object is formed.

OR

- the flow of information through the perceptual system starts from the pre - existing knowledge/representation stored in the brain and moves downwards towards evaluating the sensory input and making judgments; i.e. **top - down processing**.

Gibson's Theory of Perception

- Suppose, that visual perception is primarily based on bottom - up processing of information.

- That would at least require that the light reaching the retina is rich in information about the environment & carries enough evidence to make perceptual decisions.

- J.J. Gibson believed the same to be true,
  - ***"When the senses are considered as a perceptual system, all theories of perception become at one stroke unnecessary. It is no longer a question of how the mind operates on the deliverance of the sense, or how past experience can organise the data, or even how the brain can process the inputs of the nerves, but simply how information is picked up"***. (Gibson, 1966).

- the Gibsonian approach concentrates on the information present in the visual environment rather than on how it may be analysed.

- An important component of Gibson's approach is the link between perception & action; action rather than the formation of an internal description of the environment can be seen as the 'end point' of perception.

- Gibson conceptualized the link between perception and action by suggesting that perception is **direct**, in that the information present in the light is sufficient to allow a person to move through and interact with the environment.

- He thought that perception could never be fully explored through laboratory experiments.

Figure 3.7 *Ceci n'est pas une pipe*, 1928, by René Magritte

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.7, p. 81)

- because of the importance it gave to the real world, Gibson's approach to perception is called the **ecological approach**.
    - he referred to theories based on artificial experiments which employed 2D shapes as 'air theories' while he referred to his own theory as a 'ground theory'.
    - as it emphasised the role played by the real, textured surface of the ground in providing information about distance.

- The Optic Array
  - the structure that is imposed on light reflected by the textured surfaces in the world around us is what Gibson termed the **ambient optic array**.
  - the basic structure of the optic array is that the light reflected from the surfaces in the environment converges at the point in space occupied by the observer.

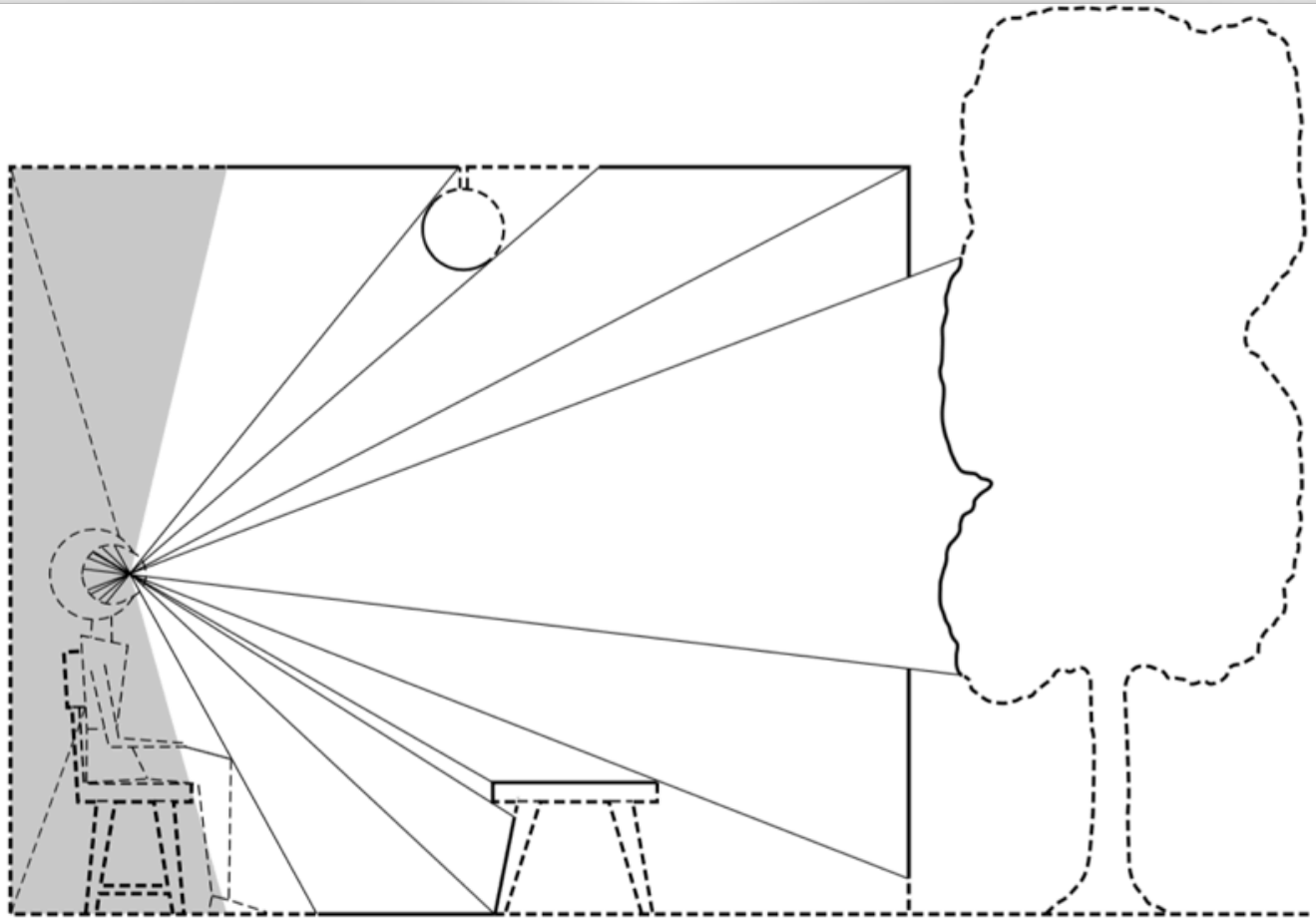

Figure 3.8 The ambient optic array

Source: Gibson, 1979, Figure 5.3

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.8, p. 83)

- an important factor also is that the observer is rarely static & the eye (the main instrument) also keeps moving by virtue of the eyeball, the head movement, the body movement etc.

- because of the said sources of motion, the position of the head with respect to the environment is altered and the optic array changes accordingly.

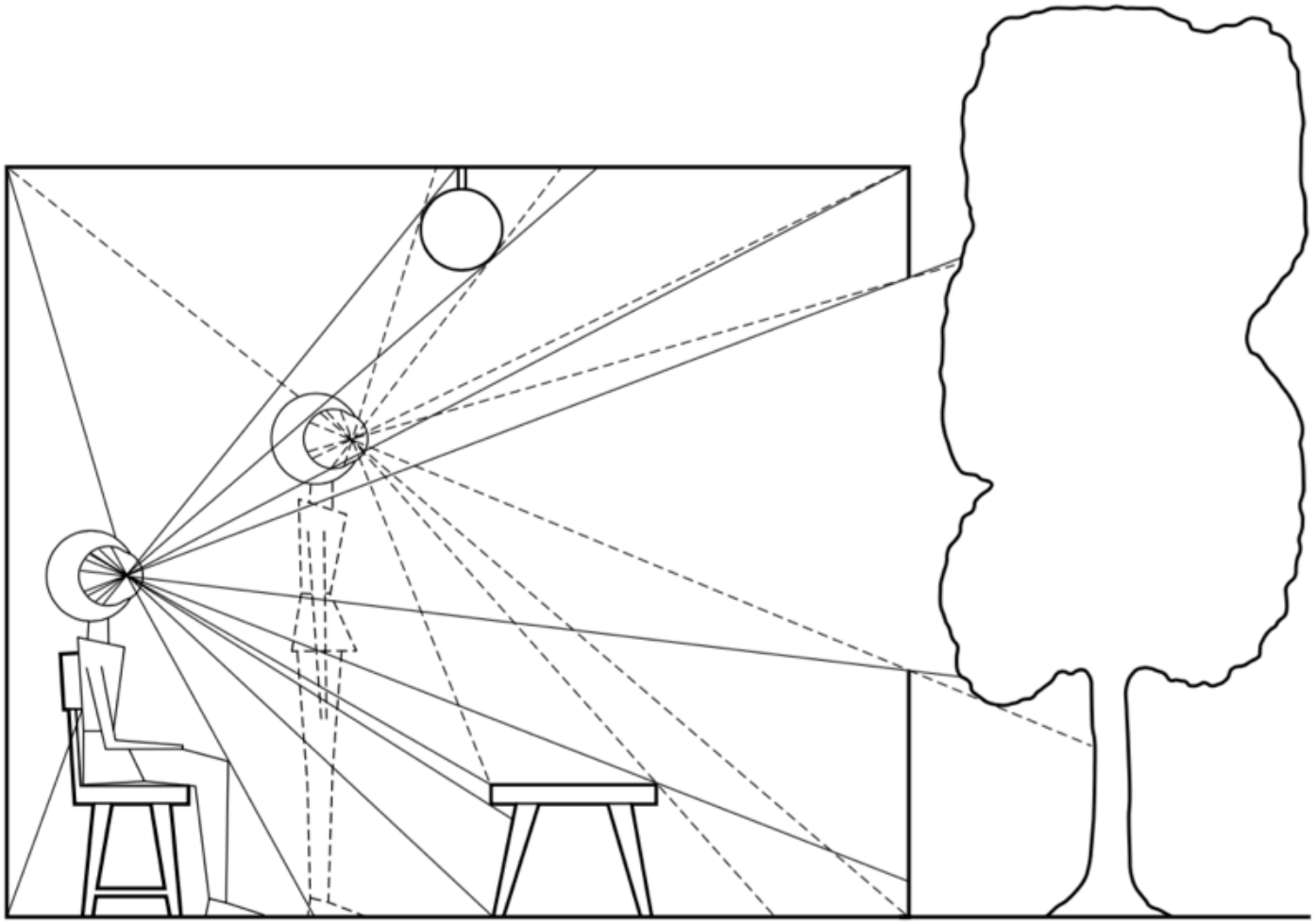

Figure 3.9 Change in the optic array caused by movement of the observer

Source: Gibson, 1979, Figure 5.4

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.9, p. 83)

- So, the primary structure of the optic array is a series of angles that are formed by light reflecting into eyes from the surfaces within the environment.
    - for e.g. an angle may be formed between the light that is reflected from the near edge of the table an that from the far edge.
- In addition to the primary structure of the optic array, Gibson maintained that there were additional, higher - order features that could provide unambiguous information regarding the nature of the environment.
    - He referred to these higher order features as **invariants**, and believed that an observer could perceive the surrounding world by actively sampling the optic array in order to detect invariant information.

- An example of an invariant feature was explored by Sedgwick (1973), i.e. **horizontal ratio relation.**
    - this specifies that the ratio of how much of an object is above the horizon to how much of it is below the horizon remains constant as the object either travels towards or away from the observer.
    - this form of invariant information allows us to judge the relative heights of different objects regardless of how far away they are.
    - the proportion of the object that is 'above' the horizon increases with the overall height of the object.

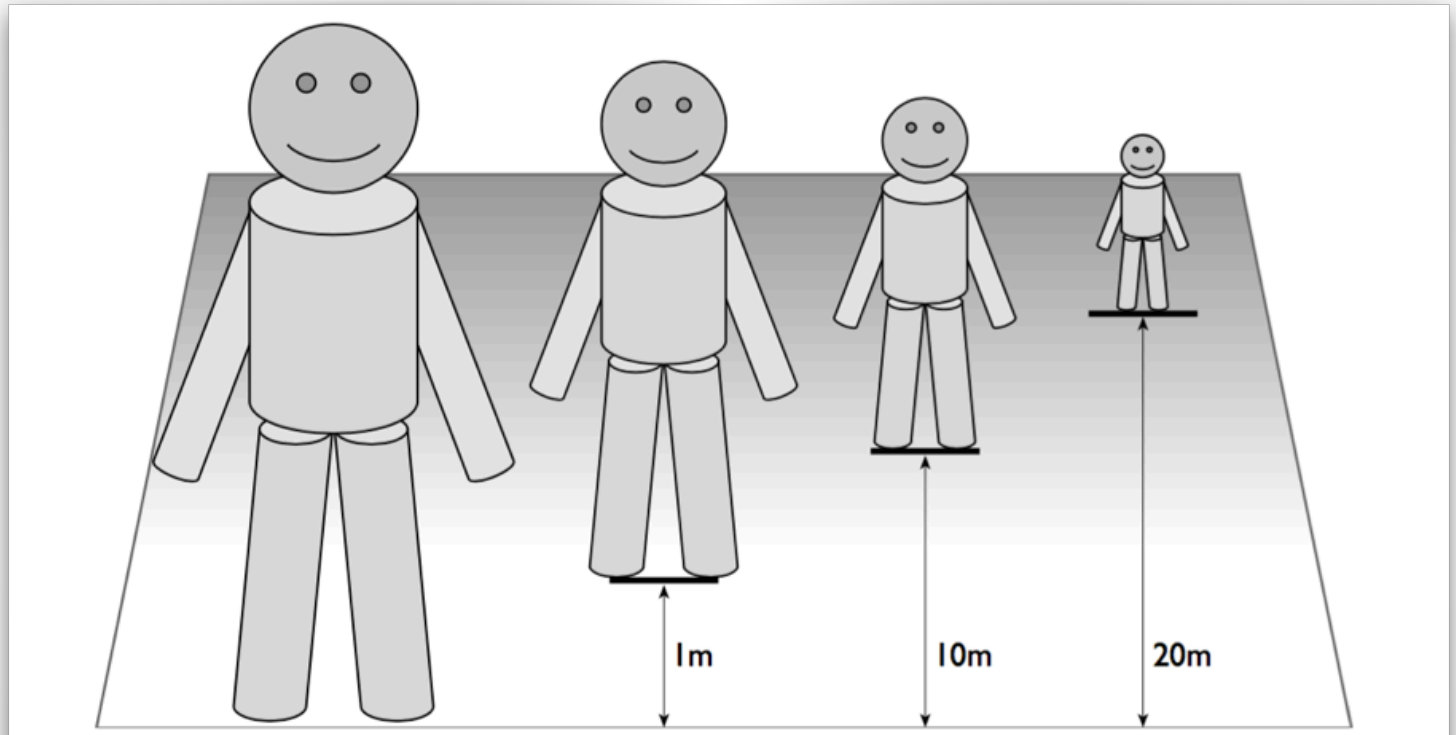

Figure 3.10 The horizon ratio relation: same height objects at different distances

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.10, p. 84)

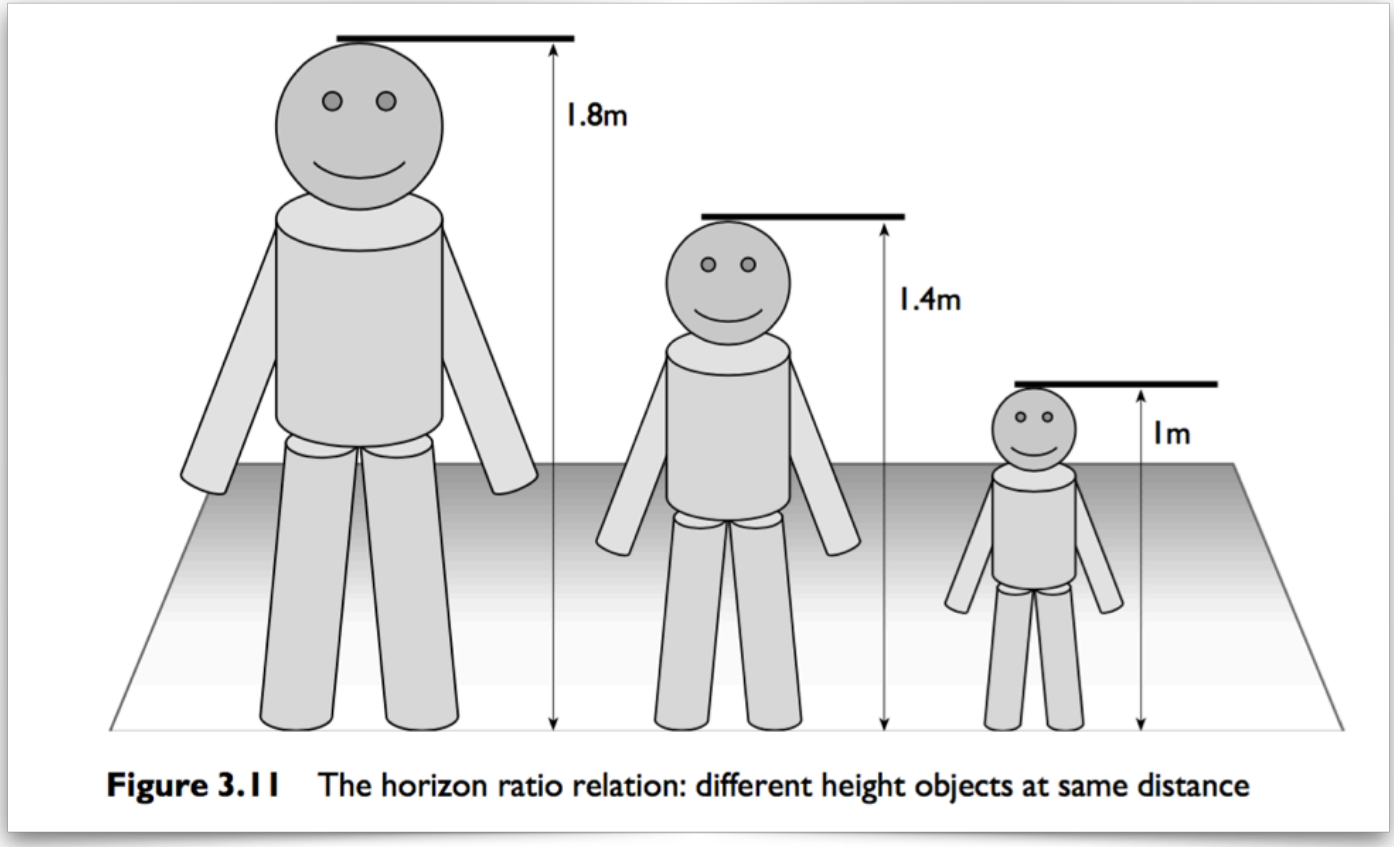

Figure 3.11 The horizon ratio relation: different height objects at same distance

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.11, p. 84)

- Another important source of invariant information in Gibson's theory is **texture gradient**.
    - there are three forms of texture gradient relating to the density, perspective and compression of texture elements.
    - the exact nature of a texture element will change from surface to surface; in a carpet the elements are caused by the individual twists of material, on a road they are caused by the small stones that make up the surface.

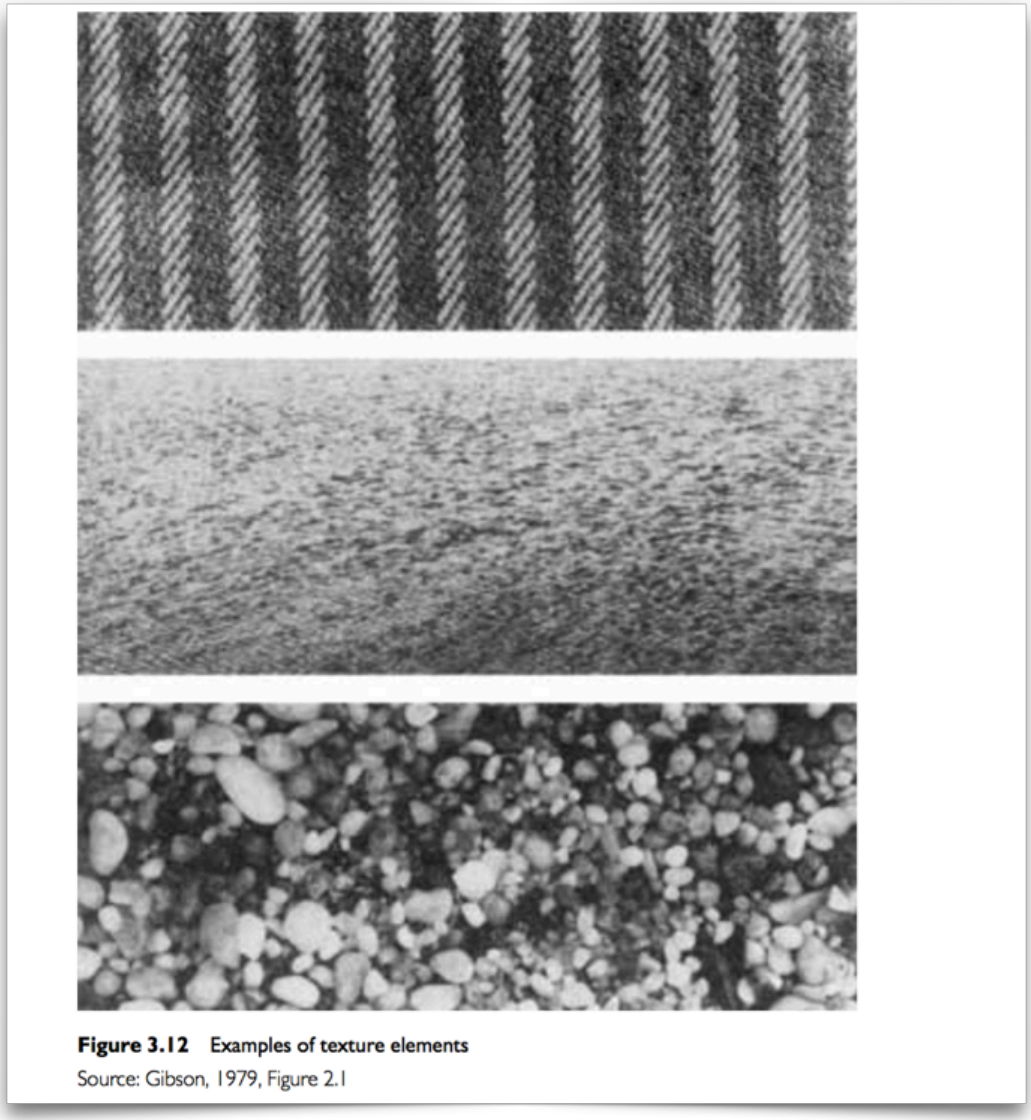

Figure 3.12 Examples of texture elements

Source: Gibson, 1979, Figure 2.1

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.12, p. 85)

- In making use of texture gradients, we assume that the texture of the surface is uniform; for e.g. that the road surface consists of stones of similar size throughout its length; and therefore any change in the apparent nature of the texture provides us with information regarding the distance, orientation & curvature of the surface.

- Using texture gradients, we can tell if a surface is receding because the density of texture elements (number of elements per sq. meter) will increase with distance.

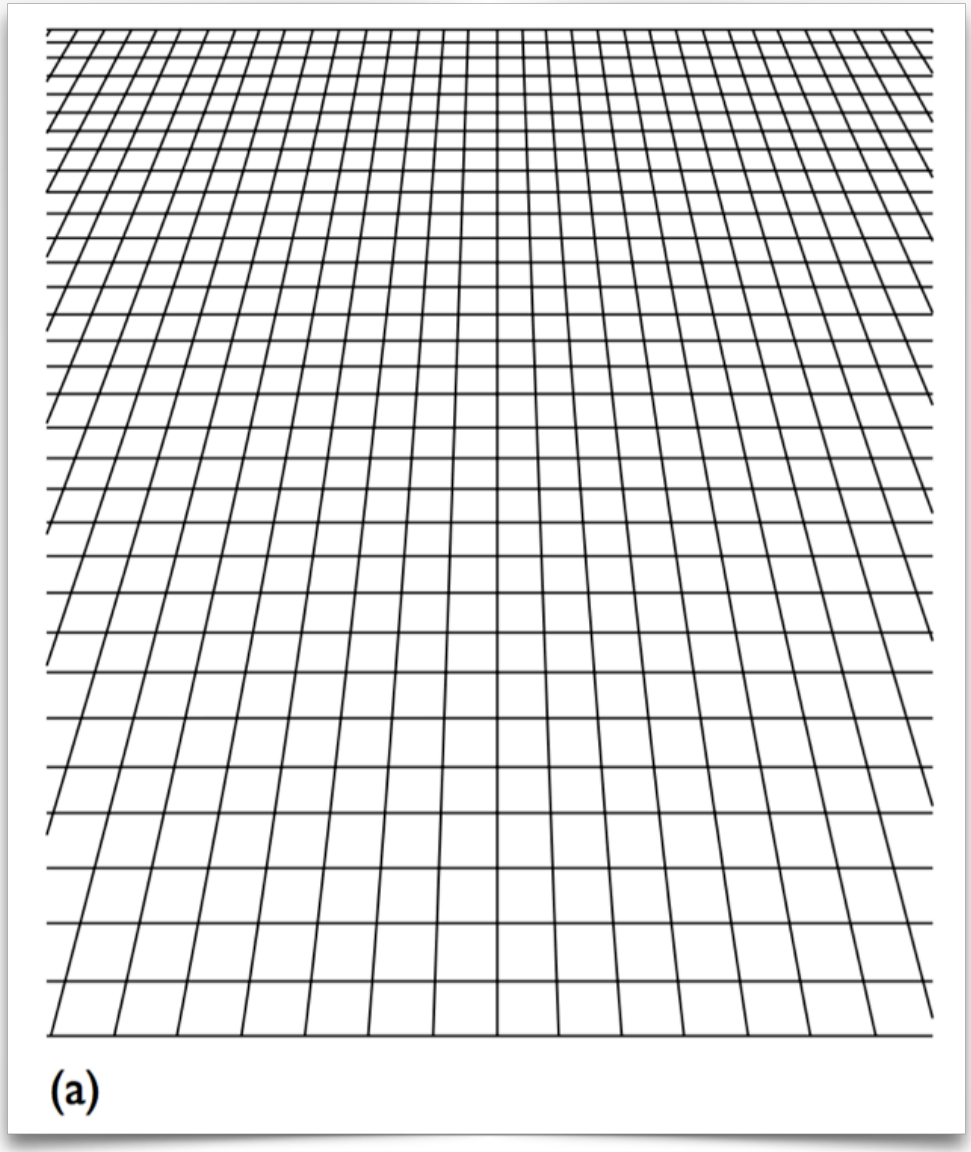

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.13a, p.86)

- in a similar way, the perspective gradient (the width of individual elements) and the compression gradient (the height of the individual elements) can reveal the shape & orientation of the surface.

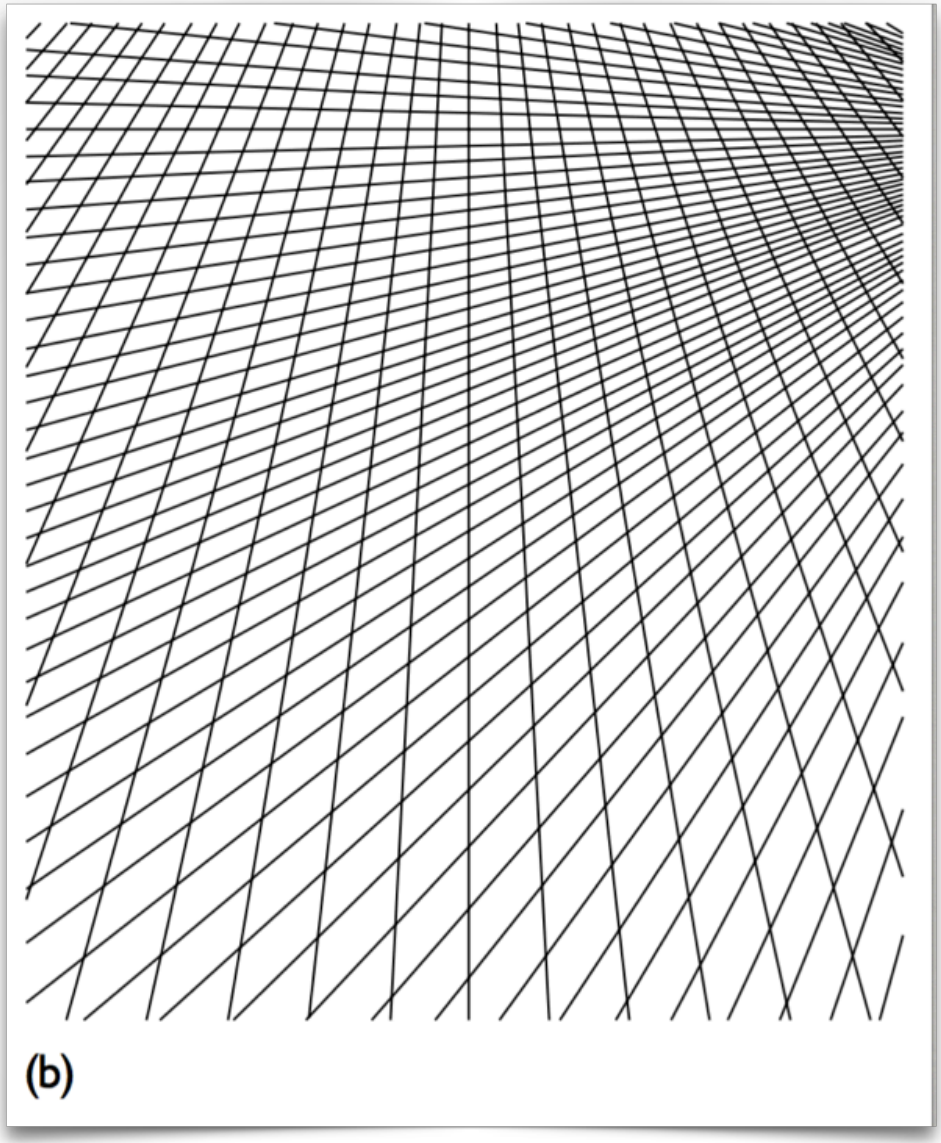

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.13b, p.86)

- Flow in the ambient optic array.
    - “What is clear to me now that was not clear before is that the structure as such, frozen structure, is a myth, or at least a limiting case. Invariants of structure do not exist except in relation to variants.” - (Gibson, 1979)
- Motion is an important aspect of the visual world; by virtue of which the environment changes over time.

- there are two basic forms of movement: motion of the observer and the motion of objects within the environment.

- motion of the observer tends to produce the greatest degree of movement as the entire optic array is transformed.

- Gibson suggested that this transformation provided valuable information about the position and shape of surfaces & objects. for e.g. information about shape & position is particularly revealed by **motion parallax.**

    - the principle that the further an object is from an observer, the less it will appear to move as the observer travels past it.

- Consider this example: the driver of a moving train looks out of their side window at a herd of cows grazing in a large field next to the line.

- the cows near the train will appear to move past much faster than the cows at the back of the field.

- thus, the degree of apparent motion is directly related to the distance of the object from the observer.

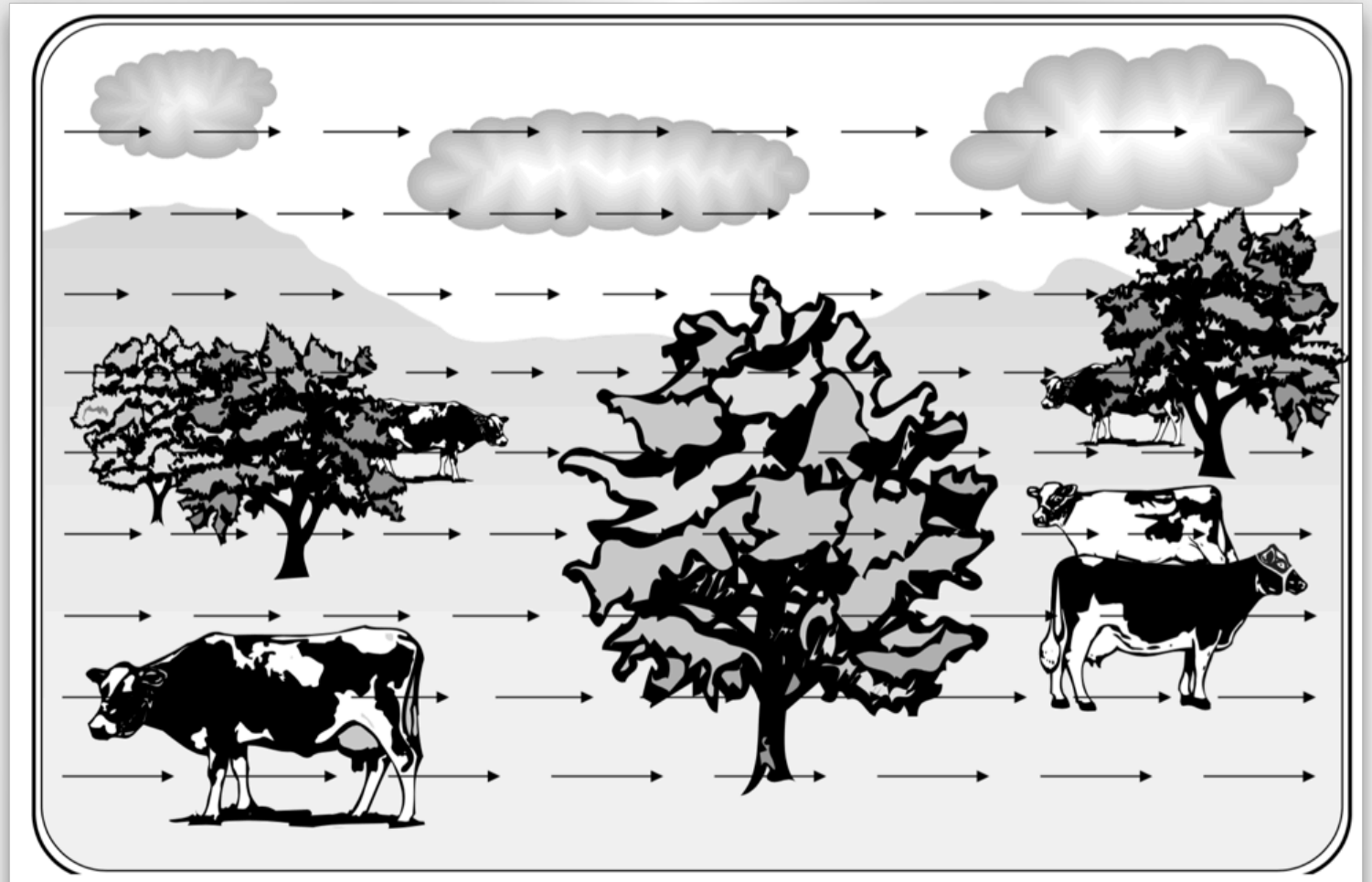

Figure 3.14 Flow patterns in the optic array parallel to the direction of the observer's motion

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.14, p. 87)

- A second means by which observer motion can provide information about the shape & position of objects is through **occlusion**.

- Imagine the same observer (train driver) travelling past the same field of cows; their motion will cause the cows nearest to the train to pass in front of, or occlude, the cows grazing further away.

- this allows the observer to deduce that the occluded cows are father away than those doing the occluding.

- Gibson dealt with the motion of the observer through the reference to **flow patterns** in the optic array.

- As our train driver looks at the grazing cows by the side of the track, the entire optic array will appear to flow past from left to right, assuming that the driver looks out of the right - hand window.

- When the train driver becomes bored of cow watching and returns their attention to the track in front of the train, the flow patterns in the optic array will change so that the texture elements appear to be radiating from the direction in which the train is travelling (the origin is known as **pole**).

- the texture elements that make up the surfaces in the environment will appear to emerge from the pole, stream towards the observer and then disappear from the view.

- this pattern would be completely reversed if the guard at the rear of the train were to look back towards the direction from which the train had come.

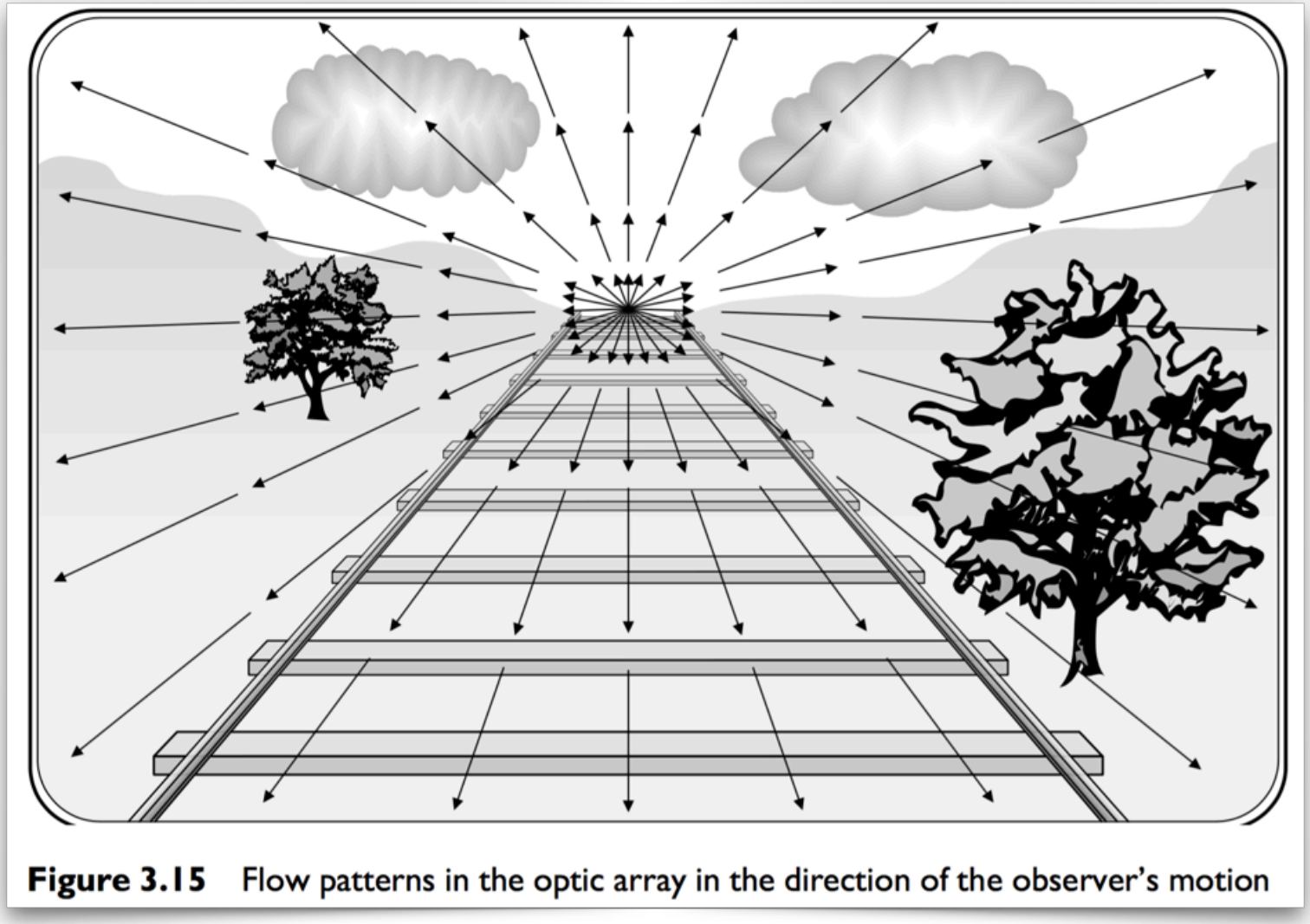

Figure 3.15 Flow patterns in the optic array in the direction of the observer's motion

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.15, p. 88)

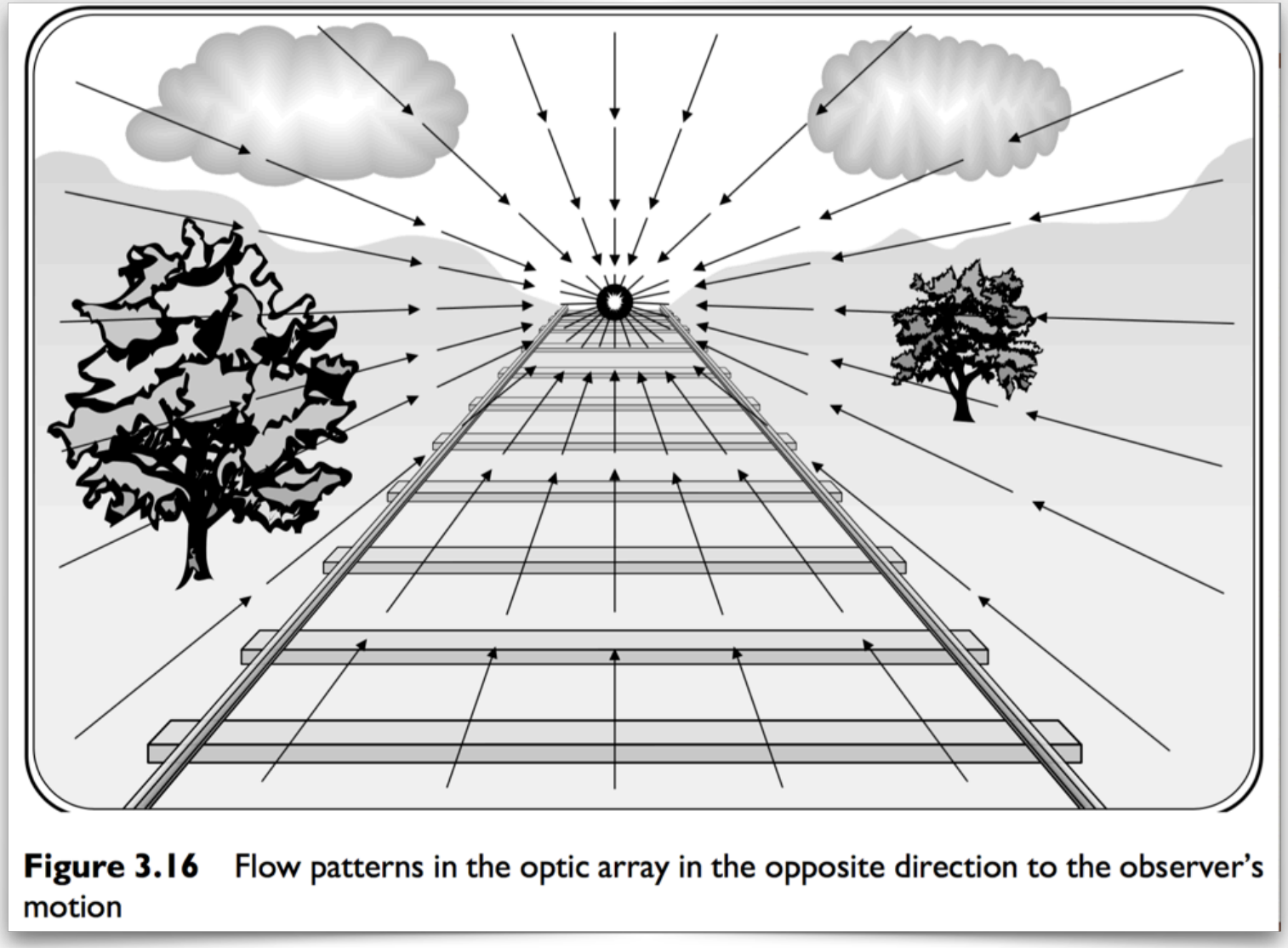

Figure 3.16 Flow patterns in the optic array in the opposite direction to the observer's motion

Image: Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.* (Fig. 3.16, p. 88)

- Gibson proposed a set of rules that linked flow in the optic array to the movement of the observer through the environment (Gibson, 1979):
  - If there is flow in the ambient optic array, the observer is in motion; if there is no flow, the observer is not moving.
  - Outflow of the optic array from the pole specifies approach by the observer and inflow to the pole specifies retreat.
  - The direction of the pole specifies the direction in which the observer is moving.
  - A change in the direction of the pole specified that the observer is moving in a new direction.

- Gibson said: “perceiving is an act, not a response, an act of attention, not a triggered impression, an achievement, not a reflex’ (Gibson, 1979).

- **Affordances & Resonance**
  - Gibson (1979) took the idea of information being 'picked up' further by stating that the end point of the perceptual processes was not a visual description of the surrounding world, but rather that objects directly 'afforded' their use.

- At its simplest the concept of **affordance** builds on earlier research conducted by Gestalt psychologists, in which features of objects were seen as providing information as to their use.

Image: [https://qph.ec.quoracdn.net/main-qimg-f0a341a110341f5a58a93b75b491448d]

Image:[https://upload.wikimedia.org/wikipedia/commons/0/05/2004_MujiWanoSyokki-TeasetMug_Masahiro-Mori.jpg]

- Gibson further claims:
  - **affordance**s act as a bridge between perception & action and do not require the intervention of any cognitive processes.
  - there is no role of memory in perception; as the observer does not have to consult their prior experience in order to be able to interact with the world around them.
    - instead, he states that the perceptual system **resonates** to invariant information in the optic array. meaning probably that 'global' information about the optic array is dealt with by the perceptual system without the need to analyse more 'local' information such as lines & edges.

- Experiments using dynamic naturalistic stimuli can now be conducted, virtual scenes can be constructed, and images of brain activity while viewing these can be captured in a way that would have been difficult to envisage a century ago. However, the stimulated lure of the screen should not blind experimenters and theorists to the differences that exist between the virtual and the real. - Wade & Bruce, 2001.

To Sum Up

- We talked about Gibson's Ecological Approach to Visual Perception.
- We saw how acc. to Gibson the light ray from the external world may be sufficient to provide us with a rich source of information to construct perceptual representations.
- We also saw that Gibson's looks at 'action' rather than just 'recognition' as the goal of perception.

References

- Braisby & Gellatly (2005). Cognitive Psychology. *Oxford University Press.*