CDL PS2011/16

Lecture 5
The ecological approach to visual perception

Reading

Essential

Bruce, Green & Georgeson, Visual Perception, Chapter 1, pp. 3-7; Chapter 10; Chapter 11, pp. 315-332; Chapter 12, pp. 348-358

Ellis, R.& Tucker M. (2000). Micro-affordance: the potentiation of components of action by seen objects. *British Journal of Psychology*, 91: 451-471. (available electronically via ingenta on on line-library catalogue)

Additional

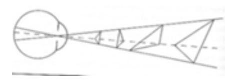
Eysenck & Keane, Chapter 3, pp. 59-73

Gordon, Theories of Visual Perception, Chapter 7

Assumptions of traditional approaches (see lecture 1)

Starting point of perception
- static pattern of light intensity on the retina

Poverty of the stimulus and ambiguity of retinal image



Perception is indirect and mediated by other processes

The outcome of perception is the formation of an internal representation of objects in the environment

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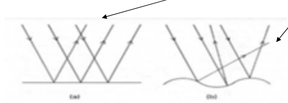
J.J. Gibson (1966; 1979)

stimulation by light
- e.g. eyes covered with halves of table tennis balls
- no information about the environment
- no perception

However,
light energy is affected by the medium that it traverses
- e.g. water, glass, air

different surfaces reflect light in different ways
depending on their textures, opacity, slant etc.
- e.g. light reflected polished or textured surfaces



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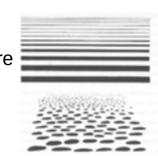
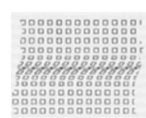
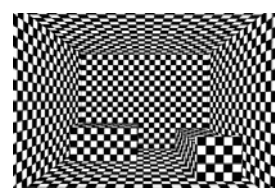
structured light
- carries information
- visual perception
  - e.g. light structured by texture



information about distance



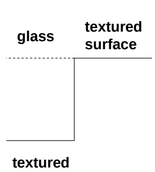
about shape



and general layout of objects in the environment

Visual cliff, E.J. Gibson (Gibson & Walk, 1960)

Perception of depth from texture
- 6-14 months old infants
- variety of animal species



apparatus

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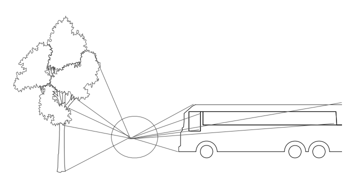
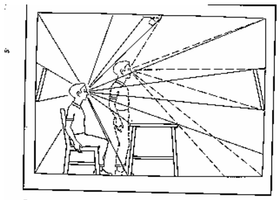
optic array
- pattern of light reaching a point in space
- determined by the nature of reflecting surfaces



optic flow

changes in the pattern of light reaching a moving observer



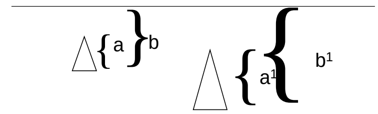
transformations of the pattern specify layout, shape and movement

Structural invariants

Patterns of relationships that remain constant despite changes in the retinal image

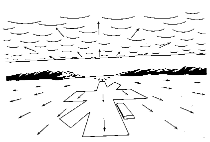
e.g. a possible invariant specifying size constancy

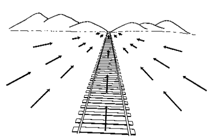
The ratio of an object's height to the distance between its base and the horizon

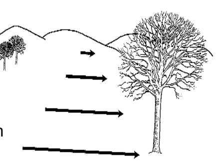


Across all distances from the viewer,
if a:b = a1: b1, then A and B are the same size

Transformational invariants







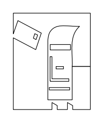
Flow - locomotion
Non flow - stasis
Outflow - approach
centre of outflow - direction
shift of the centre change of direction
Inflow - retreat from

The optic array and the optic flow provide all the information needed for perception

Role of the perceiver is
to "pick up" the information contained in the optic array
it is not needed to process the information provided by the retinal image
theory of "direct perception"

Affordances
the product of perception is not an internal representation
organisms detect functional value of surfaces and objects
bridge the gap between perception and action

radical theory of affordances
e.g.
a mail-box affords posting letters

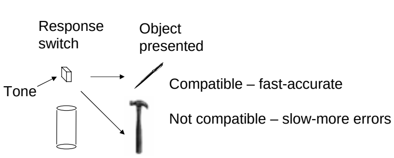


Ellis & Tucker (2000)

Micro-affordance. Potentiation of action components by seen objects.

Participants required to make a power or precision grip in response to a high or low pitch tone, respectively

If an object presented in the background (irrelevant to the task) affords a grip compatible with the response, then response is faster and more accurate

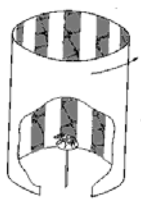


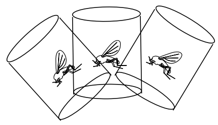
Similar results with wrist rotation in response to low and high pitch tones

"Neo-Gibsonians" (Especially David Lee)
emphasis on the relationship between perception and action
detection of invariants in the optic flow
ecological contexts
locomotion
maintain posture
avoidance of obstacles

Information needed to guide action
exteroceptive
information about the environment
e.g. spatial relationship between two objects
proprioceptive
information from the body
e.g. maintain balance with eyes closed
exproprioceptive (Lee, 1977)
position of the body relative to the environment
e.g. obstacle avoidance

Optomotor response (Kalmus, 1949; Blondeau & Heisemberg, 1982)



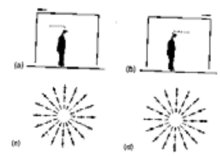


fly walking on a platform
cylinder is turned
the fly turns in the same direction
optic flow of texture is minimised

a flying fruit fly compensates
for rotation of the environment along
different axes

in a natural environment optic flow specifies movement of the insect
(Gibson, 1966)

The swinging room (Lee & Aronson, 1974; Lee & Lishman, 1975; Lishman & Lee, 1973)
- suspended bottomless box
- wallpaper provides texture
- movements of the room produce optic flow



expanding optic flow
- subject sways backwards

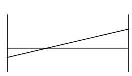
contracting optic flow
- subject sways forward

toddlers (13-16 months)
- show the same behavioural pattern
- visual information overrides proprioceptive information

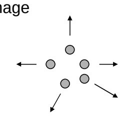
Time to contact

Avoid collision with obstacles
- traditional theories
  - initial distance from objects
    - depth cues etc.
  - speed
  - divide distance by speed
  - computationally complex
  - possibility of errors from different sources

Lee (1976)
- all the information needed can be conveyed by only one variable
- if speed is constant
- tau = inverse of rate of expansion of retinal image




textured surface


Each element of texture moves from the point of fixation

Behaviours that might be regulated by using time to contact
- long jumping (Lee et al., 1982)
- catching a bus
- jumping over puddles
- avoiding obstacles
- Fishing gannets (Lee and Reddish, 1981)

- dive from height of 30m
- reach speed of 24m/sec
- wings streamlined just before reaching the water
- predictions based on corrected tau values
- predictions based on height, velocity and acceleration
- observation of bird's behaviour
- predictions based on tau fit the data

Summary

"Classical approaches"
- Perception as a mediated process

Ecological approach
- Link between perception and action in the environment
- Optic array
- Optic flow
- Invariants
- Radical theory of affordances
- Micro-affordance
- Tau
  - invariant specifying time to contact
  - inverse of the rate of expansion of retinal image
  - avoids problems deriving from complex computations
  - used to control action in a variety of contexts by a variety of species