

UNIVERSITY OF CAPE TOWN
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Presence and Perception: theoretical links & empirical evidence

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This Talk

- Perception
 - ▣ Bottom-up
 - ▣ Top-down
 - ▣ Integration
- Presence
 - ▣ Bottom-up
 - ▣ Top-down
 - ▣ BIPs
- Presence arises from an appropriate conjunction of the human perceptual and motor system and immersion.
 - ▣ Slater 2003

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Perception

- Process of sampling an environment for information and converting into a form suitable for cognitive processing
- Basic idea:
 - ▣ World → sense organs → higher level cognition
- Widely understood area of psychology

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Two approaches to perception

- Bottom-up approach
 - ▣ Data driven
 - ▣ Most (all) of the required information comes from the sense organs
- Top-down approach
 - ▣ Concept/knowledge driven
 - ▣ Most (all) of the required information comes from the mind

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Bottom-up approaches

- Understand perception via sense organs
 - ▣ Psychophysics (frequency range of hearing, visual acuity, etc)
 - ▣ Stereopsis (two eyes provide depth perception)
- Some automatic effects
 - ▣ Vection (false sense of motion)
 - ▣ Simulator sickness (mismatch between sensors)

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Environmental Perception

- Vision theory of J.J. Gibson 1966
 - ▣ "optic flow" (environmental optics)
 - ▣ Highly influential
- All the information required is in the "visual array"
 - ▣ Shape, motion, etc determined from variations in luminance falling on the eye
 - ▣ This motion is used to identify invariants (fixed objects as opposed to view-dependant artefacts)

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Weaknesses of bottom-up explanations

- Why can we see this as a complete object?



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Weaknesses of bottom-up explanations

- Fail to account for many perceptual phenomena
 - In language we hear separate words, but speech is a continuous sound stream
 - Still see a snowball in the dark, lump of coal in the sun
- Conclusion: The sense organs alone cannot account for a great deal of perception

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Top-down explanations

- Most of the information comes from the mind
 - Conceptual – previous experience, known facts
 - Contextually cued
 - This information allows the poor quality information provided by the senses to be given meaning


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Top-down effects

- Gestalt effects



Proximity



Similarity

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Top-down effects

- Word-superiority effect (Stroop task)

blue

red

yellow

pink

green

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The problems of a perceiver

- Two major problems to overcome:
 - Ambiguity (snow or coal?)
 - Relevance (will I freeze or make a fire?)
- How do you decide what is what, but still keep behaviour relevant to the environmental situation?

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Solution: Integration

- Perception best explained by considering *the interaction* of top-down and bottom-up processes
- *Top-down*: Exploits previous successes, allows disambiguation
- *Bottom-up*: Ensures conclusions relevant to the current state of the environment

Integration: Invariants & Mental models

- Two important cognitive structures used in perception
 - ▣ Invariant: Something which is known to be static (size of an inanimate object)
 - ▣ Mental model: naïve theory of cause-effect, motion and spatial relationships
- When a sense organ transmits a change, can decide what the change means

Invariants example

- A tree seems to be shrinking (data)
 - ▣ Processing goes:
 1. A tree is a static object (concept)
 2. A static object cannot change size (concept)
 3. Therefore it is due to a distance change
 - ▣ Conclusion: My range to the tree is changing

Mental models example

- A lamp post seems to be moving past me (data)
 1. Lamp posts are static (concept)
 2. Therefore I must be moving (concept)
 3. But I am sitting still (data)
 4. I am in a car (data)
 5. Therefore the car is moving me (model)
- Conclusion: I am inside a moving car

Presence: links to perception

Perception: to ensure selected behaviours match environmental conditions

Presence: how much do the user's behaviours match the virtual environment

Implied **link**: presence is how much perception favours the virtual environment rather than the real

- 'Presence is considered as a perceptual mechanism for selection between alternative hypotheses'
- 'The issue of presence is only interesting when there are competing signals from at least two environments.'
 - ▣ Slater, 2002

Presence theories

- Presence theory historically mirrors perception theory (!)
 - ▣ Early theories (1990s) emphasize perceptual data (bottom-up)
 - ▣ Later theories (2000s) argue for the importance of learning, previous knowledge (top-down)
 - ▣ Evidence is accumulating that Presence is an integration

Bottom-up presence

- Zeltzer (1992)
 - ▣ High bandwidth “bath” of data leads to a sense of being in the world
- Slater & Wilbur (1995) — Immersion
 - ▣ Description of system variables
 - ▣ Presence is a weighted sum of immersion variables

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Top-down presence

- A developing area of research
- Major question (Biocca, 2002)
 - ▣ Why can a book cause presence? (“the book problem”)
- If Zeltzer, Slater & Wilbur are correct, it should not

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Evidence against bottom-up presence

- Towell & Towell (1997) – measured reasonable degrees of presence in MUDs
 - ▣ Shows that if there is a minimum bandwidth, it is very low
- Nunez & Blake (2003) – compared presence in text based & graphics based VEs – small differences only
 - ▣ High bandwidth affects presence, but not a necessary condition

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Adding top-down into the mix

- Implications of top-down processing in presence
 - ▣ Mental models can be exploited to “provide” data & improve interfaces
 - ▣ BUT: need to have elements in the VR which *match concepts* to some degree for this to work (i.e. identifiable invariants)
 - ▣ Result: people notice problems but it does not matter

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How top-down fits in

- Previously: “suspension of disbelief”
 - ▣ Fickle, vague notion
 - ▣ Not clear how it operates
- Now: a cognitive process
 - ▣ Can be manipulated (Nunez & Blake, 2003)
 - ▣ The relationship is complex – not simply additive as suggested by Slater & Wilbur
 - ▣ Sets the context within which the stimuli are processed

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Conceptual inputs to presence

- Conceptual variables seem to act as *mediators* to presence
- They provide a context/filter to immersion variables
- The relationship is unclear; little theoretical work

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Hypotheses on Reality

- At any given moment the brain formulates hypotheses about the world based on our perceptions.
- In a VE we are *at once* experiencing both
 - ▣ a *real* location and
 - ▣ a *virtual* one.
- Our brain picks whichever hypothesis corresponds to the location we feel most present in
 - ▣ the most likely choice will be the one with the strongest set of clues.
 - ▣ Slight changes in our perception could trigger switches in hypothesis: Breaks in Presence.

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Breaks In Presence (BIPs)

- Slater: Treats presence as a gestalt
- Argues that presence is like a figure ground illusion
 - ▣ In one state or the other exclusively
- Depending on number of BIPs estimate presence



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Breaks In Presence

II

- There are 2 competing hypotheses:
 - ▣ "I am in the real world" (figure)
 - ▣ "I am in the virtual world" (ground)
 - ▣ Which we believe can switch quickly
- The user goes through of cognitive process of collecting evidence to support either
- But the "Real" hypothesis can receive sudden support
 - ▣ A virtual → real = "break in presence"

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BiPs critique

- Does not consider presence as a continuous intensity phenomenon
 - ▣ Available empirical evidence suggests it is
- Does not provide any clear theoretical insight
 - ▣ Why do BiPs occur? Why not BiRs?
 - ▣ What are sources of evidence for the hypotheses?
 - ▣ Can one not add hypotheses *ad absurdum*?

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