Visuomotor control and Non-conscious processing

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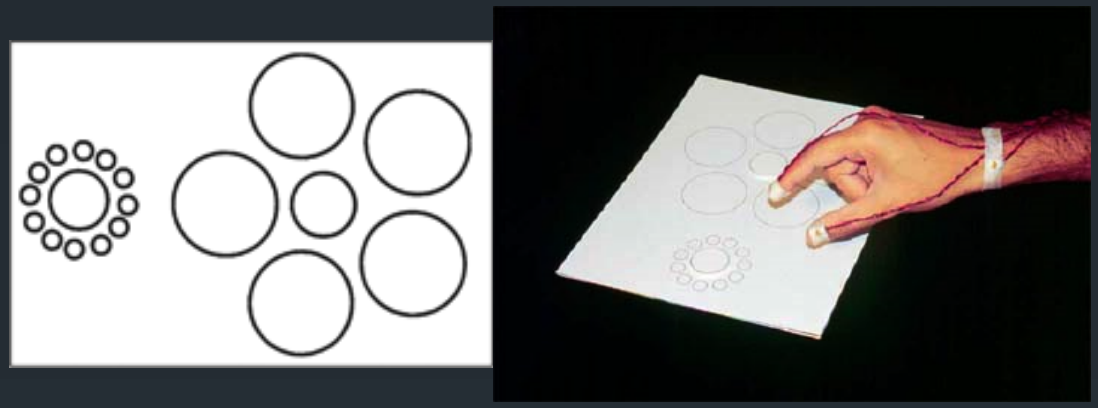
Outline

1. Visuomotor control & 2 processing streams

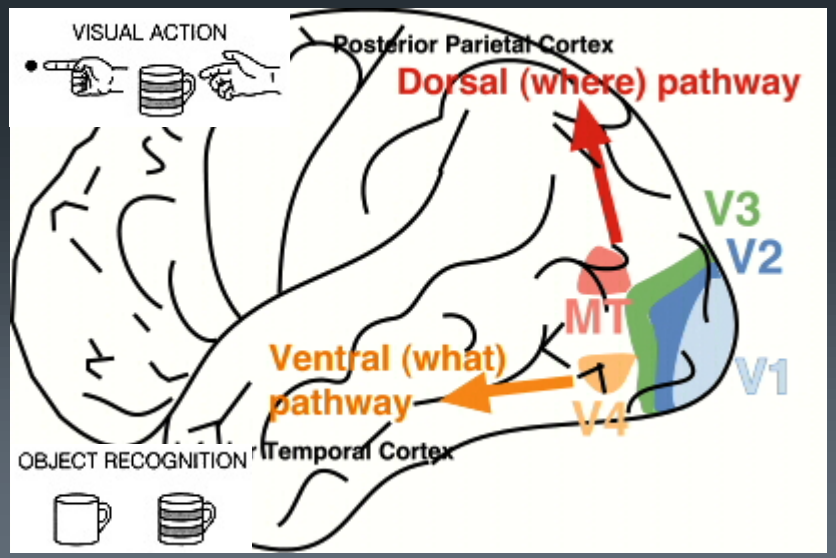
2. Non-conscious processing: clinical examples

3. Non-conscious processing: normal (non-clinical) visual function

4. Applications for Visual Design



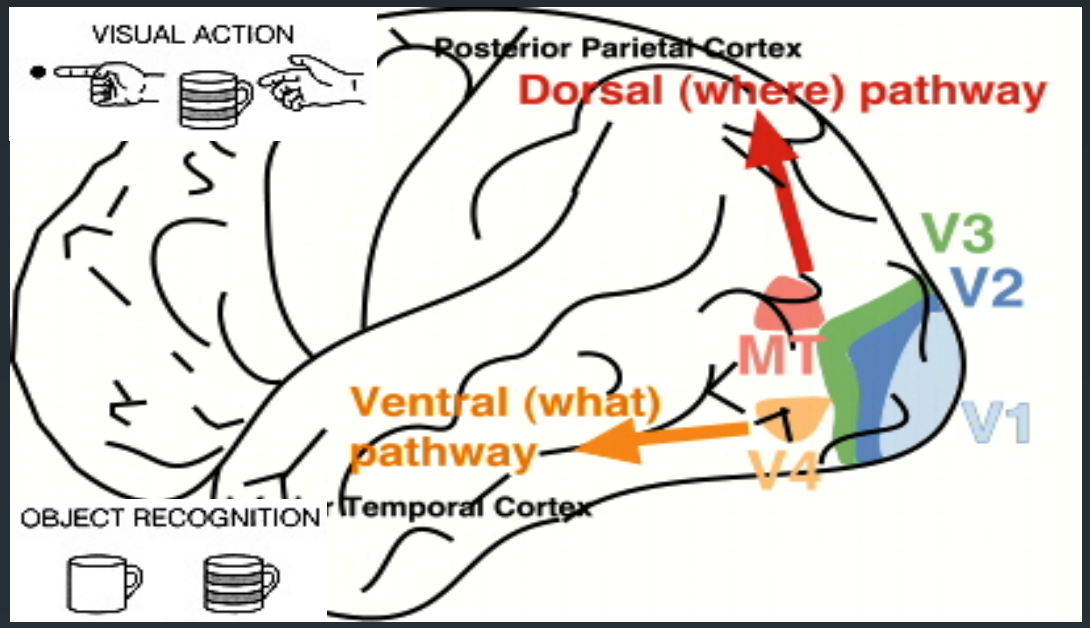
1. Visuomotor control and 2 processing streams



1.1 The curious case of DF

- Carbon monoxide poisoning-> damage to ventrolateral cortex
- Can’t recognize objects through vision, but can by touch= visual agnosia
- Random visual perception of pencil orientation, but correct orientation when grasping

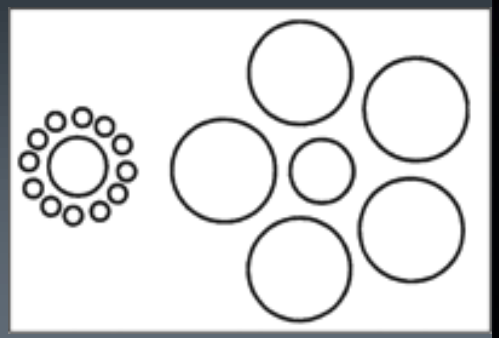
1.2 Goodale and Milner: Dual visual processing streams

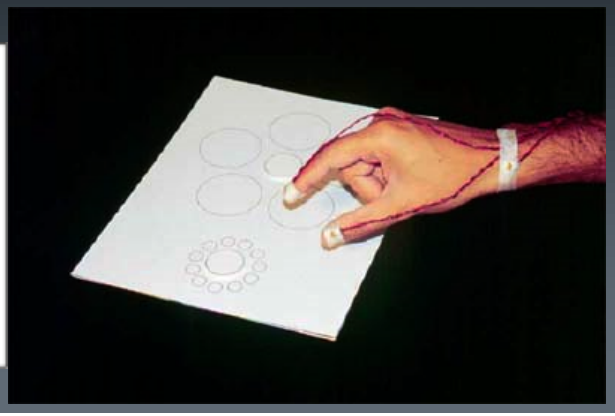


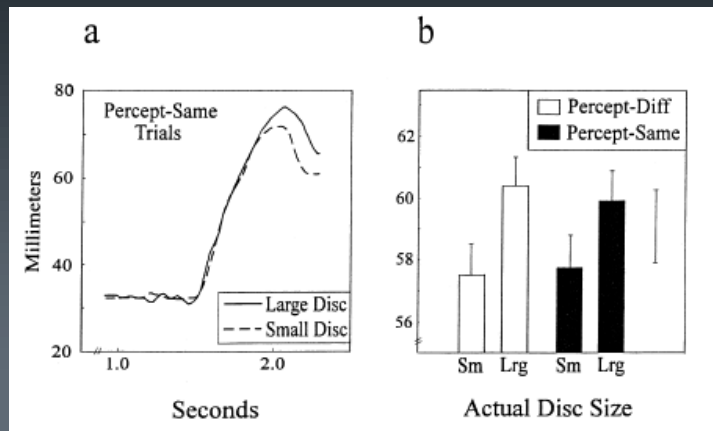
- Dorsal pathway: vision for motor control
- Ventral pathway: vision for recognition

1.3 Why two systems?

- Fast control of motor action to veridical visual stimuli, often automatic
- Delay for perception of stimuli, conscious perception of a stimulus lags its presentation by up to 500 ms; e.g., Mask renders briefly presented stimulus invisible, but motor response can be initiated in response to prior invisible stimulus
- Action is veridical, e.g., Ebbinghaus circles



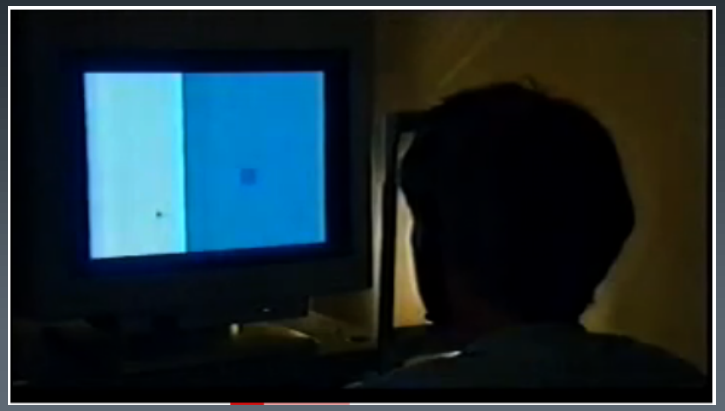




1.4 Dorsal vs Ventral: Comparison

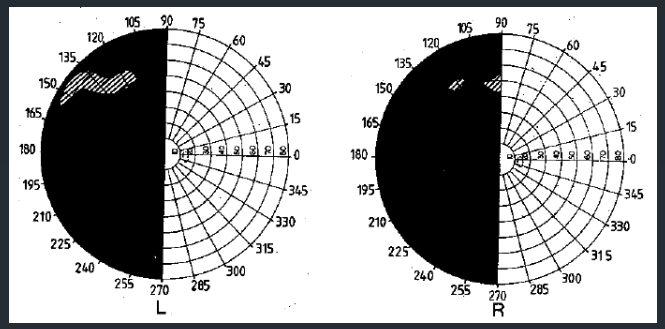
Ventral	Dorsal
Object identity	Egocentric coordinates and characteristics
Conscious experience	Unconscious “Zombie”
Selecting action to objects in world	
Perceptual lag	On-line control
Contextual influences	Veridical (when not delayed)
Less accurate in periphery	Relatively constant accuracy even in periphery

2. Non-conscious processing: clinical examples



2.1 Blindsight

- Primary visual cortex damage, results in blind field



- No conscious awareness of stimuli presented in blind field, however
  - Can still accurately reach out and grasp objects
  - Astonished to find better than guessing at forced discrimination task (moving up, down, or right?), insist nothing was there
  - color, orientation, simple shape (x or o), onset/offset
- Evolutionarily older collicular pathway, prior to damaged area
- Normal vision likely mix of conscious perception and non-conscious influences

2.2 Neglect syndrome

- Posterior parietal cortex damage-> Left side of space is often neglected, patient just not aware of it
- Object-based, e.g., left side of objects in right ("non-impaired") hemifield

- Marshall and Halligan (1988): houses reported as identical, but prefer to live in non-burning one more than half the time
  - Emotionally important (e.g., fearful) stimuli are processed, influence behaviour
    - Amygdala (emotion/fear) activation to spiders in blindsight

3. Non-conscious processing: normal visual function

3.1 Measuring non-conscious processing

- 2 part procedure:
  - 1) Measure whether stimulus was consciously perceived
    - Can be objective (behavioural) or subjective (subject report)
      - If forced choice produces chance responding, suggests not conscious
  - 2) Measure whether unconscious stimulus nevertheless influences processing of subsequent stimulus (suggests it was processed)
    - Fragment completion (A_S__I_ -> ASSASSIN), Stem completion (HE__ -> HEAD, HEAT), Lexical decision response time (word or non-word?), Identity response time (e.g., Green patch)
- Backward Masking= present one stimulus (<50ms), then another stimulus of equal or higher intensity (SOA ~ 50ms), the presentation of the second stimulus reduces the visibility of the first, but doesn't eliminate it's processing
  - Backward masked stimulus can nevertheless "prime" a subsequent related stimulus (e.g., word Green causes faster response time to identify green colour patch- Marcel, 1983)

3.2 More evidence of non-conscious processing

- Merikle's 2 criteria for demonstrating non-conscious processing: Exhaustiveness and Exclusiveness
  - Exhaustivness: measure of consciousness really gets at all conscious experience of the stimulus
  - Exclusiveness: measure of conscious processing, which shows guessing, is not really measuring unconscious processing

- Qualitative differences between conscious and non-conscious processing, not just differences along speed continuum: suggests C vs U are really different processes

  - Unconscious faces (4ms) influence affective judgments of subsequent chinese symbol, not conscious (1s) faces

  - Semantics determines similarity for unconscious word, structure/physical properties for conscious word

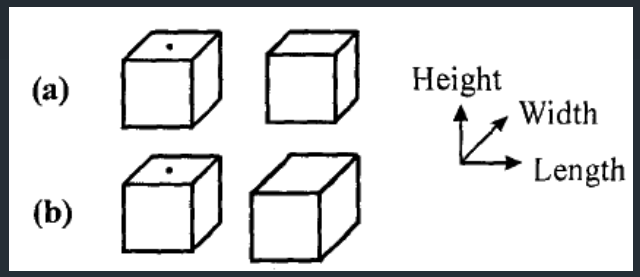
3.2 More evidence of non-conscious processing (cont°d)

- Qualitative differences (cont'd)
  - Unable to inhibit unconsciously influenced (50ms) word stem completion, capable of control for conscious prime (150ms)
  - Conscious processing constrains interpretation of polysemous words:
    - Hand-> Palm (unconscious) -> Wrist = Tree -> Palm -> Wrist
    - Hand -> Palm (conscious) -> Wrist >(faster) Tree -> Palm -> Wrist
- Note on masking: some stimuli are harder to mask than others; e.g., well rehearsed words (participant's name), biologically relevant stimuli (cartoon smiley face); Shelley-Tremblay and Mack, 1999

4. Applications for Visual Design

4.1 Hu et al.

- Delayed vs. immediate grasping actions to one object in the presence of a different-sized object

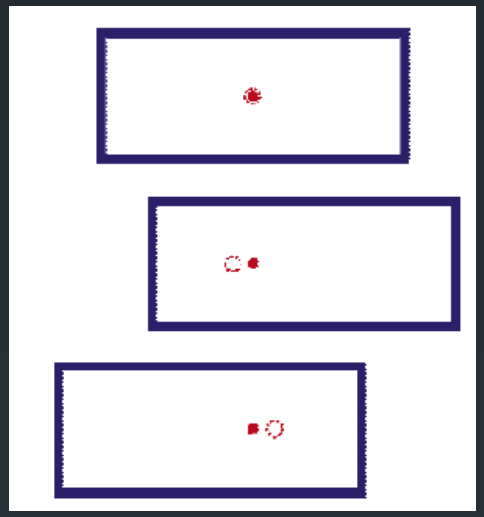


- Maximum grip aperture more accurately fits target object for no delay cf. 5 second delay group
- Delay group overcompensates, e.g., target is bigger than non-target-> open grip even wider

- Shift from absolute (egocentric) to relative (allocentric) metrics with delay

4.2 Po et al.

- Induced Roelofs effect: dashed circles= perceived, solid= actual position



- Pointing with vs. without visual feedback (cursor)

- More errors in specifying location for feedback cf. non-feedback conditions (motivates use of cognitive representations of space)

Conclusion

- Visually guided action occurs independent of vision for object identification; properties determined by purpose

- Complete consciousness of our behaviour is an illusion
- Emotionally important, or simple information transmitted along separate pathways from normal conscious vision

- Normal behaviour influenced by unconscious processing
- Qualitative differences characterize conscious and unconscious processing

- Executing vs. monitoring: using other objects may create allocentric frame of reference (esp. with delay)
- Use visual feedback with caution when executing actions to a display

Thanks!

References

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- Goodale & Milner. "***Separate Visual Pathways for Perception and Action***."
- Hu et al. "***Constraints and Principles for the Design of Human-Machine Interfaces: A Virtual Reality Approach***."
- Marshall and Halligan. ***"Blindsight and insight in visuo-spatial neglect."***
- Merikle & Daneman. "***Psychological Investigations of Unconscious Perception.***"
- Palmer, sections 13.2, 13.3.
- Po et al. "***Pointing and Visual Feedback for Spatial Interaction in Large-Screen Display Environments***."
- Shelley-Tremblay and Mack. ***"Metacontrast masking and attention."***
- Ware, pp 317-324.