APA 2120

Lecture 5: Response Programming & Sensory Systems 1: Vision
Sept 20, 2012

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Review

Input (stimulus) →  ? → Output (response)

Factors Affecting Stimulus Identification

→ stimulus identification → response selection → response programming →

Factors related to stimulus identification

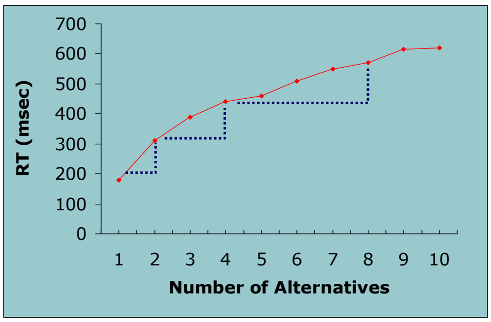
Stimulus modality
Stimulus intensity

Factors Affecting Response Selection

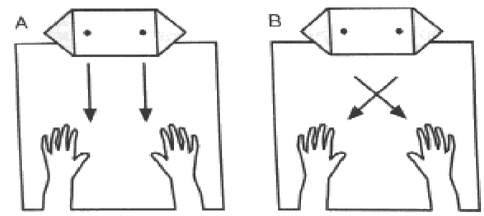
→ stimulus identification → response selection → response programming →

Factors related to stimulus-response translation

 # S-R Alternatives (Choices)
S-R Compatibility
Practice



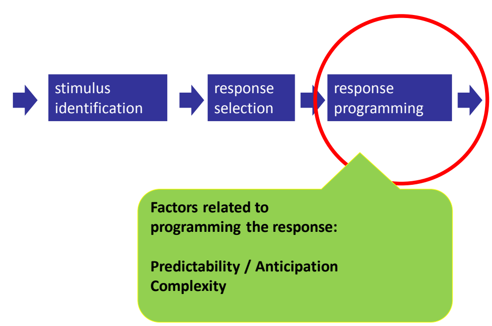
Spatial mapping



New

Response programming stage

Factors Affecting Response Programming



Event Predictability

- How does the predictability of an event influence response preparation?
  - allow performer to anticipate and bias preparation process

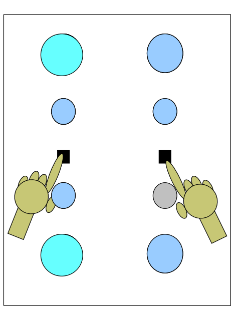
- anticipation allows for advanced information processing

RT and Response Predictability

- Precuing

The Precue Method

e.g. Rosenbaum, 1980



Results

- Advance information about arm, direction or extent (amplitude) reduces RT.
  - Knowing which arm reduces RT by **150 ms**.
  - Knowing the amplitude of the movement reduces RT by **100 ms**.
- Therefore Reduction in RT cannot be explained simply as a reduction in uncertainty.

Event Predictability

- How does the predictability of an event influence response preparation?
  - allow performer to anticipate and bias preparation processes
  - *i.e. Anticipation allows information processing in advance*

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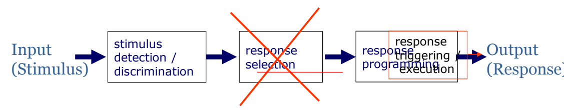
Human Information Processing



More like a Simple RT Situation

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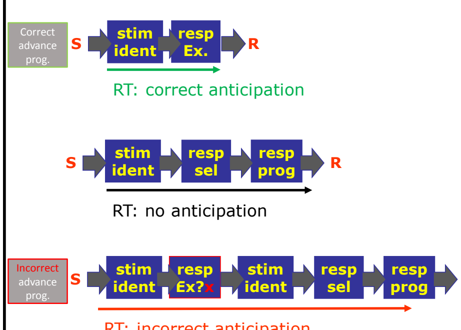
Cost-Benefit Analysis of Anticipation



Benefit:
↓ RT

Cost:
↑ RT

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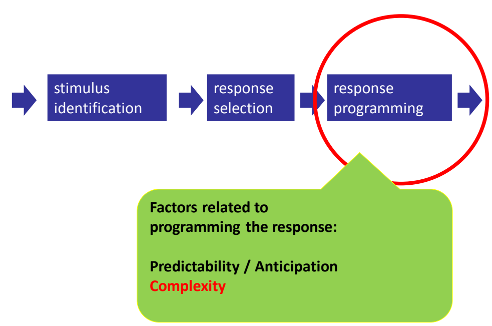
Factors Affecting Response Programming



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RT and movement complexity

- If a motor program is prepared in advance then do movements of greater complexity take longer to prepare?
- If so, then
  - RT should increase as movement complexity increases
    - and
  - Increased time must be required to organize more complex movements

A. finger lift
B. finger lift + reach and grasp a ball
C. finger lift, hit ball 1, reversal movement press button, grab ball 2

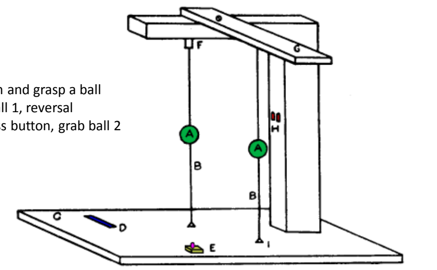


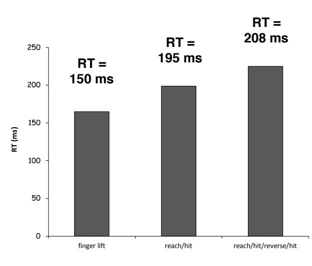
FIG. 1. Speed of Movement Apparatus. A—tennis ball; B—48 lb. nylon cord; C—base board; D—reaction key; E—push button; F—friction contacts; G—side arm; H—signal lights; I—cord holder.

From **Howell, M.L.** "Influence of Emotional Tension on Speed of Reaction and Movement" Research Quarterly, 1953, 24,22-32.

- more complex responses = longer responses

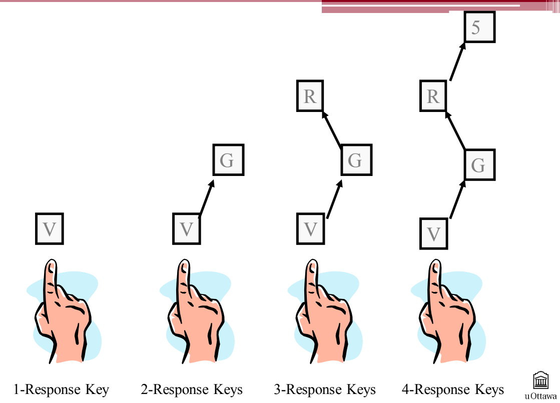
Movement Complexity Experiment

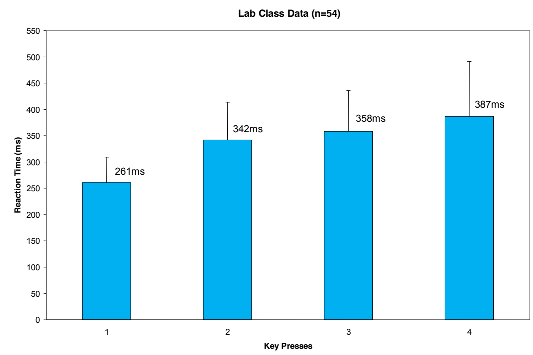
- Henry & Rogers (1960) - studied simple RT and movement complexity
  A. finger lift
  B. finger lift and reach and grasp a ball
  C. finger lift, hit ball, reversal movement to button, hit ball 2



Franklin Henry's conclusions

- "Under controlled conditions Simple RT becomes longer when the type of movement which follows the reaction is varied from very simple to relatively complex."
- "Further increase in complexity produces additional slowing, but to a lessened degree"(p.457)

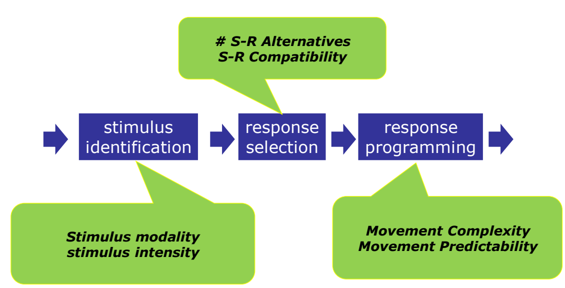




Franklin Henry's Statement #2

- "neuromotor coordination patterns are conceived of as stored..." (i.e. programmed)
- Time required for accessing the program via a memory mechanism requires increasing time as the motor act becomes more complex.(p.457)
  - Think of copying larger (e.g. more complex) files to a USB memory stick

Information Processing Summary



Sensory Systems

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- Q: Where do information processing stages occur

Movement Control

- Where does this information processing take place in the nervous system?
  1. Stimulus Identification – where does input come from?
  2. Response Selection – how do we decide to act and then select an appropriate response?
  3. Response Programming – how do we develop a plan of action and sent it to the muscles?
- ☆ What happens after the plan gets to the muscles?

Follow the information

- Sensory information comes in….
  - Types?
  - Then what?

Input (stimulus) →

→ Output (response)

Sensory Contributions 1

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VISION

- Exteroceptor
- Proprioceptor
- Dominates when performing motor tasks
  - http://www.youtube.com/watch?v=dOwLtahtmHg&feature=player_embedded
- Feedback mechanism
- Feedforward function

Seeing the Light

- Retina
  - Light sensitive receptor segment of the eyes
  - Cell types

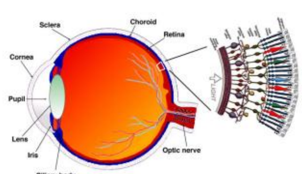

Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.

Light bombarding the retina produces the Optic Array

- image when you see is actually upside down your brain flips it over to understand it.
-

Vision as a Proprioceptor

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- eyes are super important to help you balance (think of being on a roc

Vision as a Proprioceptor

Moving Room Experiment
Lee and Aronson (1974)

http://www.youtube.com/watch?v=NTVtmUJeInY

Vision as an Exteroceptor

Vision as an Exteroceptor

1. Locomotion
   - Crowded streets
   - Doorways
   - Obstacles
   - Other examples?

Environmental cues provide us with information about how we must accommodate our actions.

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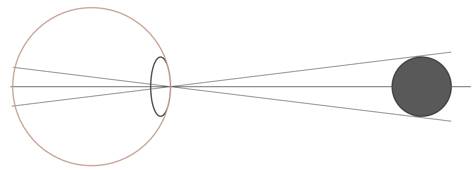
Processing Visual Information

- Time to Contact (T_C) or "Tau (τ)"



Computation of T_C (Time to contact)

A = RETINAL IMAGE

$\dot{A}$ = RATE OF EXPANSION OF RETINAL IMAGE OCCURING AT TIME t

Proportionate rate of expansion

$$T_c \ \alpha \ (A / \dot{A})$$

T_C Continued

The rate of change in retinal image is larger the faster the object's velocity

- Dividing by a larger $\dot{A}$
- ➔ T_c is less

$$T_c \ \alpha \ (A / \dot{A})$$

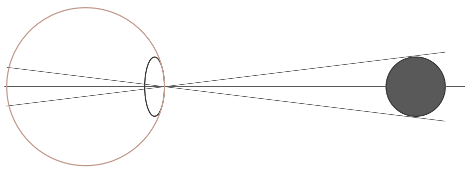
A = RETINAL IMAGE

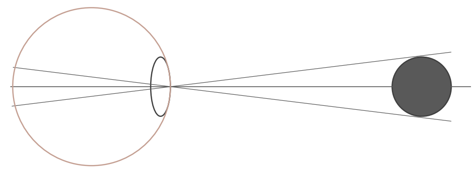
$\dot{A}$ = RATE OF EXPANSION OF RETINAL IMAGE OCCURING AT TIME t

T_c = 1 (2m / 2 $m_{/s}$) x = 1 sec

T_c = 1 (2m / 4 $m_{/s}$) x = .5 sec

NOTE: velocity assumed to be constant





- T_C may be a **control variable** for certain actions.
  - In other words, T_C may be one of the factors that animals use to guide their motions. T_C may be used in various ways:

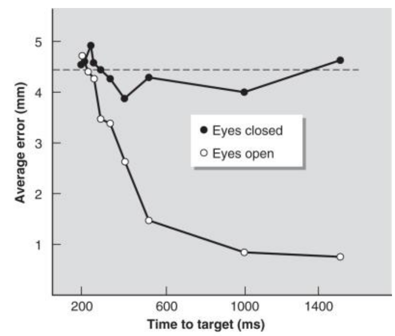
- an action is initiated when a certain threshold value of Tc is reached. Eg: diving birds folding their wings or insects dodging an incoming collision

Time to Process Visual Information

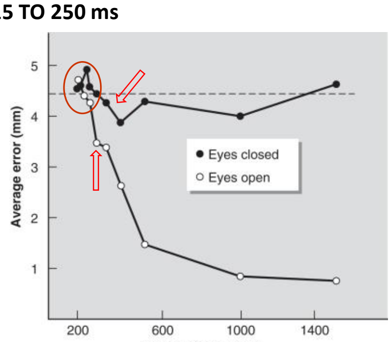
Time to process Visual Information

- Woodworth (1899)
  - Make back and forth movement with a pen
  - GOAL: each movement be equal in length to the prior movement.

  - CONDITIONS:
    - Eyes open vs. Eyes closed
    - Various speeds 300 ms to 3 s per movement cycle
    - example



- Time to Process Visual Information = **215 TO 250 ms**

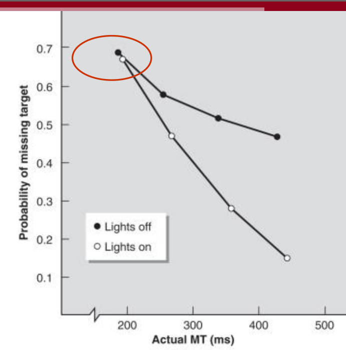


Woodworth Results

- Time to process visual info:
- 200-250 ms

KEELE AND POSNER (1968)

- Subjects performed discrete aiming movements in a situation in which the lights in the room could be extinguished when the movement had started (variable)



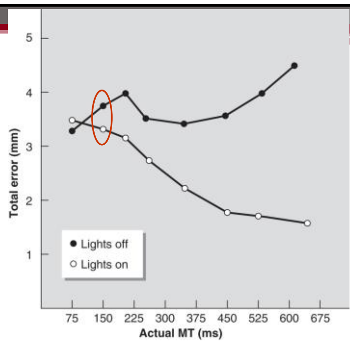
From Keele and Posner 1968.

Time to process visual information = **190-260 ms**

- On-line vision provides accuracy advantages, even for very rapid movements
- But…
- Vision under various conditions can be processed for motor control considerably faster than our usual estimates of RT to a visual stimulus

Zelaznik, Hawkins and Kisselburgh (1983)
  - Uncertainty of visual information

- Set up trials so visual information was available in a blocked pattern
- e.g. : on, on, on, on, on,- off, off, off, off, off,



Adapted from Zelaznik, Hawkins, and Kisselburgh 1983.

Found accuracy differences between vision and no-vision condition for movement times as short as **150 ms**

How Much Time is Needed to Process Visual Information?

- Initial studies suggested 300 ms is needed
- More recent studies suggest 150 ms and some even as short as 100 ms, depending on predictability of vision
- ? Is this better / faster visual processing or optimization of pre-planning?

How Vision Provides Information: Two Cortical Visual Systems

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Two Cortical Visual Systems

Dorsal route

Ventral route

Milner and Goodale: "Where?" ***ACTION***

Possibly immune to the effects of visual illusions

- It is thought to 'ignore' context, and process only the action target

Milner and Goodale: "What?" ***PERCEPTION***

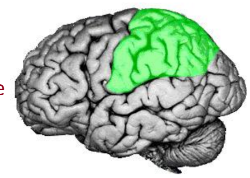
Thought to be responsible for many illusion effects

- Processes the target and its context

- Ventral: conscious perception of object identification (shape, size, color, lightness, relative location)
- Dorsal: unconscious action towards objects (how to interact with object)

What Happens if a System is Damaged?

- Optic Ataxia – brain damage occurring to the parietal lobe / Dorsal System
  - Patients can describe the object but reaching movements are inaccurate

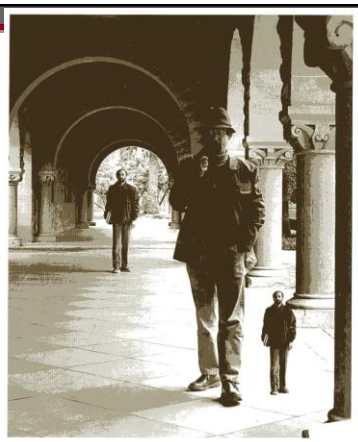


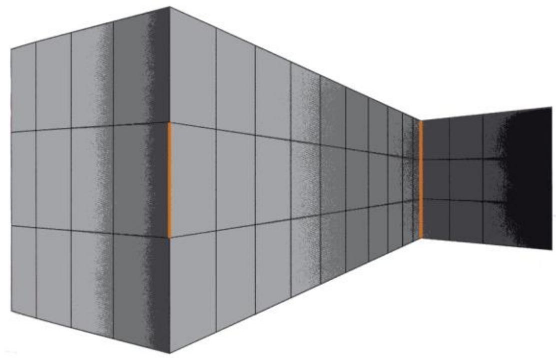
What Happens if a System is Damaged?

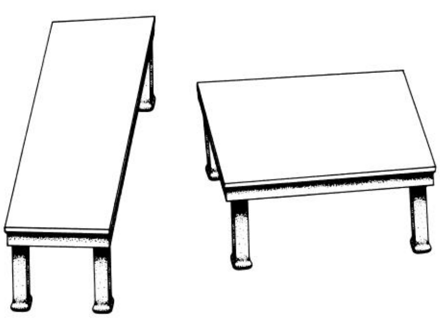
- Visual Agnosia – brain damage occurring to the temporal lobe / Ventral system
  - Patients can pick up the object but cannot recognize or describe it
    - http://www.youtube.com/watch?v=rwQpaHQ0hYw#t=0m20s
    - http://www.youtube.com/watch?v=kuKqi93FMgQ#t=1m16s

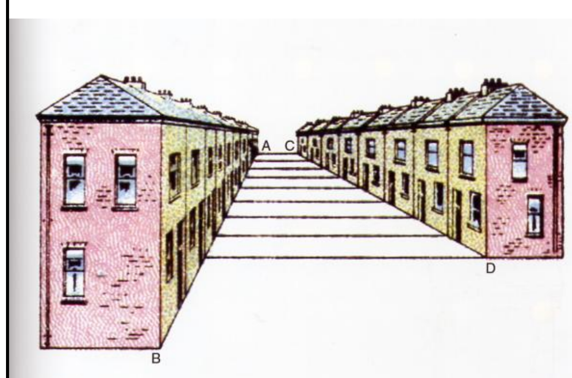
Visual Illusions

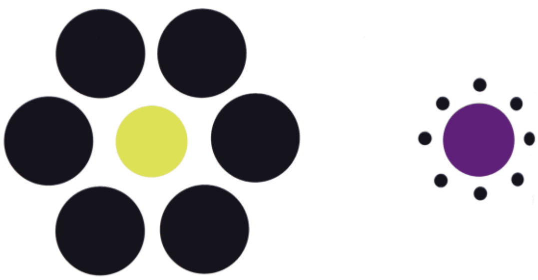
- How perception and action interact
- Illusions








A
C
B
D



Interacting with Illusions

- Some studies show that, while our perceptions are affected by illusions, our actions are not