APA 2120

Lecture 3: Measurement / Information Processing
Sept 13, 2012

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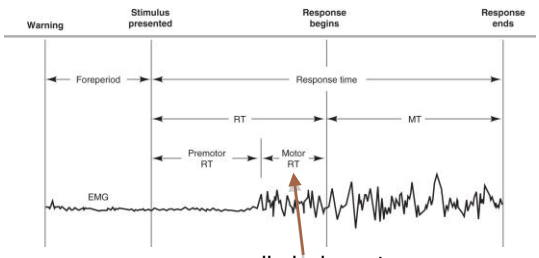
Review

- Mean, median, mode
- Performance Outcome Measures
  - RT, Distance, # of baskets
    - outcome measures such as RT, distance thrown, number of baskets hit, etc. are easy to measure… but error measurements are a little more tricky…
  - Error measures: CE, AE, VE
- Performance Process measures
  - 1. Kinematics
  - 2. Response (reaction) time

2. Response Time *(this is an important concept)

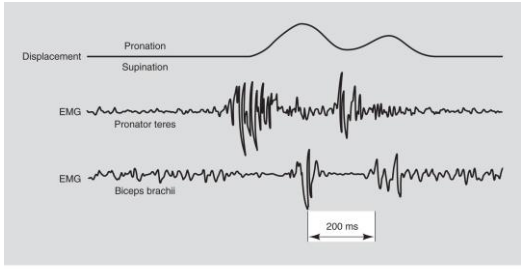


limb doesnt move yet

3. Electromyography (EMG)

- monitor electrical activity of muscle

- used to monitor changes in muscles used or activity, pattern



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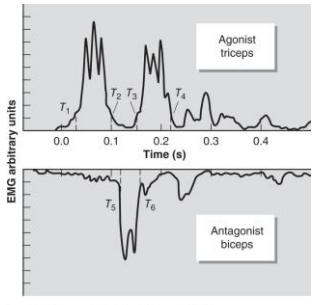
EMG Pattern



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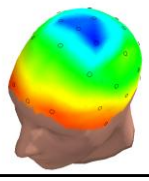
Performance Process Measures

4. **E**lectro**e**ncephalo**g**raphy (EEG)

monitor electrical activity of the brain

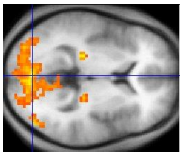
Used to monitor changes in information processing or active cortical systems in the brain



Performance Process Measures

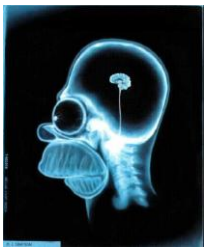
5. Functional **M**agnetic **R**esonance **I**maging (fMRI)

Monitor changes in blood flow and blood oxygenation in the brain



Magnetic Resonance Imaging

MRI



fMRI

- this can show which side of the brain is function while doing a movement.
- burn oxygen when using energy, can monitor changes in blood oxygenation.
-

Visual Information

- How we scan a visual image is dependent on what information we want to gain.
- Look at the following picture: *An Unexpected Visitor* (Repin, 1884).

Visual Information

- Did you notice where your eyes went?
- Look at the picture again for 15 sec, this time assess the ages of each person in the picture.

Visual Information

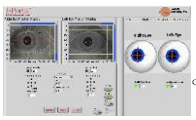
- Look at the picture again for 20 sec, this time assess:
- 1) How wealthy and educated is the family for Imperialist Russia, in 1884?
- 2) Remember peoples clothes

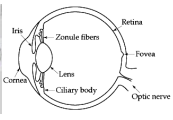
Visual Tracking

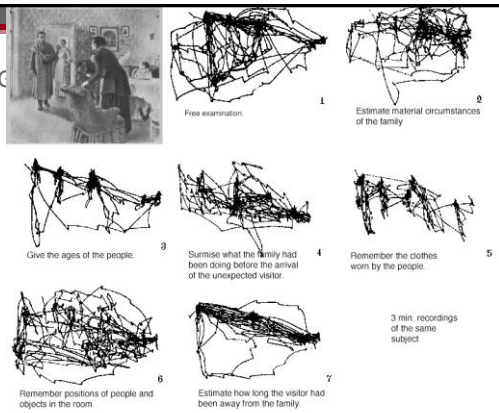
- How did you judge each person's age?
- Were you looking at their hands, clothes, or their faces?

6. Eyetracking

- With non-invasive equipment we can track your "point of gaze".
- Used to study gaze patterns for car interior design, traffic patterns, etc.
- Miniature cameras record position of eyeball relative to head.
- Calibrated using cornea reflection with respect to pupil position.







Free examination

Material Wealth?

Peoples Ages?

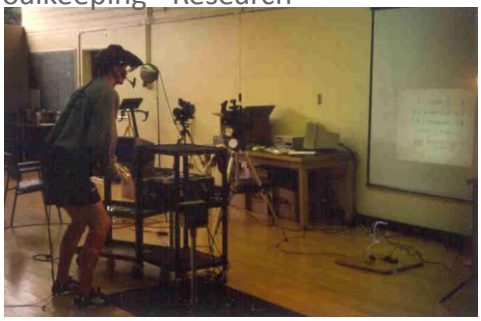
Remember Clothes

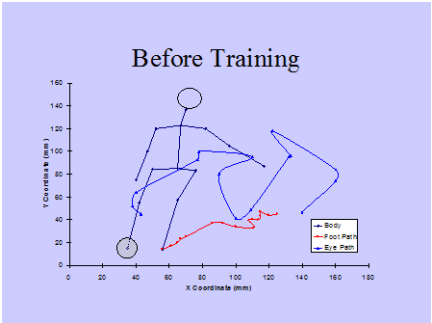
Goalkeeping - Penalty Kick

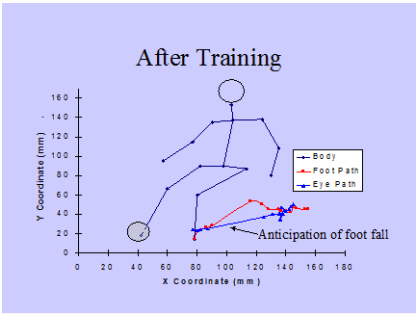
- Soccer Goaltenders have very little time to assess visual cues in order to stop a penalty kick.
- What gives the best indication of shot direction? (head, eyes, hands, torso, hips, knees, kicking foot, planting foot?)

- planting foot is the best indicator

Goalkeeping - Research







Human Information Processing I

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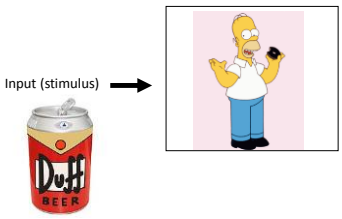
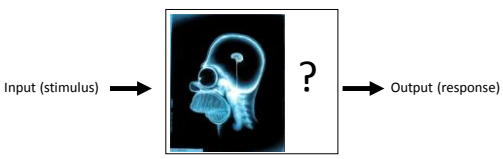


The BIG question

- **How do we figure out what is going on inside the black box????**

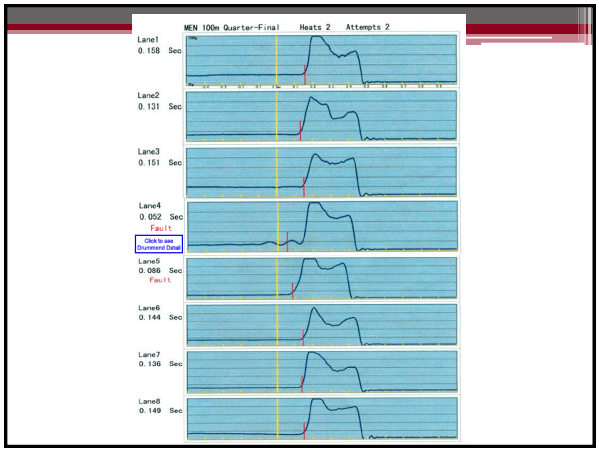


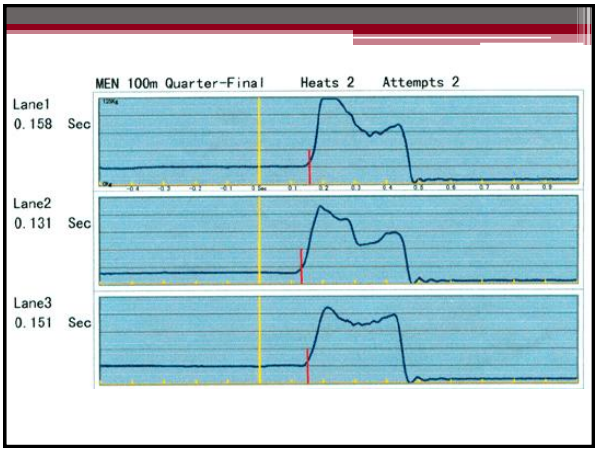
Vidéo

http://www.youtube.com/watch?v=Cxn7yaOfEoY

- is how do we figure out whats going on inside the brain?
-

the rule is 1/10 of a second after the start


MEN 100m Quarter-Final Heats 2 Attempts 2
Lane1 0.158 Sec
Lane2 0.131 Sec
Lane3 0.151 Sec
Lane4 0.052 Sec Fault
Click to see Drummond Detail
Lane5 0.086 Sec Fault
Lane6 0.144 Sec
Lane7 0.136 Sec
Lane8 0.149 Sec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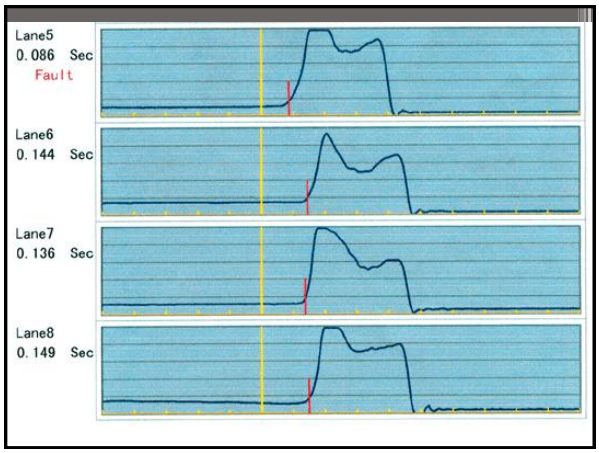
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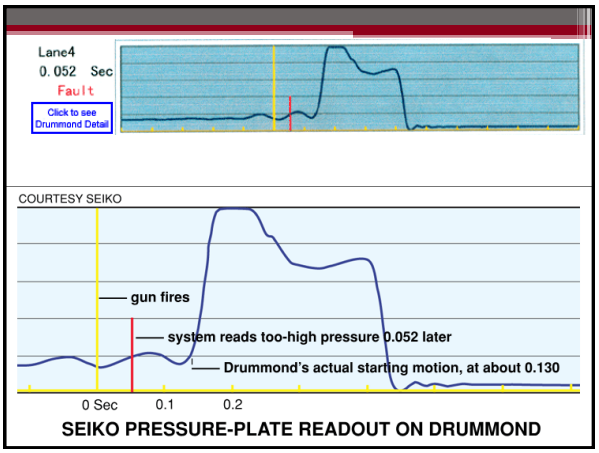
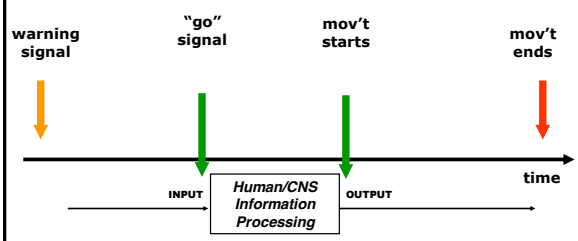
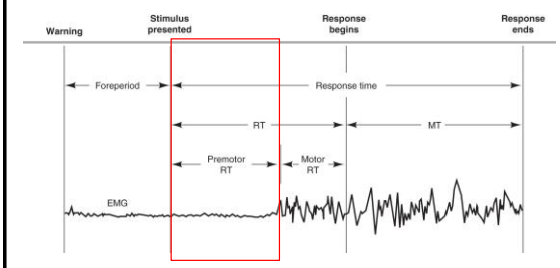
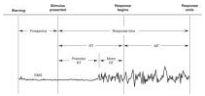

Lane4 0.052 Sec Fault
Click to see Drummond Detail
COURTESY SEIKO
gun fires
system reads too-high pressure 0.052 later
Drummond's actual starting motion, at about 0.130
0 Sec
0.1
0.2
SEIKO PRESSURE-PLATE READOUT ON DRUMMOND

Time Course for Reactions





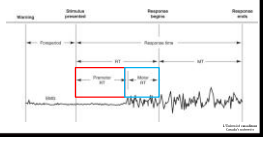
Terminology



- **Foreperiod**
  - time between warning and stimulus presentation
- ***Reaction Time (RT)***
  - interval of time between presentation of unanticipated stimulus to beginning of movement response
- ***Movement Time (MT)***
  - time between initiation and completion of movement
- ***Response Time***
  - time between signal onset and completion of movement (MT +RT)
  - includes processing and completion of movement

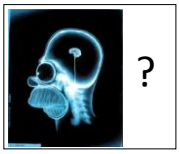
Fractionated RT

- Reaction Time (RT) can be broken down into 2 components by studying muscle EMG
  - ☆**Pre-motor time** - time between presentation of stimulus and change in EMG of prime mover
    - reflects time required to develop plan of action and send info to muscles involved
  - 🕐**Motor time** - time from change in EMG of prime mover to beginning of performer's response
    - represents the mechanical processes associated with the action



The BIG question

- **How do we figure out what is going on inside the black box????**

Input (stimulus) →  ? → Output (response)

Information processing

- Basic Tenets
  - mental operations occur between reception of stimulus and production of response
  - cognitive operations process information
  - processing is time consuming
  - stimulus characteristics, complexity of decision-making, complexity of response will affect processing

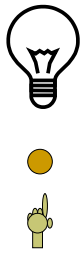
what if …
we measured the time required
for making responses when different
choices are required?

Franciscus Cornelis Donders
(1818–1889)

"This was the first determination of the duration of a well-defined mental process. It concerned the decision in a choice and an action of the will in response to that decision."

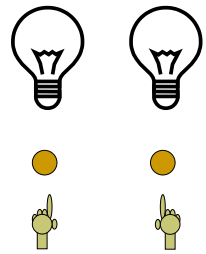
"A" reaction - Simple RT

- Simple:
  - 1 stimulus
  - 1 response



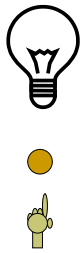
"B" reaction - Choice RT

- More than 1 stimulus - response alternative
- RT is longer than Simple RT
- Demo this



"C" reaction – Go / Nogo RT

- Simple:
  - 2 stimuli
  - 1 response



"C" reaction – Go / Nogo RT

- Simple:
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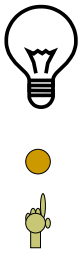

Donders' subtractive method

Reaction	Common Term	Stage(s) of processing	RT
A	Simple RT	Stimulus detection Response execution	200 ms
B	Choice RT	Stim detection Stim identification Response selection Response execution	285 ms
C	Go / No go	Stim detection Stim identification Response execution	230 ms

Processing stage	Subtraction	Example
Stim identification	C – A	230 – 200 = 30 ms
Response selection	B – C	285 – 230 = 55 ms

Donders' subtractive method

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Processing stage	Subtraction	Example
Stim identification	C – A	230 – 200 = 30 ms
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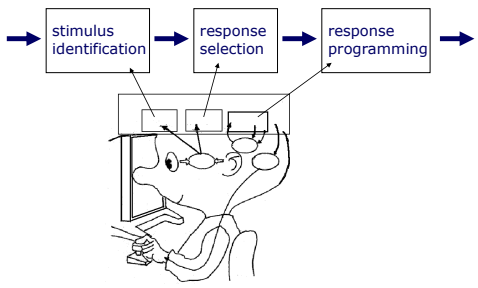
BUT...

- Does all processing happen in serial?
- Can we parallel process?
- Currently, information processing is generally thought to occur in 3 stages

3-stage model

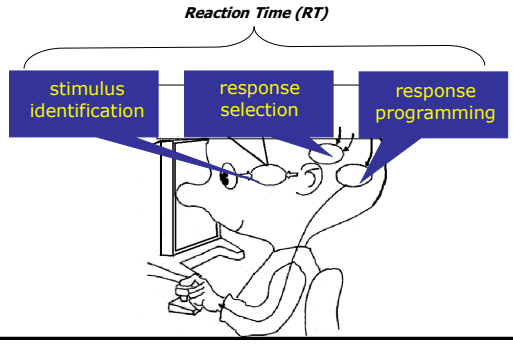


3-stage model

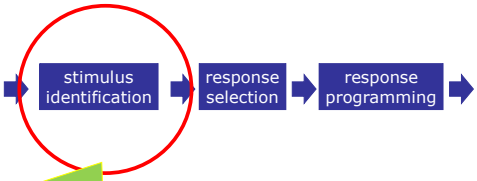
stimulus identification
- receives information from senses
- identifies and classifies information
- extract relevant information

response selection
- decide on a plan of action
- translate between stimulus and response

response programming
- organize and prepare a response
- send appropriate motor commands

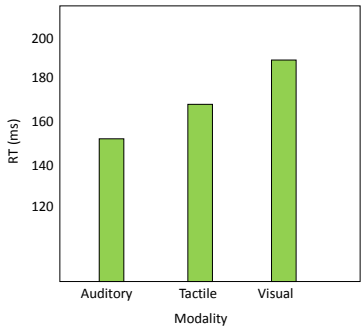


Factors Affecting Stimulus Identification

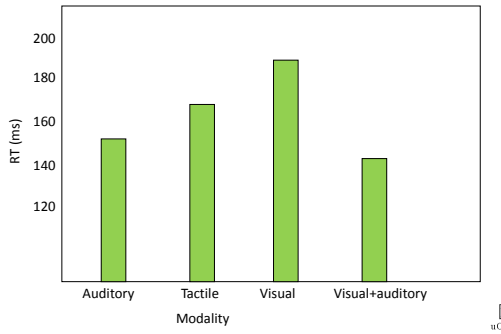


Factors related to: stimulus identification

performer's attentional focus
Stimulus modality
Stimulus intensity



Intersensory Facilitation



explanations

- Modality effect:
  - Visual information takes longer to transduce into neural impulses than auditory
  - Tactile (often) must travel longer distance to the brain (e.g. from the big toe to the brain can be more than 2 m)
  - 2 m @ 100 m/s can add 20 ms to RT
- Intersensory facilitation:
  - Accumulator model – i.e. more information is available in each sample

- The stimulus can have an effect on RT
  - Stimulus Modality
  - **Intensity**

Stimulus intensity effect

- as stimulus intensity increases, RT decreases
  - Piéron (1920) and Luce (1986).
- Seen across different modalities (e.g. Auditory, Visual, etc.)

MRI info

- When the object to be imaged is placed in a powerful, uniform magnetic fields:
  - the spins of the atomic nuclei with non-zero spin numbers (essentially, an unpaired proton or neutron) within the tissue all align in one of two opposite directions:
  - parallel to the magnetic field or antiparallel.
- The tissue is then briefly exposed to pulses of electromagnetic energy (RF pulses) in a plane perpendicular to the magnetic field
  - causing some of the magnetically aligned hydrogen nuclei to assume a temporary non-aligned high-energy state
- As the high-energy nuclei relax and realign, they emit energy at rates which are recorded to provide information about their environment

fMRI info

- Haemoglobin is diamagnetic when oxygenated but paramagnetic when deoxygenated. The magnetic resonance (MR) signal of blood is therefore slightly different depending on the level of oxygenation.
- "BOLD" (**B**lood **O**xygenation **L**evel **D**ependent) signal:
  - Increased neural activity
  - → Increased local blood flow more than compensates for O_2 use
  - → decrease in deO_2 Hb concentration
  - → increase in MR signal intensity (deO_2 Hb is paramagnetic)
- Thus Increased neural activity → time delayed blood flow response that can be imaged with an MRI

BOLD response

- Participants will perform a task in the MRI and changes in bloodflow are observed
- Indicating increased (decreased) use of that specific area