Human Factors in Systems Design

Week Three:
Human Information Processing

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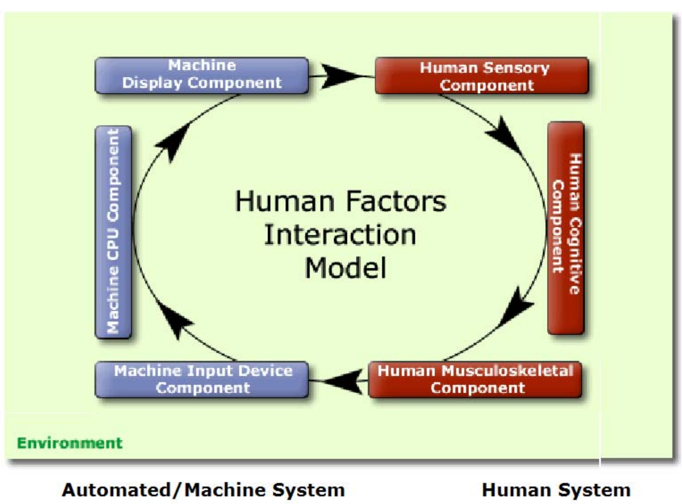
FAA Human Factors Model



Module 3 Goals

At the end of this week, students should be able to:

1. Describe a model of Human Information Processing
2. Describe the function of Signal Detection Theory in classical HFE to include ROC curves
3. Illustrate and describe the FAA Human Factors model.
4. Describe the process required to obtain approval from the IRB to conduct human subjects research.

This week

Human Information Processing Models, SDT

Wednesday

Turn in Homework (Appendix B Article Critique)

ROC curves

Review of IRB approval for Human Subjects Research

Thursday

Work with team on course project

"All models are wrong, but some models are useful."

George Box, 1979

Some Ways to Classify Models

Conceptual______________Computational

Reductionist_____________First Principled

Static________________________Dynamic

Recursive_______________Non-Recursive

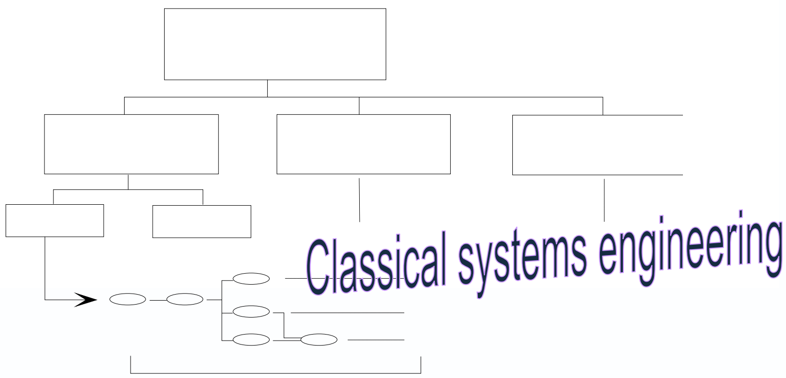
Discrete____________________Continuous

Other ways?

Two strategies to model human/system performance

Reductionist

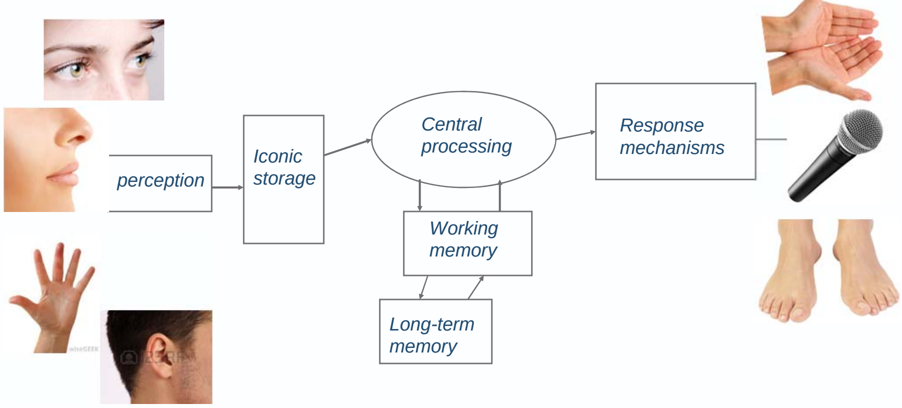
- Breaking human activity and interaction with the system into discrete activities



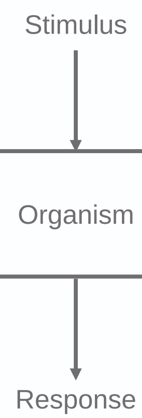
Two strategies to model human/system performance

First principled

- Based on theories of the underlying mechanisms that facilitate human behavior

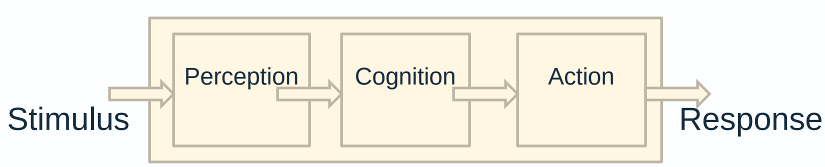


Simple Model



Human Information Processing Models

Three stage model



Human Information Processing

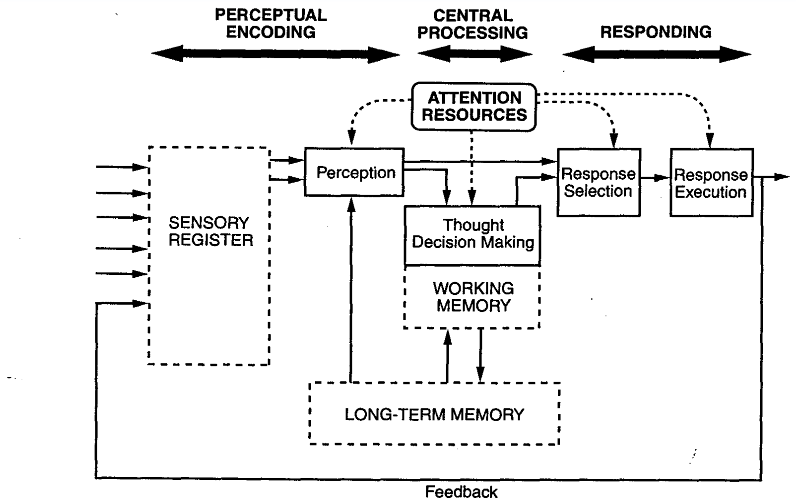


FIGURE 6.1
Generic model of human information processing with three memory systems.

Human Information Processing Model from Text

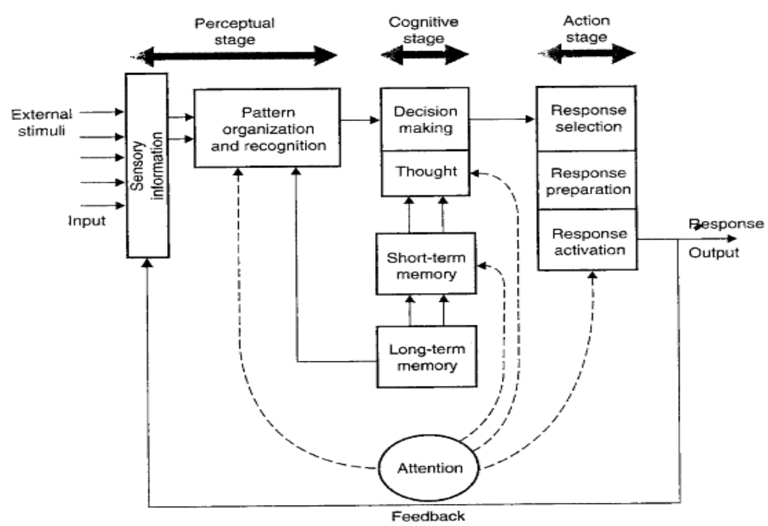
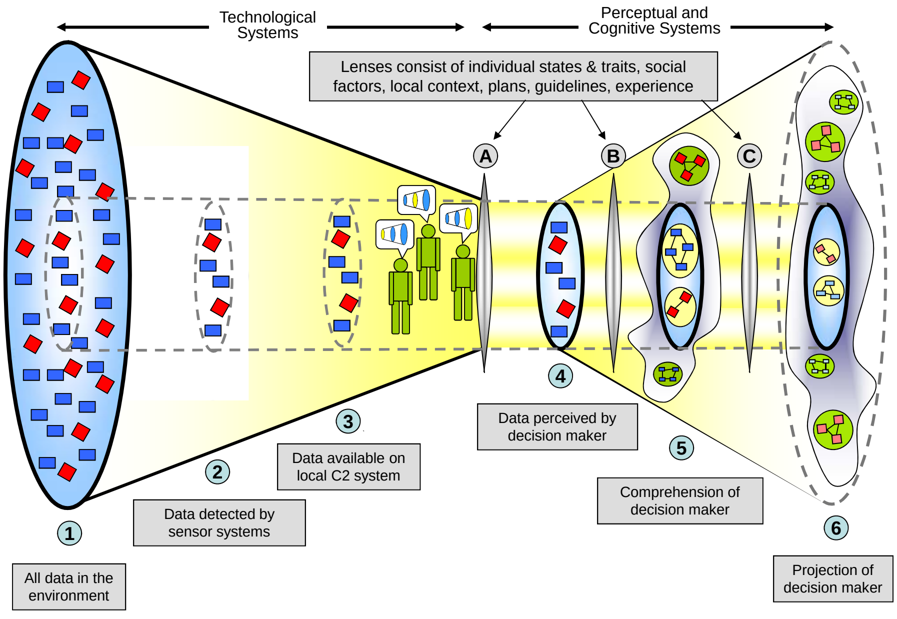


FIGURE 4.3 An elaborated model of human information processing.

The Dynamic Model of Situated Cognition



EPIC: Executive Process Interactive Control Cognitive Architecture

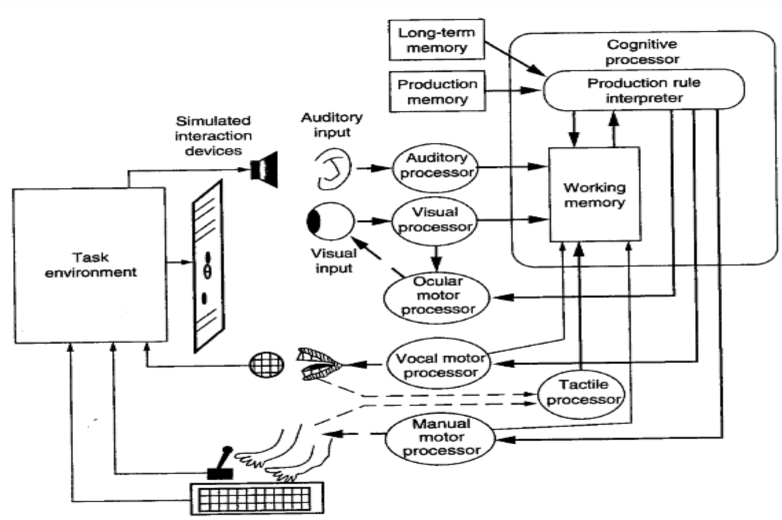


FIGURE B4.1 Structure of the EPIC architecture.

Undifferentiated Attention Model

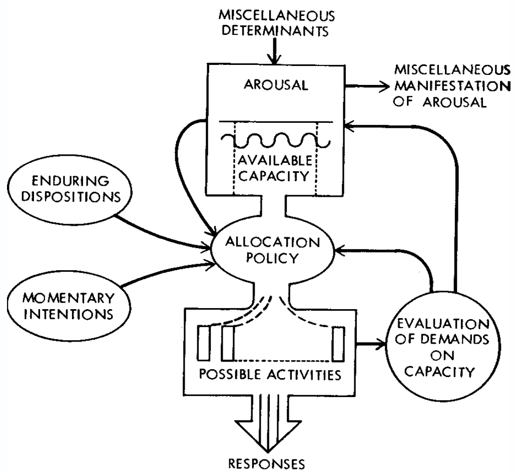


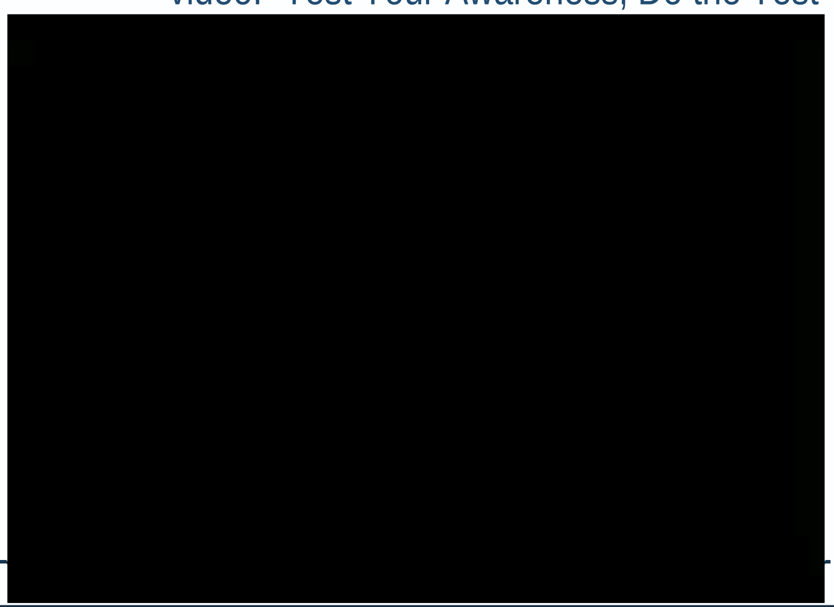
FIGURE 9–3 Unitary Resource Model of Attention.
From Daniel Kahneman, *Attention and Effort*, © 1973.

The evaluation of demand is the governor system that causes the capacity to be supplied, as needed by the activities that the allocation policy has selected.

The allocation policy is controlled by 4 factors:

- Enduring Disposition
- Momentary Intentions
- Evaluation of Demands on Capacity
- Effects of Arousal

Just how aware are you? Please view YouTube video: "Test Your Awareness, Do the Test"



So how did you do?

Signal Detection Theory

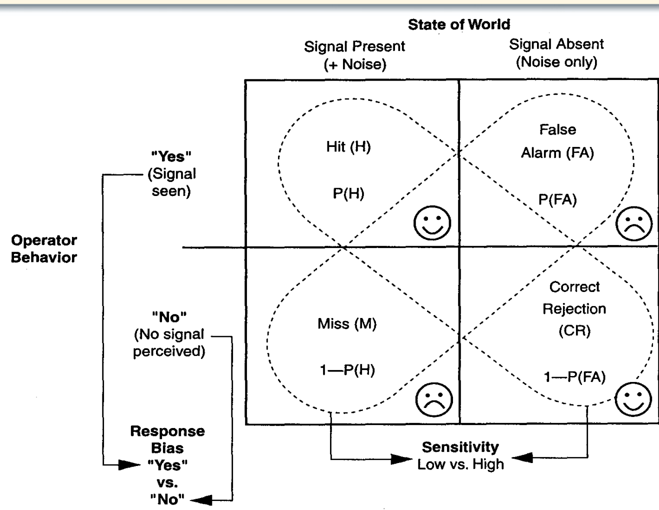
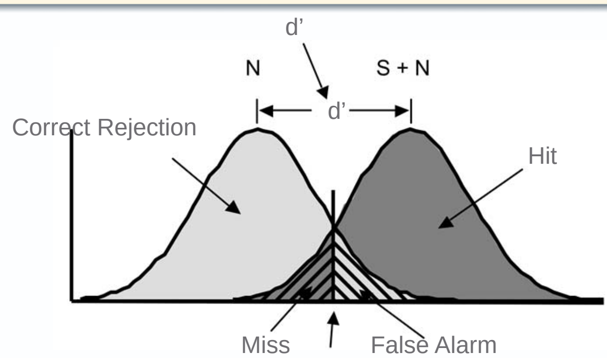


FIGURE 4.10
Representation of the outcomes in signal detection theory. The figure shows how changes in the four joint events within the matrix, influence the primary performance measures of response bias and sensitivity, shown at the bottom.

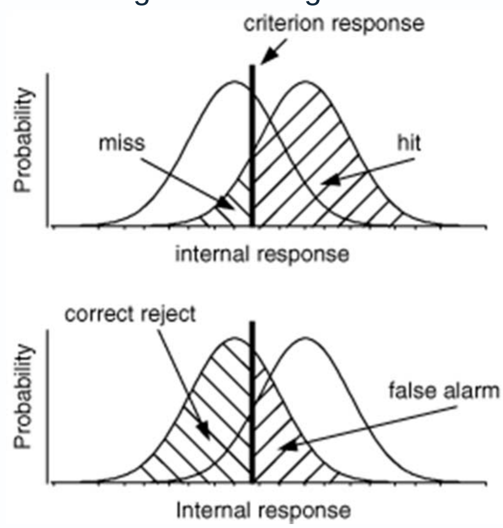
Signal Detection Theory



beta (criterion)
It’s a signal!!

Signal Detection Theory

Extract Signal from Signal + Noise



Is it a signal?

Signal Detection Theory

- Response criterion (bias): *b*
  - Optimal response criterion: b_{opt}
  - Effects of probabilities and payoffs on setting b_{opt}
  - Human performance lags when setting b_{opt}: termed the '*sluggish beta phenomenon'*

Signal Detection Theory

Human detection performance

- Sensitivity
  - d'
  - How good is the operator at the signal detection task?
- Response bias (beta)
  - Reflects the bias of the operator to respond "yes" versus "no"
  - Top down processing
    - Expectancy that a signal will be seen
    - Changes in the costs and benefits of events can shift the criterion

Signal Detection Theory (ROC Curves)

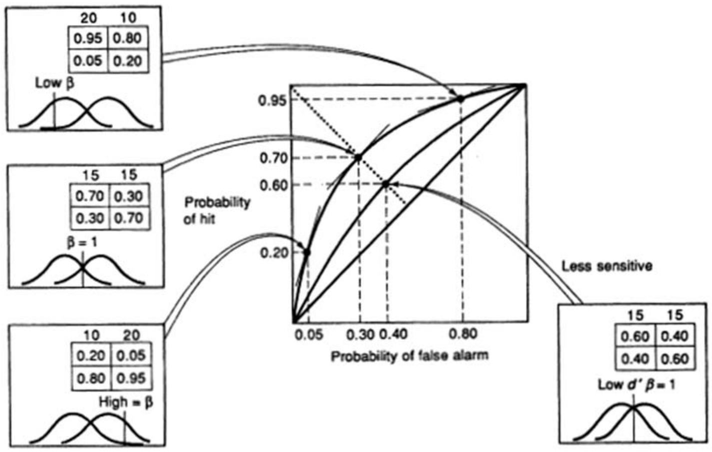


Figure 2.5 The ROC curve. The figure shows how three points on an ROC curve of high sensitivity relate to the raw data and underlying signal and noise curves. As beta is shifted at the right, the figure also shows one point of lower sensitivity.

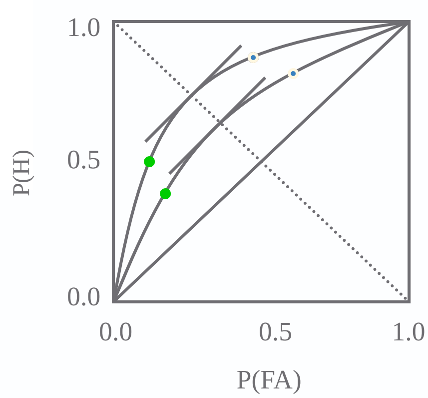
Signal Detection Theory: ROC Curve

Common method for graphically illustrating sensitivity and bias

- Why only plot P(H) and P(FA)?
- P(M) and P(FA) can be determined from these two measures

  P(M) = 1 - P(H)

  P(CR) = 1 - P(FA)



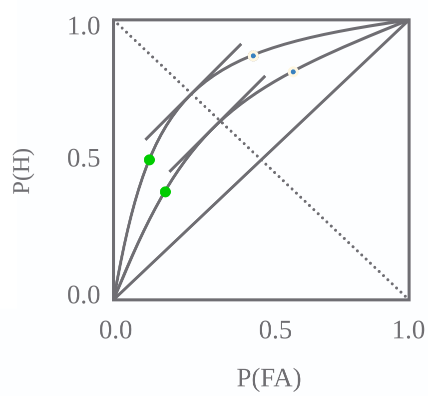
Signal Detection Theory: ROC Curve

What do single points represent?

- particular setting of response criterion at a given sensitivity

How is the “curve” created?

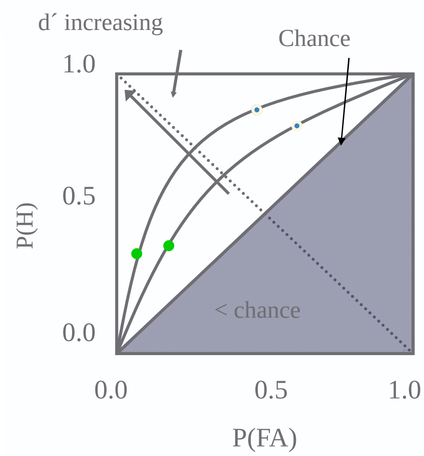
- Vary response criterion (prob. and payoffs) to collect many points



Signal Detection Theory: ROC Curve

Sensitivity (d´)

- bow in curve
- computing d´
  - determine P(H) & P(FA)
  - d´



Applications of Signal Detection Theory (SDT)

Scientific Psychological Inquiry

- Psychophysics (measuring sensitivity of detection)
- Cognitive Psychology (e.g.,recognition memory)

Practical Applications

- Medical Diagnosis
- Law (eye-witness identifications)
- Vigilance (sustained attention) tasks

Terms for Signal Detection Theory

Response Criterion *b (beta)*

Measures of sensitivity *d' (d prime)*

Applications of SDT

ROC curves

Is it a signal?

Signal Detection Theory

- Response criterion (bias): *b*
  - Optimal response criterion: b_{opt}
  - Effects of probabilities and payoffs on setting b_{opt}
  - Human performance in setting b_{opt}: *sluggish beta phenomenon*
- Sensitivity

Applications of Signal Detection Theory (SDT)

Practical Applications

- Medical diagnosis
- Law (eye-witness identifications)
- Vigilance (sustained attention) tasks
- Sensor (equipment) design

Scientific Psychological Inquiry

- Psychophysics (measuring sensitivity of detection)
- Cognitive Psychology (e.g.,recognition memory)