Theories and Constructs
Theory development and testing

• Theories as organizations of observables
• Constructs, latent variables and observables
  – Observables
    • Multiple levels of description and abstraction
    • Multiple levels of inference about observables
  – Latent Variables
    • Latent variables as the common theme of a set of observables
    • Central tendency across time, space, people, situations
  – Constructs as organizations of latent variables and observed variables
Theories as metaphors and analogies-1

- **Physics**
  - Planetary motion
    - Ptolemy
    - Galileo
    - Einstein
  - Springs, pendulums, and electrical circuits
    - Models of simple harmonic motion
  - The Bohr atom

- **Biology**
  - Evolutionary theory
  - Genetic transmission
Theories as metaphors and analogies-2

• Business competition and evolutionary theory
  – Business niche
  – Adaptation to change in niches

• Learning, memory, and cognitive psychology
  – Telephone as an example of wiring of connections
  – Digital computer as information processor
  – Parallel processes as distributed information processor
Examples of psychological constructs and their operationalization as observables

- Anxiety
  - Trait
  - State
- Love
- Conformity
- Intelligence
- Learning and memory
  - Procedural - memory for how
  - Episodic -- memory for what
    - Implicit
    - explicit
Models and theory

• Formal models
  – Mathematical models
  – Dynamic models - simulations

• Conceptual models
  – As guides to new research
  – As ways of telling a story
    • Organizational devices
    • Shared set of assumptions
Psychological Theories: the organization of constructs

- Examples from Cognitive Psychology
  - Ratcliff’s diffusion model
  - Atkinson and Shiffrin model of memory
  - Broadbent’s Maltese Cross metaphor

- Examples from Personality and Motivational Psychology
  - Revelle and Humphreys personality-motivation-performance model
Ratcliff Diffusion model

- Basic description of speed of processing and errors in decision making
- Unification of speed and accuracy
- Accuracy as a tradeoff between willingness to say yes, and willingness to say no
  - Signal detection theory of Yes/No judgments
  - Sensitivity (d’) and bias (β) of decision making
Semantic Priming and word recognition

• You will be shown a series of slides, some of them are words, some are non-words.
• Say yes if it is a word, no if it is a non-word
death
exam
daeth
fail
Random Walk - Diffusion Model of Reaction Time

RT distributions resulting from identical normal error dispersion and differing drift rates
Example of limited sensory register from Sperling

- What is the size of the sensory register?
- How many items can you detect at one time?

- 2 8 5 3 9 6 1 7 4

- report
Report
Report
Example of limited sensory register from Sperling

• What is the size of the sensory register?
• How many items can you detect at one time?
• Did the previous slides assess the size of the sensory store or were they affected by the recall process?
• How could we separate the two?
Example of limited sensory register from Sperling

- What is the size of the sensory register?
- How many items can you detect at one time?
- Confounding sensory store with ability to dump from sensory store (short term memory)
- Present a series of slides, each with 3 rows of numbers, following the slide, cue which row to report
Example of limited sensory register from Sperling

3 8 7 4

4 5 6 3

6 4 7 2

• high, medium, low tone to signal row to report
Report
Report
Sperling study of sensory store

List 1:
7 6 9 4
3 1 5 4
2 8 3 5

List 2
3 7 2 1
5 4 6 2
1 5 3 8
Theoretical integration

• Atkinson and Shiffrin combined studies from sensory memory, working/short term memory and long term memory and suggested a multiple store model of memory
Atkinson and Shiffrin, 1968
Human Memory: A proposed System

External Input

Sensory Register

Lost from SR
Visual

Short Term Store

Lost from STS
Auditory
Verbal
Linguistic

Long Term Store

Decay, Interference and Loss of Strength of LTS
AVL
Visual
Temporal
Donald Broadbent and the “Maltese Cross”

- Donald Broadbent:
  - One of the intellectual founders of Cognitive Psychology
  - Applied Psychology Unit at Cambridge, then Oxford
    - what were the determinants of efficient performance
  - known for elegantly simple models of cognition
  - Attention and Stress
Broadbent’s Maltese Cross model of information processing

- Sensory Buffers (The In Box)
- Central Executive (office worker)
- Limited Capacity Short Term Store (Desktop)
- Long Term Memory of conditional probabilities of past events (Filing Cabinet)
- Motor Programs (The Out Box)
Stage models of Processing

• Information flow models (“boxology”)
• Psychophysiology and Cognition
  – Mulder/Sanders/Gopher
• Levels of control (derived and extended from Broadbent)
Conceptual Stages of Information Processing

Stimulus Detection and Selection → Stimulus Encoding → Memory Retrieval → Memory of conditional probabilities of past events → Information Integration → Response Selection and Execution

Feedback Loops
Stimulus Detection

Stimulus Encoding

Memory Retrieval

Memory Storage

Arousal

Effort

Evaluation

Response Execution

Response Outcome

Information Integration

Feedback Loops

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Mulder/Sanders model of energetic-cognitive processing links

Evaluation Mechanism

Energetical Mechanisms

Processing Stages

Experimental Variables

Stimulus Intensity
Signal Quality
S-R Compatibility
Time Uncertainty

Stimuli
Stimulus Preprocessing
Feature Extraction
Stimulus Identification
Controlled Processing

Arousal
Core Activation
Effort
Activation

Evaluation

Feedback Loops

Response

Motor Adjustment
BP MP EMG

PD

N1

P2N2

P3

SW

(Adapted from Gopher, 1986 and Mulder, 1986)
Incentives
Task importance

Extraversion
Time of Day
Time on task
Alcohol

Upper Mechanism
where increasing demands leads to arousal inducing activities

Middle Mechanism
whose increasing activity reduces effects of sub or super optimal lower level monitors and alters parameters of lower level to maintain constant performance

Lower Mechanism
for whose activity there is an optimum decision criterion executes well established decision processes

Noise shifts criterion towards risk

Input

Output
Personality and Motivation

• Individual differences in sensitivity to environmental cues
• Motivational States
  – Approach, Avoidance, and Arousal
• Cognitive Processes
  – Working Memory
  – Sustained Information Transfer
Elaboration of a motivation mediated model of performance

Situational Variables
- Intensity
  - Time of Day
  - Time on Task
  - Stimulants
  - Exercise
  - Films
- Directional
  - Incentives
  - Feedback

Individual Difference Variables
- Approach Traits
  - Impulsivity
  - Positive Affectivity
- Avoidance Traits
  - Anxiety
  - Negative Affectivity

Motivational Constructs
- Arousal
  - Energetic
  - Tense
- Effort
  - On - Off Task

Cognitive Components
- Attention
  - Detection
  - Response
  - Sustained
- Working Memory
  - Recognition
  - Recall
- Long Term Memory
  - Recognition
  - Recall

Task Demands

Performance

Revelle/Anderson IPR, Feb, 1993
Adapted from Humphreys & Revelle, 1984; Revelle, 1989
Theories and Constructs

- Theories as a way of integrating diverse observations into coherent model
- Constructs as unobservables representing common influences on observed variables
- Goal of parsimony in theoretical description
- Goal of testability of theory
  - How can we show the theory is wrong?