

# The Big Picture

- · Need (fuzzy) borders between attention, working memory, and executive control - Avoid duplication of effort in task development
- Attention  $\rightarrow$  selection of sources of information - What to perceive? What to remember? What to act upon?
- Executive control  $\rightarrow$  selection of rules (S/R mappings) - Which set of rules is currently appropriate?
- Working memory  $\rightarrow$  dynamic storage of information and rules

### Attention as Input Selection

- William James (1890)-Everyone knows what attention is.
  - It is the taking possession by the mind,
  - in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of
  - consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others...

### Attention as Input Selection

- Attention is a process - Not a resource, a module, etc.
- It selects some objects for perception, memory storage, and action
  - Selection occurs within distinct cognitive subsystems Attention acts by modulating these systems
- Information that is not selected is lost (or delayed) - Not perceived, not remembered, not acted upon
- Used under conditions of competition Competition makes selection necessary
- Hard to select in the absence of competition A demonstration...









### **Rule Selection**

- Example: A-X CPT (Cohen et al 1999 version)
  Respond to X when preceded by A (70% of trials)
  - X rarely follows anything but A
  - Response to X becomes automatic
  - Need to exert control (attention) to avoid responding to B-X
  - SC patients are found to make many false alarms to B-X
- A and B signal different rules for processing X
  - A: Respond when X is perceived
  - B: Don't respond when X is perceived
- Because A-X is common and B-X is rare, the A rule has a high activation level
- When B is presented, it is difficult for the B rule to compete with the A rule

### **Rule Selection**

#### • Example: WCST

- Learn to sort cards according to a rule
- Rule switches at some point
- Need to suppress old rule and learn/activate new rule
- · Example: Task switching
- Frequent changes in rules
- Current rule competes with previous rule
- Current rule is stored in working memory, which must be frequently updated
- Rule-selection tasks, not input-selection tasks, are the focus of most research on executive control
  - Most basic scientists who call themselves "attention researchers" focus primarily on input-selection tasks

## The Big Picture

- Attention → selection of sources of information
  Selection among competing inputs to a processing system
- Executive control → selection of rules (S/R mappings)
  Selection among competing sets rules that could be followed by a processing system
- Working memory → storage of selected inputs and selected rules





# Control vs. Implementation

- Efficiency of input selection depends on two factors
- <u>Control of Attention</u>- Finding the right input source
  - Is the spotlight shining on the right object?
- Related to the "attention shifting" construct
  Depends on: Activation of appropriate rule Precision and stability of rule representation
  - Quality of perceptual cues that guide attention
- Implementation of Selection- Boosting selected item and inhibiting competitors
  - How bright is the spotlight?
  - Related to the "selection under distraction" construct
  - Depends on strength and precision of excitatory and inhibitory connections between representations





- Hypothesis: SC involves a deficit in control but not implementation
- Challenging to separately measure control and implementation
  - Input selection tasks always involve both
- Measure implementation by making control trivial
  Salient sensory information is available to guide attention
  Finding: Implementation appears normal in SC patients
- Measure control by varying difficulty of control
  - Presence vs. absence of salient distractors
  - Finding: Control appears to be impaired in SC patients



































# Control: Singleton Capture

- Shifting to a target in the presence of a salient distractor
  - Task: Report orientation of line inside circle
  - One item is black on 50% of trials (never the target)
  - Pits appropriate rule against bias toward salience



 Finding: Patients are dramatically slowed when the black item is present

Gold et al. (in prep.)

## The Big Picture

- · Proposed division of labor
  - Attention  $\rightarrow$  selection of sources of information
  - Executive control  $\rightarrow$  selection of rules
- Working memory  $\rightarrow$  storage of selected inputs and rules
- Performance of almost any task involves interactions between these systems
  - And perceptual and motor systems
- Input selection involves two components - Control of attention: Probably impaired in SC
  - Implementation of selection: Probably not impaired in SC
- Need tasks that isolate control of attention
- Need new research that links control of input
- selection to general theories of executive control

