



## Characteristics of Semantic Memory

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- Organized as as network
- Concepts linked together
- Semantic relatedness
- Spreading activation between related concepts
- Activation of one concept partially activates semantically related concepts



## Neeley's Test of Spreading Activation

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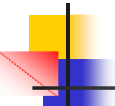
- Spreading activation is thought to be automatic
- Governed by data-driven aspects of processing
- How do expectancies affect semantic access?
  - Automatic vs Conscious Strategies (Attentional)
  - Fast vs Slow
  - Effortless vs Effortful
  - Benefits vs Costs & Benefits



## Neely's Experiment

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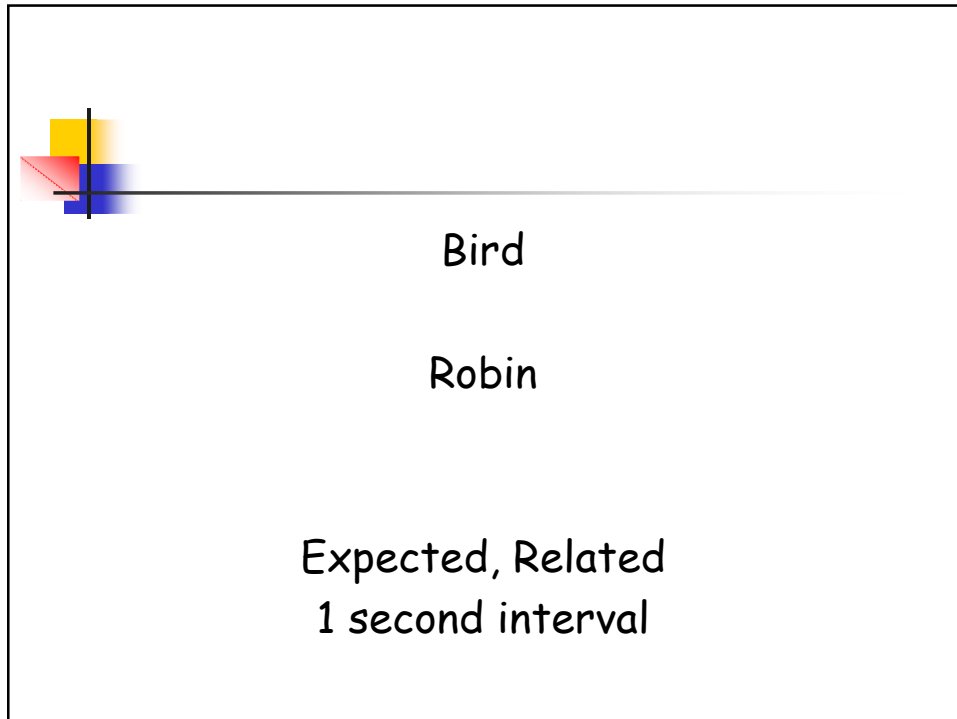
- Aimed at contrasting:
  - Automatic Spreading Activation (**ASA**)
  - Limited Capacity Attention (**LCA**)
- **ASA** : Automatic, Fast, Effortless, Benefits
- **LCA**: Attentional, Slow, Effortful,
  - Benefits (if correct)
  - Costs (if incorrect)



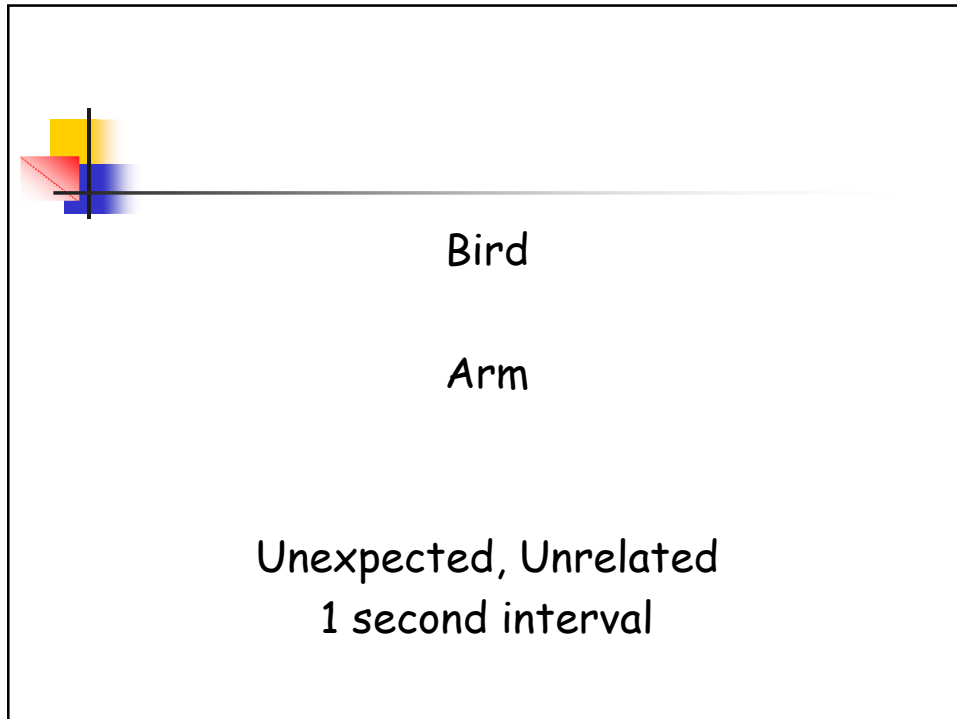
## Neely (Cont.)

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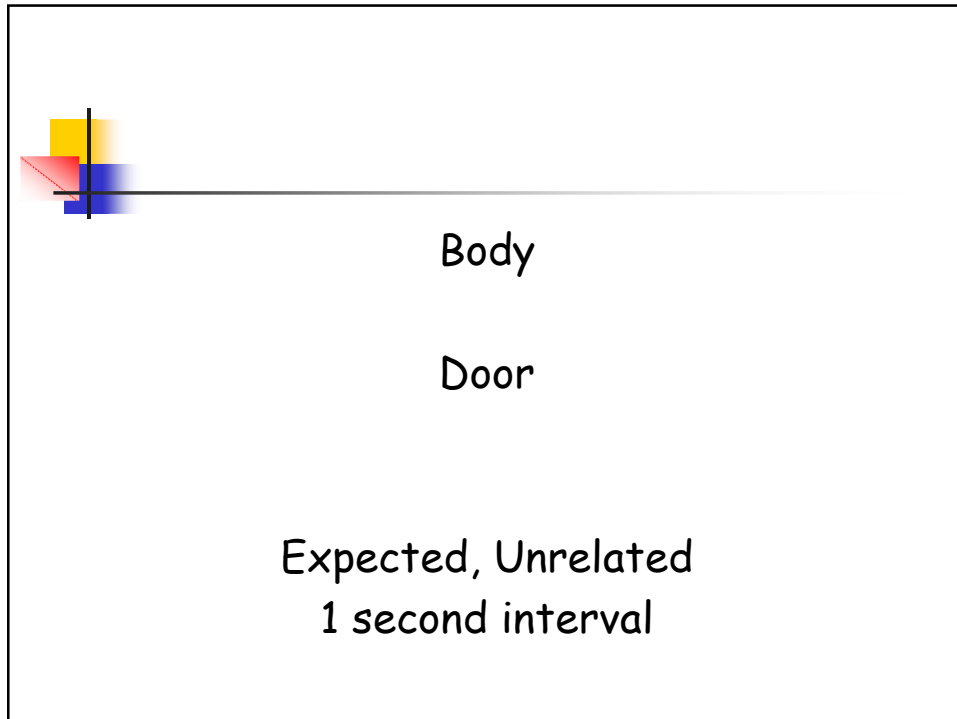
- Stimuli: (Birds, Body Parts, Buildings)
- Subjects told:
  - If prime is bird, expect to see birds (80%)
  - If prime is body, expect to see building (80%)
  - If prime is building, expect to see body (80%)
- **ASA** ==> Semantic Relatedness
- **LCA** ==> Expectancies



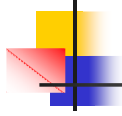
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Body

Sparrow

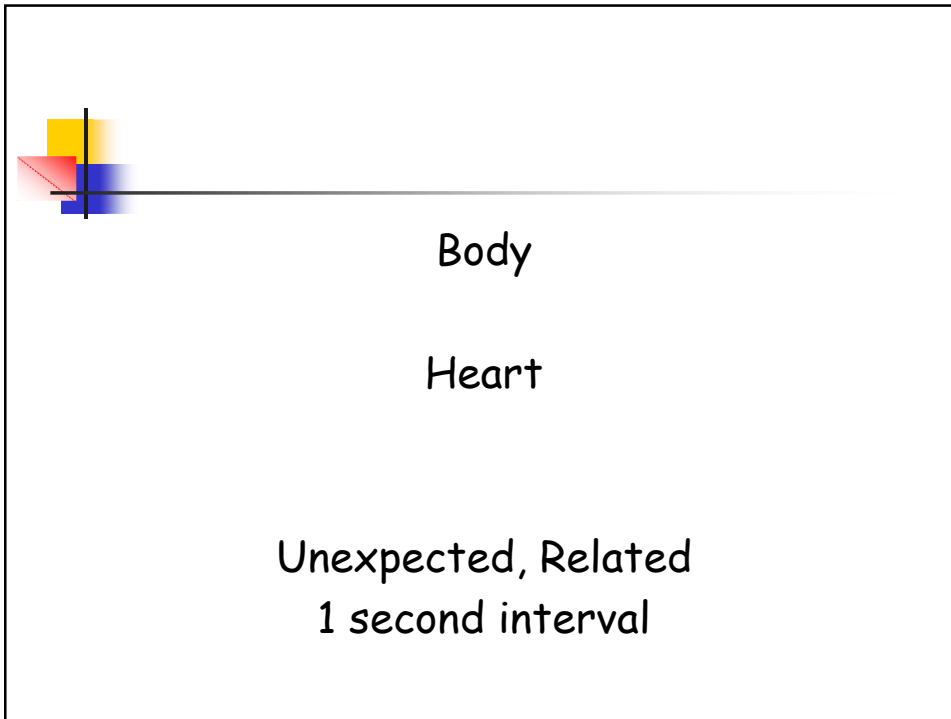
Unexpected, Unrelated  
1 second interval



## Neely (Cont.)

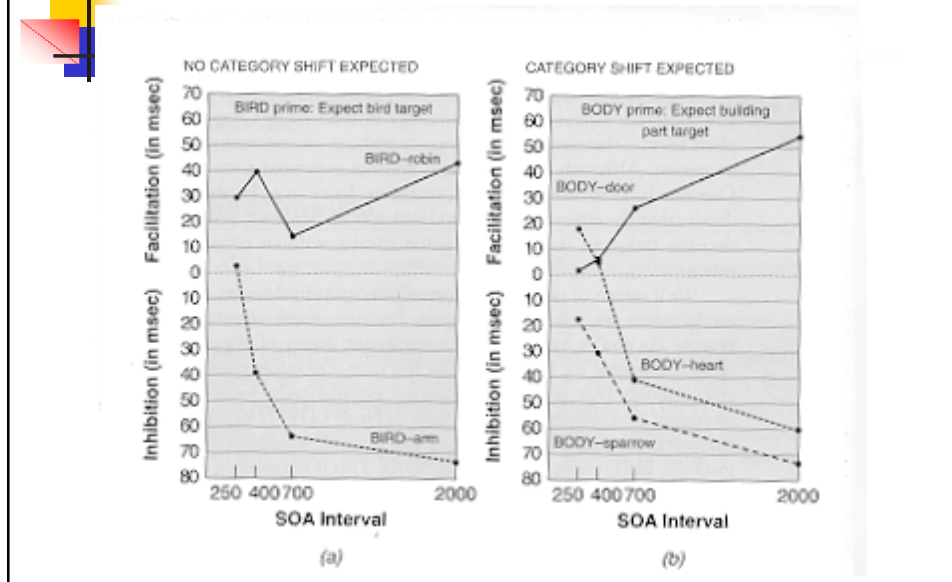
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Examples	SOA	Processing Effects		Net Effects
		ASA	LCA	
BIRD-robin	short	++	0	++
	medium	+	.	+. .
	long	0	..	..
BIRD-arm	short	0	0	0
BIRD-wall	medium	0	-	-
	long	0	--	--
BODY-door	short	0	0	0
BUILDING-leg	medium	0	.	.
	long	0	..	..
BODY-sparrow	short	0	0	0
BUILDING-cancer	medium	0	-	-
	long	0	--	--
BODY-heart	short	++	0	++
BUILDING-window	medium	+	-	0
	long	0	--	--

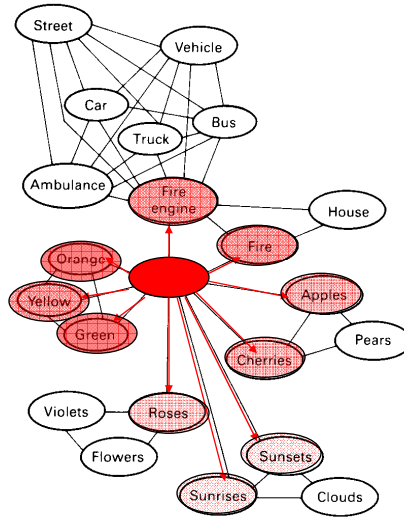
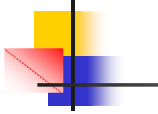
## Neely's Results



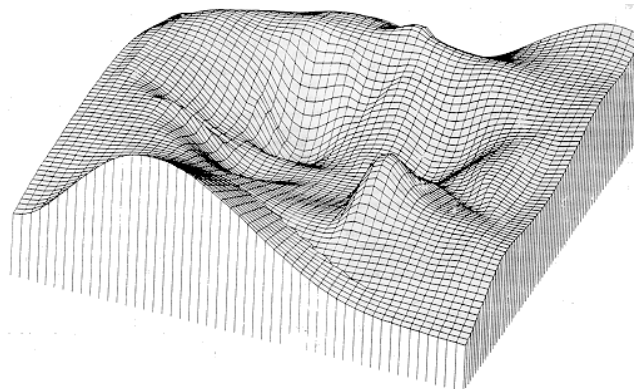
## Accessing Semantic Memory

- Short SOAs: Automatic activation (**ASA**)
  - Benefits, but no costs
- Long SOAs: Expectancies (**LCA**)
  - Benefits -- if correct
  - Costs -- if incorrect

# Semantic Network Models



# Neural Network Models of Semantic Memory



## Procedural vs. Declarative Knowledge

- Declarative -- "know that"
  - Long-term factual memory
  - Includes semantic & episodic
  - Organized as network (spreading activation)
- Procedural -- "know how"
  - Knowledge of how to do things
  - Important for skill acquisition
  - Often difficult to articulate
  - Made up of propositions



## Does Practice Makes Perfect?

- Practice makes perfect?

- N

- Requ

- I

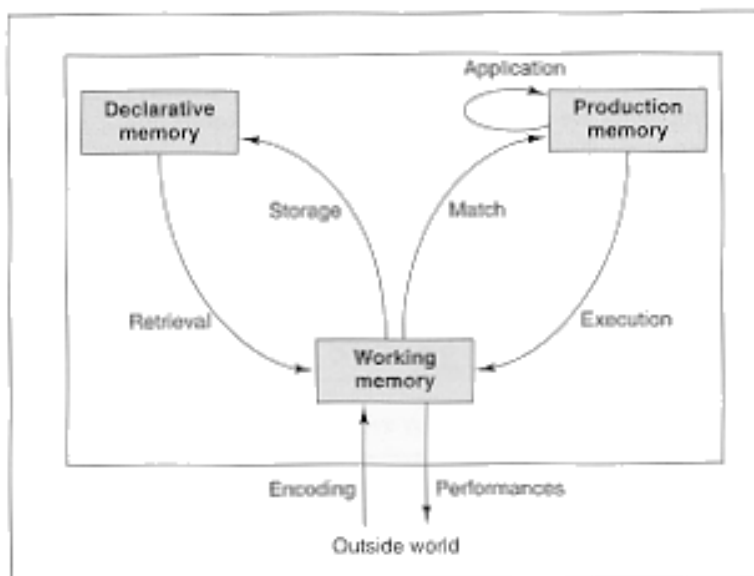


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## Adaptive Control of Thought (ACT)

- General theory of cognition
- Working memory
- Declarative memory
- Procedural memory
- Productions

Anderson's (1983) ACT\* model. (From Anderson, 1983.)



## Productions



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- Productions are condition-action pairs
  - If condition X, then action Y
  - If situation X, then action Y
  - Building blocks for complex behavior
- Initial knowledge governed by special purpose production that breaks performance down into simple units

## Productions



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- Alphabet arithmetic example
  - $A + 3 = D$  ?  $A, B, C, D \implies \text{True}$
  - $E + 3 \implies G, H, \text{ or } I$  ?
- Procedures
  - encode question in working memory
  - look for a match in procedural memory
  - execute production in working memory
  - retrieve letter from declarative memory
  - compare letter (+3) with question

## Productions for Alphabet Arithmetic



- P1: Encode question (T-4=P?)
- P2: If at beginning then set counter to 0
- P3: If counter < 4 then move back one letter
- P4: If counter < 4 then increment counter by 1
- P5: If counter = 4 then compare letter with question

## Anderson's Process-Based Theory



- Novice performance  $A \Rightarrow E$   
information processing broken into sub-goals
  - if A, then B
  - if B, then C
  - if C, then D
  - if D, then E
- Attempt to minimize distance to goal using existing procedures or general purpose procedures

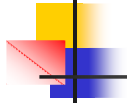
## Knowledge Compilation

- Proceduralization
- Composition
- Strengthening

## Proceduralization

- Builds productions that perform behavior directly
- Establishes productions in procedural memory
- Slow process of building new productions
- Frugal in adding new productions
- Operates in working memory

## Composition



- Takes productions that are always, consistently, executed in sequence and creates a new production that does exactly what the old production does, but in fewer steps
- If A, then B: If B, then C: if C, then D: if D, then E
- If A then BCDE
- 4 steps to 1 step

## Strengthening



- Compiled productions which are performed often are strengthened so that they fire rapidly given initial conditions

## Knowledge Compilation



- Together Proceduralization, Composition, and Strengthening speed performance and ease the demands placed upon working memory
- Are information processing steps different between novice and expert, or are just performed faster?