Announcements

- Experiment Participation Requirement
  - You MUST do 2 hours of experiments (or write 2 summaries)
  - You MAY do 2 additional hours of experiments (or write 2 additional summaries) for extra credit
- Article Summaries due Wednesday (bring to final)
- Non-Experimetrix Experiments must also be done by Wednesday (have experimenter email your TA or bring a credit slip to the final)
- Final – Wednesday 8am
- Review Session: Sunday 11am in Solis 104
- Coulson’s Office Hours: Monday 10am – noon (CSB 161)
  - appointments outside of this time also possible

Infantile Amnesia

- Inaccessibility of early childhood memories
  - Very Few Memories from Before Age 4
  - Almost No Mem from Before Age 2

Frequency of Early Memories

<table>
<thead>
<tr>
<th>Years of Age at Time of Remembered Event</th>
<th>Mean Memories Reported</th>
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<tr>
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</table>

Bruce (2000)

![Graph showing age vs. years when event occurred](image)

Specific Datable Event Memns

- Sheingold & Tenny
  - Study 1
    - Kids quizzed about sibs’ birth
    - 4s, 8s, & 12s all remember 10-12 items
  - Study 2
    - Asked teenagers what they remembered about sibs’ birth
    - 9 yrs = 3 yrs
    - < 3 No memories

Recall of Sibling’s Birth

<table>
<thead>
<tr>
<th>Age at Time of Sibling’s Birth</th>
<th>Recall of Sibling’s Birth</th>
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</table>

Explanations

- Amnesia, what amnesia?
- Repression
- Episodic memory formation deficit
- Change in Encoding Techniques
- Context-dependence
- Neural reorganization

Amnesia, what amnesia?

- Normal Forgetting
- But
  - 80-year-olds can remember when they were 10 years old (retention interval 70 years!)
  - Wetzler & Sweeney: Disproportionate loss of early memories
Repression

- Freud
  - Greedy thoughts and desires (selfish Id)
  - Sexually inappropriate thoughts
- But animals show infantile amnesia as well
  - Rats
  - Guinea pigs

Episodic memory formation

- Lack brain structures for episodic memory formation?
  - Medial temporal lobe structures
- But toddlers can recall episodic memories (just not when asked later)
- Habituation/Dishabituation
  - Babies habituate
  - Monkeys habituate
  - Monkeys with medial temporal lobe lesions don’t habituate

Encoding Techniques

- Language acquisition
- Storytelling ability

Context-dependence

- Internal context radically different in infancy and adulthood
- Physical perspective
- Language acquisition (2-4 yrs)
- Sense of self

Neural re-organization

- Equivalent to context-dependence
- Brain undergoes substantial re-wiring as it matures
  - Especially medial temporal lobes and frontal lobes
- Infantile Amnesia in
  - Guinea pigs (brain maturation prenatal)
  - Rats (substantial postnatal brain maturation)

Greatest Hits
Goals

- Facts
- Models/Theories → Experimental Evidence
- Develop scientific writing skills
- Applying Cognitive Science

Models & Theories

Models of Pattern Recognition

- Template Models
- Feature Models
- Prototype Models
- Neural Network Models

IAC Model

Perceptron

Appeal of Neural Nets

- Parallel
  - Not subject to 100-step constraint
- Distributed Representations
  - Less Brittle
- Graded Rules
  - More Flexible
Biological Nets
- $10^{10} - 10^{11}$ neurons
- $10^5$ interconnections per neuron
- Excitatory & Inhibitory
- Learning involves modifying synapses

Connectionist Nets
- Neuron basic processing unit
- Highly interconnected
- Excitatory & Inhibitory
- Learning done by changing strength of connections

Buzzwords
- Spontaneous Generalization
- Graceful Degradation
- Mutual Constraint Satisfaction
- Capacity for Learning and Self-Organization
- Biologically Plausible (?)

Role Attention in FIT
- Attention moves within the location map
- Selects whatever features are linked to that location
- Features of other objects are excluded
- Attended features are then entered into the current temporary object representation

Dual Coding
- Stimuli
- Sensory Systems
- Mental Imagery

Mental Imagery
- Are images distinct from propositional representations?
- What is the relationship between imagery and perception?

Propositional
- Not discrete
- No symbol for relation
- One rule for combo
- Concrete
- Ambiguous
- Spatial medium
- Point-for-point correspondence

Analogue
- Discrete
- Symbols needed for relation
- Rules for combo
- Abstract
- Unambiguous
- No spatial medium
- No point-for-point correspondence
Internal Representation of Spatial Knowledge

- Network
- Node=Place
- Link=Relationships
  - Distance
  - Adjacency
  - Direction
- Route=pathway thru nodes

Route Representations

- Production Rules
- Unordered Productions
- Ordered Productions

Concrete Route Representations

IF the goal is to go to TJ and you are on Nobel and you see the 5 entrance THEN get on 5 South

Spatial Configuration

- Cognitive Maps contain distortions
  - Distance
  - Direction
- Egocentric Reps
- Topological Reps

Hierarchical Structuring

Habituation of the gill withdrawal reflex results from changes in the S-R pathway

Less transmitter released here

Sensitization occurs because tailshock augments the release of neurotransmitter from the sensory neuron
Pavlov

- Stimulus-substitution theory
  - A connection forms in the brain between the CS and the UCS activation sites
  - When the CS is activated alone following acquisition, it will automatically activate the UCS site in the brain
  - Therefore, the CR should be almost identical to the UCR (because the connection between UCS and UCR in the brain is hardwired)

Other stimulus-response models

- Preparatory Response Model
  - Kimble
  - CR is a response that serves to prepare the organism for the upcoming UCS
  - CR eyeblink may actually prepare the person for the upcoming airpuff such that the eye would be partially closed when the airpuff occurs
- Compensatory Response Model
  - Siegel
  - Learned association between CS and UCS serves to elicit a CR that compensates for effects of UCS
  - Sometimes CR=UCR
  - Sometimes CR opposite of UCR

Rescorla-Wagner Model

- Rescorla and Wagner used a mathematical model to make their “cognitive” account more rigorous
  - $\Delta V_a = \alpha a_b [\lambda - V_a]$
    - $\Delta V_a$ - Change in associative strength to $CS_a$
    - $V_a$ - Current associative strength to $CS_a$ (context)
    - $\alpha_a$ - Salience of $CS_a$
    - $\lambda$ - Maximum associative strength possible

Early Flawed Assumptions

- Equipotentiality
  - All stimuli have equal potential for association with one another
  - Association determined by stimulus pairings
- Universality
  - “Pigeon, rat, monkey, which is which? It doesn’t matter.” B.F. Skinner (1961)
- No internal representations
  - Associations learned

Norman’s Model

- Late Selection
  - All stimuli processed to recognition
  - Bottleneck after recognition just before the formulation of response
- Selection (pertinence) based on importance
- Memory devoted to selected inputs
Deutsch & Deutsch Model of (late) selective attention

Attenuator Model

Johnston & Heinz’s Hybrid Model

Multiple Resources

Automatic  Controlled

Instance Theory of Automaticity (Logan)
Visual Attention

- Can be directed at particular regions of space
  - Exogenous Cues
  - Endogenous Cues
- Facilitates/Inhibits target detection
  - Attended/Unattended
- Adjustable Width

Parallel Theory (Baddely & Ecob)

- Rate to perform comparisons depends on how active items are in WM
- Activity level depends on how many items in WM
  - A B C D (.25, .25, .25, .25)
  - A B (.5, .5)

Limited Capacity Parallel Retrieval

- Retrieval done in parallel
- “Strategic resources” available for task limited
- Processing time increases w/set size because resources distributed over the entire set
  - Larger sets, less resources for any given item

STM vs. LTM: 1 System or 2?

- Older View
  - 2 Systems w/Distinct Characteristics
- Newer View
  - Different States in a Single System

Baddely’s Revised WM Model

- Central Executive
- Visuospatial Sketch Pad
- Episodic Buffer
- Phonological Store
- Visual Semantics
- Language
- Episodic LTM

Norman and Shallices (1986) model of attentional control

- Supervisory Attentional System
- Effector System
- Schema Control Units
- Inhibition
- Contention Scheduling
- Trigger Data Base
- Perceptual System
Phonological Loop: Take 2

NN Approach to Memory

• LTM – connection strengths among nodes
• WM – activation
• "Transfer" to LTM is learning
• Capacity Limitations – limitations on total level of activation

WM in NNs

• Rehearsal
  – Resonant positive feedback loops
• Interference Effects
  – Lateral inhibition btw. nodes coding similar items
• Set Size Effects
  – Activation limitations
• Serial Order Effects
  – Lateral inhibition most affects items in the middle

Levels of Processing

• Craik & Lockhart
  – Continuum of Processing
  • Shallow: surface, perceptual features
  • Deep: processed, meaningful interpretation
  – Level or "depth" of processing affects its memorability
  – Deeper encoding produces more elaborate, longer-lasting memory traces

Doubts about Depth

• Levels of Processing doesn’t account for all factors that affect memorability
  – Importance of Organization
  – Memory for Personally Relevant Information
  – Self-Generation Effect
  – Elaboration
  – Distinctiveness

Doubts about Depth

• Transfer Appropriate Processing
• Morris and colleagues
Encoding Specificity

• The probability of recalling an item at test depends on the similarity of its encoding at test and its original encoding at study
  • Thomson
    – Study: sky blue
    – Task: remember 2nd word
    – Recognition Test: blue vs. sky blue
    – 76% vs. 85%
    – Conceptual aspects of study context helpful in test context

Why do we have multiple memory systems?

• Explicit, declarative memory
  – Cortex, Medial temporal lobe structures
  – Fast, phylogenetically recent
  – Interference, retrieval failure
• Implicit, procedural memory
  – Phylogenetically early
  – Nonconscious ways of responding to world

Piaget’s Stages

• Sensorimotor
  – (birth – 2 yrs)
• Preoperational
  – (2 – 7 yrs)
• Concrete Operational
  – (7 – 11.5 yrs)
• Formal Operational
  – (11.5 yrs and on)

Key Piagetian Concepts

• Schemas
  – Action Patterns
• Assimilation
  – Interpreting environment w/schemas
• Accommodation
  – Changing schemas
Criticisms of Piaget

• Empirical Details
  – Piaget consistently underestimates age at which children able to do certain things
  – Perhaps his children were somewhat slow in developing?
• Stages versus gradually development
  – Objections to discrete series of stages versus idea of development as more of a gradual process
• Ethnocentric
  – Some have noted that Piaget’s theory is how to become a Swiss scientist
  – Much of the changes outlined in childhood reflects the western educational system rather than inevitable changes related to maturational

Neo-Piagetians

• Agree w/Basic Stages
  – Faster
• Believe Piaget Underestimated Child’s Capacities
  – Inter-sensory Relations
  – Object Permanence

Development of baby physics

• Predisposition to learn critical physical facts rapidly
• “…infants are not born with substantive beliefs about objects…but with highly constrained mechanisms that guide the development of infant reasoning about objects.” Renee Baillargeon

Explanations for Infantile Amnesia

• Amnesia, what amnesia?
• Repression
• Episodic memory formation deficit
• Change in Encoding Techniques
• Context-dependence
• Neural reorganization

Cognitive Phenomena

Word Superiority Effect

<table>
<thead>
<tr>
<th>WORK</th>
<th>K</th>
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<tbody>
<tr>
<td>C/K</td>
<td>C/K</td>
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</tbody>
</table>
Sentence Superiority Effect

- Tulving, Mandler, and Baumal
- Disorder (red)
- Filled with dirt and disorder (blue)
- The huge slum was filled with dirt and disorder (black)
- Dependent Variable is Proportion Correct
  - Higher on graph means better performance

Phoneme Restoration Effect

The state governors met with their respective legislatures convening in the capital city.

Word Superiority Effect

- WORD and WORK both begin to get activated because of WOR
- Activations feedback and activate K and D nodes
- But only K gets bottom-up activation
- D gets top-down activation that gets inhibited
- Letters presented alone don’t get top-down activation from word level!

Pop Out Effect

- Without focused attention features should be combined at random
- Illusory Conjunctions

2 X T O 8

Agnosia

- Apperceptive
  - Object recognition failure due to perceptual processing
  - Difficulty recognizing pictures w/deleted segments
  - Unable to utilize top-down information for pattern recognition
- Associative
  - Perceptual processing intact but subject cannot use information to recognize objects
  - Can draw objects but not say what they are
  - Language otherwise intact
  - Often don’t know other things about object (how it’s used, etc.)
Prosopagnosia

- Specific inability to recognize faces
- Are faces and other objects in the world represented in fundamentally different ways in memory?
- Does face-memory depend on fundamentally different brain systems?

Free Recall

- Set of Pictures versus List of Words
- Pictures encoded by both systems
- Memory for pictures better than memory for words

Word Imaging & Concreteness

- Pavio et al. (1968)
  - Rate imagability, concreteness of words
  - Better memory for concrete, imagable words

“cup” vs. “truth” vs.

Repetition Effects

- Show subjects list of concrete nouns, either image or pronounce
  - Probability of imaged words twice pronounced
- Repetition Manipulation: image/pronounce, image/image, pronounce/pronounce
  - image/pronounce additive
  - pronounce/pronounce, image/image not

Cooper & Shephard

Rotations in 3-D

- Are 2 objects identical?
- Angular disparity and RT are linearly related
  - Rotation in plane
  - Rotation in depth
Map Experiment

Finke & Pinker
- Would arrow point to dot?
- RTs increase linearly w/distance btw. arrow and dots
- Never told to scan in instructions
- No info to cause people to “fake” it

Retinotopic Areas

Klein et al. (2004) show clear evidence of activation in retinotopic areas during an imagery task.

Neglect Patients
- Trouble attending to left side of space
- Trouble imagining the left side of space

Change Blindness
- Inability to detect what should be obvious changes in a scene

Original Image | Blank/Mud | Modified Image
<table>
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<tbody>
<tr>
<td>400 ms</td>
<td>40-80 ms</td>
<td>400 ms</td>
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</table>
Distance Estimation

Byrne

- Estimate distance of 12 well-known routes
- 6 in Town Center
  - 3 straight
  - 3 w/2-4 curves
- 6 on Outskirts
  - 300, 540, 700 meters
- Short routes: Overestimated
- Long routes: Underestimated
- Short routes w/curves: overestimated more than short straight routes
- Effects more pronounced for routes in town center than outskirts

Direction Estimation

- Byrne (1979)
  - Draw 10 Road Junctions
    - 5 Acute
    - 5 Obtuse
  - Means: 83.5° - 103.7°
    - 89.7°
    - 94.5°

Direction Estimation

- Chase & Chi (1981)
  - Maps of CMU
    - Two Streets really 45°, Drawn 90°
- Lynch (1960)
  - People draw Boston Common w/4 sides
- Smith (1978)
  - Blind subjects directions off by a constant factor (= degrees the campus deviated from a true rectangle)

Direction Estimation

- Which is farther east, San Diego or Reno?
- Which is farther north, Seattle or Montreal?
- Which is farther west, the Atlantic or the Pacific entrance to the Panama Canal?

Distortions

Distortions

Habituation/Dishabituation

- GSR measured at onset of either high or low tone
  - Tone gradually elicits less anxiety
- 15th trial is the opposite tone
  - high for low group & low for high group
**Sensitization**

After the gill withdrawal reflex has habituated, a shock to the tail sensitizes the gill withdrawal reflex elicited by touching either the mantle or siphon.

**Classical Conditioning**

- Process by which a neutral stimulus (CS) comes to be associated with another stimulus (UCS) that elicits a response (UCR)
- Results in elicitation of response by CS

**Appetitive & Aversive Conditioning**

- **Appetitive**
  - US is an event the organism seeks out & considers pleasant
    - food
    - physical touch
    - warmth
- **Aversive**
  - US is an event the organism avoids & considers unpleasant
    - shock
    - painful stimulus
    - air puff in eye

**Acquisition & Extinction**

**Acquisition and Extinction**

- Spontaneous Recovery

**Conditioned Drug Tolerance**

- Siegel, et al., 1978
  - Experimental Group: CS (light change & noise reduction) paired with UCS (injection of morphine) for 9 days
  - Placebo Control Group (CS paired with injection of saline)
  - Unpaired Control Group
- **Test** present CS, inject every rat with morphine, place rat on hot surface
  - Measure latency to lick their paws (lick when they feel pain)
Factors that influence CC

- Eye-blink conditioning
- CS Intensity
  - Loud vs. Soft Tone
- US Intensity
  - Hard vs. Soft Puff
- Anxiety
  - High vs. Low

Stimulus Generalization

- Conditioned responses (CRs) occurring to stimuli other than the CS used for training
- Similarity
  - The more similar the second stimulus is to the CS, the more generalization will occur
- Critical feature of learning
  - We rarely encounter the exact same stimulus twice

Discrimination

- Hypothetical example
- Initially the organism responds to both stimuli
  - shows generalization

Second-Order Conditioning

- Phase 1:
  - Pair CS1 → UCS until learning occurs
- Phase 2:
  - Pair a new stimulus (CS2) as the CS with the first one (CS1) as the UCS
  - CS2 → CS1
  - Because CS1 reliably elicits a CR, the new stimulus, CS2 that is paired with it, will begin to elicit the CR as well

Overshadowing

- Grice & Hunter, 1964
- Human eyeblink conditioning
- 3 Groups:
  - 100 trials w/ CS (loud tone)
  - 100 trials w/ CS (soft tone)
  - 50 trials w/ CS (loud tone)
    & 50 trials w/ CS (soft tone)

Blocking

- Phase 1: Pair CS1 → UCS
- Phase 2: Pair compound stimulus with UCS: CS1CS2 → UCS
- Phase 3: Test element stimuli alone to determine amount of conditioning
- Conditioning to CS1 will be strong, but conditioning to CS2 will be weak: Blocking
**Latent Inhibition**

- CER Procedure:
  - Phase 1: Train thirsty rats to drink from tube
  - Phase 2: Separately present Tone during 3 Sessions; Controls had no Tone while in box
  - Phase 3: All rats had Tone + Shock pairings
  - Test Phase: Present Tone while rats were drinking from water tube

**Superstitious Behavior**

- Skinner
  - 8 Pigeons
  - Grain presented every 15 minutes
- Results
  - 6 of 8 developed clearly defined behaviors
    - turned in circles
    - bobbed head up and down
    - brushing movements toward floor as if pecking
    - raised head toward one of the corners
    - two swung head side to side
- Other Examples
  - Athletes
  - Gamblers

**Reinforcement Schedules**

- **Fixed Ratio**
  - Reinforcement occurs after a particular number of responses
    - Every 10:1
- **Fixed Interval**
  - Reinforcement occurs after a particular amount of time
    - Every 10 minutes
- **Variable Ratio**
  - Reinforcement occurs on average after a particular number of responses
    - 3,4,5,3,5,4
- **Variable Interval**
  - Reinforcement occurs after a variable amount of time
    - 3 minutes, 5 minutes, 3 minutes, 10 minutes

**Learned Helplessness**

- Animals must learn to jump barrier to avoid shock
- Results
  - Spot learns, Lassie yelps but eventually becomes passive and accepts shocks
- Contingency
  - Spot learns his actions matter
  - Lassie learned that it was helpless
- Contiguity
  - Spot learned to press lever
  - Lassie learned to act passively
Garcia Effect

- Are all stimuli equally associable?
- Radiation vs. Shock on Taste Aversion vs. Tone Aversion
  - Light/sound paired w/
    - Shock
    - X-Rays
  - Sweet water paired w/
    - Shock
    - X-Rays

Cognitive Maps

- Tolman's research suggests need for intervening variables
- S [int. var.] R
- Path 1 shortest
- A blocked, take 2
- B blocked, now what?

What do we notice while shadowing?

- Listeners are good at detecting physical info
  - could tell whether unattended channel was...
    - Male vs. Female
    - Speech vs. Buzzing
- Listeners are bad at detecting meaning info
  - couldn't identify any word/phrase
  - couldn't tell whether unattended channel was...
    - Forward vs. Backward
    - English vs. German
- So, attention is
  - sensitive to physical properties
  - insensitive to meaning

Evidence Against

- Cocktail Party Effect (Moray)
  - Shadow 1 Channel
  - Report Salient Words from Un-shadowed Channel
    - e.g. Own Name
    - Fire!

Errors in Shadowing

- Treisman (1964)
- Subjects sometimes report mixtures of things from both ears

Von Wright and colleagues (1975)

- GSR -- indicates increased arousal
- Training: shock for certain words
- Later: present to unattended ear during shadowing
- Emotional response to word (altho not aware of hearing it!)
Evidence for the model

- Sophisticated meaning analysis of unattended channel
  - Mackay (1973).

They threw stones towards the bank

... ... ... money
or
... ... ... river

QUESTION: what does the sentence mean?

Subjects favored the interpretation of the sentence suggested by the unattended word.

Treisman & Geffen (1967)

- Method
  - Task 1: shadow message in one ear
  - Task 2: tap pencil when you hear the target word “green”

- Results
  - Tapping to green in shadowed ear: 87%
  - Tapping to green in the other ear: 8%

Task Similarity

- MacCleod (1977)
- Continuous Tracking
  - (Manual Response)
- Tone Identification
  - Manual Response
  - Spoken Response
- Spoken Response Easier

- Treisman & Davies
- Monitor
  - Visual
  - Auditory
- Detect
  - Visual
  - Auditory
- Aud/Vis, Vis/Aud Easy
- Aud/Aud, Vis/Vis Hard

Task Difficulty

- Sullivan (1976)
- Method:
  - Dichotic Listening
  - Tone Detection on Unattended Channel
  - Shadowing Simple Message
  - Shadowing Complex Message

- Result:
  - Tone Detection Worse when Shadowed Message Complex

Practice, Practice, Practice

- Spelke et al.
  - Read stories
  - Write down dictated words
- Hirst et al.
  - Read stories
  - Write down dictated sentences

Stroop Effect

- Experiment I: Say the word.
  - Incongruent: GREEN (43.3 secs)
  - Congruent: BLUE (41.0 secs)

- Experiment II: Say what color the word is printed in.
  - Incongruent: GREEN (110.3 secs)
  - Congruent: BLUE (63.3 secs)
Memory Span Tasks

- **Forwards Memory Span**
  - Experimenter: 8 1 3 9 1
  - Subject: 8 1 3 9 1
  - 5-7 Digits

- **Backwards Memory Span**
  - Experimenter: 8 1 3 9 1
  - Subject: 1 9 3 1 8
  - 5-7 Digits

- People can only store a small amount of unrelated information temporarily

The Power of Chunking

- **Task:** recreate chess board from memory
  - Novice vs. Expert

- **Chess boards from the middle of actual chess games**
  - Experts WAAAY better than Novices
  - 91% vs. 41% correct

- **Chess pieces randomly arranged on the board**
  - Experts = Novices

Chess champions chunking

- **Release from PI**
  - Recall improvement that results when recall category is switched
  - E: shirt, socks, tie, blazer
  - S: shirt, socks, tie, blazer
Duration

- Apparent Duration in STM: short
  - seconds
- Apparent Duration in LTM: long
  - years

Sternberg's Findings

- Chad
- Burma
- Greece
- Cuba
- Malta
- 4.17/5
- Czechoslovakia
- Somaliland
- Nicaragua
- Afghanistan
- Yugoslavia
- 2.8/5

Speech Rate & Serial Recall

Brown-Peterson Paradigm

Word Length Effect

- Chad
- Burma
- Greece
- Cuba
- Malta
- 4.17/5
- Czechoslovakia
- Somaliland
- Nicaragua
- Afghanistan
- Yugoslavia
- 2.8/5

Word Length Effect Depends on Articulatory Loop

* signals reliable word length effect
Brooks

The cow jumped over the moon.
(no, yes, no, no, no, yes)

- Verbal Response
- Pointing Response
- Tapping Response

Brooks’ Data

Visuospatial Sketchpad

Hyde & Jenkins

- Better Recall for Semantic Encoding Tasks
  - Pleasantness, Frequency > PoS, E/G checking
- Performance Equivalent on Intentional and Incidental Learning Tasks
  - The mere intention to remember does not affect memorability unless it changes encoding strategies

Craik & Tulving Data

- Sentence Task Best!
- Congruency Effect
  - Finding that people do better on “yes” items than “no”
  - Due to differences in retrieval cues
  - Is a yacht a ship?
  - Is a robin a ship?
Bower & Colleagues

**Minerals**
- Rare: Platinum, Silver, Gold
- Common: Aluminum, Copper, Lead, Iron
- Alloys: Bronze, Steel, Brass
- Precious: Sapphire, Emerald, Diamond
- Masonry: Limestone, Granite, Marble, Slate

**Memory for Personally Relevant Info**
- **Self-Relevance Effect**
  - Finding that judgments about self-relevance lead to better recall than other common encoding tasks

Self-Generation Effect
- **Generation Effect (Slamecka & Graf)**
- Subs who generate their own associations for words remember more than those who take the experimenters'
  - Rhymes with ‘sow’ and begins w/a 'b'
  - Sow—Bow

Elaboration
- **Levels of Processing not full account**
- **Craik & Tulving**
  - She cooked the ____
  - The great bird swooped down and carried off the struggling ____
- **Kind of elaboration matters**
- **Bransford & colleagues**
  - A mosquito is like a doctor because they both draw blood.
  - A mosquito is like a racoon because they both have heads, legs, and jaws.

Von Restorff Effect

Context-Dependent Learning
- **Divers learned 40 unrelated words**
  - On shore
  - 20 feet underwater
- **Recall list in same or different environment**
Emotional Context

- Bower, Monteiro, and Gilligan
  - Learn 2 lists
  - Hypnotically induced positive/negative state
  - Recall test under either (hyp. Ind.) positive/negative state
- Better memory when emotional state at test matched emotional state at study

State-Dependent Learning

- Recall easier when in same physical/emotional state as learning
- Drunks
  - Where did I hide that gallon of scotch?
  - Where did I hide the last $10 from my paycheck?

Spacing Effect

- Finding that memory better for repeated information if repetitions are spaced apart, rather than massed together
- Melton
  - Present words 2x per list with repetition varying in number of intervening items
  - When # of intervening items increases, so does the probability of recall

HM: Amnesic

- Profound failure to create new memories
  - Can’t find new home (after 10 mos.)
  - Can’t remember new people, names, tasks
  - Events/People since operation
  - Language essentially frozen in 50’s
  - Exceptions: Ayatollah, rock ‘n roll
**HM: Amnesic**

Mirror tracing task, Milner, 1965
- Improvement in H.M.
- No conscious recollection of previous training episodes

**Behavioral Features**
- STM functioning
  - Normal performance among amnesiac in digit span
- Procedural memory
  - H.M. (Corkin 1984)
    - Severe episodic memory impairment
    - Pursuit rotor task (see next slide)
    - Demonstrated learning within and across sessions
    - No memory of having done the task before

**HM: Stem-Completion**

HM: No memory for studying of list

**Dissociations & Patients**

**Dissociations in Normals**

**Amnesia & Episodic/Semantic Distinction**
- Amnesics remember what words mean, basic facts about the world, but don't remember what happens to them
- However,
  - Little conclusive evidence that different brain systems mediate episodic and semantic memory
Retrograde Amnesia

- **Difficulty**
  - Identify people and events from different decades
  - Autobiographical cueing
    - Date memories retrieved in response to specific cue words
  - Temporal gradient
    - Memories formed early in life are more likely to survive than memories formed later in life
    - The vulnerability of a memory to brain injury is inversely related to its age

Retrograde Amnesia in PZ

- Scientist who became amnesic after writing an autobiography
- Memory for events in life
  - Temporal Gradient
- Memory for scientific facts
  - Temporal Gradient
- Suggests memory for events and for facts more tied together than previously thought

Egocentrism

- My dad is a fireman.
  - He’s a hero!
- I’m 6 years old!
  - My birthday is today.

Mountain Task

- What can the doll see?
- Mountain w/trees, Mountain w/cross, Snowy Mountain

Conservation of Number

- **Row 1**
- **Row 2**
- Are there the same number of objects in each row?

Conservation of Mass

- Is there the same amount of clay in each ball?
- Is there still the same amount of clay?
Conservation of Liquid

• Which glass has more water in it?

Conservation of Liquid

• Bruner
  • Child succeeds when tall beaker is covered

• Physical Appearance
  • Child does understand conservation

Transitivity

\[
\bullet > \bigcirc \text{ AND } \bigcirc > \bullet \quad \Rightarrow \quad \bullet > \bigcirc
\]

• 8-9 years of age
• Important for Seriation

Seriation

• Ability to put things in an ordered series
• 4-year-olds baffled!
• 5-year-olds use pairwise comparisons
• 7-year-olds have adult competence

B not-A Error

Sees object in A
Hand searches B

Object Permanence
**Barrier Phenomena**

- Habituation
- Possible Event
- Impossible Event

**Baby Physics**

- 3 Months
- 6 months

**Collision Phenomena**

**Infant Sensory Memory**

- Habituation
  - Propensity to look less at previously presented pattern
- Dishabituation
  - Increase in looking time when new pattern introduced

**Infantile Amnesia**

- Inaccessibility of early childhood memories
  - Very Few Memories from Before Age 4
  - Almost No Mem from Before Age 2

**Repression**

- Freud
  - Greedy thoughts and desires (selfish id)
  - Sexually inappropriate thoughts
- But animals show infantile amnesia as well
  - Rats
  - Guinea pigs
**Episodic memory formation**

- Lack brain structures for episodic memory formation?
  - Medial temporal lobe structures
- But toddlers can recall episodic memories (just not when asked later)
- Habituation/Dishabituation
  - Babies habituate
  - Monkeys habituate
  - Monkeys with medial temporal lobe lesions don’t habituate

**Deferred Imitation**

- Evident in children as young as 6 months
- Not evident in adult anterograde amnesics

**Continuity of Memory Development**

**Applications**

**How to Study**

- Identify Text Organization
- Preview
- Question
- Read and Relate
  - Connect material to your own knowledge and experience
- Reduce
- Review

**Advertising**

- Pair products with stimuli that elicit positive emotions
- Second-order conditioning
Taste Aversion

- Chemotherapy
- Give children distinctive-flavored Lifesaver candy (CS) between their evening meal and the chemo session (UCS)
  - 12/15 children ate the food at the meal again later
- Control: no lifesaver
  - 6/15 children would eat that meal again

Treating Phobias

- Peter Jones (1924) brought a rabbit into the same room but far away from Peter while he was eating his cookies and milk snack
  - Rabbit: CS that elicits anxiety
  - Snack: CS that elicits good feelings
- Brought the rabbit closer and closer until there was no fear to the rabbit
  - Eventually the rabbit was put into his lap!

Practice

- Both amount & distribution of practice matter
- Better to have less practice/day distributed across more days
- Better to have repetitions separated by other things to learn
- Best practice comes from retrieving the information at expanding intervals

Encoding: Practical implications

- Memory influenced by exhaustiveness of processing
  - Self-generation effect
  - Maintenance Rehearsal
    - Inefficient but it works!
  - Elaborative Rehearsal
    - Most Effective Strategy

Real-life Examples

Shaping

- Reward animal for closer and closer approximations to the desired behavior
- Main way of training animals to do tricks