Top topics for the Final

- **Chapters 2-9**
  - Perception
    - Models/theories
  - Attention
    - Kinds
  - Working Memory
    - Baddeley’s model
  - Long-Term Memory
    - Kinds
    - Semantic organization

- **Chapter 10: Language**
  - Word recognition; word meaning
  - Sentence structure; sentence ambiguity
  - Context and sentence processing

- **Chapter 11: Text Comprehension**
  - Prior knowledge of topic & Text organization
  - Kintsch’s model
  - Inferences and coherence

- **Chapter 12: Problem Solving**
  - Problem space; search space
  - Means-ends analysis; heuristics vs algorithms
  - Types of problems

- **Chapter 13: Expertise & Creativity**
  - Characteristics of expertise
  - Approaches to study of expertise & creativity
  - Stimulating creativity

- **Chapter 14: Decision making**
  - Models of decision making
  - Subjective vs objective probabilities, value, utility
  - Heuristics for estimating and predicting probabilities

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Exam
66 questions total, 1.5 pts each
16 on Ch 2-9,
50 on Ch 10-14
All multiple choice
Bring a Scantron and a pencil
Why study this stuff?
Understand Cognition better to improve your life, both in and out of school

- **“Think” better** (working memory, problem solving, expertise, attention)
  - Identify and understand problems faster and more clearly
  - Improve your “crap detector”
  - Get better jobs; better salaries
  - Get more independence
- **Deal with risk and uncertainty better** (decision making)
  - Life is an extreme sport for some people
  - Avoid risky behaviors; help others do the same
  - Make more informed choices
  - Gamble better : )

Why study cognition?

- **Understand the subjectivity of language better** (comprehension)
  - Words don’t mean, people do
  - Communicate better your needs, goals, ideas
  - Understand your clients, patients, co-workers better
  - Identify when and how people try to fool you
- **Acquire information better** (learning, studying)
  - Read better
  - Study more effectively
  - Retain more information
- **Live a more thoughtful, rational life**
- **An option for further study and research…**
The Workbench metaphor

Cognitive processes can be described in terms of actions happening at a workbench

- Interpreting information is an **ACTIVE** process; we don’t “absorb” information passively from the environment
- There is a very **limited amount of “space”** in which to work (short-term memory)
- Well organized information takes up less space and is stored more easily (chunking)
- The Central Executive can choose **which input** to process (attention1)
- The Central Executive can choose **which information to use** from prior experience (attention2)
- The Central Executive can choose **which processes to prioritize** (attention3)

Take-away re Perception / Pattern Recognition

Perception / Pattern recognition

- What you see is NOT what you get
  - Sensory array ≠ mental representation
  - Objective stimulus ≠ subjective experience
- Knowledge, goals, context can affect perception
  - “top-down” effects
  - Perception is to a great extent subjective
- Theories need to talk about features and their structure (or interrelations)
Takeaway re Attention

Three separate notions of “attention” – the three things that the Central Executive does:

- Selection of sensory input
  - What to process?
  - Attention_1 is control of perception

- Focus of processing
  - How to process input?
  - Attention_2 is control of processing in STM
  - Processing can be automatic or controlled
  - Global focus first

- Selection of information from LTM
  - What knowledge to use during processing?
  - Attention_3 is control of retrieval from LTM
  - We’ll see this later, in Chapters 5 and 6
Take-away for Working Memory

- Limited
  - In time: 2-20 seconds
    - Forgetting is due to decay and/or interference
  - In capacity: 7±2 “chunks”
    - Chunking is very flexible; uses prior knowledge

- WM is used for processing everything
  - For immediate response
  - For getting info into Long-term Memory

- Easy to confuse with Short-term Memory
  - Working Memory = Central executive + STM + sensory stores

- WM is an ACTIVE skill
  - not a passive store

STM ➔ Working Memory

- STM: A passive storage container for information
  ➔ WM: An active skill for processing information

- STM: How much can it hold?
  ➔ WM: How fast can WM process information?
    - Emphasis on different tasks or skills

- STM: How long can the information last just sitting in STM?
  ➔ WM: How does WM control which information to process? (~ Attention)
    - Emphasis on different tasks or skills
Take-away for Long-term Memory

Three topics
- Getting information into LTM
  - Rehearsal
  - Encoding & Mnemonics
- The form of information in LTM
  - Memory "codes"
  - Kinds of knowledge and memory
- Getting information out of LTM
  - Search
  - Activation
    - Recognition tasks
  - Retrieval
    - Recall tasks

into LTM

Getting information INTO LTM
- ~ this is what happens in Working Memory
- ~ “transfer” from WM to LTM
- LEARNING (acquisition of information)
- LEARNING (acquisition of skill)
- Rehearsal (cf. brainwashing, advertising)
  - Rote learning, drill, practice, memorization
  - Experience!
- (En)coding ("hooks" to prior knowledge)
  - Semantic mnemonics
  - What’s related to what?
  - Meta-cognitive strategies
- Imaging
  - Visual mnemonics (looks like, location)
Inside LTM

– **Explicit** Memory (accessible to consciousness)
  - Episodic memory (for individual events)
  - Semantic memory (for generic facts)
  - Intentional learning
  - Direct tests

– **Implicit** Memory (not accessible to consciousness)
  - Procedural memory (for skills)
  - For other things?
  - Incidental learning
  - priming; conditioning; habits
  - Indirect tests

Take-away for Semantic Memory

Semantic memory is made up of (in part!):

– **Categories** (or concepts)
  - True/false categories, or
  - Fuzzy (“natural”) categories (Prototype theory)
    - Exemplars are more or less **typical**

– That are organized hierarchically
  - One category includes (or *subsumes*) another

– The process of linking an individual with its category (called “categorization”)
  - Promotes long-term memory
  - Ex: “Fido is a dog”
  - Establishes a basic fact
    - Semantic memory is like a network of facts
Reasoning

Reasoning
– About new information = knowledge integration
– About old information
  Relating information
  Schema building
  Re-evaluating coherence, reliability, etc.
– About probabilities: decision making

Reasoning: using knowledge to create and retain knowledge

Problem Solving

*Cognitive* problems
– Not social or emotional problems

Three steps:
– Understand the problem
  • Build a problem space
    – = a problem *schema* from the description of the problem
  • Plan a strategy
    – Analogy with known problems
– Explore the possible solutions
  • Means-ends analysis of candidates
  • Predict, recall, or compute the outcomes
– Identify a correct solution
Problem Spaces

Strategies

- Means-ends analysis
  - At each step, are you getting closer to a solution or not?
- Sub-goals
  - Divide and Conquer
- Analogy
  - Use similarity with other, known solutions
    - Doesn’t happen as readily as we would hope
    - Can work with explicit instruction
- Diagrams
  - Help with spatial, but not temporal arrangement problems
Types of Problems

Three main types of (cognitive) problems (Greeno, 1978):

– Problems of arrangement
  • Rearrange existing objects to form new relations

– Problems of inducing structure
  • Infer existing relation from given objects

– Problems of transformation
  • Given X, make Y

Types of Problems

Well-defined
– Definite initial state “7 + 8 – x”
– Goals and operators are known “= 12”

Ill-defined
– The solver does not know (or isn’t sure of) the goals or operators, or even the current state

Examples?
**Expertise**

Table 1.1. Different approaches to accounting for outstanding performance

<table>
<thead>
<tr>
<th>Attribution</th>
<th>Construct</th>
<th>Research approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Primarily inherited</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General abilities</td>
<td>Intelligence, personality</td>
<td>Correlation with personality profile, general intelligence</td>
</tr>
<tr>
<td>Specific abilities</td>
<td>E.g., music ability, artistic ability, body build</td>
<td>Correlation with measures of specific ability</td>
</tr>
<tr>
<td><em>Primarily acquired</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General learning and experience</td>
<td>General knowledge and cognitive strategies</td>
<td>Investigation of common processing strategies</td>
</tr>
<tr>
<td>Domain-specific training and practice</td>
<td>Domain- or task-specific knowledge</td>
<td>Analysis of task performance, i.e., the expertise approach</td>
</tr>
</tbody>
</table>


**Experts vs. novices**

- **Experts**
  - More directed perception
  - More selective attention
  - Better chunking
  - More information
  - Better knowledge integration

- **Novices**
  - Less directed perception
  - Less selective attention
  - Worse chunking
  - Less information
  - Worse knowledge integration
Expertise

Expertise: domain-specific cognition
- Focus reasoning on a specific domain
- Accumulate above-average knowledge
  - Memory of domain-specific facts
  - Memory of domain-specific operations
  - Memory of domain-specific examples
  - Memory of domain-specific subjective experience
- LMT is different; Cognition is different
  - Amount of knowledge is different from novices
  - Kinds of knowledge are different from novices
  - Use of knowledge is different from novices

Creativity

What’s “creativity”??
- A cognitive process
- Reasoning and problem solving
  - In new ways
  - With new results
    - The opposite of functional fixedness (~routine thinking)
      - MacGyver TV show
- “Absolute” creativity
  - New for the human race (is this useful? Can you know?)
  - Political oppression > cognitive oppression
- “Relative” creativity
  - New for you or your group
  - This is the relevant notion of creativity
Parts of Creativity

Creative problem solving
– Choosing new problems
– Viewing old problems in different ways
  • Different problem space; new formulation
  • New analogies with other problems
– Using new or different information to solve problems
  • New notions of relevance

Theory and intuition
– Theory is key
  • General, situation independent knowledge
– Intuition is key
  • Implicit memory, implicit reasoning

Decision Making

Reasoning about probabilities
– Probability of positive outcomes (eg. Gambling)
  • Avoid subjectivity in assessing probabilities and values
  • Procrastination (see Psych*FM)
– Probability of negative outcomes (eg. Risk)
  • What risks should you worry about?
    – Plane accidents or car accidents?
    – Nuclear accidents or falling out of bed?
    – Snakebites or biking accidents?
    – Heart disease or homicide?
    – (see Psych*FM)
Takeaway for Decision Making

How people evaluate their options
- Evaluating the probability and utility of positive outcomes
- Evaluating the risk (probability) and utility of negative outcomes
- Heuristics
  - Heuristics for estimating **objective** probabilities
    - Availability
    - Representativeness
    - Expected value
  - **Subjective** probabilities play an important role
    - Expected utility
    - Subjective expected utility
    - Perceived risk
- Evaluating the reliability of the knowledge used is **KEY**

Language (Ch. 10)

People use "language" in several different senses:

**Language1** is an (innate) cognitive ability
- The **language faculty** or **language organ**
- ...that you use to learn...**Language2**

**Language2** is a kind of knowledge
- Knowledge of rules or principles for manipulating words and sentences
- ...that you use when you are doing...**Language3**

**Language3** is a cognitive process
- Speaking, listening, reading, writing, translating, ...
- ...that happens when you manipulate...**Language4**

**Language4** is linguistic entities with special structure
- Like English, Finnish, Thai , ... words, sentences, etc.
- ~ grammar of a language
Language (Ch. 10)

Important terms
- "surface ambiguity" – possibility of different grammatical groupings of the same words
  - *The cop hit the lady with the cane.*
  - How well can we decide?
  - a. error recovery heuristics
  - b. working memory capacity
  - c. the ability to quickly suppress inappropriate meanings
- "ambiguity" or "lexical ambiguity" - possibility of different meanings of the same word
  - *Bank* [river bank], [financial institution]
- "phrase structure" – relations between parts of a sentence, ex: subject, direct object
- "transformational structure" – relations between different versions of the same sentence, ex: active sentence vs. passive sentence

Word Recognition
Marslen-Wilson’s Cohort Model
When we hear the beginning of a word this activates ALL words beginning with the same sound: the "word-initial cohort".
  - Subsequent sounds eliminate candidates from the cohort until only one remains
  - Failure to fit with linguistic or semantic context can also eliminate candidates

- **t** - tea, tree, trick, tread, trestle, trespass, top, tick, etc.
- **tr** - tree, trick, tread, trestle, trespass, etc.
- **tre** - tread, trestle, trespass, etc.
- **tres** - trestle, trespass, etc.
- **tresp** - trespass

Uniqueness point
Word Recognition

Multiple possible meanings are activated initially for each word

A clarifying context influences:
- How the correct meaning is selected from the possible meanings after activation
- Lexical priming technique

Building Sentences (Parsing)

How do we build sentences, once we’ve recognized the words? (or even if we haven’t?)

- Use rules of "grammar" to see which words fit together
  - Colorless green ideas sleep furiously.
  - BUT, sometimes there are multiple options
    - The copy hit the old lady with a cane.
  - BUT, sometimes we don’t have enough information
    - She saw her friend from the hill with a telescope.

- Use knowledge of meaning to see which words fit together
  - But, sometimes there are multiple options
    - I saw him going home.
  - But, sometimes we don’t have enough information
    - The spy found bugs in his hotel room.
Text comprehension

Words and sentences are clues
– You have to put them together in your own way
  • We instinctively look for coherence
  • We look for ways to “make sense” of things
– If the clues are unknown, unusual, or unorganized, then you have to compensate by thinking more about how the ideas relate
  • According to your experience and knowledge
  • Meaning is subjective

Text comprehension

Words and sentences are clues
– The evidence examined by the lawyer turned out to be unreliable.
– The witness examined by the lawyer turned out to be unreliable.
Semantic interpretation

How do we know what a sentence means?

I ate the cake with a fork

Event: eat

agent: I

affected object: cake

instrument: fork
Evaluating meaningfulness

How can we choose the best possible interpretation from the candidates?
- Maximize coherence
- \textit{Coherence: a function of the number and strength of connections among concepts and conceptual relations}
  - Among sentence concepts
  - Sentence concepts and context concepts
  - Sentence concepts and conceptual relations
  - Etc.

Inferences

Ross added brick after brick. After a while, the pizza was done.
- Ross added brick after brick to the pile. After a while, the wall was done.
- Ross added brick after brick. After a while, the wall was done.

Ellie got the picnic supplies out of the trunk. But the elephant was warm.
- Ellie got the picnic supplies out of the trunk. But the beer was warm.
- Ellie got the picnic supplies out of the trunk. But the beer was already warm.
Schemas

Knowledge integration

- Build “larger” knowledge structures, like plans, scripts, narratives, procedures, etc: schemas
  - paragraph and chapter-sized structures
  - Update prior propositions
  - Add new propositions
  - Add new conceptual relations
  - Reorganize prior propositions

- What in the text can help?
  - Titles and headings
  - Questions, instructions
  - Conjunctions
  - Examples? Exercises?

Take-away re Text comprehension

Words and sentences activate the knowledge you have in LTM
- Meaning = activated knowledge

Words and sentences do NOT carry, convey, or transmit meaning: they are just clues; the “meaning” is your reaction to the text
- Meaning/knowledge is subjective
- Common experience and culture mean we have similar knowledge, so we react similarly
- This creates the illusion that words mean the same thing to everyone

When there are problems with the words or sentences in the input, we compensate by adding information from our experience
Takeaway re Cognition

Cognition is…

• What we do to get/locate information/knowledge/experience from the environment (perception)
• What we do to store/find the information/knowledge/experience we have from before (learning, comprehension, memory)
• What we do to put together different pieces of information that we have (reasoning, problem solving, decision making)
• What we do to organize and use different pieces of information (planning, execution)

– Cognition (traditionally) doesn’t include:
  • Volition
  • Emotion
  • Physiology
  • Social psychology

Go forth and prosper.
May the Force be with you.