Cognitive Psychology

- The study of the mental processes by which the information humans receive from their environment is modified, made meaningful, stored, retrieved, used and communicated to others.
The Circle of Thought

- 5 core functions that characterize human thinking: describe, elaborate, decide, plan, and guide actions
Information Processing System

- **Stage 1**: Information about the stimulus reaches the brain by way of the *sensory receptors*.
- **Stage 2**: The information must be *perceived and recognized*.
- **Stage 3**: The person must *decide* what to do with the information.
- **Stage 4**: In *response selection*, one response is chosen from the options available.
- **Stage 5**: *Execution* of the response occurs.
Figure 8.2: An Information-Processing System
Information Processing

- Mental chronometry (the timing of mental events) gives clues about information processing stages.
- Reaction time is the time elapsing between the presentation of a stimulus and a response.

Test Your Reaction Time!
Reaction Time

- Influenced by several factors:
  1. The **complexity of the decision** — the larger the number of possible actions, the longer the time
  2. **Expectancy** — expected stimuli are perceived more quickly
  3. **Stimulus-response compatibility** — when relationship between a set of possible stimuli and possible responses is a natural one
  4. **Speed-accuracy tradeoff** — quick responses can lead to an increase in errors — error-free performance results in an increase in time
Figure 8.3: Stimulus-Response Compatibility

A compatible relationship

(A)

An incompatible relationship

(B)
Evoked Brain Potentials

- Small temporary change in voltage that occurs in response to specific events
- Each peak reflects the firing of large groups of neurons within different regions of the brain, at different times during the information-processing sequence
- Pattern of peaks provides info that is more precise than overall reaction time
When scientists use PET scans, fMRI, and other techniques to watch what happens in the brain during information processing:

- **Frontal lobes** are important in problem solving and cognitive tasks.
- Once skill is learned, the *hippocampus* is activated.
Mental Representations

- Information can be mentally represented in many forms, including: concepts, propositions, schemas, scripts, mental models, images, and cognitive maps.
Categories of objects, events, or ideas with common properties

- Formal concepts – defined by a set of rules so that each member of the concept has all of the defining properties and no nonmember does

- Natural concepts – have no fixed set of defining features but share a set of characteristic features
  - A member of a natural concept, which possesses all or most of its characteristic features, is called a prototype
Propositions

- Mental representation that expresses a relationship between concepts
  - Can be true or false

= SMART?
Schemas, Scripts, & Mental Models

1. **Schemas** – generalizations we develop about categories of objects

2. **Scripts** – schemas about familiar sequences of activities

3. **Mental Models** – clusters of propositions that represent people’s understanding of how things work
Figure 8.6: Eating at a Restaurant

Restaurant script

Scene 1: enter
- Go inside
- Go to table
- Sit down

Scene 2: order
- Get menu
- Read menu
- Choose food
- Give order

Scene 3: eat
- Get food
- Eat food

Scene 4: pay
- Ask for check
- Receive check
- Tip server
- Pay check
- Exit
Figure 8.7: Applying a Mental Model

What path will the marble follow when it leaves the curved tube?
Images & Cognitive Maps

1. **Images** – mental representations of visual information

2. **Cognitive maps** – mental representations of familiar parts of your world - spatial layout
Thinking Strategies

- **Reasoning** – the process through which people generate and evaluate arguments and reach conclusions about them
- **Formal reasoning** – the process of following a set of rigorous procedures for reaching valid conclusions
  - **Algorithms** - always reach a correct solution to a problem
  - **Rules of logic** – a system for drawing correct conclusions from a set of statements known as premises
  - **Syllogisms** – logical arguments containing two or more premises and a conclusion
    - Validity depends both on the accuracy of the premises and the usage of proper rules of logic
Impact of Belief Bias in a Syllogism

- Premise #1
  - Some professors wear ties.
- Premise #2
  - Some men wear ties.
- Conclusion
  - Some professors are men.
  - Does this follow logically?

- Premise #1
  - Some scarecrows wear ties.
- Premise #2
  - Some professors wear ties.
- Conclusion
  - Therefore, some scarecrows are professors???
Errors in Logical Reasoning

- Belief bias — accept illogical conclusions that agree with prior beliefs and wishes
  - Confirmation bias

- Limits on working memory:
  - Conversion effect — when you assume that premises are symmetrical
  - Cultural differences
  - Language differences
Thinking Strategies – Informal Reasoning

- Situations where we are trying to assess the believability of a conclusion based on evidence available to support it
  - Also called inductive reasoning
- Heuristics – mental shortcuts or rules of thumb
Problematic Heuristics

- Anchoring heuristic – people estimate an event’s probability by adjusting an earlier estimate
- Representative heuristic – people decide whether an example belongs in a certain class on the basis of how similar it is to other items in that class
- Availability heuristic – judging the probability of an event or hypothesis by how easily the hypothesis of the event can be brought to mind – people choose the one that is most mentally available
Problem Solving

- Where you are (the problem) is not where you would like to be (the solution)

- Strategies:
  - **Incubation** – putting a problem aside
  - **Means-End Analysis** – identifying a sub-goal that will take you toward a solution
  - **Working Backwards** (from desired goal)
  - **Analogies** – using strategies to solve similar problems to provide insight to current problems
Obstacles to Problem Solving

1. **Multiple hypotheses** – the correct hypothesis is often neglected

2. **Mental set** – tendency for old patterns of problem solving to persist, even when better alternatives are obvious
   - Functional fixedness – avoiding using familiar objects in creative and useful ways

3. **Ignoring negative evidence** – absence of symptoms can provide important evidence, but people are less likely to notice and observe symptoms that do not occur

4. **Confirmation bias** – tendency to confirm the hypothesis chosen, even in the face of strong evidence against the hypothesis
Figure 8.13: The Nine-Dot Problem

- Draw no more than four straight lines that run through all nine dots on the page without lifting your pencil from the paper.
Figure 8.15: Two Creative Solutions to the Nine-Dot Problem
Figure 8.14: An Example of Functional Fixedness
Problem Solving by Computer

- Field of Artificial Intelligence (AI)
- Limitations of Logic-Based Approach to AI
  - Limited ability in narrowly defined fields
  - Inability to draw analogies or recognize patterns
  - Inability to form natural concepts – limited to “if, then” rules
- Connectionist or Neural Network Approach
  - Reproduced some aspects of human perception (speech & print) but fall short of full human capacities
- Computer-Assisted Problem Solving
  - Combined human-computer effort is often efficient
Decision Making

- **Evaluating Options**
  - **Comparing attributes** — weighing options that have both positive and negative features or attributes
    - *Utility* — term used to describe the personal value of each attribute
  - **Estimating probabilities** — taking into account the probabilities and risks of possible outcomes
    - Best decision is one that maximizes expected value, or total amount of benefit you could expect to receive
    - (Probability of gain x size of gain) – (Probability of loss x size of loss)
Biases and Flaws in Decision Making

- Positive utilities are not mirror images of negative utilities — people feel worse about losing a certain amount than they feel good about gaining the same amount.
- The utility of a specific gain depends on your starting point.
- Biases — tendency to overestimate rare probabilities and underestimate frequent ones
  - Gambler’s fallacy — belief that events in a random process will correct themselves.
- Unrealistic confidence — people tend to be unrealistically confident in the accuracy of their predictions.
Naturalistic Decision Making

- Used when facing time and resource limitations.
- Involves use of prior experiences.
  - Results in formation of mental representations.
  - Development of situation awareness.
- Situation awareness — ability to appreciate all elements of a problem as well as all elements of the environment within which it appears and to make decisions that take them into account simultaneously.
Group Processes in Problem Solving and Decision Making

- Impact of group interactions on problem solving and decision making.

- *Group polarization* can occur because:
  - Most arguments favor majority view.
  - Some may try to associate with desirable decision.

- *Group performance* – group performance usually outperforms individual performance when solution is clear
  - When solution is not clear, groups do not perform better than most talented member
  - Social loafing – when people work as part of a group, they are often less productive than when they work alone
Language

- 2 Basic Elements:
  - Symbols - words
  - Grammar – set of rules for combining words
From Sounds to Sentences

- **Phoneme** – smallest unit of sound
- **Morphemes** – smallest unit of language that has meaning
- **Words** – made up of one or more morphemes
- **Phrases** – words are combined to form phrases according to a set of rules called syntax
- **Sentences** – governed by a set of rules called semantics
Surface Structure & Deep Structure

- Surface structure – word strings that people produce
- Deep structure – abstract representation of the relationships expressed in a sentence
Figure 8.16: Surface Structure and Deep Structure

SPEAKER’S IDEA

LISTENER’S IDEA

Idea (proposition)

Phrase(s)

(The shooting of the psychologist was terrible.)

Morphemes (meaningful units of sound)

Phonemes (basic units of sound)

“The shooting of the psychologist was terrible.”

Speech production

Speech comprehension
Understanding Speech

- Physical features of speech are not always the same – understanding can be difficult
- Understanding language is primarily knowledge driven and relies on the context of the words spoken – people use schemas, scripts, and past experiences to interpret language
- Perceiving words and sentences
  - Bottom-up & top-down processing
  - Nonverbal cues
Development of Language

1st Year

- Babblings — repetitions of syllables beginning at 4 months
- 9 months — use short vocalizations in context with obvious people
- 10-12 months — understand several words
- 12 months — begin to talk
Development of Language

- **2\textsuperscript{nd} Year**
  - One-word stage of speech lasts for about 6 months
  - Age 2 – vocabulary is 50-100 words
  - 2-word utterances are telegraphic – brief and to the point
  - 2-word sentences

- **3\textsuperscript{rd} Year and beyond**
  - Formation of complex sentences
  - Acquire most of the syntax of their language by age 5
Acquisition of Language

- Language is partly acquired by conditioning, imitation, and rules.
- Adults tend to modify their speech when talking to children – *motherese* - does not help acquire language.
- Modeling correct speech is important.
Acquisition of Language

- Biological bases for language acquisition – are humans prewired to learn language?
  - Chomsky – built-in universal grammar that allows us to identify dimensions of language
    - Broca’s and Wernicke’s areas

- Critical period – experiences can lead to language development, but after which language learning is difficult – must be exposed to speech at a certain age

- Bilingualism – better results if occurs before the end of the critical period
Culture, Language, and Thought

- Whorf: Language actually determines how we think.
  - “Linguistic determinism”
- Language may not determine, but still may influence how one thinks.
- Language can affect reasoning, problem solving, and decision making.
  - e.g., framing effect — a collection of stereotypes individuals rely on to understand an idea
References

- [http://college.cengage.com/psychology/bernstein/psychology/7e/instructors/index.html](http://college.cengage.com/psychology/bernstein/psychology/7e/instructors/index.html)