

Introduction to Cognitive Science

Fall 2019

Tue 9/3 Lecture: An Introduction to Cognitive Science

- I. Domains
 - A. Language, perception, infant cognition, working memory, choice, emotions, moral judgement
- II. Themes
 - A. Computation (AKA algorithm)
 - 1. How cog sci was essentially founded
 - 2. How things work: **Representations** (eg., lightswitch flips on and off) and **Rules** (eg., binary addition)
 - a) Versus the traditional method of explaining the scientific set up of a program
 - 3. Reasoning, rationality, etc. - representations and rules (computation)
 - B. Levels of analysis / 3 Levels of Explanation
 - 1. Functional: Problem the capacity is supposed to solve
 - 2. Algorithmic: Procedures that enable the problem to be solved
 - 3. Physical: The neural/chemical substances in which the procedures are implemented
 - C. Tacit knowledge
 - 1. Things that you “know” but can’t readily articulate
 - 2. Ex. “Kim is happy” and “Kim’s happy”
 - a) Versus: “Kim is happier than Tim is” and “Kim’s happier than Tim’s”
 - b) Why doesn’t that work?
 - (1) The *real* structure - “Kim is happier than Tim is [happy]”
 - 3. This rule isn’t taught, but we all know how it works
 - a) Even young children understand this rule and can’t explain it
 - D. Unconscious processing
 - 1. Things your mind does without your awareness
 - E. Modularity
 - 1. Functional specialization within the mind/brain
 - 2. Ex. Different organs inside the body all working together to keep the body alive
 - a) Same thing in the mind? Or the entire mind does everything?
 - (1) Both: some modularity and some overall work
 - 3. Blind man can see but avoid obstacles
 - F. Innateness
 - 1. Where do the contents of the mind originate?
 - 2. DNA? Learning? Different pathways?
 - 3. How do babies know about natural, physical occurrences? Gravity, etc.
 - G. Rationality
 - 1. Reasoning correctly, doing the right thing
 - 2. Heuristics and Biases Program

- a) People are terrible at logical reasoning, probability, and statistics
 - b) We make judgements using a grab bag of simplifying “heuristics” - shortcuts that are quick and easy but often lead to error
 - 3. Neuroeconomics Program
 - a) The brain is outfitted with sophisticated mechanisms for rapidly and accurately doing logical reasoning, probability, and statistics
- III. Dual process models
 - A. Fast, automatic, effortless processing VS slow, controlled, effortful processing
 - B. Stroop test - reading ink colors of words (red, green VS red, green)
- IV. The Trolley Problem
 - A. What makes actions right or wrong?
 - 1. Simply outcomes? Or the manner in which you achieve them?
 - B. 1 person dies vs. 5 are saved
 - 1. Push man off bridge? Switch train to only kill one person?

Thurs 9/5 Lecture: Two Approaches to Language

- I. Why start with language?
 - A. 1959 debate (Chomsky vs. Skinner) about language - “founding moments” of cognitive science
 - B. Association vs cognitivism
- II. Language - device for communication
 - A. Based on **sound-meaning pairings**
- III. Associationism
 - A. John Locke
 - 1. Mind starts out as a “white paper”
 - 2. Experience makes the brain learn ideas, language, etc.
 - B. B.F. Skinner
 - C. Associations between events
 - 1. If you regularly experience A’s followed by B’s, form an association between A and B
 - D. Associations between situations and actions (instrumental conditioning)
 - 1. Action followed by reward → increase the number of times you perform that action
 - E. Associationistic word learning
 - 1. Baby says “cat”... people clap
 - a) Baby’s more likely to say “cat”
 - 2. Same with sentence learning
 - F. What’s in the head?
 - 1. A lot of associations between verbal actions and situations
 - G. How did it get there?
 - 1. Associationistic learning, instrumental conditioning
 - H. But what about children that don’t have rewards (parents clapping, etc.)
 - I. What about grammatical structure?

J. Problems with this view:

1. Stimulus independence
 - a) People utter sentences in contexts that are independent of the contexts in which the sentences were learned
 - b) “Where is your cat?” → “the cat is on the mat”
2. Novelty
 - a) Many sentences that a person knows have never been encountered before
3. Productivity
 - a) A language is productive if there is no upper bound on the number of sentences it can express
4. Systematicity
 - a) A language is systematic when: a person who knows the language reliably knows “groups” of expressions at a time

IV. Cognitive Views

- A. Noam Chomsky
- B. Sound → meaning
- C. Phonology: processing of sounds of utterance
 1. Syntax: processing of sentence structure
 2. Semantics: processing of sentence meaning
 3. “Colorless green ideas sleep furiously”
 - a) Semantically meaningless
 - b) Syntactically well-formed
- D. Phrase structure grammar
 1. Hierarchical
 - a) Sentence is broken down into abstract constituents, in turn broken down into further constituents
 2. Combinatoric
 - a) Rules are defined over elements that can be recombined in open-ended ways
 3. Recursive
 - a) Allow for repeated application of certain rules allowing for sentences of potentially unbounded length
- E. What’s in the head?
 1. Abstract combinatoric rules
- F. How did it get there?
 1. Most of it is innate
 2. It is part of “universal grammar”
- G. How does Chomskian view account for setbacks of associationism?
 1. Stimulus independence
 - a) You have set of rules that you can recombine in any context
 - b) People routinely utter sentences in contexts that are independent of the contexts in which the sentences were learned

- c) Ex. Hey where is your cat? The cat is on the mat
- 2. Novelty
 - a) You can produce new sentences with the combinatorial rules you know
 - b) Many of the sentences that a person knows have never been encountered before
 - c) Ex. When a male octopus spots a female, his normally grayish body suddenly becomes striped...
- 3. Productivity
 - a) Recursive rules
 - b) No upper bound on the number of sentences it can express
- 4. Systematicity
 - a) You have a set of rules, and you have a lexicon that you know
 - b) A person who knows the language reliably knows “groups” of expressions at a time
 - c) Ex. man loves monkey, monkey loves man

Fri 9/6 Discussion: Syntax and Recursion

- I. What is syntax?
 - A. The study of how syntactic units can be combined into larger syntactic units
- II. What is a syntactic unit?
 - A. Words
 - 1. Dog, red, the (noun, adjective, determiner)
 - B. Phrases
 - 1. The red dog, in the doghouse, eats the food (noun phrase, prepositional phrase, verb phrase)
 - C. Sentences
 - 1. The red dog eats the food in the doghouse
 - D. Phrase structure rules describe what a syntactic unit is made of
 - 1. NP → Det Adj N
 - a) Noun phrase = determiner, adjective, noun
 - 2. NP → NP PP
 - 3. PP → P NP

Tue 9/10 Lecture: Language and Innateness

- I. Chomskian arguments - language is innate
 - A. Language has a unique pattern of universality
 - 1. Present in all human societies
 - 2. Everyone in a group of normal intelligence develops language
 - 3. “No stone age languages”; same complexity everywhere
 - 4. VS another complex trait: cooking
 - a) Not present in all societies