Representation of knowledge

PSY 200
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Lecture 23

What is a shoe?

Concepts

- What is the information in Long Term Memory?
  - May be several different types
- We have knowledge about the world
  - Due to personal experience
  - Or due to language
- Such information must be in some kind of format, which we call concepts
- But what are the concepts?
  - what is the concept of “dog,” “walking,” or “free-market capitalism”?

Concepts

- We will look at three topics in concepts
  - Definitions (don’t really work)
  - Prototypes (closer to how humans think)
  - Exemplars (more likely than prototypes)
- And then combinations of concepts
  - propositions

Definitions

- Plato (and Socrates) spent a lot of effort trying to define terms like virtue and knowledge
  - they were largely unsuccessful
- the 20th century philosopher Wittgenstein wondered if definitions of even simple concepts were possible

Definitions

- Consider the concept shoe, you might define it as Webster’s Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
  - Lots of shoes fit this definition
- Consider the concept shoe, you might define it as Webster’s Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
  - But now consider some situations and decide if they are really shoes
  - A shoe that is intended for display only

PSY 200: Intro. to Cognitive Psychology
Definitions

- Consider the concept shoe, you might define it as Webster's Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
- But now consider some situations and decide if they are really shoes
  - A shoe filled with cement, which cannot be worn
  - A covering worn on the hands of a person without legs who walks on his hands
  - And this?  

Definitions

- The difficulty is the same one that Plato and Socrates had trying to define virtue
  - For any definition you come up with, I can find examples that do not seem to fit the definition
- But we all know what a shoe is
  - So our knowledge of this concept must not be based on some precise definition
- Note, scientists can (sometimes) create precise definitions (e.g., a dog is defined by a DNA pattern or by mating abilities)
  - But the definition is somewhat arbitrary

Prototypes

- Perhaps what defines a concept is similarity among its members
  - There may be no absolutely necessary characteristics
  - There may be no absolutely sufficient characteristics
- Prototype theory supposes that similarity is judged relative to a prototype example of the concept
  - E.g., an ideal, average, or most frequent version of the concept

Prototypes

- In prototype theory it is possible for an object to be “more” or “less” a certain concept
- Consider the concept “coffee cup”
  - And variations (some are “cup-ier” than others)
In prototype theory it is possible for an object to be “more” or “less” a certain concept. Consider the concept “coffee cup”, and variations (some are “cup-ier” than others).

Lots of experiments suggest the role of prototypes.
- Posner & Keele (1968): learning category names for random dot patterns
- Discriminate two sets of random dot patterns
- Each pattern is a variation of one of two prototype patterns

The key test is done after subjects learn to classify the variants.
- Reaction time for judgment is recorded for stimuli they have never seen before
  - New variants
  - The prototypes
- Reaction time is faster for the prototypes
- Which suggests that the mental representation of the categories (concepts) are built to favor the prototype of the category.

Look at CogLab data.
Prototypes

- Results are based on data from 89 participants (29,191 for global).
- Pattern type Reaction time (ms) Global RT (ms)
  - Prototypes 787 971
  - Variants 791 1003
- Unanswered by this (and many other) experiments is what a prototype is:
  - A "thing" that resides in memory and contains information about the category features?
  - The result of processing information?
- A bit of thought suggests it is the result of processing information.

Prototypes

- Consider the types of concepts you can have and how specific they can be:
  - Things: bird, dog, chair, shoe, ...
  - Actions: walking, running, sleeping, ...
  - Goal-derived: "things to eat on a diet", "things to carry out of a house in case of a fire" ...
  - Ad hoc: "things that could fall on your head", "things you might see while in Paris", "gifts to give one's former high school friend who has just had her second baby" ...
- When studied, these concepts all seem to have prototype characteristics.

Exemplars

- A concept consists of lots of examples of the concept:
  - E.g., a "coffee cup" concept might contain lots of examples of coffee cups.
  - Even if it is a new object, it may match several exemplars well enough to generate an overall response to indicate it is a coffee cup.

Exemplars

- Comparing an object to see if it is a coffee cup involves comparing it to each example in memory and seeing if it matches anything well enough.
Exemplars
- Some coffee cups seem prototypical because they match lots of exemplars
  - that’s what defines a prototype

Exemplars
- Unlike prototype theory, exemplar theory also contains information about the variability of examples within a concept
  - Thus, we know that pizzas have an average size of 16 inches but can come in lots of different sizes
  - And we know that foot-long rulers have an average size of 12 inches, but essentially no variability in size

Complex associations
- How do we represent a concept that involves combinations of concepts?
  - e.g., “Dogs chase cats.”
  - e.g., “Last Spring, Jacob fed the pigeons in Trafalgar Square.”
  - Need to identify the role of each concept

Propositions
- Higher order ideas
  - things doing something
  - Statement that is either true or false
    - things cannot be judged true or false
    - e.g., Book, Albert, Threw, Professor, Test, Gave
    - consists of an ordered list of concepts
      - e.g., (relation:X, Agent:Y, Object:Z)
        - Albert threw the book.
        - (relation:Throw, Agent:Albert, Object:Book)

Proposition
- The proposition connects the appropriate concept nodes

Proposition
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Proposition

- Network Representation
  - The proposition connects the appropriate concept nodes

- Proposition

- One way of combining concepts
  - there are also other theories of how to do this
- Used a lot in Artificial Intelligence
- Do humans represent interactions of concepts with propositions?
- Some experimental evidence

- Proposition

- Ratcliff & McKoon (1978)
  - study phase
    - subjects are asked to memorize a set of 504 sentences
    - 18 - 1 hour sessions!
  - test phase
    - show words and have subjects decide if they were in the study sentences or not
    - measure reaction time for words from the sentences

  The bandit who stole the passport faked the signature

- Proposition

- In the test phase, a word is given and the subject responds as quickly as possible
Proposition

- In the test phase, a word is given and the subject responds as quickly as possible

- The expectation is that activation will flow through the entire proposition that includes this word

- So, if the next word is part of the same proposition, a subject will respond even faster

- If words are from different propositions, no priming

- Activation will flow through the entire proposition that includes this word
Proposition

- When the next word is shown, its node has not been primed, so it responds more slowly

Test Phase: Priming Task
- compare RTs for second in a pair of words
  - within a common proposition (bandit -- passport)
  - between propositions (passport -- signature)
  - not related in sentence (horizon -- signature)
  - interested in RT to second word in each pair

Ratcliff & McKoon (1978)
  - results
    - within same proposition words: 561 msec
    - between proposition words: 581 msec
    - unrelated: 671 msec
  - evidence of priming by propositional activation
- We think in propositions!

Conclusions

- Concepts
  - definitions
  - prototypes
  - exemplars

- Propositions
  - Evidence we think in terms of propositions

Next time

- Other types of knowledge
- Mental images
  - mental rotation
  - mental scaling
  - limitations of

- CoGLab on Mental rotation due!
- Is a picture in your head like a picture in the world?