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”?

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

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
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?

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.

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- 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 145 participants (39,285 for global).
  - Pattern type
    - Reaction time (ms) | Global RT (ms)
    - Prototypes       798      969
    - Variants         843      1000
- 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

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

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

- 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

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

Prototypes

- We can generate new concepts from old concepts
  - it's inconceivable that every possible prototype exists ready to be used
  - some must just be built as they are needed
  - perhaps even the prototypes for simple concepts like "bird" or "shoe" are also just built when they are needed
  - A theory that can account for this processing approach is exemplar theory
**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:

\[
\text{(Relation: Threw, Agent: Albert, Object: Book)}
\]

\[
\text{(Threw, Albert, Book)}
\]

**Proposition**

- Network Representation
  - The proposition connects the appropriate concept nodes.

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Albert threw the book.

Albert

agent

Throw

relation

Book

object

Professor

agent

Gave

relation

Test

object
Proposition

- Network Representation
  - The proposition connects the appropriate concept nodes

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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

One way of combining concepts.

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


Proposition

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Proposition

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Proposition

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Proposition

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

Proposition

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

Proposition

- If words are from different propositions, no priming

Proposition

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

Proposition

- 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

**Proposition**

- 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旋转 due!
- Is a picture in your head like a picture in the world?