9.65 October 31, 2001 Concepts and Prototypes

Outline:

I. Categorization: Why?
II. How?
    a. images
    b. classical view
    c. prototypes
    d. exemplars
    e. all of the above?
III. Basic level categories of objects
    a. Theory
    b. Evidence
    c. Basic level and typicality
    d. Conclusions

First: write down an example that comes to mind, of each of these:

a vegetable

a prime number

a precious stone

also: draw a triangle

(We'll get back to this later.)

I. Categorization of experience: Why?

Two terms: concept and category. I'll be using the term CONCEPT for a mental category that we use regularly to classify experiences, and CATEGORY or categorizing to refer to any classification or grouping of experiences or ideas.

We need categories (and their associated mental concepts) in order to:

-use past experience to make INFERENCES

-STORE information efficiently

-PUT TOGETHER information about a SINGLE OBJECT

-think about RELATIONS between concepts

SOME categorizations will have these useful consequences, and others will NOT. (Infinite number of ways to group objects.)

We create categories of things that have relevant common properties: e.g., edible things.

TO SUMMARIZE: Why do we categorize? To use past experience, to organize memories of

experience in such a way as to reduce storage, and to think about relations between concepts.

II. How do we mentally represent concepts?

Four theories of mental representation of concepts:

a. IMAGES

abstract ideas

ambiguity

conceptual combination, negation

In sum: Imagery plays a role in thinking and remembering, but we can dismiss the idea as a GENERAL theory of how concepts are represented.

b. CLASSICAL VIEW

Definitions: necessary & sufficient conditions

bachelor

prime number

triangle

Can be used to make inferences: is this bachelor married?

Usually good for combining into more complex ideas

Some problems:

decoy duck

tall man

mountain pass

glue factory

Specialized system or theory supports definitions:

triangle ---> geometry

prime number ---> mathematics

cousin ---> kinship system

felony ---> law

These kinds of categories are termed NOMINAL KINDS

Problems for the classical view of categories:

NATURAL KINDS (such as FISH): no definitions

ARTIFACT KINDS (manmade objects), such as SPOON: no definitions

FURNITURE? Or, a GAME?

c. PROTOTYPES: A way of representing categories?

FAMILY RESEMBLANCE structure

GRADED MEMBERSHIP

ROSCH and her colleagues: we represent categories by [proto]typical exemplars, best examples or ideal examples (see Reisberg on Rosch).

Typical or central instances

EVIDENCE that typical instances play a role in the way we mentally represent categories:

1. **Sentence verification**: "An X [item] is a member of category Y"

2. **Production**. What first comes to mind.

3. **Picture identification**: "Is this a member of category Y?"

4. **Judgments about the typicality of exemplars**, as in the Lab 2 list of possible pieces of furniture.

5. **Induction, reasoning**.

6. **Tasks asking subjects to "think about" categories**.

Problems with the prototype theory:

SUMMING UP PROTOTYPES IN CATEGORIZATION: We use prototypicality (esp. visual/sensory) to help categorize new instances rapidly, and we may instantiate more **general** terms with specific (typical) instances when **making inferences**, understanding language.

"The fruit fell on the floor"

By assuming that we're talking about typical members of a category, we'll usually be correct in our inferences--but that's not guaranteed. With a definition, inferences can be deductively valid.

d. The Exemplar Theory of concept representation: An alternative to the idea that we develop a representation of a typical member of a category, a prototype, is that we simply remember many or all of the individual experiences we've had with instances ("examples") of that category: e.g., all the dogs we've seen, read about, etc. To classify a new entity we retrieve memories of one or more previous examplars that seem similar to the new entity--rather than comparing the new entity with a prototype or typical instance. (See text, beginning on p.279, for a full discussion of this alternative.) Note that the exemplar theory has most of the properties (and weaknesses) of the prototype theory just discussed.

e. ALL OF THE ABOVE? Images, definitions, prototypes, exemplars

NOMINAL KINDS have satisfactory definitions

NATURAL KINDS: essences?

ARTIFACT KINDS (manmade objects): designed functions?

Prototypes and exemplars are both useful in classifying novel items and in thinking about categories of objects and events.

Implicit theories.

III. Basic level categories of objects

a. Theory

Our concepts are arranged in HIERARCHIES: e.g., THINGS (contrast with IDEAS), MANMADE ARTICLE, FURNITURE, CHAIR, DESK CHAIR, SWIVEL DESK CHAIR,...

Such hierarchies are the basis for SEMANTIC NETWORKS, discussed in Reisberg Ch. 7 and in class.

ECONOMY OF STORAGE

PREFERRED LEVEL?

ROSCH, Mervis, Gray, Johnson, & Boyes-Braem (1976): Basic level categories for objects.

More theory: **clusters** of features

Example: self-winding ladies' analog wristwatch: most useful level of categorization?

List attributes of objects at each level (e.g., watch) [in brackets are possible features true of everything at that level]

thing [lumped together in space-time? not-an-idea?]

concrete object [mass? etc.]

manmade [might have been made with tools, deliberately chosen for some purpose or use...]

device to tell time [tells time]

watch [wearable; most have strap to hold on wrist; shows minutes and hours, maybe seconds; made of metal; most adults in our society have one; range and typical price....]

wristwatch [worn on wrist; not-a-lapel-watch; not-on-a-chain]

analog wristwatch [has hands to show hour, minutes, sometimes seconds; may tick]

.... [little further increase in attributes]

Rosch hypothesized that the point at which there is a lot of information gain, as you moved down the hierarchy, would generally be the point at which you'd want to categorize.

IN SUMMARY:

Theory: While few categories of objects consist of physically identical members, there are some perceptual characteristics of objects, and some functional properties of objects, that cluster in feature-space and invite categorization.

Further, the "best" level at which to categorize--the "Basic" level--is one at which the correlation of properties within the cluster is maximal, and the differences between objects in the cluster, and other objects, is maximal: **maximally the same within, maximally different between clusters**.

b. Evidence:

All the following measures correlate:

(1) the point when there is the largest jump in feature information (when you ask subjects to list features true of that level of categorization)

(2) the highest level in the hierarchy at which overlap of visual outline permits recognition

(3) motions used in interacting with object are fairly consistent for all objects at that level

The convergence of all these measures on a single level supports the basic claims of the theory that as you go down the hierarchy, you reach a point where the number of features common to the category jumps, with little additional gain at still lower levels.

IF THERE IS A BASIC LEVEL, WHAT ARE ITS IMPLICATIONS FOR PROCESSING? Does the evidence support the predicted implications?

The basic level is used preferentially in categorizing:

1. Naming: Adults name most objects at the basic level.

2. First level perceived: it's the level used in initially recognizing a pattern.

3. Develops first with age:

a. Three-year olds can categorize most accurately with basic level term.

b. Older children sort preferentially by basic level.

c. Child uses that word earliest.

4. Most important in language:

ASL has single signs for basic level, but for superordinates may just list several basic level objects.

Translations tend to exist for basic level names, more so than for other levels.

c. Basic level and typicality: Objects that are atypical of basic level objects tend to be named and identified at a subordinate level (Jolicoeur, Gluck & Kosslyn '84):

Reason:

d. Conclusions: Basic level

The concepts that we most readily use in thought are at some basic level.

Just culture-specific, or universal?

-Some of each.

-For biological and natural objects, shared "naive" level.