Lecture Notes

# Chapter 8: Knowledge Representation: Storing and Organizing Information in Long-Term Memory

## Learning Objectives

* Identify the types of information stored in permanent memory
* Describe the network theories of memory that help to organize knowledge
* Compare network and connectionist models of semantic memory
* Differentiate among the various views of concepts and categorization

## Outline

**I.** Setting the Stage

**A.** People store a vast range of information but can often access it successfully even years after storing it.

**1.** This raises the question of how stored information is organized in memory for later retrieval.

**2.** There are several ways that remembered information could be organized, much as there are several possible ways to organize your bookshelves.

**B.** In this chapter, we will also consider the topic of concepts and categories, which forms the building blocks for human thought and behavior.

**II.** Organizing Knowledge

**A.** Network models are built around the concept of cognitive economy; to conserve storage space, we avoid storing redundant information wherever possible.

**1.** Collins and Quillian provided support for a semantic network model organized as a hierarchy, with larger categories at the top of the hierarchy and smaller subcategories beneath them.

**a)** Facts or properties are stored with the highest appropriate node in the hierarchy.

**b)** Consistent with this model, people react more quickly to statements like “A canary is yellow” (a fact specific to canaries) than to “A canary breathes” (a fact that is relevant to all animals).

**2.** Meyer and Schvaneveldt elaborated this proposal, reasoning that whenever one node is activated, energy spreads to related nodes, leading to priming effects.

**3.** However, other researchers have provided evidence that contradicts the predictions of hierarchical network models.

**a)** The principle of cognitive economy is sometimes contradicted, such as when people respond equally quickly to “A shark can move,” “A fish can move,” and “An animal can move.”

**b)** Hierarchical structures are contradicted by evidence indicating that people can verify “A pig is an animal” faster than they can verify “A pig is a mammal.”

**c)** The **typicality effect** represents another problem for the hierarchical network model: People respond more quickly to “A robin is a bird” than to “A turkey is a bird,” even though these instances should both reside at the same hierarchical level under “bird.”

**4.** Collins and Loftus elaborated the original Collins and Quillian model in their *spreading activation theory.*

**a)** They conceived of semantic memory as a network of concepts, connected by paths.

**b)** As one concept node is activated, activation spreads to related concepts.

**c)** As activation spreads outward, it decreases in strength, activating closely related concepts a great deal but activating distantly related concepts only a little bit.

**d)** This model eliminates the concepts of cognitive economy and hierarchical organization.

**e)** It has been criticized, however, for being too broad; it is difficult to make clear and strong predictions from the model.

**B.** Another type of network model, t**he ACT (adaptive control of thought) model of memory**, was developed by John Anderson.

**1.** ACT models do not make a distinction between semantic and episodic memory, but they do distinguish three kinds of memory systems: working memory, declarative memory, and procedural memory.

**a)** Declarative memory stores information in networks that allow for activation of any node and spreading activation to connected nodes.

**b)** Procedural memory represents information in **production rules** that specify a *goal* to achieve, one or more *conditions* that must be true for the rule to apply, and one or more *actions* that result from applying the rule.

**2.** Anderson’s overall aim was to create a theory of *cognitive architecture,* a theory of how human cognition actually operates in practice.

**C.** Connectionist models see concepts not as nodes in a network, but rather as a set of units that are simultaneously activated.

**1.** Connectionist networks learn concepts through developing patterns of activation through many trials with training examples.

**2.** Connection weights between units are adjusted with each new trial, until the system arrives at a consistent, correct output.

**III.** Forming Concepts and Categorizing New Instances

**A.** A **concept**is a mental representation of an object, event, or pattern that includes much of the knowledge relevant to that object, event, or pattern; in contrast, a **category** is a class of similar things that share an essential core or some similarity in properties.

**1.** The **classical view of concepts** holds that all examples of a concept share fundamental characteristics that are individually necessary and collectively sufficient.

**a)** This view assumes that concepts mentally represent lists of features.

**b)** It also assumes that membership in a category is clear-cut.

**c)** Finally, it assumes that all members of a category are created equal.

**2.** Work by Eleanor Rosch and others, however, demonstrated that people judge different members of a category as varying in “goodness” as examples of that category.

**3.** Furthermore, evidence suggests that categories do not always have clearly defined boundaries, and that most people cannot generate lists of features that are necessary and sufficient to specify membership in a category.

**B.** The **prototype view of concepts** denies the existence of necessary-and-sufficient feature lists, instead regarding concepts as a different sort of abstraction.

**1.** This view holds that people store idealized representations of a category, including features that are *characteristic* (typical) of the category.

**2.** No individual feature need to be present in an instance for it to count as a member of the category, but the more characteristic features an instance has, the more likely it is to be regarded as a member of the category.

**3.** Each member of a category has a number of features, sharing different features with different other members of the category—a notion referred to as the **family resemblance structure of concepts.**

**a)** This idea helps to explain typicality effects.

**b)** The more characteristic features an instance of a concept has, the stronger the family resemblance between that instance and other instances and the more typical that instance is.

**4.** Rosch and colleagues also distinguished between several levels of categorization, in which one level (the **basic level of categorization**) appears psychologically fundamental.

**a)** The basic level is considered to be the best compromise between distinguishing accurately among objects and grouping together similar objects.

**b)** For example, “piano” and “guitar” are basic level categories; **superordinate levels of categories** (“musical instruments”) contain members that are dissimilar in several respects, while **subordinate level categories** (“grand piano,” “upright piano”) are less distinct.

**5.** However, the prototype view fails to capture all of people’s knowledge about conceptual boundaries and underestimates the importance of context in typicality ratings.

**C.** The **exemplar view of concepts** argues that concepts include representations of at least some actual individual instances, not just abstract averages or summaries.

**1.** People categorize new instances by comparing them to representations of previously stored information.

**2.** There are no necessary and defining features in this view.

**3.** People have difficulty categorizing atypical instances because they are similar to exemplars from different categories.

**4.** Like the prototype view, the exemplar view is criticized for being too unconstrained; it does not specify which instances are stored as exemplars and how exemplars are called to mind at the time of categorization.

**5.** However, evidence suggests that ordinary cognition often does involve **nonanalytic concept formation** (also called **implicit learning**) that requires paying attention to individual exemplars.

**6.** Brooks argues that we are likely to store information about individual exemplars under these circumstances:

**a)** We are likely to store such information when the task requires us to distinguish among individual instances.

**b)** We are likely to store such information when the same instance appears repeatedly.

**c)** We are likely to store information about exemplars when things vary in many complicated ways and the relevant dimensions are not obvious.

**d)** When instances may belong to a number of categories at the same time, we are more likely to store exemplar information.

**e)** In natural settings, we store exemplar information because we don’t know how we will be called upon to use the information later.

**D.** Another way we represent knowledge and concepts is through the use of a **schema** (a large unit of organized information used for representing concepts, situations, events and actions in memory).

**1.** Schema are packets of information that contains both variables and a fixed part.

**2.** Schemata can be connected to other schemata in a variety of ways.

**3.** A schema for routine events is called a **script.**

**4.** Schemas and scripts allow us to make inferences about omitted information in stories.

**5.** The “price” of using scripts, however, is that script-related information may intrude into our memory, such as in Bartlett’s “The War of the Ghosts” research.

**6.** The schemata/scripts approach, like the prototype and exemplar views, has been criticized for not being empirically testable.

**E.** The **knowledge-based view of concepts** holds that a person classifying objects and events doesn’t just compare features of those objects and events to features of mental representations; instead, the person uses his or her knowledge of how the concept is organized to justify classifications.

**1.** Context is critical to this view: “Things to save in a fire” only “go together” as a category when we know the context of a fire.

**2.** Medlin proposed a framework called **psychological essentialism** to explain people’s reliance on underlying nature as a basic for many concepts.

**a)** People act as if objects have certain essences that make them what they are.

**b)** That essence limits the kinds of variation that different instances of a category can show.

**c)** People’s knowledge of the essence of a category varies by expertise.

**3.** The way people represent concepts may also vary as a function of what the concepts are.

**a) Nominal-kind concepts** have clear definitions, such as “odd number” or “bachelor.”

**b) Natural-kind concepts** (such as “tiger”) are of things that occur naturally in some environment and may have more of a family resemblance structure.

**c) Artifact concepts** are constructed to accomplish some task and may be adequately described only within the knowledge-based approach.

**F.** Approaches to conceptual structure may themselves be categorized into two major types.

**1.** The classical, prototype, and exemplar views are *similarity*-*based*, focusing on the similarity of an instance to some abstract specification of the category.

**2.** The schemata/scripts view and the knowledge-based view are *explanation-based,* seeing people as making classifications based on meaningful relationships among instances and categories.