PSYC 332 COGNITIVE PSYCHOLOGY I

Session 9 – NATURE OF INFORMATION IN THE STORE

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Session Overview

- We are always aware of something and we can always retrieve information we have been privy to including objects and events. The problem we face now is how to determine the specific location of storage in the brain. We have made progress through the work of neuropsychologists and we look forward considerably to the future for more research evidence. In this section we turn our attention to look at what is in the storehouse without bothering to know the precise location.

Session Objectives

At the end of the session, the student will be able to

- Understand how memory is represented
- Explain our memory representation in terms of category, exemplar, and generalization
- Explain the classical view of identification
- Explain the typicality effects
- Explain category hierarchy, prototypes and exemplar models

Session Outline

The key topics to be covered in the session are as follows:

- Topic One: Representation in the store I
- Topic Two: Representation in the store II
- Topic Three: Organization of Memory I
- Topic Four: Organization of Memory II

Reading List

- Ashcraft, M. H. (2006). Cognition (4th edn.), London: Pearson Education Int.

- Galotti, K. M. (2004). *Cognitive Psychology: In and out of the laboratory* (3rd Edn.). Belmont, CA: Wadsworth.

- Hunt, R. R. & Ellis, H. C. (1999). *Fundamentals of Cognitive Psychology* (6th edn.), New York: McGraw-Hill.

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Topic One

REPRESENTATION IN THE STORE I

What is in the Store House?

- We now turn our attention to look at what is in the storehouse without bothering to know the precise location.

- ***What is in the storehouse?***
  - The provisional answer could be *"memory representations that allow us to identify objects with different properties as nevertheless belonging to the same class."*
  - We can all identify a cup whether it is small, large or whether it has a handle.
  - Again on the street you see a strange dog and you call it "doggie" rather than a goat, a fox or a cat. How do you retrieve this strange dog from your storehouse?

What is in the Store House?

- The answer is that you are able to identify the class or category to which an object belongs, even if you have never seen that particular example of the object before.

- A **category** is a group of objects that have something in common. In our example, *dog* is a category.

- An **exemplar** is an instance of a category. A particular dog that you see is an exemplar of the category dog.

What is in the Store House?

- You are able to identify the novel, never-met-before dog on the street because your experience with other dogs transfers to new dogs; this is the ability to **generalize**.

- To **generalize** refers to application of information gathered from one exemplar to a different exemplar of the same category.

- The importance of our ability to generalize cannot be overestimated.

What is in the Store House?

- Our mental life would be chaotic because you would approach any object you had not interacted with as though it were completely novel.

- Think for a moment the results if a physician showed a similar reluctance to generalize from patients seen before to new patients. He would continue with the cycle of examining patients without any precedence.

- **Concepts** are therefore the mental representations that allow one to generalize.

- ***So what is a concept and how does it allow one to generalize?***

The Classical View

- A number of different views on concept.

- **The Classical View**
  - The problem of identifying an object as a dog may not sound difficult. If the object has four legs and a tail and it is furry, it is a dog. That is very much the **classical view of categorization**; it was so named because it was first articulated by Aristotle.

- According to the classical view, a **concept** is a list of necessary and sufficient conditions for membership in the concept. Remember a concept is the mental representation of *dog* or *cake* or any class of objects.

The Classical View

- The classical view is that you have a list of attributes or features, an object must have all the attributes on the list, and having those attributes is sufficient to be an example of the concept.

- For example, the concept grandmother consist of two conditions:

  - female and
  - parent of a parent.

- The two conditions are necessary to be identified as a grandmother – you must have both of them to be a grandmother – and they are sufficient. That is it does not matter what other characteristics you have or do not have, you are still a grandmother if you have those two.

The Classical View

- The classical view seems efficient because the representation of concepts takes up so little room in memory.

- This shows that we can have a **mental representation** from which we can **generalize**. Based on this, we should be able to recognize a novel grandmother when we see one, and the classical view says that any grandmother, whatever her characteristics, can be identified as a grandmother using only this list of properties.

Criticisms of the Classical View

- The classical view works pretty well for a few real-world concepts (e.g., kinship terms such as grandmother or sister) and terms that have been formally defined (legal terms such as murderer and mathematical terms such as rectangle).

- There are many terms for which a list of necessary and sufficient conditions seems difficult to generate. For example, the concept *game*, what makes something a game?

- You may say something like contest, but children's games are not competitive. This suggests that we are somehow poor at coming with list of necessary and sufficient properties.

Criticisms of the Classical View

- Even though there seem to be a weakness, the mind nonetheless uses mental representation for concepts. (The fact that you cannot describe something does not mean that your mind does not use it. You certainly cannot describe all the rules of English grammar, but your mind nevertheless uses these rules when you construct English sentences).

Topic Two

REPRESENTATION IN THE STORE II

Typicality Effects

- **Typicality Effects**
  - The inability of the classical view to account for a wide variety of issues in terms of their representation calls for a more critical look at other ways through which information is represented in our minds.
- Let us consider how we classify things based on how **typical** they are to the real concept object.

Typicality Effects

- In fact, for humans, our ratings of events around us conform to typicality effects. Consider the following typicality rating of birds. How would you rate the following birds from 1 to 6?
  - Wren
  - Chicken
  - Robin
  - Bat
  - Ostrich
  - Eagle

Typicality Effects

- Experiment by Eleanor Rosch (1973) showed that subjects are likely to rate them in this order:
  - Robin
  - Eagle
  - Wren
  - Chicken
  - Ostrich
  - Bat

Typicality Effects

- What does this mean for us? It means the classical view is inadequate. If it were right, you would simply have a list of necessary and sufficient conditions.

- There would not be ***gradations*** of membership in the concept. If the classical view were correct, you would say a penguin and a robin are equally good examples of the concept *bird*.

Category Hierarchy

- Category Hierarchy
  - Category reflects a group of objects that have something in common. An interesting aspect of category is that it is possible to have one category nested in another category.
  - Consider a wren (a type of songbird), it is a bird but it is also an animal, because the category bird is nested in the category animal, which in turn is nested in the category living things.
- What does this mean for cognition?

Category Hierarchy

- The structure of *category* as suggested by Eleanor Rosch and her colleagues (1976).

- We have three types of categories – **Basic level category**, **Superordinate level category** and **Subordinate level category**.

- **Basic level categories** are those that are most inclusive, but members still share most of their features. For example, category *bird* has members that for most part share the attributes “winged,” “lays eggs,” “sings,” and so on.

- A **superordinate level category** is one level more abstract than the basic level. For example, the members of the category *animal* do not all share features: Some are winged, some are not; some have tails, some do not; some are warm blooded, some are not.

Category Hierarchy

- **Subordinate level categories** are less abstract than basic level categories. For example, the members of the category wrens are all very similar; only a few features differentiate a house wren from a marsh wren. But members outside the category *wren* also share many features with members of the category. In other words, there are objects outside the category *wren* that share many features with wrens; they are winged, egg laying and so on.

- These analyses show that categories are not represented as lists of necessary and sufficient features as the classical model maintains but these effects alone do not tell us how categories are represented in memory.
- We can now consider categories as ***probabilities*.**

Category Hierarchy

- In other words, the mind's representation of a concept is not set in black and white judgment about category membership. An object is seen as ***more*** or ***less*** likely to be a member of a category. A key assumption here is that there is no feature or group of features that are essential for category membership. Rather, each member of the category will have some but not all of the features.

- A bird might have the features "sings" and "eats insects" but it does not have the feature "lives in trees." There are two versions of the **probabilistic view** of categories: **prototype** theories and **exemplar** theories.

Category Hierarchy

Note.

- A key assumption here is that there is no feature or group of features that are essential for category membership. Rather, each member of the category will have some but not all of the features. A bird might have the features “sings” and “eats insects” but it does not have the feature “lives in trees.”

- There are two versions of the **probabilistic view** of categories: ***prototype theories*** and ***exemplar theories***.

Probabilistic View

- ***Prototypes***
  - A prototype has all of the features that are characteristic of the category. People abstract the central features of examples and store the prototype. What is not clear is how it is formed or what it includes.
- ***Exemplar Models***
  - The prototype model assumes that as you see each example of a category, you use that example to update your prototype and then toss out the example, as shown in Figure 9.1.

Category Hierarchy

- The **exemplar model** maintains that all exemplars are stored in memory and categorization judgments are made by judging the similarity of the new exemplar to all the old exemplars of a category.

- Notice that the prototype and exemplar models have something in common and that is **similarity**.

- Nonetheless, the models are very different in terms of what they propose is stored in memory. The **exemplar model** holds that multiple exemplars of a category are stored in memory. The **prototype model** holds that only the prototype is stored.

Example of Prototype Model

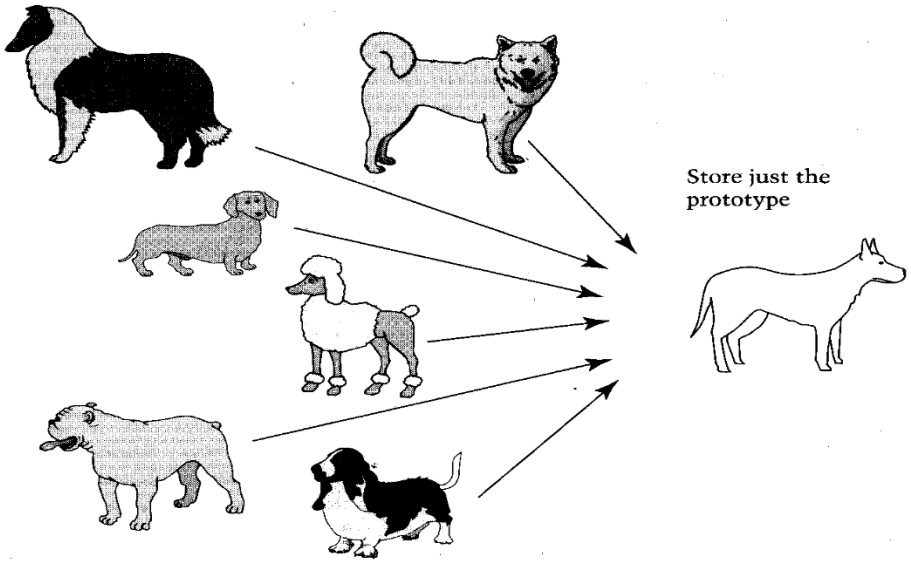

Figure 9.1. Schematic presentation of the prototype model. Although many type of exemplars are seen, only the prototype is stored. The prototype is updated continually as one has more experience with new exemplars (From Willingham, 2001).

Problem with Similarity Models

- **Problems with Similarity Models**
- More research evidence accumulated in the late 1980s suggesting that there is more to categorization than similarity. Similarity is judged by the number of features two objects share. But it is possible to select features to make two things look alike.

- Researchers point out that the similarity of two objects appears to depend on the context in which they appear.

Summary

- Context sets the stage for perceptual processes and it could have important influence on what information we store.

- **Summary**

  - The classical view of categorization was that categories were defined by a set of necessary and sufficient rules.

  - It became clear that category structure is not all-or-none, as the classical view would suggest, but rather has a graded structure; some exemplars of a category are considered more typical or better examples of the category than others are.

Summary

- This finding and others led to probability models of categorization, in which categorization is viewed as a matter of probability, not all-or-none.

- Two types of probability models were developed: **prototype** models (in which exemplars are abstracted into a prototype which are stored) and **exemplar** models (in which all the exemplars are stored).

- In the late 1980s new results indicated that similarity could not account for all categorization. It seemed that rules are used to categorize at least some of the time. **The latest work in this area has been directed toward determining when similarity is used and when rules are used.**

Topic Three

ORGANIZATION OF MEMORY I

Organization of Memory

- Remember that memory represents a highly and orderly register of past events. You can liken it to a registry assistant who is well organized in her duties. Files are properly labelled and indexed and that makes retrieval time very short.

- Organization is crucial because it is organization that helps you retrieve the right memory out of the storehouse.

- If the targeted information is not in memory, the system provides something close in meaning, or it provides material that may help you come to a reasonable guess about the information you wish you had.

Organization of Memory

- One early theory of memory organization, the **hierarchical model**, suggested that concepts were organized in a taxonomic hierarchy (e.g., *animal* above *bird, bird* above *canary*).

- Later models used an idea called **spreading activation**, where thinking about one concept would bring semantically related concepts to mind, *for example, thinking about the concept doctor makes it a little more likely that you will think of the related concept patient.*

Hierarchical Theory

Hierarchical Theory

- One of the early models to address the question of brain organization came from Allan Collins and Ross Quillian (1969, 1972).

- They proposed a clever solution called the **hierarchical theory**. In their model and other related ones, memory is composed of two basic elements: **nodes** and **links**.

- **Nodes** represent concepts such as *red, candy, bird, president*, and so on. Nodes have levels of activation. Activation in this context means that the node has some level of energy or excitement.

Hierarchical Theory

- In practical terms, nodes become active when the concept they represent is present in the environment. Thus, the concept *bird* might become active through my seeing a picture of a bird, seeing a real bird or hearing or reading the word *bird* and so on.

- The second component of hierarchical network is links. **Links** represent relationships between concepts such as “has this property” or “is an example of”. The links connect nodes and can provide property descriptions of concepts.

- Thus, the idea that a living thing must breathe is represented in the model through a concept (living thing), a property (breathe) and a link (must). An example of a simple hierarchical memory structure is shown in Figure 9.2.

Example of Hierarchical Model

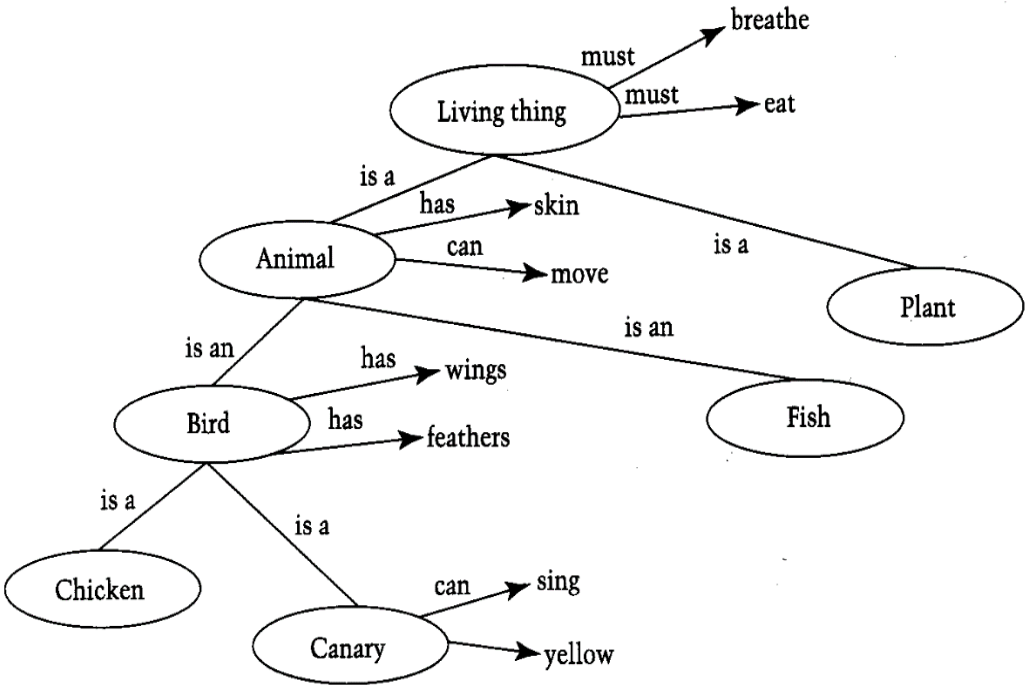

Fig. 9.2. An example, of a hierarchical network described by Collins and Quillian (1972) representing animal, canary and chicken among other concepts. There are also links such as “is a” and “has.”

- One problem of the model is that the hierarchy sometimes did not seem to hold. For example, people were faster to verify the sentence *"A chicken is an animal"* than to verify *"a chicken is a bird."*

- Another problem was that participants were faster to verify a sentence such as "A canary is a bird" than they were to verify "A chicken is a bird" (Rips, Shoben & Smith, 1973)

Topic Three

ORGANIZATION OF MEMORY II

Theories of Activation

- **Spreading Activation Theories**
  - Collins and his colleagues developed a different approach to address the shortcomings of his earlier model. Allan Collins and Elizabeth Loftus (1975) proposed a spreading activation model. This is another network model, again consisting of nodes and links.

  - The new feature of the model is that the links represent associations between concepts. Concepts are linked to (i.e., associated with) semantically related concepts. Memory is thus conceived as a vast network of linked concepts called a **semantic network.**

Theories of Activation

- What is new in this model is that active nodes send some of their activity to nodes to which they are linked. Hence, nodes can also become active by receiving activity from other nodes that have become active.

- The nodes send a high proportion of their activation to concepts they are closely related to and a smaller proportion to concepts they are not so related to. *President Akufo Addo* might send a lot of activation to *Flagstaff house* but less to *Parliament house*.

Characteristic of Semantic Network

- We can define six properties of a semantic network (Rumelhart, Hinton & McClelland, 1986).
  - ***A set of units***. Each unit represents a concept.
  - ***A state of activation***. Each unit has its own state of activation or how much "energy" it has a given moment.
  - ***An output function***. Units pass activation to one another. How much of a unit's activation it passes to its neighbours

Characteristic of Semantic Network

- ***A pattern of connectivity.*** Units are connected to one another by links and each link has a weight associated with it. The knowledge of the system is in these weights. The extent to which you know that birds fly depends on the strength of the link between *bird* and *flies*.

- ***An activation rule.*** This is a rule by which a unit integrates the activation sent to it by other units via links. If you hear "amber colour, foamy, cold," these words are closely associated with the concept *beer*.

Characteristic of Semantic Network

- ***Learning rule to change weights.*** A semantic network cannot be static. The knowledge of the network is in weights, so there must be a mechanism to change the weights if the model is to learn.

Criticisms of Spread of Activation

- The spread of activation idea is quite popular in cognitive psychology and the use of spreading activation is widespread in models of memory. Nevertheless, there are some problems with the concept of spreading activation.
  - The first problem has to do with the concept of spreading activation, which is somewhat vague.
  - The second problem concerns just how far activation spreads.

Sample Questions

- Examine the various theories of how memory is organized.
- Describe the classical view of categorization.
- What are the two main types of categorization that rely on similarity and what is the key difference between them?

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