CHAPTER

Recognition is Easy; Recall is Hard

9

Chapter 7 described the strengths and limitations of long-term memory and their implications for the design of interactive systems. This chapter extends that discussion by describing important differences between two functions of long-term memory: recognition and recall.

RECOGNITION IS EASY

The human brain was "designed," through millions of years of natural selection and evolution, to recognize things quickly. By contrast, recalling memories—that is, retrieving them without perceptual support—must not have been as crucial for survival, because our brains are much worse at that.

Remember how our long-term memory works (see Chapter 7): Perceptions enter through our sensory systems, and their signals, when they reach the brain, cause complex patterns of neural activity. The neural pattern resulting from a perception is determined not only by the features of the perception but also by the context in which it occurs. Similar perceptions in similar contexts cause similar patterns of neural activity. Repeated activation of a particular neural pattern makes that pattern easier to reactivate in the future. Over time, connections between neural patterns develop in such a way that activating one pattern activates the other. Roughly speaking, each pattern of neural activity constitutes a different memory.

Patterns of neural activity, which is what memories are, can be activated in two different ways:

1. By more perceptions coming in from the senses
2. By other brain activity

If a perception comes in that is similar to an earlier one and the context is close enough, it easily stimulates a similar pattern of neural activity, resulting in a sense of

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recognition. Recognition is essentially perception and long-term memory working in concert.

As a result, we assess situations very quickly. Our distant ancestors on the East African savannah had only a second or two to decide whether an animal emerging from the tall grasses was something they would regard as food or something that would regard *them* as food (see Fig. 9.1). Their survival depended on it.

Similarly, people recognize human faces very quickly—usually in a fraction of a second (see Fig. 9.2). Until recently, the workings of this process were a mystery. However,

FIGURE 9.1

Early humans had to recognize quickly whether animals they saw were prey or predators.

FIGURE 9.2

How long did it take you to recognize these faces?[1]

[1] U.S. Presidents Barack Obama and Bill Clinton.

that was when scientists assumed recognition was a process in which perceived faces were stored in separate short-term memory and compared with those in long-term memory. Because of the speed with which the brain recognizes faces, cognitive scientists assumed that the brain must search many parts of long-term memory simultaneously via what computer scientists call *parallel processing*. However, even a massively parallel search process could not account for the astounding rapidity of facial recognition.

Nowadays, perception and long-term memory are considered closely linked, which demystifies the speed of facial recognition somewhat. A perceived face stimulates activity in millions of neurons in distinct patterns. Individual neurons and groups of neurons that make up the pattern respond to specific features of the face and the context in which the face is perceived. Different faces stimulate different patterns of neural response. If a face was perceived previously, its corresponding neural pattern will already have been activated. The same face perceived again reactivates the same pattern of neural activity, only more easily than before. That *is* the recognition. There is no need to search long-term memory—the new perception reactivates the same pattern of neural activity, more or less, as the previous one. Reactivation of a pattern *is* the reactivation of the corresponding long-term memory.

In computer jargon, we could say that the information in human long-term memory is *addressed by its content*, but the word "addressed" wrongly suggests that each memory is located at a specific spot in the brain. In fact, each memory corresponds to a pattern of neural activity extending over a wide area of the brain.

That explains why, when presented with faces we have not seen before and asked if they are familiar, we don't spend a long time searching through our memories to try to see if that face is stored in there somewhere (see Fig. 9.3). There is no search.

FIGURE 9.3

How long did it take you to realize that you do not recognize this face?[2]

[2]Average male face (FaceResearch.org).

FIGURE 9.4

We can recognize complex patterns quickly.

A new face stimulates a pattern of neural activity that has not been activated before, so no sense of recognition results. Of course, a new face may be so similar to a face we have seen that it triggers a *misrecognition*, or it may be just similar enough that the neural pattern it activates triggers a familiar pattern, causing a feeling that the new face reminds us of someone we know.

An interesting aside is that face recognition is a special type of recognition. It has its own dedicated mechanisms in our brains, hardwired in by evolution; we do not have to learn to recognize human faces (Eagleman, 2012, 2015).

Similar mechanisms make our visual system fast at recognizing complex patterns, although unlike face recognition, they develop largely through experience rather than being wired in from birth. Anyone with at least a high school education quickly and easily recognizes a map of Europe and a chessboard (see Fig. 9.4). Chess masters who have studied chess history may even recognize the chess position as Kasparov versus Karpov, 1986.

RECALL IS HARD

In contrast, *recall* is long-term memory reactivating old neural patterns without immediate similar perceptual input. That is much harder than reactivating a neural pattern with the same or similar perceptions. People *can* recall memories, so it obviously *is* possible for activity in other neural patterns or input from other areas of the brain to reactivate a pattern of neural activity corresponding to a memory. However, the coordination and timing required to recall a memory increase the likelihood that the wrong pattern or only a subset of the right pattern will be activated, resulting in a failure to recall.

Whatever the evolutionary reasons, our brain did not evolve to recall facts. Many schoolchildren dislike history class because it demands that they remember facts, such as the year the English Magna Carta was signed, the capital city of Argentina, and the names of all 50 US states. Their dislike is not surprising; the human brain is not well suited for that sort of task.

Because people are bad at recall, they develop methods and technologies to help them remember facts and procedures (see Chapter 7). Orators in ancient Greece used the *method of loci* to memorize the main points of long speeches. They imagined a large building or plaza and mentally placed their talking points in spots around it. When presenting the speech, they mentally "walked" through the site, picking up their talking points as they passed.

Today we rely more on external recall aids than on internal methods. Modern-day speakers remember their talking points by writing them down on paper or displaying them in overhead slides or presentation software. Businesses keep track of how much money they have, owe, or are owed by keeping account books. To remember contact information of friends and relatives, we use address books. To remember appointments, birthdays, anniversaries, and other events, we use calendars and alarm clocks. Electronic calendars are best for remembering appointments, because they actively remind us; we don't have to remember to look at them.

RECOGNITION VERSUS RECALL: IMPLICATIONS FOR USER-INTERFACE DESIGN

The relative ease with which we recognize things rather than recall them is the basis of the graphical user interface (GUI) (Johnson et al., 1989). The GUI is based on two well-known user-interface design rules:

- ***See and choose—or hear and choose—is easier than recall and type***. Show or tell users their options and let them choose rather than force them to recall the options and tell the computer what they want. This rule is the reason GUIs have almost replaced command-line user interfaces (CLIs) in personal computers (see Fig. 9.5), and CLIs are absent in tablets and smartphones. "Recognition rather than recall" is one of Nielsen and Molich's (1990) widely used heuristics for evaluating user interfaces. By contrast, using language to control a software application sometimes allows more expressiveness and efficiency than a GUI would. Thus, *recall and type* remains a useful approach, especially in cases where users can easily recall what to type, such as when entering target keywords into a search box.
- ***Use pictures where possible to convey function***. People recognize pictures very quickly, which also stimulates the recall of associated information. For this reason, today's user interfaces often convey function through pictures (see Figs. 9.6 and 9.7), such as desktop or toolbar icons, error symbols, and graphically

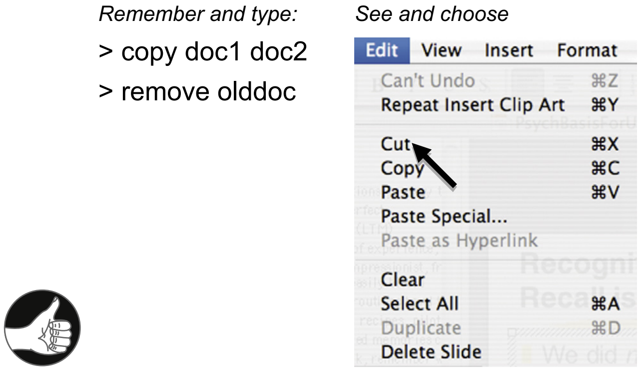

FIGURE 9.5

The main design rule behind GUIs: "See and choose is easier than remember and type."

FIGURE 9.6

Wordpress.com uses symbols plus text to label functional pages on the dashboard.

> depicted choices. Pictures that people recognize from the physical world are useful because they can be recognized without needing to be taught. This recognition is good as long as the familiar meaning matches the intended meaning in the computer system (Johnson, 1987). However, using familiar pictures from the physical world is not absolutely crucial. Computer users can learn to associate new icons and symbols with their intended meaning if these graphics are well designed. Memorable icons and symbols hint at their meaning, are distinguishable from others, and are used consistently to mean the same thing even across applications.

The GUI originated in the mid-1970s and became widespread in the 1980s and 1990s. Since then, additional design rules have arisen based on human perception in general and on recognition and recall in particular. The following sections outline a few of these newer rules.

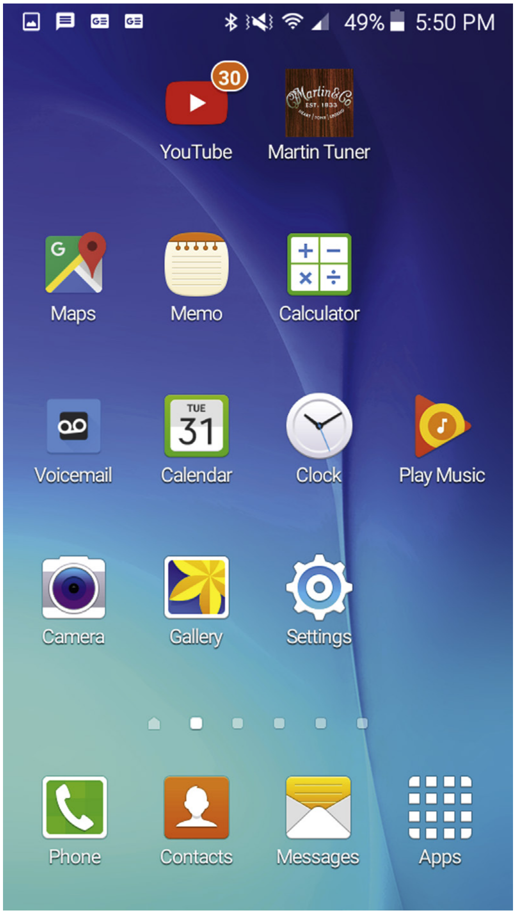

FIGURE 9.7

Desktop icons convey function via recognition—by analogy with physical objects or by experience.

Use thumbnail images to depict full-sized images compactly

Recognition is fairly insensitive to the size at which objects and events are displayed. After all, we are able to recognize objects regardless of their distance from us. What is important are features: as long as most of the same features are present in the new picture that were in the original one, the new perception stimulates the same neural pattern, resulting in recognition.

Therefore, a great way to display pictures people have already seen is to present them as thumbnail images. The more familiar a picture, the smaller the thumbnails of it can be and still be recognizable. Displaying thumbnails instead of full-sized images allows people to see more of their options, data, history, etc. at once.

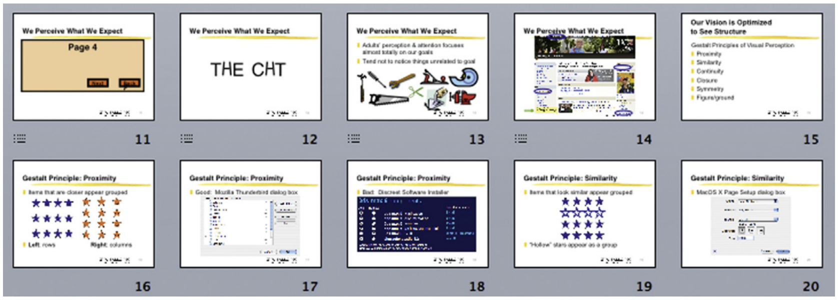

FIGURE 9.8

Microsoft PowerPoint can show slides as thumbnails, providing an overview based on recognition.

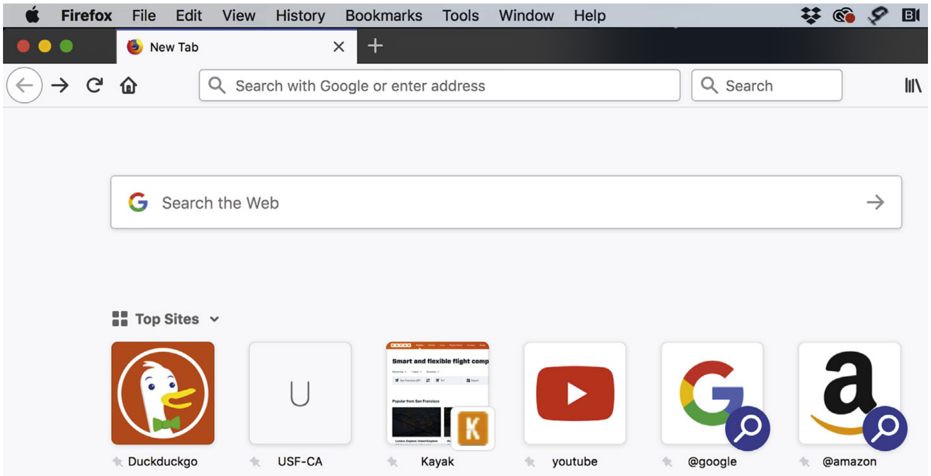

FIGURE 9.9

The Mozilla Firefox Web browser lists logos of frequently visited sites for quick recognition and choice.

Photo management and presentation applications use thumbnail images to give users an overview of their images or slides (see Fig. 9.8). Web browsers use website logos to show sites a user has frequently visited (see Fig. 9.9).

The larger the number of people who will use a function, the more visible the function should be

For the reasons described before, recall often fails. If a software application hides its functionality and requires its users to recall what to do, some percentage of users will fail at doing so. If the software has many users, that percentage who fail to recall—even if it is small—adds up to a significant number. Software designers obviously don't want a significant number of users to fail in using their product.

The solution is to make the functions that many people need highly visible so users see and *recognize* their options rather than having to *recall* them. By contrast, functionality that few people will use—especially when those few people are highly trained—can be hidden, for example, behind "Details" panels, in right-click menus, or via special key combinations.

Provide cues to let users recognize where they are

Visual recognition is fast and reliable, so designers can use visual cues to show users instantly where they are. For example, it is a well-known Web design rule that all pages in a website should have a common distinctive visual style so people can easily tell whether they are still on the site or have gone to a different one. Slight but systematic variations of a site's visual style can show users which section of the site they are in.

Some desktop operating systems allow users to set up multiple desktops ("rooms" or "workspaces") as locations for different categories of work. Each has its own background graphic to help users recognize where they are.

Avoid changing prominent visual cues on a given page needlessly—it can disorient users

Since visual cues help indicate where users are in an information space, *extraneous* changes of visual cues can mislead users into thinking they have moved to a new screen or page. If a prominent image or color on an app screen or Web page changes without warning, some users, especially older adults, may mistakenly believe they are on a different page (Finn and Johnson, 2013; Johnson and Finn, 2017) (see Fig. 9.10).

FIGURE 9.10

GrandCircleTravel.com's homepage has large images that change automatically, causing some visitors—especially older adults—to think they are on a different page.

Make authentication information easy to recall

People know it is hard to recall arbitrary facts, words, and sequences of letters or digits. That is why they often write passwords and challenge-question answers down and keep the information in places that are easy to reach and thus insecure. Or they base passwords on their children's initials, their birthdates, their street address, and other information they know they can recall. Unfortunately, such passwords are often too easy for other people to guess (Schrage, 2005). How can designers help users avoid such unsafe behavior?

We can at least not make it hard for people to recall their login information, like the systems cited in Chapter 7 that impose burdensome password restrictions or offer a limited choice of challenge questions.

Instead, we can give users the freedom to create passwords they can remember and challenge questions for which they can remember the correct response. We can also let users supply password *hints* that the system can present to them, under the assumption that users can devise hints that will serve as a recall probe for them but not identify the password to third parties.

Authentication methods that do not rely on users to recall the authentication data would seem to be a solution. Biometric authentication methods, such as iris scans, digital fingerprint scans, and voice identification, fall into this category. However, many people regard these methods as privacy threats because they require the collection and storage of individuals' biometric data, creating the potential for information leaks and abuse. Therefore, while biometric authentication does not burden a user's memory, it would have to be implemented in a way that meets stringent privacy requirements to be widely accepted.

IMPORTANT TAKEAWAYS

- The human brain is basically a recognition engine. Similar perceptions in similar contexts activate similar patterns of neural activity. That is recognition. It occurs very quickly, without what computer scientists would regard as searching. Recognition—or nonrecognition—of human faces is especially fast.

- Recall requires reactivating a neural pattern when the original stimulus is absent. The stimulus comes from within the brain—from other neural activity. The brain is not as good at recall as at recognition. Therefore, people throughout history have invented methods and tools to help them recall information, such as writing, books, printing, calendars, grocery lists, alarm clocks, computers, smartphones, and slide presentations.

- Recognition versus recall—implications for UI design:
  - See and choose—or hear and choose—is easier than recall and type. Design to let people perceive their options rather than requiring users to recall their options.
  - Use pictures where possible to convey function: desktop icons, toolbar symbols, error symbols, etc.
  - Use thumbnail images to depict full-size images compactly. Once someone has seen a full-sized picture, thumbnail images are usually enough to spark recognition. Using small thumbnails let people see more of their data at once.
  - The larger the number of people who will use a function, the more visible it should be. If many people will use a function, it should be highly visible. If only a few highly trained people will use a function, it can be hidden, requiring extra steps to get to it.
  - Provide cues to let users recognize where they are. Avoid changing prominent visual cues on a page needlessly—it can disorient users.
  - Make authentication information easy to recall. Don't force users to devise passwords they cannot recall. Provide support for managing, recovering, and changing passwords. Transition to biometric authentication, but keep users' data secure.