Memory Recall

http://www.human-memory.net/processes_recall.html

Recall or **retrieval** of memory refers to the **subsequent re-accessing** of events or information from the past, **which have been previously encoded and stored in the brain**. In common parlance, it is known as **remembering**. During recall, the brain "replays" a pattern of neural activity that was originally generated in response to a particular event, echoing the brain's perception of the real event. In fact, there is **no real solid distinction between the act of remembering and the act of thinking.**

These **replays are not quite identical to the original, though** - otherwise we would not know the difference between the genuine experience and the memory - but are mixed with an **awareness** of the current situation. One corollary of this is that memories are not frozen in time, and new information and suggestions may become incorporated into old memories over time. Thus, remembering can be thought of as an act of **creative reimagination**.

Because of the way memories are encoded and stored, **memory recall is effectively an on-the-fly reconstruction** of elements scattered throughout various areas of our brains. Memories are **not stored in our brains like books on library shelves**, or even as a collection of self-contained recordings or pictures or video clips, but may be **better thought of as a kind of collage or a jigsaw puzzle, involving different elements stored in disparate parts of the brain linked together by associations and neural networks.** Memory retrieval therefore requires re-visiting the nerve pathways the brain formed when encoding the memory, and the strength of those pathways determines how quickly the memory can be recalled. Recall effectively returns a memory from long-term storage to short-term or working memory, where it can be accessed, in a kind of mirror image of the encoding process. It is then re-stored back in long-term memory, thus re-consolidating and strengthening it.

The efficiency of human memory recall is astounding. Most of what we remember is by **direct retrieval**, where items of information are linked directly a question or cue, rather than by the kind of **sequential scan** a computer might use (which would require a systematic search through the entire contents of memory until a match is found). Other memories are retrieved quickly and efficiently by **hierarchical inference**, where a specific question is linked to a class or subset of information about which certain facts are known. Also, the brain is usually able to determine in advance whether there is any point in searching memory for a particular fact (e.g. it instantly recognizes a question like “What is Socrates’ telephone number?” as absurd in that no search could ever produce an answer).

There are **two main methods** of accessing memory: recognition and recall. **Recognition** is the association of an event or physical object with one previously experienced or encountered, and involves a process of comparison of information with memory, e.g. recognizing a known face, true/false or multiple choice questions, etc. Recognition is a largely unconscious process, and the brain even has a dedicated **face-recognition area**, which passes information directly through the **limbic areas** to generate a sense of familiarity, before linking up with the **cortical path**, where data about the person's movements and intentions are processed. **Recall** involves remembering a fact, event or object that is not currently physically present (in the sense of retrieving a representation, mental image or concept), and requires the direct uncovering of information from memory, e.g. remembering the name of a recognized person, fill-in the blank questions, etc.

Recognition is usually considered to be “superior” to recall (in the sense of being more effective), in that it requires just a single process rather than two processes. Recognition requires only a simple **familiarity decision**, whereas a full recall of an item from memory requires a two-stage process (indeed, this is often referred to as the **two-stage theory** of memory) in which the search

and retrieval of **candidate items** from memory is followed by a familiarity decision where the correct information is chosen from the candidates retrieved. Thus, recall involves actively **reconstructing** the information and requires the activation of all the neurons involved in the memory in question, whereas recognition only requires a relatively simple decision as to whether one thing among others has been encountered before. Sometimes, however, even if a part of an object initially activates only a part of the **neural network** concerned, recognition may then suffice to activate the entire network.

In the 1980s, **Endel Tulving** proposed an alternative to the two-stage theory, which he called the **theory of encoding specificity**. This theory states that memory utilizes information both from the specific **memory trace** as well as from the **environment** in which it is retrieved. Because of its focus on the retrieval environment or state, encoding specificity takes into account **context cues**, and it also has some advantages over the two-stage theory as it accounts for the fact that, in practice, recognition is not actually always superior to recall. Typically, recall is better when the environments are similar in both the learning (encoding) and recall phases, suggesting that context cues are important. In the same way, **emotional material** is remembered more reliably in moods that **match** the emotional content of these memories (e.g. happy people will remember more happy than sad information, whereas sad people will better remember sad than happy information).

According to the **levels-of-processing effect** theory, another alternative theory of memory suggested by **Fergus Craik** and **Robert Lockhart**, memory recall of stimuli is also a function of the **depth** of mental processing, which is in turn determined by connections with pre-existing memory, time spent processing the stimulus, cognitive effort and sensory input mode. Thus, **shallow processing** (such as, typically, that based on sound or writing) leads to a relatively fragile memory trace that is susceptible to rapid decay, whereas **deep processing** (such as that based on semantics and meanings) results in a more durable memory trace. This theory suggests, then, that memory strength is continuously variable, as opposed to the earlier **Atkinson-Shiffrin**, or **multi-store**, memory model, which just involves a sequence of three discrete stages, from sensory to short-term to long-term memory.

The evidence suggests that memory retrieval is a more or less **automatic** process. Thus, although **distraction** or **divided attention** at the time of recall tends to **slow down** the retrieval process to some extent, it typically has little to no effect on the **accuracy** of retrieved memories. Distraction at the time of encoding, on the other hand, can severely impair subsequent retrieval success.

The efficiency of memory recall can be increased to some extent by making **inferences** from our personal stockpile of world knowledge, and by our use of **schema** (plural: **schemata**). A schema is an organized mental structure or framework of pre-conceived ideas about the world and how it works, which we can use to make realistic inferences and assumptions about how to interpret and process information. Thus, our everyday communication consists not just of words and their meanings, but also of what is left out and mutually understood (e.g. if someone says “it is 3 o’clock”, our knowledge of the world usually allows us to know automatically whether it is 3am or 3pm). Such schemata are also applied to recalled memories, so that we can often flesh out details of a memory from just a skeleton memory of a central event or object. However, the use of schemata may also lead to **memory errors** as assumed or expected associated events are added that did not actually occur.

There are three **main types of recall**:

- **Free recall** is the process in which a person is given a list of items to remember and then is asked to recall them in any order (hence the name “free”). This type of recall often displays evidence of either the **primacy effect** (when the person recalls items presented

at the beginning of the list earlier and more often) or the **recency effect** (when the person recalls items presented at the end of the list earlier and more often), and also of the **contiguity effect** (the marked tendency for items from neighbouring positions in the list to be recalled successively).

- **Cued recall** is the process in which a person is given a list of items to remember and is then tested with the use of cues or guides. When cues are provided to a person, they tend to remember items on the list that they did not originally recall without a cue, and which were thought to be lost to memory. This can also take the form of **stimulus-response recall**, as when words, pictures and numbers are presented together in a pair, and the resulting associations between the two items cues the recall of the second item in the pair.

- **Serial recall** refers to our ability to recall items or events in the order in which they occurred, whether chronological events in our autobiographical memories, or the order of the different parts of a sentence (or phonemes in a word) in order to make sense of them. Serial recall in long-term memory appears to differ from serial recall in short-term memory, in that a sequence in long-term memory is represented in memory as a whole, rather than as a series of discrete items. Testing of serial recall by psychologists have yielded several **general rules**:

    - more recent events are more easily remembered in order (especially with auditory stimuli);
    - recall decreases as the length of the list or sequence increases;
    - there is a tendency to remember the correct items, but in the wrong order;
    - where errors are made, there is a tendency to respond with an item that resembles the original item in some way (e.g. “dog” instead of “fog”, or perhaps an item physically close to the original item);
    - repetition errors do occur, but they are relatively rare;
    - if an item is recalled earlier in the list than it should be, the missed item tends to be inserted immediately after it;
    - if an item from a previous trial is recalled in a current trial, it is likely to be recalled at its position from the original trial.

If we assume that the "purpose" of human memory is to use past events to guide future actions, then keeping a perfect and complete record of every past event is not necessarily a useful or efficient way of achieving this. So, in most people, some specific memories may be given up or **converted into general knowledge** (i.e. converted from episodic to semantic memories) as part of the ongoing recall/re-consolidation process, so that that we are able to generalize from experience.

It is also possible that **false memories** (or at least wrongly interpreted memories) may be created during recall, and carried forward thereafter. Research into false memory creation is particularly associated with Elizabeth Loftus' work in the 1970s. Among many other experiments in this area (see the side panel on the Psychogenic Amnesia page, for example), she showed how the precise **wording of a question** about memories (e.g. "the car hit" or "the car smashed into") can dramatically influence the recall and re-creation of memories, and can even **permanently change** those memories for future recalls - a phenomenon which is not lost on the legal profession. It is thought that it may even be possible, up to a point, to **choose to forget**, by blocking out unwanted memories during recall, a process achieved by **frontal lobe** activity, which inhibits the laying down or re-consolidation of a memory.

However, there is a rare condition called **hyperthymesia** (also known as **hypermnesia** or **superior autobiographical memory**) in which a few people show an extraordinary capacity to recall detailed specific events from a person’s personal past, **without** relying on practised

mnemonic strategies. Although only a handful of cases of hyperthymesia have ever been definitively confirmed, some of these cases are quite startling, such as a California woman who could recall **every day** in complete detail from the age of 14 onwards, a young English girl with an IQ of 191 who had a perfect **photographic memory** spanning almost 18 years, and a Russian man known simply as **"S."** who was only able to forget anything by a deliberate **act of will**. One of the most famous cases, known as **"A.J."**, described it as a burden rather than a gift, but others seem to be able to organize and compartmentalize their prodigious memories and do not appear to feel that their brains are "cluttered" with excess information. There is a good "60 Minutes" documentary on the subject at http://www.cbsnews.com/video/watch/?id=7166313n. Interestingly, recent research has shown that such individuals tend to have significantly larger than average **temporal lobes** and **caudate nuclei**, and many exhibit mild Obsessive Compulsive Disorder-like behaviour (the caudate nucleus is also associated with OCD).

??? Did You Know ???

Memory recall appears to be **state-dependent**, at least to some extent. Studies have shown that, when material is learned under the influence of a **drug** or **alcohol**, for example, it is subsequently recalled better when in the same drug state than when sober.
Similarly, individuals tend to retrieve information more easily when it has the same **emotional content** as their current emotional state, and when the emotional state at the time of retrieval is similar to the emotional state at the time of encoding.

??? Did You Know ???

Several studies have shown that both episodic and semantic memories can be better recalled when the **same language** is used for both encoding and retrieval.
For example, **bilingual** Russian immigrants to the United States can recall more autobiographical details of their **early life** when the questions and cues are presented in Russian than when they are questioned in English.

??? Did You Know ???

Colour may have an effect on our ability to memorize something.
People remember colour scenes better than black-and-white ones, although only if **naturally** (as opposed to falsely) coloured. In particular, **warm colours**, like red, yellow and orange, may help us to memorize things by increasing our level of **attention** (our ability to select from information available in the environment). The more attention is focused on outside stimuli, the greater the likelihood of those stimuli being stored in long-term memory.

??? Did You Know ???

Several recent studies in the growing area of **neuro-education** have shown the value of the **"testing effect"** (or **"retrieval effect"**), where quizzes a short time after initial learning significantly improves subsequent retrieval of facts and ideas, as well as overall understanding of topics and the ability to solve related problems. Testing helps protect against **"proactive interference"** (the familiar feeling of being overwhelmed by too much information), and the studies suggest that a quick test is much more effective than en extra hour of study or re-reading.