

Memory

Introduction to Cognitive Science

What is Memory, and What is it for?

- Memory is the capacity to retain information (as picked up from the environment)
- Memory forms the basis for learning, reasoning, prediction, and decision making: it allows a cognitive agent to better deal with situations it finds itself in
- In other words, memory makes one an experienced agent allowing for higher chances of survival

Types of Memory

- **Sensory Memory (Sensory Buffer)**
 - Very short-term (on the order of tenths of seconds; a few seconds at best)
 - Unconscious
 - Modality-specific (i.e. specific to a sense (visual, auditory, etc))
 - Capacity determined by senses
- **Short-Term Memory**
 - Short-term (on the order of seconds to minutes to hours (without distraction))
 - Conscious (?)
 - Modality-specific (?)
 - Low capacity (~5-6 'items') (or more?)
- **Long-Term Memory**
 - Long-term (some memories last lifetime, i.e. basically indefinite)
 - Unconscious
 - Often less modality-specific (see next slides)
 - Large ('indefinite') capacity

Sensory Memory

- We seem to have a kind of buffer, specific to each of our senses, that is able to hold raw sensory data
- Iconic (Visual) Memory
 - Experiment by Sperling
 - Subjects shown 3 rows of 4 letters for short time (~100 msec)
 - In free recall, subjects remember about 4 out of 12 letters
 - Prompted to report any one specific row, subjects could report all 4 out of 4 letters
 - So, all information is there, but by the time information enters conscious recall, much information is lost.
- Echoic (Auditory) Memory
 - ‘Echo’ of what was said or heard
 - Phone number
 - Spelling

Short-Term Memory

- Typical short-term memory task in Cognitive Psychology: recall of word lists!
- Some experimental results:
 - Subjects can hold only about 5 or 6 words (or other ‘items’) in memory
 - ‘Chunking’ (combining multiple items into one item) can help
 - Items can be (are?) held in place through rehearsal (‘phonological loop’)
 - Distractions or other changes in attention or cognitive tasks quickly eliminates short term memory
 - Lists of items are better remembered through elaboration (e.g. imagine taking walk from dorm room to classroom, and associating landmarks along the way with items in list) -> mnemonics

Long-Term Memory

- Cognitive psychologists have proposed many different types of (or distinctions within) long-term memory
 - Episodic (specific) vs Semantic (abstract)
 - Declarative ('know-that') vs Procedural ('know-how')
 - Explicit (can be consciously recalled) vs Implicit (not)
- How distinct are these different types?
 - Is there a clear qualitative difference, e.g. are they represented differently, or in different places, in our brain?
 - Or are these differences more quantitative, i.e. is there some continuum along which these different types are located?

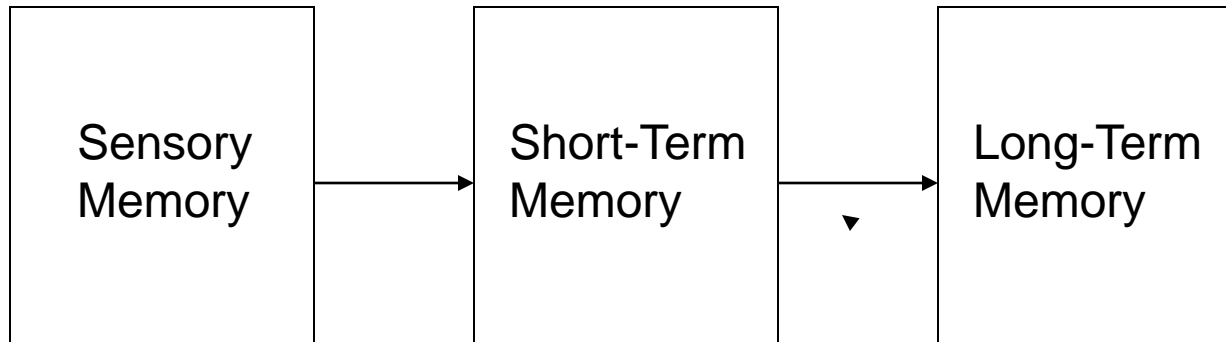
Short Term vs Long Term?

- In fact, some cognitive psychologists wonder whether there is even a clear distinction between short-term and long-term memory.
- Maybe there is really just one kind of memory, i.e. one kind of way in which memories are created and stored, and what we call 'short-term' and 'long-term' are just different ways in which memories behave themselves over time.

Evidence for more Fundamental Distinction

- Double Dissociation:
 - Cases of amnesia (short-term memory is fine, but doesn't make it to long-term memory)
 - Patients whose long-term memory is ok, but can't form short-term memories
- Drugs affecting short-term and long-term memory performance in clearly distinct ways
- Possible neurological distinctions
 - Neural activation (short-term) vs neural connections (long-term)
 - Hippocampus (short-term) vs neocortex (long-term)

Relationships Between Types of Memory: Early Model

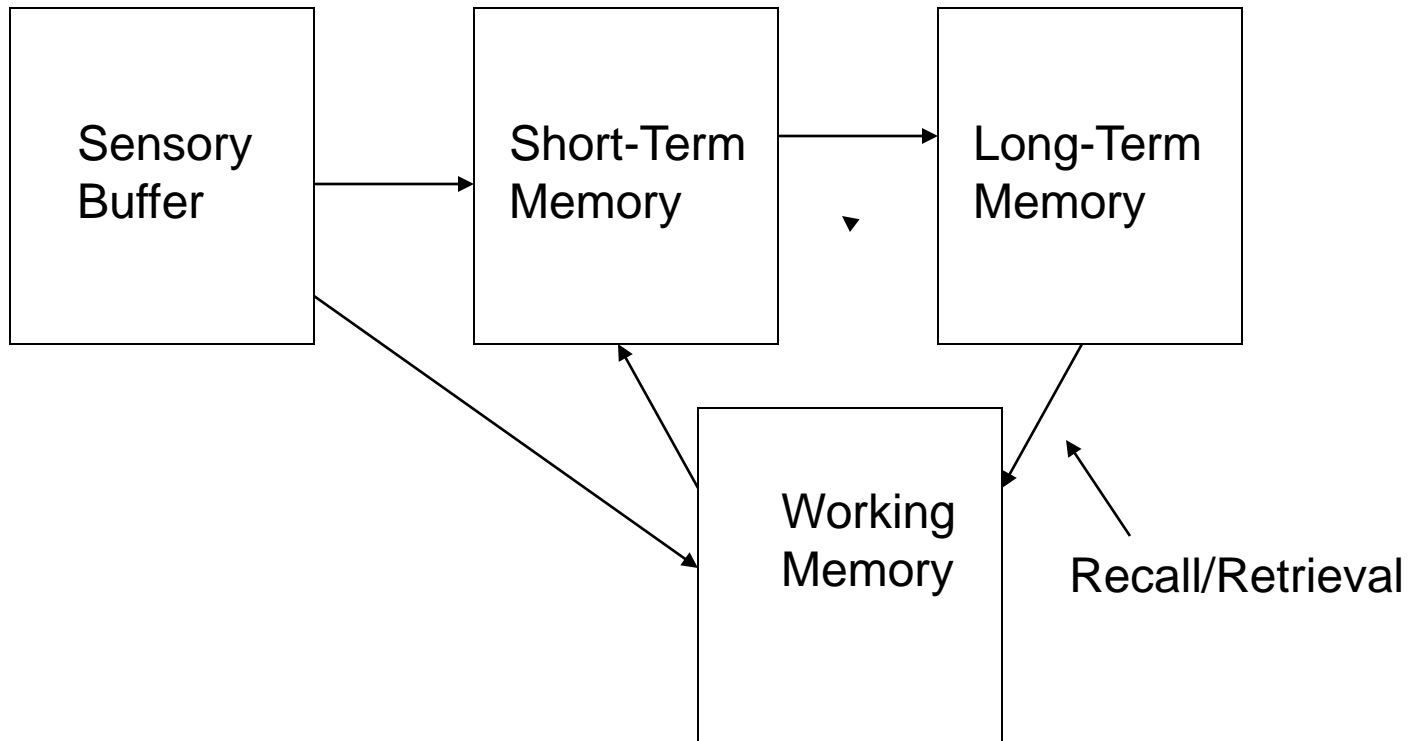


Attention?
Rehearsal?
Interference?

Working Memory

- Later models of memory added the notion of Working Memory
- ‘Working Memory’ can be seen as a workbench, useful for all kinds of cognition.
 - What would be placed on such a workbench would obviously be effected by attention and interference.
 - And, rehearsal would be a way of keeping the items on the workbench ... although a rather uninteresting cognitive activity
 - Indeed, reasoning, planning, etc. also make use of working memory, and are much more interesting

Relationships Between Types of Memory: Later Model



Computer Similarities

- Notice how the modern-day computers have very much this architecture
 - Sensory buffer (keyboard buffer, mouse buffer)
 - Working Memory (RAM)
 - Plain Memory (ROM)
- Indeed, much of the recent focus on working memory was probably inspired by the computer
- Another way to look at this:
 - Thinking about information-processors from a practical engineering point of view, we found it useful to have buffers, a workspace, and long term memory.
 - Therefore, is it all that surprising that Mother Nature came up with something similar?

Computer Dissimilarities

- Computer working memory seems much bigger than human's working memory
- Maybe working memory requires attention, and attention is (as we saw earlier) not very divisible, possibly due to human cognition being embodied and situated?
- Or is there much more going on than meets the (conscious) eye?

Short-term vs Working Memory

- And what happened to short-term memory?
 - Some researchers have suggested that working memory and short-term memory are the same, or at least that working memory uses short-term memory (working memory = short-term memory + attention?)
 - On the other hand, while many short-term experiments may turn out to be working memory experiments (e.g. the 5 or 6 item short-term memory capacity limit may well be a working memory (attentional?!) limit) there still seems to be a kind of memory that lasts many hours or even a day or two, (definitely longer than working memory) but shorter than long-term memory.

Memory and Sleep (and Dreams)?

- Maybe short-term memory is where we collect a day's events and, when we sleep (and dream!), we sift through this and assimilate some of it, and discard the rest.
- Lack of sleep certainly decreases memory performance (actually, it decreases pretty much *all* physical and mental performance!)

'Perfect' vs 'Imperfect' Memory

- Computer long-term memory is 'perfect'; human long-term memory is 'imperfect'
 - Barring unintended hardware and software problems, if we tell a computer to remember something, it will not only remember it, but it will do so completely accurately.
 - With the exception of a few people, humans both forget things, as well as misremember things
 - Memory is *selective*: Little of what we are consciously aware of ever make it to long-term memory
 - Memory is *leaky*: Much of what was once in memory fades away
 - *False memory*: Sometimes, what we remember didn't happen at all!
- But is there may a good reason for having such 'imperfect' memory?

Selective and Leaky Memory

- A possible good reason for memory being selective and leaky is that only certain things may be deemed important to remember as far as the agent's functioning and survival goes
 - Indeed, if everything was remembered, then maybe there is too much information to sift through in order to make quick decisions
- Experiment:
 - Subjects had to watch video.
 - Half had arms in freezing ice water while watching
 - Half had not
 - The first group had better recollection of video
 - Possible explanation: events were deemed more important, as situation was one subjects would like to avoid in future.
- Indeed, typical long-term memories are often 'unusual' or 'emotional' events: vacation trip, performance, fight, etc.

False Memories

- Famous experiment by Elizabeth Loftus
 - Subjects saw video of car accident
 - A week later, subjects were brought back
 - One half was asked: “How fast was the car going when it bumped into the other car?”
 - Other half: “How fast was the car going when it crashed into the other car?”
 - Second half estimated (remembered) speed higher than first half. They also recalled seeing glass laying on the road after accident, even though there was none
- Courts are relying less on eyewitness testimony!
- But what’s the point of having false memories?!

Memory is Constructive

- Rather than to look at memory as a place of storage, maybe it is more useful to think of memory as a process of reconstruction-when-useful-or-needed
 - Cues from the environment will trigger experiences from memory that agent will try and apply to current situation
 - Since no two situations are exactly alike, some amount of abstraction will have to take place in order for such a generalization to work
 - So, agents will try to ‘match’ their memory with current situation -> constructive memory (and, on the perception end: -> constructive perception)
 - Such a ‘matching’ process, while useful, may produce false memories however. So maybe false memories are the unfortunate side-effect of a useful process.