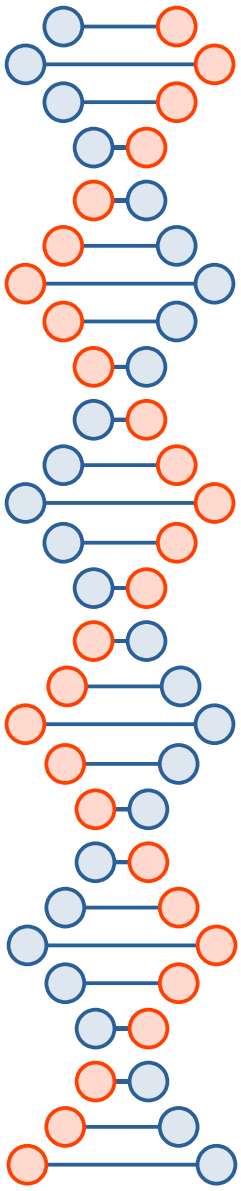
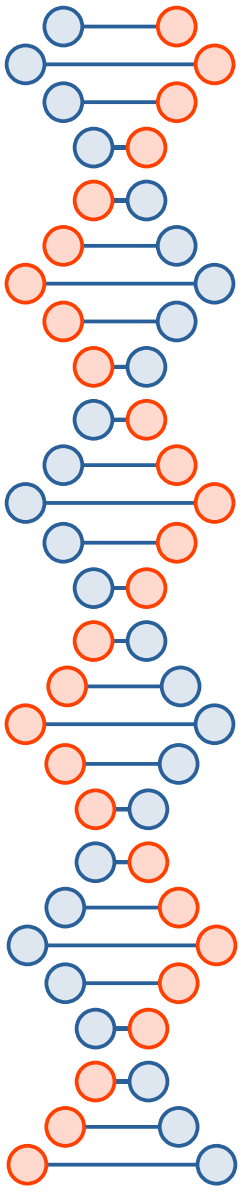


IST 605: Human Information Processing

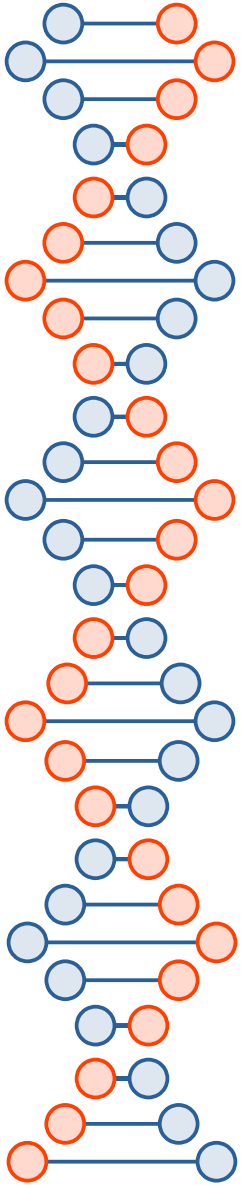
Memory: Remembering New Information

Denis L. Nkweteyim



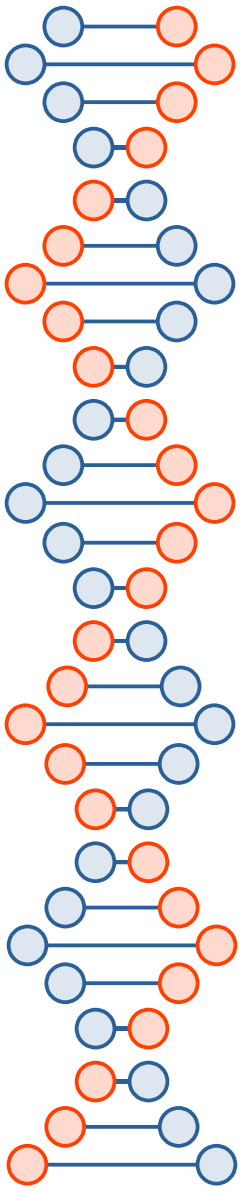
Outline

- Introduction
- Short-Term Memory
- Long-Term Memory



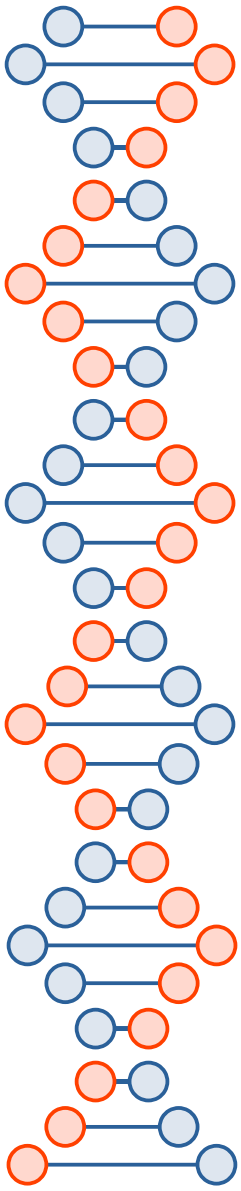
Introduction

- Uses of memory
- Processes of memory



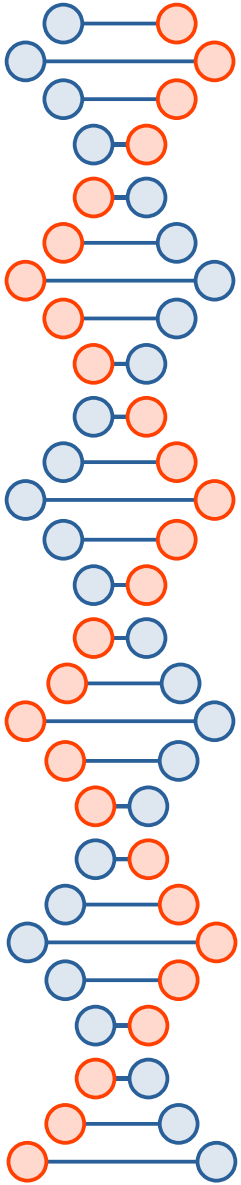
Uses of memory (1)

- Store and retrieve facts
  - What is the capital city of Cameroon?
- Sometimes, we do not retrieve facts, but rather relevant information that may allow us to answer the question
  - What is the telephone number of the President?
    - We do not need to search through all of our knowledge about the President to realize that we do not have this information
  - How many windows are there in your current residence?
    - Most people can answer this question correctly
    - But not by retrieving the answer directly from memory
    - Rather, they employ mental imagery, and imagine themselves walking through their residence, and counting the windows



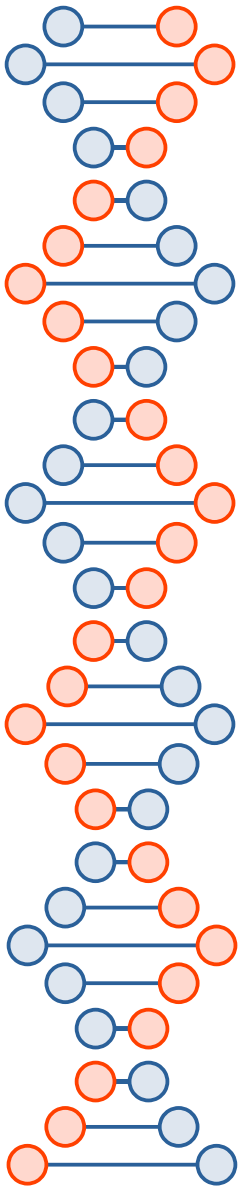
Uses of memory (2)

- Sometimes, we do not retrieve facts, but rather relevant information that may allow us to answer the question
  - Did Julius Caesar have toes? Do elephants eat more in a day than lions?
  - Both questions above can be readily answered
    - But not because the answer is retrieved from memory
    - Rather, the answers are inferred
      - Most people have toes, so it is plausible that Julius Caesar also had toes
      - Large animals tend to eat more than smaller ones, so elephants are likely to eat more than lions



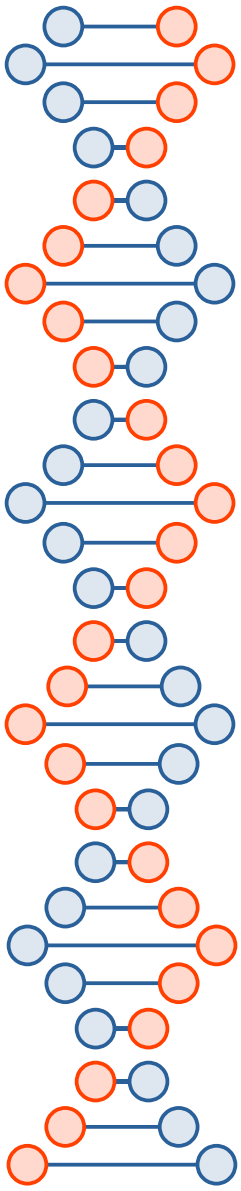
Uses of memory (3)

- Relate new events to prior knowledge in order to understand them (more on this later)
- Deliver relevant knowledge when it is needed
  - Even though we rely heavily on inference, we do have a huge amount of facts and other bits of information stored in memory
  - Just how do we access this knowledge is an important memory function



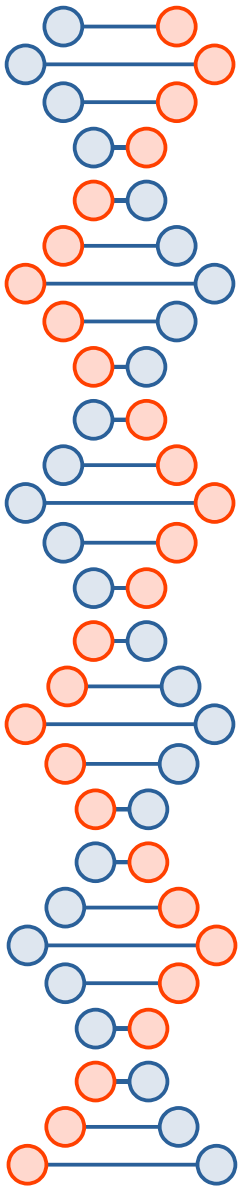
Processes of Memory

- Encoding (Storage)
  - Information in the real world must be represented in some form in memory
  - How is the experience in the world translated into representations in memory?
  - What is the nature of this representation?
  - What can one do to encode information in a useful way?



Processes of Memory

- Storage
  - The information in memory must be stored and maintained
  - What is the capacity (limit) of memory?
  - How is information kept and lost?
  - What factors of encoding may affect how information is stored?
- Retrieval
  - Information stored in memory is only useful if it can be retrieved when needed
  - How is information retrieved?
  - What can be done to increase useful retrievals?
  - What factors of encoding and storage might affect retrieval



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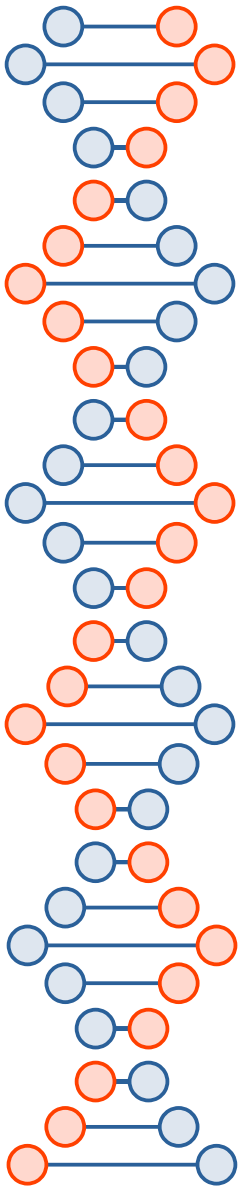
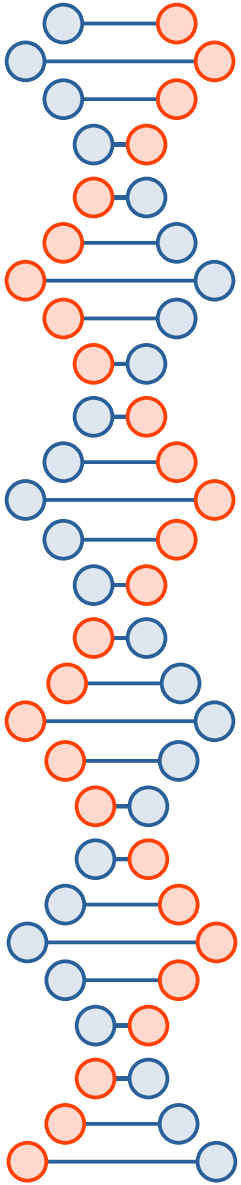


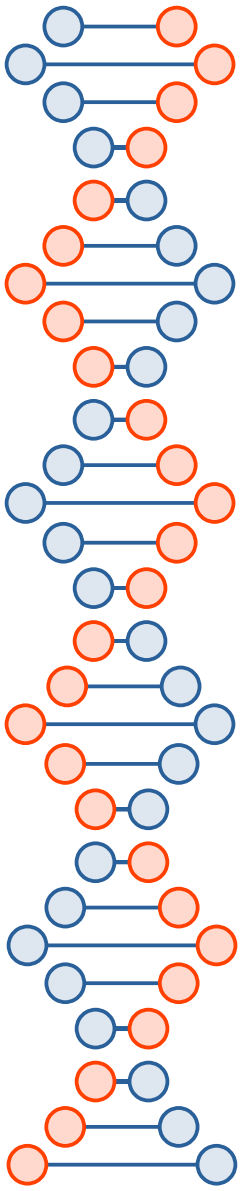
Short-Term Memory

- Introduction
- Characteristics of short-term memory
- Working memory



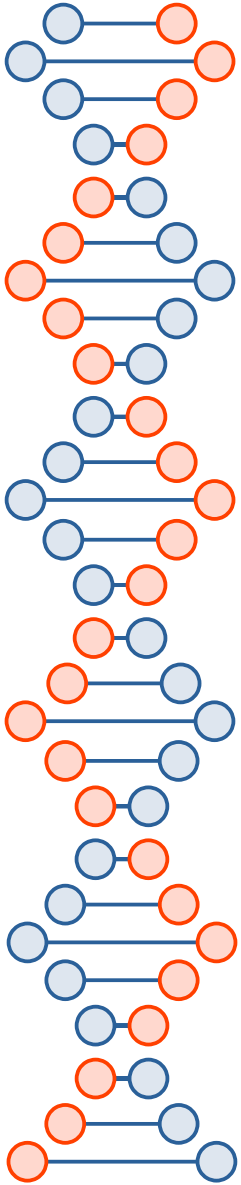
STM - Introduction

- Assume you are given a password, but you are not allowed to write it down
- What can you do to keep from forgetting the password?
- Common strategy
  - Keep repeating the password to yourself to keep it active and available
- Short-term memory
  - Also called primary memory
  - The mechanism that keeps information active and available



STM - Introduction

- Why is short-term memory useful?
  - First, if you attend carefully to information (e.g., the password), it is registered in STM, making the information available for
    - (1) further processing
    - (2) permanent storage
  - Second, if you recall information from permanent memory into STM, that information is available for further processing
    - Example 1: Figuring out the age of a sibling whose data of birth you recalled form permanent memory
    - Example 2: Keeping (incomplete) information in the world, which can then be augmented with other knowledge from memory



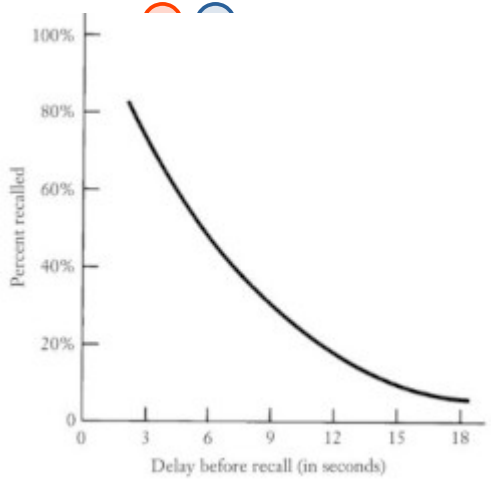
STM - Characteristics of Short-Term Memory

- Rehearsal and forgetting in short-term memory
- Coding in short-term memory
- Limitations and chunking

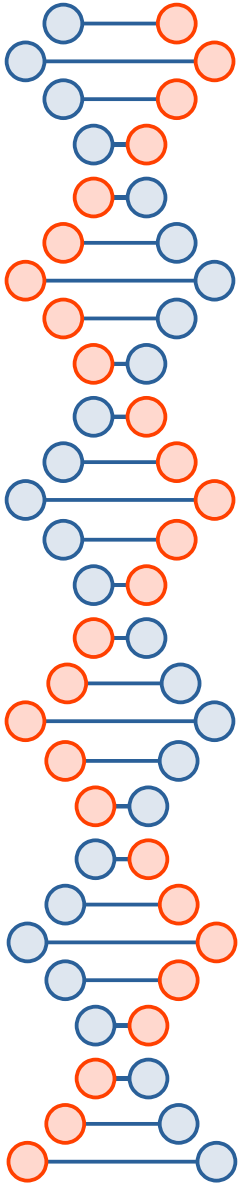
Rehearsal and Forgetting in Short-Term Memory

- Maintenance (primary) rehearsal
  - We are able to maintain memory for a few letters, numbers, or words just seen or heard almost indefinitely if we rehearse them repeatedly
  - We imprint the items in memory anew on each repetition
- But we cannot keep rehearsing a small number of items because we get to encounter other items
  - This may lead to forgetting in short-term memory

Rehearsal and Forgetting in Short-Term Memory



- Forgetting in STM may result from
  - Additional tasks that interfere with rehearsal of items in STM
    - Example, as you are trying to rehearse the letters of a word, you are faced with an additional task, e.g., counting backwards by threes (i.e., 97, 94, ...etc)
    - Typical result on the left
  - Limited capacity of STM
    - Hence, new items may get into STM and crowd out some items that are already there



Coding in Short-Term Memory

- How is information encoded in STM
  - i.e., do we remember the information in terms of how it looks, how it sounds, what it means, etc.?
- A lot of research has been done on this
- Results indicate that there are various encodings of information in STM
  - Accoustic – illustrating importance of verbal rehearsal
  - Visual codes
  - Semantic (meaning-related) codes

Limitations and Chunking

10, 20, 30, 40, 50, 60, 70, 80
50, 30, 60, 20, 80, 10, 40, 70

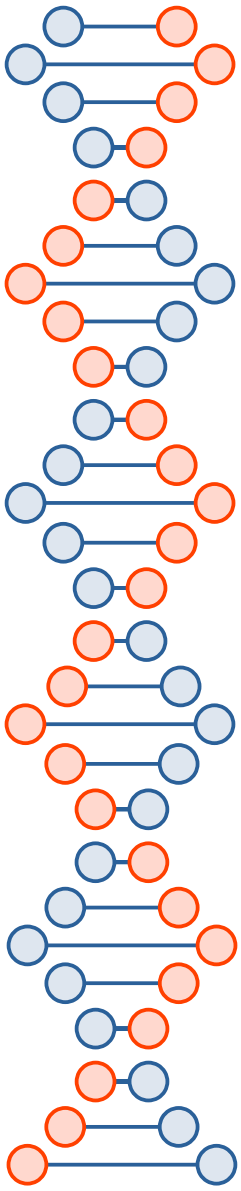
- Consider the sets of the same numbers, arranged differently, on the left, which we are requested to recall

  Almost everyone will agree that the first set is easier to recall than the second one

- Also consider the following, presentations of letters and words

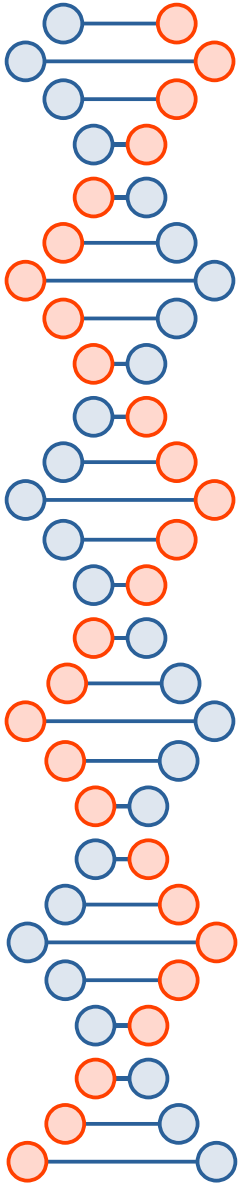
  A string of 10 letters: R, P, L, B, V, Q, M, S, D, G
  A set of 52 letters: I pledge allegiance to the flag of the United States of America

  - Most people (Americans) find it easier to remember the words comprising 52 letters than the random collection of 10 letters
- Explaining the observations
  - Numbers
    - We remember (i.e., keep in short term memory) the fact that the top numbers went from 10 to 80 in increments of 10 rather than remember the exact order of the numbers
  - Letters and words
    - An American only needs to remember that the sentence is the opening of the Pledge of Allegiance, rather than remembering the exact letters and their order



Chunking

- Chunk
  - The code used to store information in short-term memory
    - Any meaningful group of information
    - You do not have to store every piece of information – you could simply store the idea that the chunk occurred
      - To retrieve the information, you retrieve the idea from short-term memory, and the constituents of the chunk from long term memory

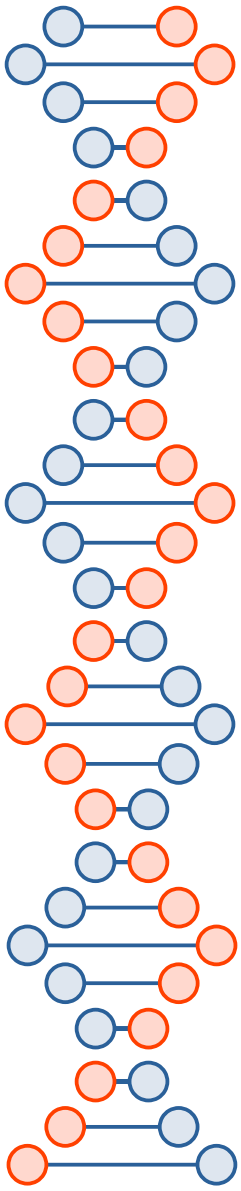


Chunking

- Chunking is a function of our previous knowledge
  - What is meaningful depends on what we know

    C RT VBB CCNN harder to remember than

    CRTV BBC CNN
- 7 ± 2 (or 5 to 9)
  - This is short-term memory span
  - Theoretical number of chunks of information that can be stored in short-term memory

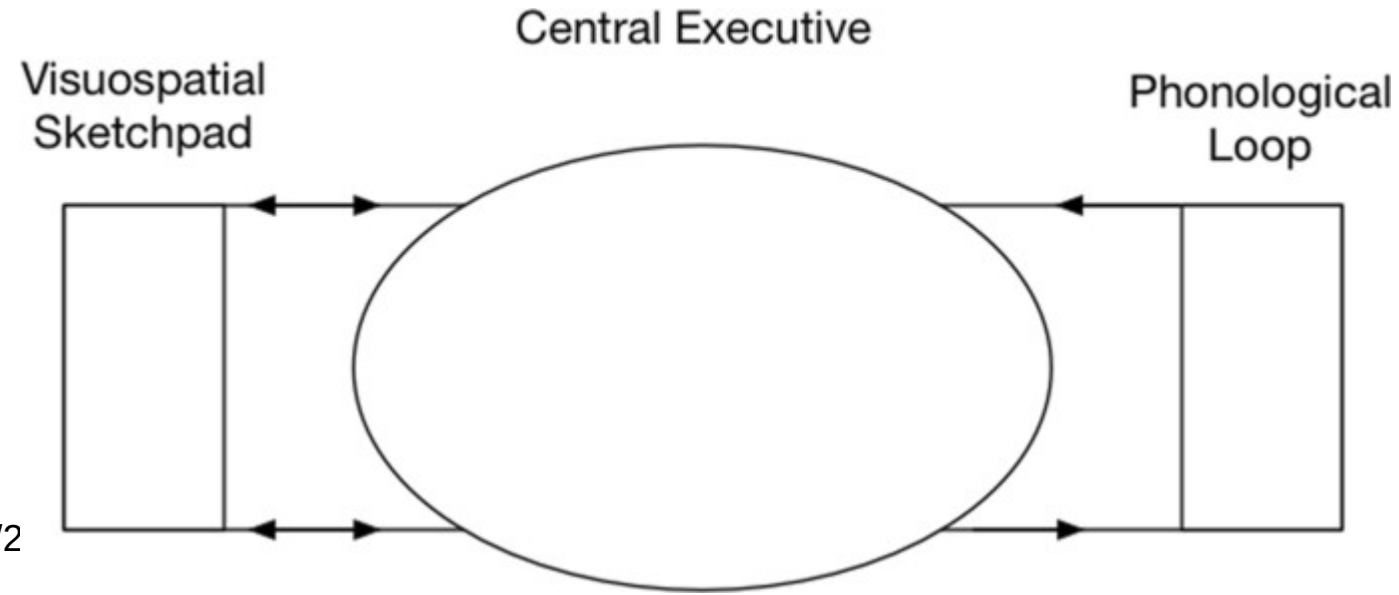


STM - Working Memory

- We have so far considered short-term memory simply as a storage device
  - Encoding information, retaining the information, and accessing the information.
- But how is this information used in complex tasks?
- Working memory
  - Refers to a brain and cognitive system that provides temporary storage and manipulation of information that is necessary for a variety of complex cogitive tasks

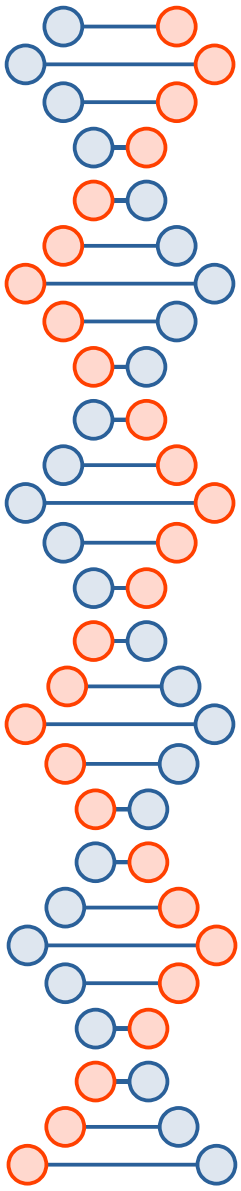
Braddeley's Model of Working Memory

- Central executive plus two specialized subsystems
  - Phonological loop
  - Visuospatial sketchpad



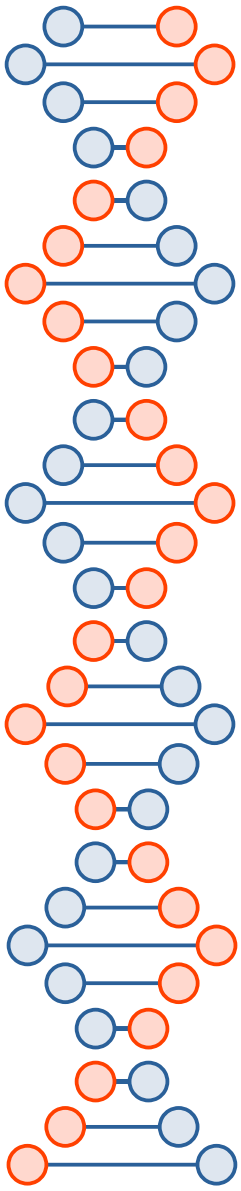
Phonological Loop

- Consists of 2 parts
  - Phonological store
    - Holds acoustic or speech-based information for about 2 seconds
    - Explains why if you hear someone talking but do not pay attention to him, you can usually repeat the the last part of his speech if asked to do so
      - Phonological store still has the last 2 seconds of the speech
  - Articulatory control process
    - Produces the inner speech that we hear in ourselves
    - This is what allows us to subvocally rehearse information to ourselves, helping to keep the information available by refreshing the phonological store



Phonological Loop

- Gives a different interpretation than chunking of memory span
- Chunking interpretation
  - Span is the number of chunks that can be held in STM
- Phonological loop interpretation
  - The time it takes to rehearse the information is what is important
  - If the chunks are fast to rehearse, then the memory span is greater

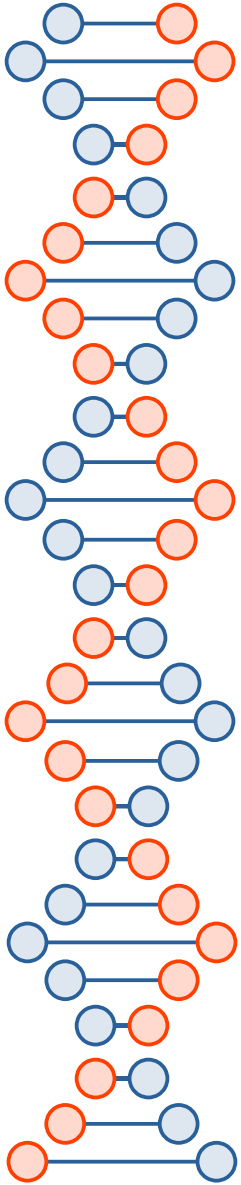


Visuospatial sketchpad

- Allows us to manipulate visual and spatial objects
- Operates differently from the phonological loop
- Use of the sketchpad is interfered with by other visual tasks, but not by verbal tasks
- Similarly, the phonological loop is interfered with by other verbal tasks, but not by visual tasks

Central Executive

- Functioning not well understood
- But believed to include coordination of the phonological loop and visuospatial sketchpad



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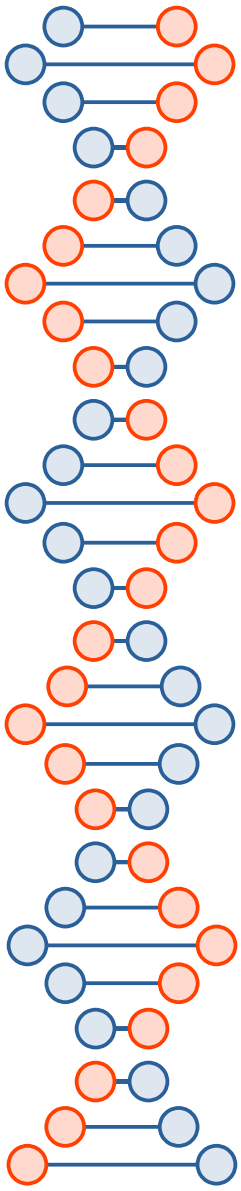
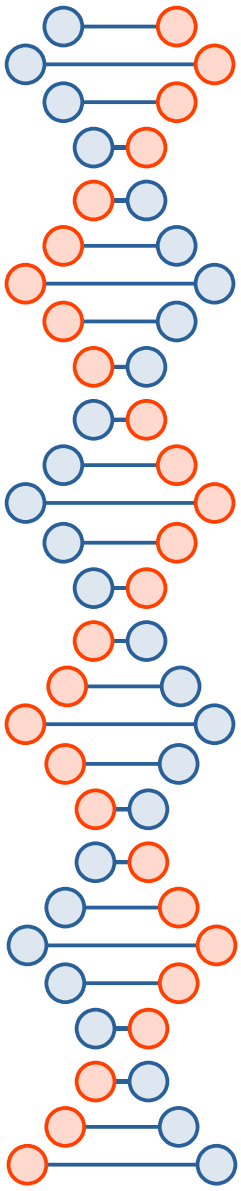


Long-Term Memory

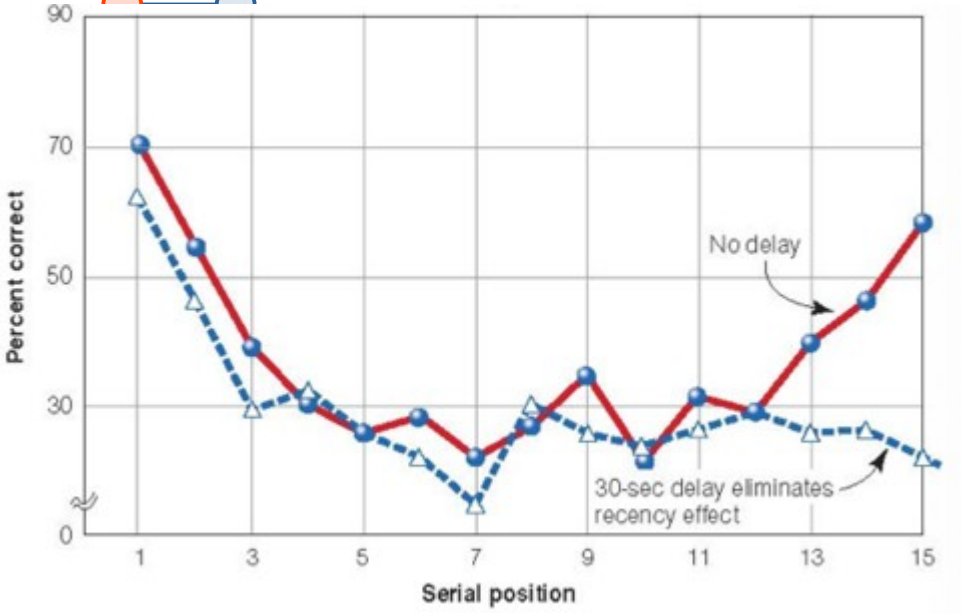
- Introduction
- Encoding
- Retrieval
- Encoding-retrieval interactions
- Forgetting



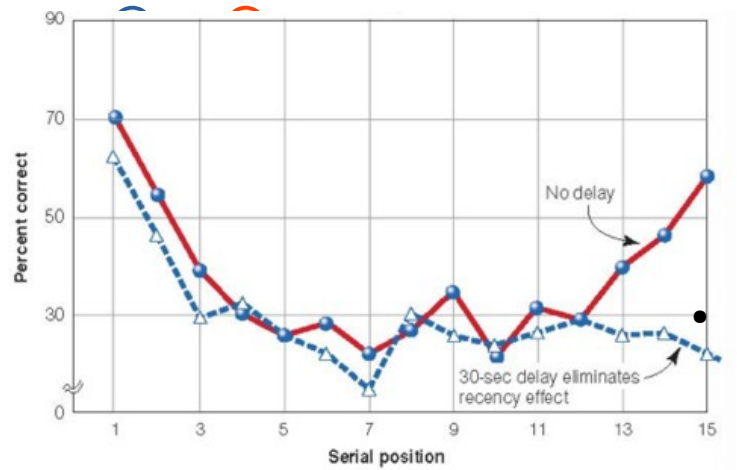
Long-Term Memory - Introduction

- Items that enter the memory system and survive the first few seconds may be retained for long periods
- Some important questions relating to long-term memory
  - Why does it sometimes fail, or mislead us, e.g., when our memory for an event changes over time?
  - Why do we sometimes have difficulty recalling names, dates, etc.?
  - How do people figure out the relevant information to retrieve from the huge store of knowledge in long term memory for the task at hand?

Free Recall



- Technique commonly used to analyse memory
- Subject presented with a list of words and asked to reproduce from memory as many of the words as possible
  - Only a small number of words is recalled, e.g., 10 to 20 out of 50
  - Serial position effect (red line)
    - Probability of recalling an item depends on where it appeared on the list
    - Items at the beginning (primacy effect) and end (recency effect) of the list are more likely to be recalled than items at the middle of the list

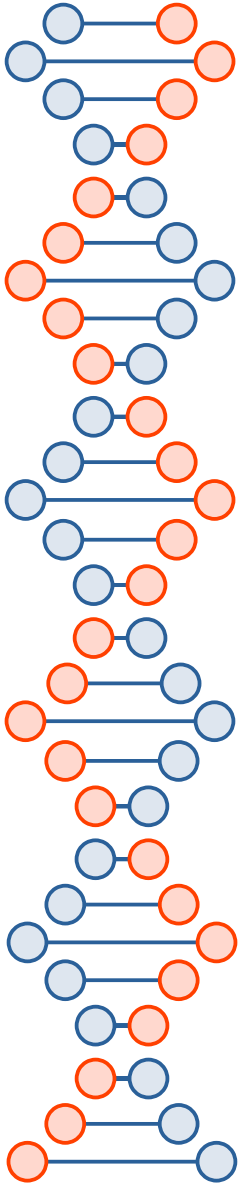


Free Recall

- Delay recall for about 30 seconds while distracting the subjects with an irrelevant problem (blue line)
  - Recall of items at the end of the list suffers
  - Performance at the beginning and middle of the list remains the same
- One interpretation
  - The recency effect was due to the fact that items at end of list were recalled from STM (phonological loop of working memory), and the distracting task eliminated this advantage
  - Recall of the other items that were not affected were recalled from long term memory

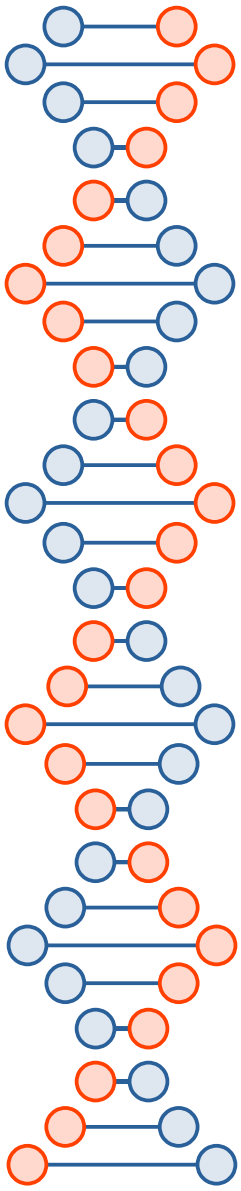
Free Recall

- What caused the primacy effect
  - Items added and encoded earlier (top of list) were not quickly bumbed out (we were still within limit of STM capacity)
  - They stayed longer in the list, were rehearsed for longer, and had the best opportunity to be transferred to long term memory



Long-Term Memory - Encoding

- Refers to the initial processing of an item that leads to a representation of it in memory
- We consider 4 encoding influences on memory
  - Levels of processing
  - Memory for meaning
  - Organization
  - Elaboration



Levels of Processing

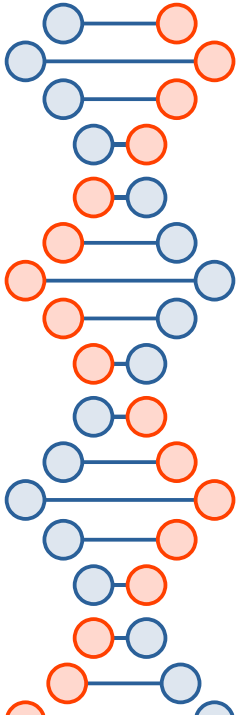
- Some researchers have suggested that an item can be processed in many ways, and that the resulting memory depends on the level or depth of processing
- The level of processing is viewed as a continuum that ranges from shallow analysis of the physical characteristics of the item, to a deeper level of meaning

Memory for Meaning

- Very often in our daily lives, we do not need to remember a precise set of words, but rather their meaning
- Could investigate this further from the errors people make when tested for their memory of meaningful material
- Example
  - Given the statement on the left and asked shortly afterwards whether you had read that the fish swam under the turtles, you are likely to say Yes

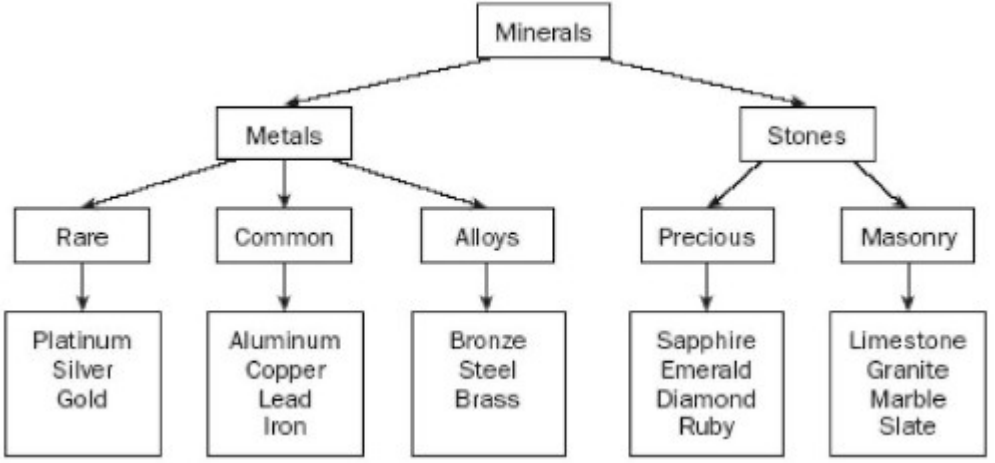
Three turtles rested on a floating log and a fish swam beneath it.

- Research has confirmed that
  - When people are tested for exactly what they had read, they were generally unable to distinguish between the literal information and the natural inferences based on the information
  - However, they detected even small changes in sentences that altered the meaning
  - Example: substituting the word on in the statement with beside, subjects would know that they had not seen a sentence about a fish swimming under the turtles



Organization

- Often, our encoding of, and memory for an item depends not only on single items, but on other items that are present
- If the items are organized in some way, performance often increases
- Example
  - Good students have stuff well organized in memory



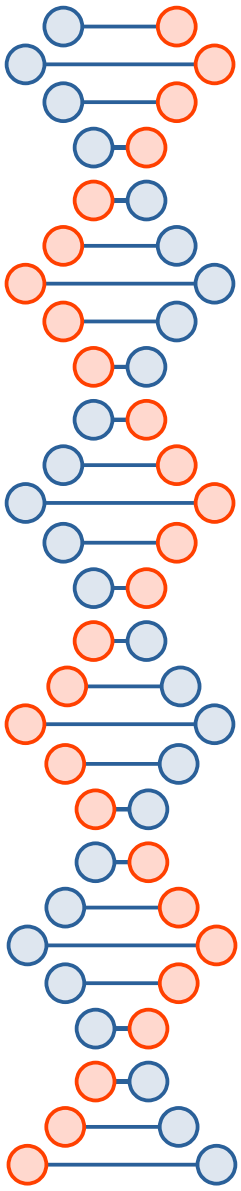
- In an experiment for example
  - Group of items either organized by their category or in random order, were presented to participants
  - Recall was much better when the items were categorized (65% vs 18%)
  - And after 4 trials, performance in both conditions had improved, but the recall for the random condition was 63% less than for the organized condition

Elaboration

- Often, when we are presented with some information, we not only encode its meaning but also elaborate or explain it
  - e.g., on seeing someone at a door with an umbrella, we may make a simple elaboration that she is taking the umbrella because she believes it might rain
  - If someone later asks if the woman had taken an umbrella with her, we are more likely than not to remember she had, if we had elaborated upon it earlier
- When we take in incomplete information, elaborations can be viewed as helping to augment it with further information from memory, and interpret it

Long-Term Memory - Retrieval

- i.e., remembering encoded information
- Try this experiment
  - Time some friends and see how many animals they can name in a minute
  - Then give them a minute to name as many countries in Africa as possible
  - Although there are many more animals than countries in Africa, chances are that your friends will name many more countries than animals in one minute
  - Easier to name the countries rapidly because one can use a natural retrieval plan, e.g., based on geographic location: e.g., southern African countries, East Africa, Central Africa, West Africa, North Africa)
  - Retrieval plan could be used for animals too (domestic animals, wild animals, etc.), but they do not provide a systematic order of recall, and one often comes up with a name that had been mentioned before

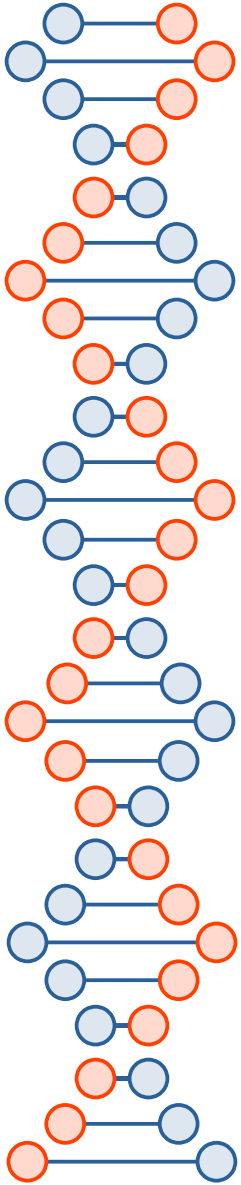


Retrieval

- Retrieval plan should have 2 main characteristics
  - Cues in the plan should be organized such that no cue is likely to be forgotten
    - Remembering the regions in Cameroon by moving from one geographic location to the next
  - Each cue in the plan should be able to lead to the recall of a number of items not recallable from other cues and also do so in as systematic a way as possible (so items are not recalled more than once or missed altogether)

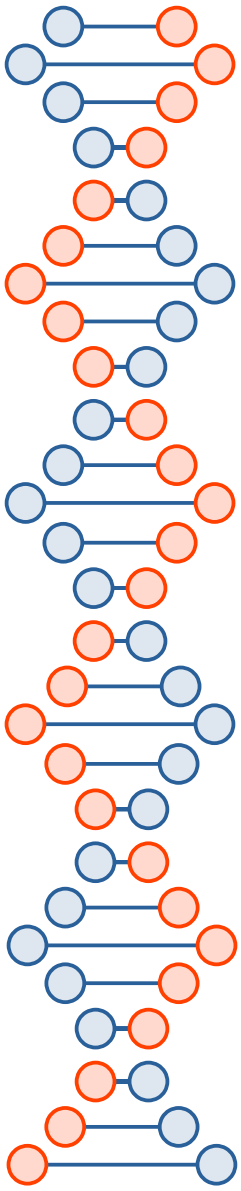
Long-Term Memory - Encoding-Retrieval Interactions

- Memory for events is affected by more than simply encoding and retrieval
- Consider a large library
  - Very easy to find any book on the shelves
  - Why? Because of a good organization and retrieval system used
    - Catalogue (manual or electronic) used to record position of every book
    - Same catalogue used to search and retrieve any book from the shelves
    - Crucial point here is that the same cues are used for encoding information on books, and retrieving that information
    - Much better than, for example, trying to retrieve a book by our knowledge that the cover is green and was written by somebody called Smith



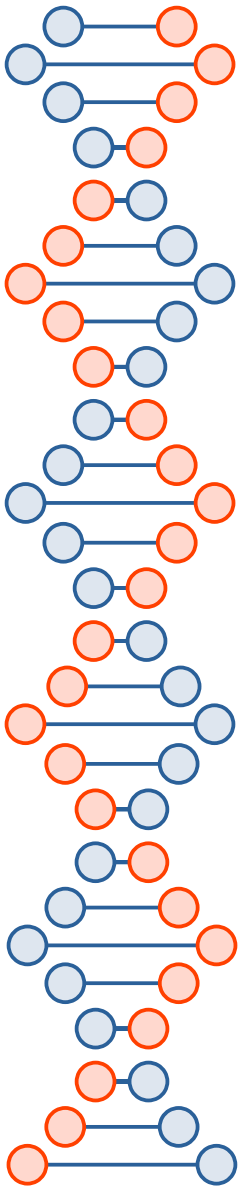
Encoding-Retrieval Interactions

- We now consider 3 points wrt encoding and retrieval matching
  - Encoding specificity
  - Context change
  - Spacing effect



Encoding Specificity Principle of Human Memory

- States that matching the encoding contexts of information at recall assists in the retrieved memories
  - i.e., memory for an item is affected by the match of encodings at learning and retrieval
  - It provides a framework for understanding how the conditions present while encoding information relate to memory and recall of that information

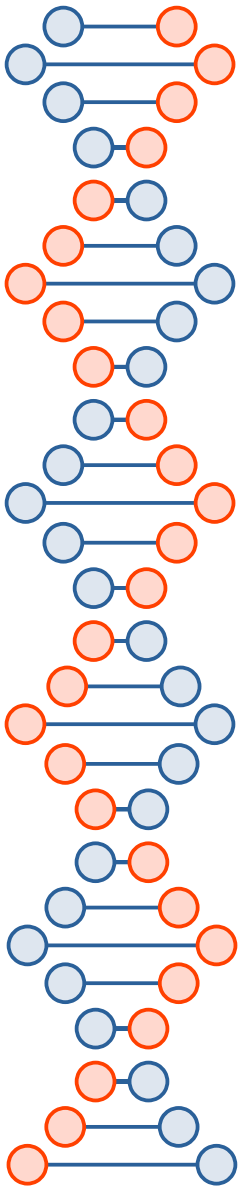


Encoding Specificity Principle of Human Memory

- Recognition vs Recall
  - It is well understood that recognition is generally more accurate than recall
    - Our memory for an event is better if we see (i.e., recognize) it than having to recall it
    - Reason: individual is presented with more of the context of the original experience than would be the case in recall
  - But there are situations when recall is superior
    - Explained by the encoding specificity principle

Example

- Suppose you were given a list of word pairs (e.g., river bank) and asked to remember the second word of each pair
- Later, you are given one of two tests
  - Recognition test
    - You are given a word pair (e.g., piggy bank) and asked if you remember having seen the second word on the original list
  - Cued recall test
    - You are given a cue (e.g., river) and asked to recall the word from the original list that it had been paired with
- Performance is better in the recall test
  - The difficulty in the recognition test is that the word bank has two very different meanings
  - Even though the word had been seen before, it was encoded with a different meaning, and was not recognized in the recognition test
  - In the cued recall task, you are asked to recall a word that is consistent with the meaning used in the encoding

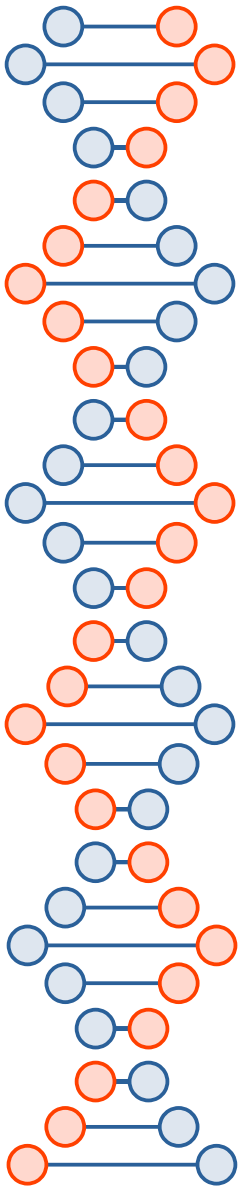


Context Change

- Context
  - All the information that might be encoded aside form the item of interest
- Context effects
  - Improvement (or decrement) in memory of having information occur with the same (or different) context in which it was encoded
- Research on context examines the influence of more peripheral factors than meaning
- Two types of context cues
  - External cues, e.g., physical environment
  - Internal cues, e.g., body states

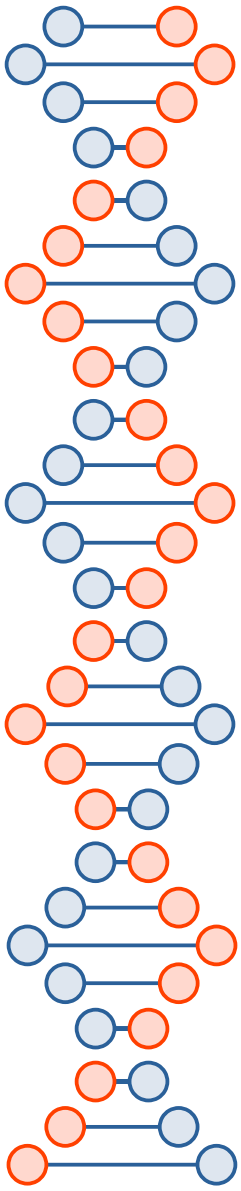
Context Change

- External context
  - Recall is better in the same physical setting that learning (encoding) took place
    - Example
      - Experiments to demonstrate that recall is facilitated if the test is carried out in the same room in which the learning occurred
  - Effect has been more difficult to obtain when recognition (not recall) is the measure



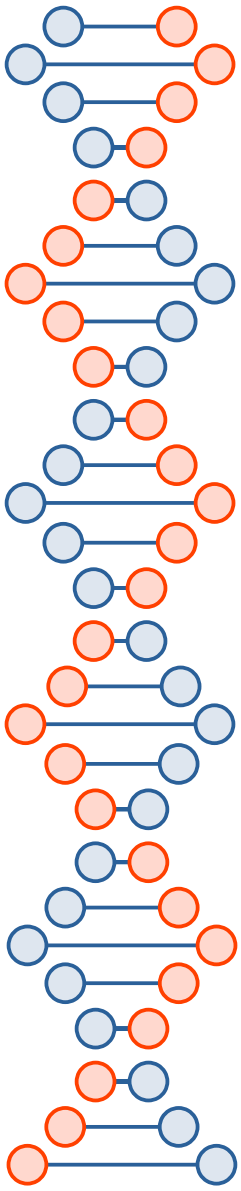
Context Change

- Internal context
  - How one feels inside can partially determine how items are encoded and retrieved
  - Examples
    - A person who has too much to drink one night may have little memory of the evening's events the next day
      - But this memory failure is not permanent as the individual may recover this memory the next time s/he drinks too much
    - Mood: in experiments, people sometimes recalled more if they were in the same mood (happy or sad) at study and test



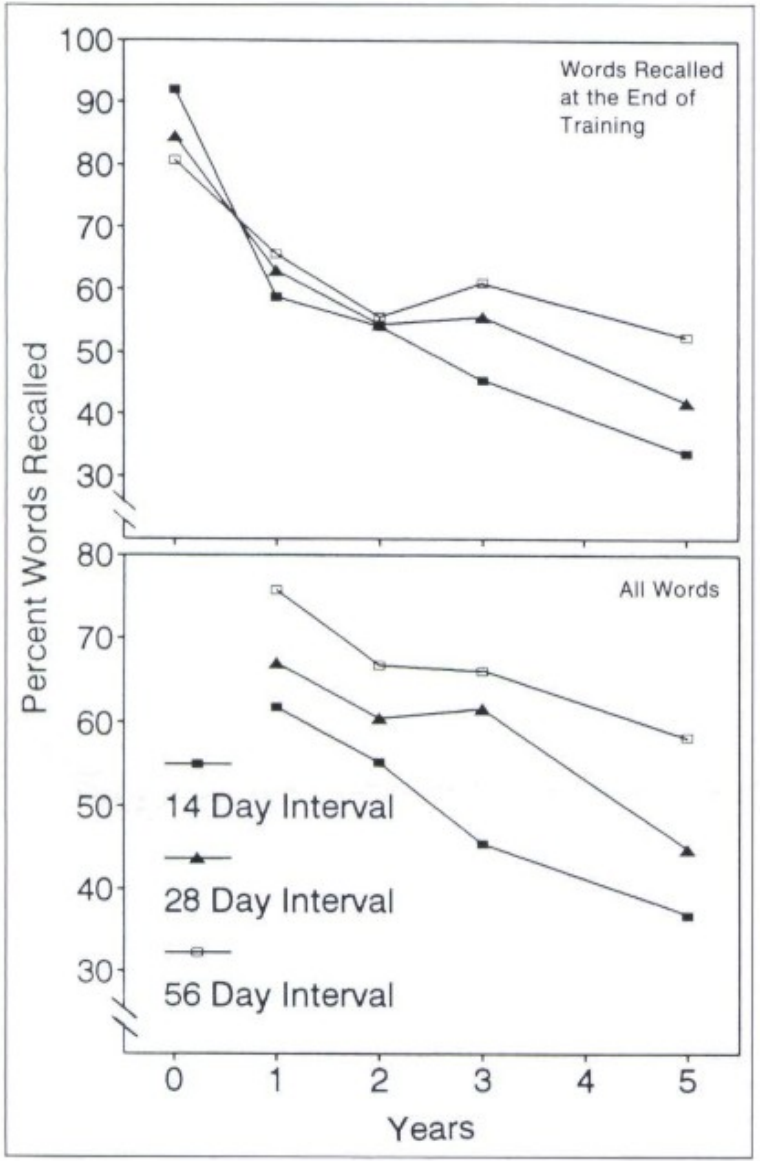
Spacing Effect

- The observation that repetitions spaced in time tend to produce stronger memories than repetitions massed closer together in time
- Examples/applications
  - For a customer to remember an advertisement better, it would be better for the advertisement to be spaced out and not play the same commercial back-to-back on the television, or in other forms of media
  - Spacing out multiple study sessions over a long period enhances long-term learning and retention
    - Far better than cramming the night before an exam



Possible Reasons for Spacing Effect

- When repetitions occur further apart, they are more likely to be encoded under different contexts, leading to multiple ways to retrieve the information
- The repetitions may be reminding the learner of the earlier presentation
  - Learner stores some information about the changes in the encoding and context from the prior presentation

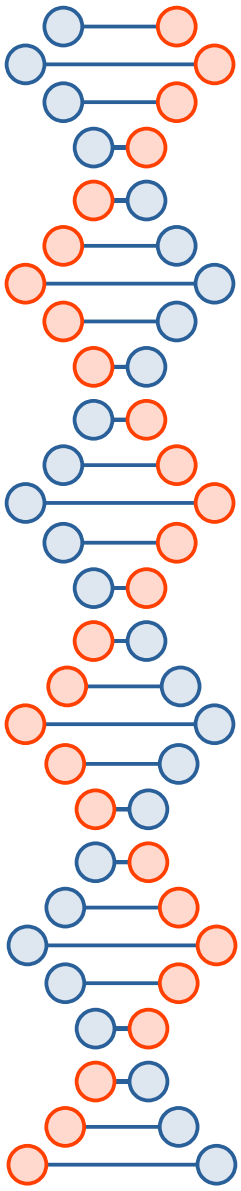


Spacing Effect

- Most studies on spacing effect have considered short spacings and delays
- But studies demonstrate that the effect appears to work over long periods as well
- Example: Foreign language vocabulary study
  - Learning done over 14-day, 28-day, 56-day intervals for various groups
  - Recall declined over the years as expected
  - But consistently, recall was better the longer the interval between learning

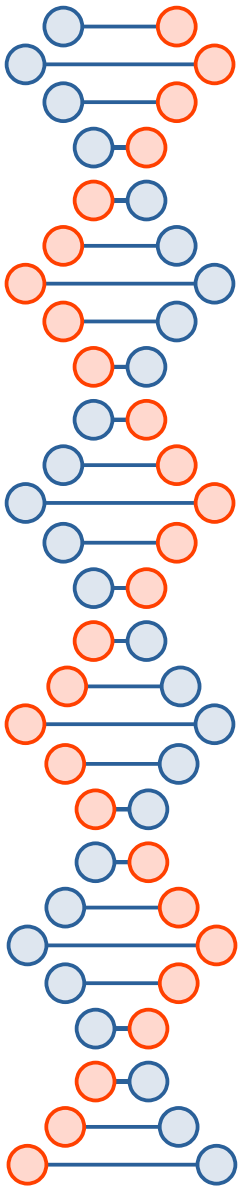
Long-Term Memory - Forgetting

- We all have had experiences in which we know the answer to a question but the answer seems to slip our minds temporarily
  - What happened to the missing items?
    - Are they permanently lost or are they still in memory
  - What caused the forgetting?



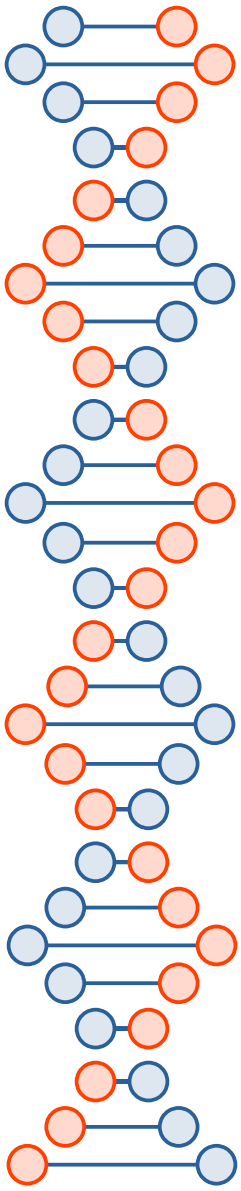
Not Remembering vs Permanently Forgetting

- Current thinking
  - Once entered into long term memory, most items are not lost but may be retrievable only under certain circumstances
- Example: Experiment on intentional forgetting
  - Subjects shown a number of lists of items to remember
  - On some trials, partway through the list, subjects are signalled to try to forget everything preceding the signal
  - Results
    - When asked to **recall** the full list, subjects were unlikely to remember any of the items preceding the **forget** signal, suggesting loss from memory storage
    - However, given a **recognition** test, subjects were able to recognize the **forget** items as belonging to the list, demonstrating that the items were not lost



Causes of Forgetting

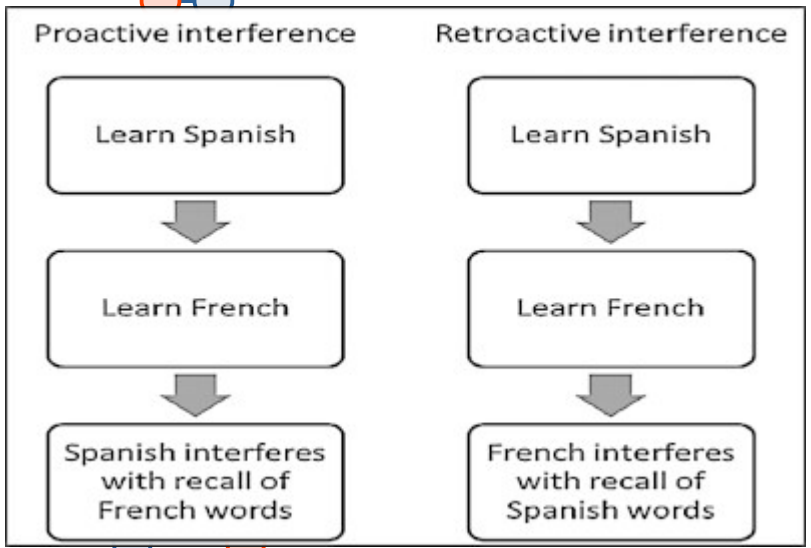
- Memory gets worse (we tend to forget) with time. Why is this?
  - Three main hypotheses have been proposed for how forgetting occurs
    - Decay
    - Interference
    - Overwriting



Decay

- The hypothesis that memories that are not recalled or studied for a period of time lose strength in memory as a result of an automatic process of decay
- Also, it often seems that if you have not thought of an event for a while, the longer this period is, the less likely it is that you will be able to remember the event
- As appealing as it looks, it has been very difficult to find support for the memory decay hypothesis

Interference



- The hypothesis that forgetting is as a result of interference from other material on the earlier items
- Two types of interference
  - Retroactive interference
    - Forgetting caused by later learning
  - Proactive interference
    - Earlier learning interfering with related material that is learned later

Interference

- Typical experimental setting (retroactive interference)
  - One group of subjects learns certain materials – say list of vocabulary words (List A)
    - After an interval, a recall test for List A
  - A second group of subjects learns List A, then List B consisting of different words
    - After the same interval, a recall test for List A
  - Typical finding
    - Recall for List A is poorer for the experimental group than for the control group

Group	Original Learning	Interpolated Learning	Test
Experimental	List A	List B	List A
Control	List A	Rest	List A

Interference

- Typical experimental setting (proactive interference)
  - One group of subjects learns certain materials – say list of vocabulary words (List A)
    - Followed by a recall test for List A
  - A second group of subjects learns List B, then List A consisting of different words
    - Followed by a recall test for List A
  - Typical finding
    - Again, recall for List A is poorer for the experimental group than for the control group

Group	Original Learning	Interpolated Learning	Test
Experimental	List B	List A	List A
Control	None	List A	List A

Overwriting

- The hypothesis that our memories may be changed by later events so that the original memories cannot be retrieved because they no longer exist
- Example
  - A roller coaster ride encoded the first time you took the ride
  - Then encoded again the next time you took the ride
  - Overwriting refers to a case in which an originally encoded part is replaced with a related part of the later event (second ride)
    - Implications of this kind of overwriting in misleading questions in eyewitness testimony