

In-depth Area of Study: Memory

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|--------------------|--|
| Aim | To describe and evaluate two theories of memory. |
| Objective 1 | To describe and evaluate the multi-store model. |
| Objective 2 | To describe and evaluate the levels of processing theory. |
| Key Terms | sensory memory, short-term memory, long-term memory, coding, capacity, duration, encoding, storage, retrieval, visual coding, acoustic coding, semantic coding, displacement, chunking, episodic, procedural memory, structural processing, phonetic processing, semantic processing, elaboration. |

Guidelines for Teachers

Although students need to have a thorough understanding of the two theories of memory it is important that they are able to write a summary for 4 or 5 marks in an exam. Therefore, once students are familiar with the main concepts, it will be necessary for them to practise writing a concise summary.

In the lesson activities below, there are a number of materials for short memory tests that can be carried out to highlight some of the major features of the multi-store model. These memory tests might also provide students with ideas for their coursework. Studies of chunking (activity 4c) and interference (activity 4d) are given as suggestions for coursework in the specification.

Craik and Tulving's study can also be used as a *Study in Detail* (see page 47), but it is sensible to teach it here rather than as a separate area.

Timing

Approximate teaching and learning time: 3–4 hours

Lesson Planning

The first objective can be achieved by:

- presenting students with a diagram of the multi-store model (see page 28);
- describing the main features of sensory memory and carrying out lesson activity 1a) as a demonstration (see page 31);
- carrying out lesson activity 1b) to demonstrate the separate short-term and long-term stores (see page 31);
- describing the main features of short-term memory and carrying out lesson activities 1c) and 1d) (see page 32);
- carrying out lesson activity 2 and describing the main features of long-term memory (see page 32);
- ensuring students have formal notes on the multi-store model (see page 28);
- carrying out lesson activity 3a) for students to research the evaluation of the multi-store model in text books (see page 32);
- (if time and facilities permit) carrying out lesson activity 4 (see page 32).

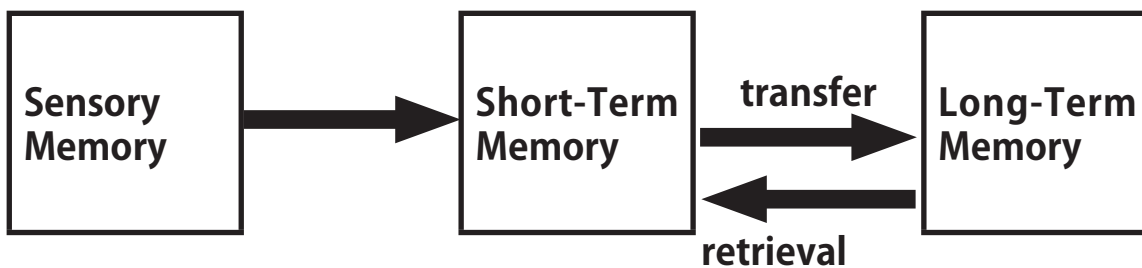
The second objective can be achieved by:

- carrying out lesson activity 5 or an adaptation of Craik and Tulving's original study as an introduction to levels of processing (see page 33);
- describing the main features and ensuring students have formal notes on the levels of processing model and Craik and Tulving's study (see page 30);
- carrying out lesson activity 3b) to evaluate the levels of processing model (see page 32).

Topic Structure

The Multi-store Model

Atkinson and Shiffrin (1968) developed the concept of the Multi-store Model to describe how memory is organised. Incoming information enters a sensory memory for a brief period of time. A tiny fraction of it is then transferred to short-term memory where it can be held and manipulated. A fraction of that information is then transferred to long-term memory for more permanent storage.



Like many other cognitive psychologists, Atkinson and Shiffrin drew a strong distinction between short-term and long-term memory stores. Because of this, the multi-store model is sometimes called the dual-process model or dual-memory model.

Sensory Memory

Sensory memory could be seen as many of different sensory stores that hold on to sensory information long enough for us to attend to it and do some initial processing before it passes on to short-term memory.

Sensory memory is able to deal with a number of different types of information from the senses – images, sounds, tastes, smells and feelings from the body.

The duration of storage in sensory memory may depend on the type of information received. A visual image may remain unprocessed for around 0.5 second whereas sounds may be stored for up to 4 seconds.

The capacity of sensory memory has been found to be large. Sperling (1960) demonstrated that a lot of information is available in sensory memory immediately after presentation but it disappears rapidly.

Short-Term Memory (STM)

Short-term memory allows us to hold on to information long enough to use it. It deals with new information that is transferred from sensory memory as well as old information retrieved from long-term memory. It also plays an important part in conscious thought and can be used as a kind of cognitive work-space for manipulating ideas and solving problems.

According to Atkinson and Shiffrin, STM has a duration of about 15 – 30 seconds. This can be extended through rehearsal and repetition, which often involves using some kind of inner speech to keep the information active in the STM.

As early as the 1860s, Wundt found that STM had a limited capacity of around seven pieces of information. However, in 1956 Miller described “the magical number seven, plus or minus two” and demonstrated how this could be increased by ‘chunking’. STM has been compared to a ‘leaky bucket’ and because of its limited capacity, as more items are introduced, existing information is displaced. Therefore, grouping information together in meaningful chunks can increase the amount of items stored.

Coding in STM tends to be primarily acoustic, i.e. items are often converted into sounds and stored in this manner. Evidence for this comes from Conrad (1964), who found that letters that sound similar (e.g. P, V, D, C, etc.) are more likely to be confused than those that sound very different (e.g. K, I and F).

Of course, not all information can be coded acoustically and STM is able to store information in different ways. For example, information can be coded semantically, by meaning.

Long-Term Memory (LTM)

Long-term memory is a more permanent store that allows us to use our past experiences and knowledge to deal with future situations. Bower (1975) believed that LTM contains information such as knowledge of the physical world, spatial maps of our surroundings, beliefs, norms and values, motor skills and perceptual skills. Other psychologists have categorised information into episodic (personal experiences), semantic (general knowledge and meanings) and procedural (how to do things).

Information in LTM may be stored for a number of minutes, several years or a lifetime. LTM is thought to have an unlimited capacity. At least, if there is a limit, psychologists have not yet been able to devise a study to find out what it might be.

Coding in LTM appears to be predominantly semantic and visual. That is, we store information by its meaning or in the form of images. However, other types of coding may be used to deal with different kinds of information.

Evaluation

Strengths

- Case studies of brain-damaged patients such as Clive Wearing (see page 20) and H. M. provide evidence for separate short-term and long-term memory stores. For example, H. M.’s long-term memory seemed to be relatively intact. His problem was one of transferring items from STM to LTM.
- The serial position curve (Murdock (1962)) provides further evidence for separate STM and LTM. When participants are presented with a list of words, they tend to remember more from the beginning and end of the list than the middle. More words are remembered from the beginning of the list (the primacy effect) because they have been transferred to LTM. Words in the middle are displaced from STM by later words. More words are remembered from the end of the list (the recency effect) because they are still held in STM at the time of recall.

Weaknesses

- The multi-store model has been criticised for being too rigid and simplistic. Baddeley and Hitch (1974) proposed a more comprehensive version of STM called the **working memory**. The working memory involves different systems that deal with sounds, images, and verbal material in different ways. It is more useful to see STM as a set of systems rather than a single store.
- According to the multi-store model, the amount of rehearsal determines the likelihood of information being stored. Other theories such as the Levels of Processing Model (see page 30) do not draw such a distinction between STM and LTM and believe that retention of information is dependent on how deeply it is processed.

Craik and Lockhart (1972) The Levels of Processing Model

In 1972, Craik and Lockhart proposed that the amount of information retained depended on how deeply it was processed. Memory is then almost a by-product of processing as stimuli are analysed at various levels.

| | | |
|---------------------|---------------------------------|--|
| SHALLOW | structural processing | stimulus is analysed by visual characteristics |
| INTERMEDIATE | phonemic or phonetic processing | stimulus is analysed by its sound |
| DEEP | semantic processing | stimulus is analysed by its meaning |

Craik and Tulving carried out a study in 1975 to assess how depth of processing affected the likelihood of information being remembered. They presented participants with a set of words by flashing them on a screen for a short period of time. They were then asked a question about each word, to which there was a “yes” or “no” answer.

For example:

- a) DOG Is the word in capital letters? **Shallow processing**
- b) Castle Does the word rhyme with pin? **Intermediate processing**
- c) Tiger Is it the name of an animal? **Deep processing**

Participants were later given a surprise memory recognition test and had to identify words that they had seen in the previous task. It was found that recall of words was higher for those that had been processed at the deep semantic level. Incidentally, when the answer to the question was “yes”, participants were much better at recognising the words than if the answer had been “no”.

Craik and Tulving took the levels of processing model further with the idea of elaboration. The more complex the processing, the more likely information is to be remembered.

If the word “chicken” was embedded in a complex sentence such as “The great bird swooped down and carried off the struggling chicken”, it was twice as likely to be remembered than if it was embedded in a simple sentence such as “She cooked the chicken”. Craik and Tulving concluded that semantic encoding was most effective if it was elaborate.

Evaluation

Strengths

- The levels of processing model has been supported by Nyberg (2002) who investigated brain activity during information processing. Brain scans showed that the frontal and temporal lobes were more active during deep processing. Hence, deep processing does seem to involve more cognitive effort than shallow processing.
- The levels of processing model has been usefully applied in advertising. For example, rather than just showing the product (structural processing) or even having a song or jingle to accompany the product (phonemic processing), advertisers create a story that makes customers think more deeply about the product (semantic processing).

Weaknesses

- It is very difficult to control or measure the type of processing that participants do. If participants are asked a shallow question about the structure of a word, the experimenters cannot prevent them from processing the word at a deeper level. It is also difficult to measure depth of processing independently.

- The original definition of deep processing may be too narrow. Bransford et al (1979) found that information is easier to remember if it is distinctive. Other studies have identified other important factors such as amount of effort during learning or relevance of the material to the individual.

Lesson Activities

- 1) **A number of small studies, which, if time permits, can be carried out to highlight key features of the multi-store model**
 - a) **Sperling's study to demonstrate capacity of sensory memory.**

Prepare boxes of random letters, like the one below, that can be flashed up on a screen for no more than one or two seconds.

| | | |
|---|---|---|
| J | M | X |
| U | D | G |
| E | Y | P |

- First, flash the letters onto a screen and then ask students to recall as many letters as they can. It is likely that they will remember the first three or four letters and claim that they did not even see the other letters.
- Then repeat the procedure, but between presentation and recall nominate a row for students to remember – top, middle or bottom. It is expected that students will be able to recall the nominated row but not many letters from the other rows.

This demonstrates that sensory memory has a large capacity (i.e. all the letters enter sensory memory) but limited duration (i.e. letters are lost before they can be recalled).

b) The serial position curve.

Read out the following words to the class:

| | | | | |
|--------|--------|-------|----------|--------|
| SHOE | GIRL | TABLE | SCISSORS | SOAP |
| DOG | BOTTLE | LAMP | SKY | MIRROR |
| KETTLE | DANCE | APPLE | PIN | BEE |
| CARROT | HORSE | PEN | BALLOON | KEY |

Then ask students to write down as many words as they can remember in any order.

- i) Add up the number of students that remembered each word and prepare a graph.
 - x axis = position of word in the list
 - y axis = number of students recalling that word
- ii) Does the graph show a serial position curve?
- iii) Which words did students write down first?
- iv) Did students feel they were able to process the words at the beginning of the list?
- v) Did students feel that the words in the middle of the list were being displaced by incoming information?
- vi) Were any words particularly well remembered? Why might this be?

c) Chunking.

Divide the class in two groups and separately present the following letters:

Group 1 B B C I T V R E M K F C

Group 2 C K E V I B F M R T C B

When asked to recall the letters, group 1 should recall a higher number as they were able to chunk the letters in a meaningful and familiar way.

d) The effects of interference and displacement in short-term memory.

Divide the class into two groups. Both groups should be presented with the following list of letters:

 F Y W O D H C N P L

Group 1 should then be allowed to rehearse the letters for 30 seconds.

Group 2 have to count backwards in threes from 100.

Students must then write down as many of the letters as they can remember. It is expected that group 1 will have higher recall as they were able to rehearse. Counting backwards in threes from 100 displaced the letters from group 2's short-term memory and did not allow them to rehearse.

2) Group work to discuss features of long-term-memory

Ask students to produce a list of the kinds of information stored in long-term memory. For example, memory for faces, spatial maps, general knowledge, skills, personal experiences, beliefs, etc. Students might also be able to consider how the information is coded.

3) An activity for students to research the evaluation of models of memory

Students may be asked to evaluate one theory or model of memory using the following criteria:

- evidence from research studies;
- alternative theories/contradictory claims;
- practical applications;
- methodological issues;
- ethical issues.

Refer students to textbooks (see *References*, page 33) to research evaluation in these areas for:

- a) the multi-store model;
- b) the levels of processing model.

4) An Internet activity

Direct students to Neuroscience for Kids website at <http://faculty.washington.edu/chudler/chmemory.html>

There is a lot of information about memory plus a variety of games and activities.

5) An activity to demonstrate levels of processing

Tell students that they will be read a list of 20 target words. After each target word they will be asked to write down a rhyming word (phonemic processing) or an adjective (semantic processing) for that word.

| | | | |
|--------|-----|----------|-----|
| Car | Adj | Fish | Adj |
| Beach | Rhy | Robber | Adj |
| Sky | Rhy | Monkey | Adj |
| Rabbit | Adj | Girl | Rhy |
| Cake | Rhy | Football | Adj |
| Book | Rhy | Sight | Rhy |
| Hour | Rhy | Clock | Rhy |
| Jacket | Rhy | Cow | Adj |
| Pencil | Adj | Bed | Adj |
| Ink | Rhy | Dress | Adj |

Then ask students to hide their adjectives and rhyming words and write down as many of the original target words as they can remember.

They should remember more of the target words for which they had to produce an adjective as these required deeper processing.

Informal Assessment**1) An exercise to assess students' understanding of two models of memory**

Ask students to complete the multiple-choice exercise on page 35.

Formal Assessment

- 1) Describe one theory of memory. (5)
- 2) Evaluate one theory of memory in terms of one or more of the following criteria: evidence from research studies; alternative theories; its usefulness in explaining memory in real-life. (5)
- 3) Outline one theory of memory. (4)
- 4) Evaluate one theory of memory. Make it clear which theory you are evaluating. (5)
- 5) Identify two models or theories of memory. (2)
- 6) Describe any one model or theory of memory. (4)
- 7) Evaluate one theory or model of memory in terms of two of the following criteria: methodological issues; ethical issues; alternative theories; research evidence for, contradictory claims or its practical application. (4)

References

General information on models of memory can be found in:

Cardwell, M., Clark, L. and Meldrum, C. (2000) *Psychology for A Level*. London: Collins.

Gross, R. (1996) *Psychology: The Science of Mind and Behaviour* (Third Edition). London: Hodder and Stoughton.

Gross, R., McIlveen, R. and Coolican, H. (2004) *Psychology: A New Introduction for AS Level*. London: Hodder and Stoughton.

Haralambos, M. and Rice, D. (2002) *Psychology in Focus, A Level*. Ormskirk: Causeway Press Limited.

Hill, G. (2001) *Psychology A Level Through Diagrams*. Oxford: Oxford University Press.

Jarvis, M., Russell, J. and Gorman, P. (2004) *Angles on Psychology for Edexcel: AS Level*. Cheltenham: Nelson Thornes Limited.

The following book is very accessible and provides a number of memory tests:

Baddeley, A. (1982) *Your Memory: A User's Guide*. Harmondsworth: Penguin Books Ltd.

The following book is an excellent resource for this approach with up to date research and numerous examples of studies:

Matlin, M. W. (1997) *Cognition*. Orlando: Harcourt College Publishing.

The following text contains a very comprehensive section on "Models of memory and memory studies" along with questions, answers, a crossword and anagrams. The section also contains information on the Baddeley and Hitch's (1974) Working Memory Model, which can be referred to as an alternative to the multi-store model and levels of processing:

Hill, G. (2003) *Exercises for AS Level Psychology*. Oxford: Oxford University Press.

Related articles can also be found in:

Bentley, E. (2004) "Making Sense of Memories", *Psychology Review*, Vol 10/3.

(2004) "Memory psychword", *Psychology Review*, Vol 10/2.

Eysenck, M. (2005) "How does emotion affect your memory?", *Psychology Review*, Vol 11/1.

(2005) "Memory and research methods psychword", *Psychology Review*, Vol 11/1.

Gross, R. (2006) "How language affects memory", *Psychology Review*, Vol 1/1

(2006) "Memories Psychword", *Psychology Review*, Vol 1/2.

Original sources can be found in:

Atkinson, R. C. and Shiffrin, R. M. (1968) "Human memory: A proposed system and its control processes". In K. W. Spence and J. T. Spence (Eds.), *The psychology of learning and motivation*, Vol. 2. London: Academic Press.

Baddeley, A. D. and Hitch, G. (1974) "Working memory". In G. A. Bower (Ed.), *Recent advances in learning and motivation*, Vol. 8. New York: Academic Press.

Bower, G. H. (1975) "Cognitive psychology: An introduction". In W. Estes (Ed.), *Handbook of learning and cognitive processes*, Vol. 1. Hillsdale, New Jersey: Lawrence Erlbaum Associates Inc.

Bransford, J. D., Franks, J. J., Morris, C. D. and Stein B. S. (1979), "Some general constraints on learning and memory research". In L. S. Cermack and F. I. M. Craik (Eds.), *Levels of processing in human memory*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Conrad, R. (1964) "Acoustic confusion in immediate memory". *British Journal of Psychology*, 55, 75–84.

Craik, F. I. M. and Lockhart, R. S. (1972) "Levels of processing: A framework for memory research". *Journal of Verbal learning and Verbal Behaviour*, 11, 671–684.

Craik, F. I. M. and Tulving, E. (1975) "Depth of processing and the retention of words in episodic memory". *Journal of Experimental Psychology: General*, 1, 268–294.

Murdock, B. B. (1962) "The serial position effect of free recall". *Journal of Experimental Psychology*, 64, 482–8.

Nyberg, L. (2002) "Levels of processing: a view from functional brain imaging". *Memory* 10, 345–348.

Sperling, G. (1960) "The information available in brief visual presentation". *Psychological Monographs*, 74 (Whole No. 498).

Exercise: Theories/Models of Memory

- 1) The Multi-store model is made up of:
 - a) semantic memory, short-term memory, long-term memory
 - b) episodic memory, semantic memory, procedural memory
 - c) sensory memory, short-term memory, long-term memory
 - d) sensory memory, short-term memory, working memory
- 2) According to Miller, the capacity of the short-term memory is:
 - a) seven plus or minus two
 - b) seventeen plus or minus ten
 - c) seventy-two
 - d) seven
- 3) The limited capacity of short-term memory can be increased by:
 - a) practice
 - b) chunking
 - c) rehearsal
 - d) all of these
- 4) According to the levels of processing theory:
 - a) memory for information depends on how deeply it was processed
 - b) information passes through sensory, short-term and long-term memory
 - c) words in the middle of a list will be less well remembered than those at the beginning or end
 - d) information is arranged in a hierarchy
- 5) According to the levels of processing theory, asking "Is the word in capital letters?" involves:
 - a) structural processing
 - b) phonemic processing
 - c) semantic processing
 - d) episodic processing
- 6) Subjects will show greater recall of a word list if:
 - a) all the words are abstract
 - b) they have to think deeply about the meaning of the words
 - c) they take a break between learning and recall
 - d) none of these

- 7) Adverts at the beginning and end of a segment will be remembered more than those in the middle. This can be explained by:
- the working memory
 - primacy and recency effects
 - trace decay
 - retroactive inhibition
- 8) Asking _____ involves a _____ level of processing:
- if a word is written in capital letters, semantic
 - if a word rhymes with another, structural
 - what a word means, phonemic
 - none of these
- 9) The multi-store model has been criticised because:
- it is too simplistic
 - it is too complicated
 - it is not supported by case studies of brain-damaged patients
 - it cannot explain the serial position curve
- 10) Factors found to increase the likelihood of material being remembered are:
- distinctiveness of the material
 - the amount of effort put in during learning
 - relevance of the material to the individual
 - all of these
- 11) Levels of processing theory has been supported by evidence that shows that:
- there is more activity in the frontal and temporal lobes during deep processing
 - there is more cognitive effort required during shallow processing
 - information is less likely to be remembered if it is elaborated
 - none of these
- 12) According to the multi-store model, long-term memory contains:
- spatial maps
 - knowledge of the physical world
 - norms and values
 - all of these

Answers to Exercise: Theories/Models of Memory

| Question | Answer |
|----------|--------|
| 1 | c |
| 2 | a |
| 3 | b |
| 4 | a |
| 5 | a |
| 6 | b |
| 7 | b |
| 8 | d |
| 9 | a |
| 10 | d |
| 11 | a |
| 12 | d |