

Chapter 6

Memory: Structure and Processes

CHAPTER OVERVIEW (SUMMARY)

INTRODUCTION

Theories normally consider both the structure of the memory system and the processes operating within the structure.

(1) *structure*: the way in which the memory is organised

(2) *processes*: activities occurring within the memory system

Learning and memory involve a series of stages:

- a. *encoding*: occurring during the presentation of the learning material
- b. *storage*: some information is stored in the memory
- c. *retrieval*: recovering or extracting stored information

1. THE STRUCTURE OF MEMORY

Spatial metaphor

Plato: compared mind with a aviary (Vogelhaus), the individual memories are represented by birds

For many years know: the workings of human memory have been compared with to computer functioning:

Spatial metaphor

(3) Memories are stored in specific locations within the mind

(4) Retrieval of memories involves a search through the mind

- a. storage system is inflexible (some kinds of information must be stored closer together than other)
- b. retrieval from memory is very flexible

Neuronal networks: information about an individual or an event is stored in the form of numerous connections among units and is NOT stored in a single place

Memory stores

Basic architecture of the memory:

(5) *Sensory stores*:

- a. each of which holds information very briefly and is modality-specified (limited to one sensory modality)
- b. receives environmental information

(6) *Short term store*:

- a. very limited capacity
- b. process of information
- c. transformation to the LTM

(7) *Long term store:*

- a. essentially unlimited capacity
- b. can hold information over extremely long periods of time
- c. storage often depends on rehearsal

Sensory stores

Iconic store (visual store):

- (8) an icon are formed from the visual fixation
- (9) experiments showed: information has been faded before most of it could be reported
- (10) information in iconic storage decays within about 0,5 seconds

How useful is iconic storage?

- (11) the mechanism responsible for visual perception operates on the icon rather than directly on the visual environment

Echoic store (transient auditory store):

- (12) holds relatively unprocessed input
- (13) temporal duration of unattended auditory information is about 2 seconds (jemanden nicht verstanden haben, dann aber doch wissen, was er gesagt hat)

Short- and long-term stores

The distance between STM and LOM is like between primary store and secondary store:

- (14) *Primary store:* relates to information that remains in consciousness after it has been perceived and forms part of the psychological present
- (15) *Secondary store:* contains information about events that have left consciousness, and are therefore part of the psychological past

2 key characteristics attributed to the STM:

- (16) very limited capacity: 7 +/- 2 chunks (integrated pieces or units of information)
- (17) fragility of storage: any distraction causes forgetting

Recency effect: the last few items in a list are usually better remembered in immediate recall than the other items, this effect is mainly effected in counting backwards for only 10 seconds between the end of the list presentation and the start of the recall: the last 2 or 3 items may be in the STM.

Why does counting backwards cause forgetting from STM?

- (18) maybe a source of interference
- (19) diverts attention from the information

Both are mechanism that seem to play a role in forgetting from the STM .

Double dissociation demonstrates the distinction between STM and LTM:

Two tasks probably involve different processing mechanism if there is a double dissociation, i.e. some patients with brain damages perform normally on task A but poorly on task B and the other way around.

Evaluation

The three types of memory that have been introduced differ in:

- (20)temporal duration
- (21)storage capacity
- (22)forgetting mechanism(s)
- (23)effects of brain damage

Problems with the Multi-Store-Theory:

- (24)The multi-store model is very oversimplified.
- (25)It was assumed that the STM as the LTM are unitary (each store operates in a single , uniform way), but: the STM is not unitary but has to be distinguished into a “auditory-verbal STM” and maybe a “visual STM” and whatever else.
- (26)In addition this model is simplified because it’s impossible that all the differnt sortes of knowledge that shall be stored in the LTM is stored in in on single memory.
 - (2) Rehearsal, that shall be the main way to transfer information from the STM to the LTM is much less in everyday life than multi-store theorist assumed: they perhaps focus too much on structural aspects of memory than on memory processing.

2. WORKING MEMORY

Three components of the Working Memory:

- (27)a modality-free *central executive* resembling attention:
- (28)limited capacity
- (29)deals with any cognitively demanding task
- (30)articulatory loop (*phonological loop*) holding information in a phonological (speech based) form: the order in which words are presented
- (31)visuo-spatial scratch pad (*visuo spatial sketch pad*) specialised for spatial and or visual coding
 - a. (2) and (3) both are slave systems used by the central executive for specific purpose.

Every component has limited capacity and is relatively independent from the other components. Hence:

- (32)if two tasks use the same component, they cannot be performed successfully together
- (33)if two tasks use different components, it should be possible to perform them as well together as separately

Phonological loop

The word-length-effect depends on the phonological loop: The ability to reproduce a sequence of words is better with short words than with long words. This effect depends on the PL as was shown in experiments: some participants had to repeat the digits 1 to 8 (articulatory supression task) while reproducing the sequence of words. The counting made use of the PL

and prevent it being used on the main task. Articulatory suppression eliminated the word-length-effect.

The capacity of the PL is determined by temporal duration, the memory span is determined by rehearsal.

The PL is complex, it consists of:

- (34) passive phonological store directly concerned with speech perception
- (35) articulatory process linked to speech production that gives access to phonological store
 - a. words that are presented auditorily are processed differently from those presented visually

will say: *auditory presentation* of words produces *direct access* to the phonological store, *visual presentation* of words only permits *indirect access* through subvocal articulation.

The irrelevant speech effect: irrelevant or unattended speech impairs (beeinträchtigt) immediate recall. Reason: all spoken material necessarily enters the phonological store.

The phonological similarity effect: immediate recall is impaired when the memorised items are phonologically similar. Reason: this reduces the discriminability in the phonological store.

Importance of the PL:

- (36) increases the memory span (not within activities of everyday life)
- (37) aids reading difficult material
- (38) less important to remember familiar words but more to learn new words

But: in spite little practical significance

Visuo-spatial sketchpad

The two components of the VSS:

- (39) *visual cache:* stores information about visual form and colour
- (40) *inner scribe:* deals with spatial and movement information, rehears information in the visual cache, transfers information from the visual cache to the central executive, involved in the planning and execution of body and limb movement

Importance of the VSS:

- (41) important for geographic orientation
- (42) planning spatial tasks

Assumption: There are maybe different systems for spatial and visual information. Nevertheless, visual and spatial information becomes interlinked in many situations.

Central executive

The CE resembles an attentional system and is the most important component of the working memory, its major functions are:

- (43) switching of retrieval plans
- (44) timesharing in dual-task studies
- (45) selective attention to certain stimuli while ignoring others
- (46) temporary activation of LTM

CE is not unitary: patients with brain damage showed that parts of the CE can be intact (ability for reasoning, resistant to distraction) whereas other parts are damaged (unable to make decisions). Other studies showed that verbal and spatial working memory are rather separate.

Overall evaluation

Advantages of the working memory system over the multi-store memory system of Atkinson and Shiffrin:

(47)the WM system is concerned with both active processing and transient storage of information (-> involved in complex cognitive tasks, eg. language comprehension)

(48)the WM system can explain the partial deficits of STM that have been observed in brain-damaged patients: as it consists of three separate components

(49)the WM incorporates verbal rehearsal as an optional process that within the PL, this is more realistic than the enormous significance of rehearsal in the multi-store model of Atkinson and Shiffrin

Disadvantages of this model:

(50)the role of the CE remains unclear

(51)the capacity of the CE is limited, but it is hard to measure that capacity

(52)what are the precise constraints on the functioning of the CE?

3. MEMORY PROCESSES

Levels-of-processing theory (by Lockhart and Craik)

Attentional and perceptual processes at the time of learning determine what information is stored in LTM. There are various levels of processing and:

(53)the level or depth of processing of a stimulus has a large effect on its memorability

(54)deeper levels of analysis produce more elaborate, longer lasting, and stronger memory traces than do shallow levels of analysis

Distinction between maintenance rehearsal and elaborative rehearsal:

Maintenance rehearsal: involves repeating analysis that have previously been carried out.

Elaborative rehearsal: involves deeper or more semantic analysis of the learning material.

- a. maintenance rehearsal increases LTM but less than elaborative rehearsal.

Elaboration:

Elaboration benefits LTM which depends on the kind of elaboration as well as of the amount of elaboration.

Distinctiveness: Memory traces that are distinctive or unique are more readily (bereitswillig) retrieved than those resembling other memory traces.

Evaluation:

The levels-of-processing approach describes rather than explains:

(55)processes during learning have a major impact on subsequent LTM

(56)elaboration and distinctiveness are important factors in learning and memory

But: it is hard to decide the level of processing used by learners as there is a lack of independent measure of processing depth.

Transfer-appropriate theory: different kinds of processing lead the learners to acquire different kinds of information about a stimulus: whether the stored information leads to subsequent retention depends on the relevance of that information to the memory test.

There is also *implicit memory*, memory that does not involve conscious recollection.

Levels-of-processing theory: Update

The levels-of-processing theory was oversimplified: Lockhart and Craik had not considered retrieval processes in enough detail. Three differences now:

- (57) Lockhart and Craik accepted the notion of “transfer-appropriate processing” (Morris): memory performance depends on an interaction between the type of processing at encoding and the type of processing at retrieval.
- (58) It is not right that shallow processing always led to rapid forgetting: sensory information can persist for hours and even months.
- (59) It was wrong that processing of stimuli proceeds in an ordered sequence: processing at different levels rather can be temporally parallel or partially overlapping.

THEORIES OF FORGETTING

Ebbinghaus’s (1885, 1913) basic measure of forgetting:

savings method: involved seeing the reduction or saving in the number of trials during relearning compared to original learning.

Rubin & Wenzel (1996) found, that a logarithmic function describes the rate of forgetting:

- (60) forgetting functions from individual participants are very similar
- (61) the same functions fit different data sets, main exception: autobiographical memory

Trace decay theory

Claims: Forgetting occurs because there is spontaneous decay of memory traces over time: forgetting depends crucially on the length of the retention interval rather than on what happens during the time between learning and test.

Very little support for trace decay, because:

- how to explain that we remember so well events that happened years ago?

Repression

Claims: Very threatening or anxiety-provoking material is often unable to gain access to conscious awareness: mostly involves traumatic events (that’s why it is hard to examine) Repressors are much slower than other groups to recall negative childhood memories.

Non-experimental evidence for repression:

Childhood trauma: adults recovering repressed memories of sexual and or physical abuse during childhood:

- (62) some believed the recovered memories are genuine
- (63) some argued that they are false

Interference theory

Claims: Our ability to remember what we are currently learning can be disrupted or interfered with by what we have learned previously (*proactive interference*) or what we learn in the future (*retroactive interference*).

Effect strength of proactive and retroactive interference:

- (64)*maximal* when two different responses have been associated with the same stimulus
- (65)*intermediate* when two similar responses have been associated with the same stimulus
- (66)*minimal* when two different stimuli are involved

Three main reasons why the interference theory is less important today:

- (67)it is uninformative about the internal processes involved in forgetting
- (68)it requires special conditions for substantial interference effects to occur (see effect strength)
- (69)associations learned outside the laboratory seem less liable to interference than those learned in it

Cue-dependent forgetting and context-change theory (both are compared with the interference theory)

Claims two major reasons for forgetting:

- (70)there is a *trace dependent forgetting*, in which the information is no longer stored in memory
- (71)there is a *cue dependent forgetting*, in which the information is in memory, but cannot be accessed -> the information is said to be available but not accessible

The cue dependent forgetting involves *external cues* (e.g. presenting category names) and *internal cues* (e.g. mood state).

Information about current mood state is often stored in memory trace and there is more forgetting if the mood state at the time of retrieval is different and less forgetting when the mood state at learning and at retrieval is the same: *mood-state-dependent-memory* (this effect is stronger with positive mood states than with negative mood states and for information about personal events than them without personal relevance).

Encoding specificity principle (Tulving):

“ A to-be-remembered item is encoded with respect to the context in which it is studied, producing a unique trace which incorporates information from both the target and context.”

- a. memory performance depends directly on the similarity between the information in memory and the information available at retrieval.

The change in contextual information between storage and test can produce reductions in memory performance. Forgetting over time can be explained the same way.

Context-change theory based on the search of associative memory SAM (Mensinck & Raaijmakers):

- (72) Forgetting over time occurs when the contextual retrieval cues at time 2 are less strongly associated with the memory trace than are the retrieval cues used at time 1
- (73) There is a contextual fluctuation (Schwankung) process operating over time which can produce forgetting as indicated in (1)
- (74) Forgetting over time will occur if the strength and number of incorrect memory traces associated with the contextual retrieval cues are greater at time 2 than at time 1

Evaluation:

Internal and external cues available at learning and at test have a great influence on memory performance. That forgetting over time can be attributed to a contextual fluctuation process is more speculative.

THEORIES OF RECALL AND RECOGNITION

Recognition memory is usually much better than recall.

Two-process theory

Claims:

(75) *Recall* involves a search or retrieval process, followed by a decision or recognition process based on the appropriateness of the retrieved information -> TWO fallible states

(76) *Recognition* involves only the second of these processes -> only ONE fallible state

The two-process-theory explains also the *frequency paradox* (a) common words are better recalled than rare words but b) the opposite is the case for recognition):

- a. common words have more associative links to other words and so are easier to retrieve
- b. it's easier to make decisions about words that have relatively little irrelevant information from previous encounters stored in LTM

Criticism on the two-process-theory:

(77) Recall is sometimes better than recognition.

(78) Recognition failure should practically never happen but does.

Encoding specificity

Tulving assumed:

(79) there are basic similarities between recall and recognition.

(80) What is stored in memory is a combination of information about the to-remembered-material and about the context

Recall performance is best when the cues provided at recall are the same as those provided at input.

The relationship between recall and recognition:

(81) the overlap between the information contained in the memory test and that contained in the memory trace is greater on a recognition test than on recall test

(82) a greater amount of information overlap is required for successful recall than for successful recognition

Evaluation:

Danger with the encoding specificity principle:

(83) memory depends on “informational overlap”?!, but how to measure this overlap?

(84) The information available at the time of retrieval is compared in a simple and direct way with the information stored in memory?!, but how simple is it really to answer the question “What did you do six days ago?”?

Search of associative memory (SAM) model

Main assumptions of the SAM:

memory traces of an item contain information about the item, the learning context and about other items on the list

in recognition memory, each item plus context forms a compound that activates memory representation

in recall, the participant uses contextual information to search through LTM using associations among items