Introduction

Three logical stages to memory – **encoding, storage and retrieval**.

Episodic memory – a record of episodes that represent our life.

Semantic memory – our store of general knowledge.

Data from neurophysiological studies (of both normal and abnormal brain functioning) constrain psychological accounts of memory.

Encoding

Perception – requires encoding; but application of further encoding means that our representation of objects and events in memory can be very different from that which arises from perceptual processes alone.

Levels of processing

Craik and Lockhart – originally produced as a counter to **Atkinson and Shiffrin**'s multi-store (modal) memory model which postulated multiple, separate stores for each sensory modality. **Craik and Lockhart** argued that what determined if something was memorable was not the store in which the item was held, but the level of processing it received when being encoded.

A fixed sequence of 'levels' was postulated – from early perceptual processes, then to pattern recognition, then to semantic processing. The greater the depth of processing – the more likely an item would be remembered.

Evidence from **Craik and Tulving** – graphemic processing (e.g. case of a word) and phonetic processing (e.g. rhyme) – both types of perceptual processing less well remembered than semantic processing (e.g. is the word a type of fish) and less well remembered than elaborative semantic

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processing (e.g. does the word fit in the sentence "the man peeled the ….")

It is processing that modifies and leaves traces in the memory – i.e. a memory of an item is not a special artefact – merely an after effect of processing information.

Not all levels are necessarily used to process information – as it may be interrupted or simply repeat at the current level.

Type I processing – e.g. keeping a 'phone number in mind by repeating it to yourself vs.

Type II processing – that which proceeds through further levels.

Craik and Lockhart assumed Type II processing benefits long term memory but there is no benefit to LTM from repeated Type I processing.

Problems with the levels of processing theory:

(i) No objective definition of what a 'deeper' level is – instead, improved memory of something is taken to be an indication of a deeper level of processing – a circular argument.

(ii) Does not provide explanations of all memory phenomena. e.g. **Glenberg et al** – using the same technique to investigate Type I processing (i.e. maintenance rehearsal).

Participants asked to remember numbers, but were stopped from rehearsing them by being presented with words at intervals. When asked to free recall words (which they had been led to believe were not relevant) the expectation was that only Type I processing would have been carried out. This was the case – but they also found it had improved recognition memory. Levels of processing theory has no explanation for this effect (as it focuses on encoding and not retrieval.)

Relational and item-specific processing

Distinctive items well remembered (**Koffka**) – would be explained by LoP f/w in that a more unique trace would be left from the deeper processing required.

Eysenck and Eysenck – distinctive processing benefits memory independently of LoP. Nouns used. Participants had to process:

(i) semantically distinct (S-D) nouns by providing a descriptor used infrequently to modify the noun (e.g. slow Ferrari)

(ii) semantically non-distinct (S-ND) – (e.g. fast Ferrari)

(iii) phonetically distinct (P-D) – participants had to pronounce the word in the way it was spelt rather than said – e.g. comb (with the silent 'b' pronounced)

(iv) phonetically non-distinct (P-ND) – normal pronunciation

Result – little difference between P-D, S-ND and S-D conditions (all good); much better than P-ND. Shows semantic processing does improve memory, but distinctive processing with phonetic distinctions also helps – i.e. distinctiveness benefits performance independent of LoP engaged.

However, large body of evidence indicates organising items at encoding based on shared properties helps later recall – e.g. **Deese, Tulving, Elio and Reutener**.

Paradox - **McDaniel** – how can similarity and difference both be beneficial?

Argued different forms of processing are responsible:

Relational processing underlies similarity.
Item-specific processing underlies distinctiveness.

Mandler – different memory representations created by these two forms of processing.

Item-specific – focus is on its mental representation and how the coherence of the cognitive processes that carry it are enhanced – termed 'integration'.

e.g. practising saying a word is item specific processing – integration is expressed as an increase in fluency.

Relational processing – focus is on the relationship between it and other items – e.g. a dog chases a cat.

Maintenance rehearsal results in integration (item-specific processing); Semantic processing results in elaboration (relational processing).

Encoding processing & Mandler's dual process model of recognition

One process runs quickly; based on familiarity. This depends on the degree of integration of an entity's representation.

Second is slower – uses more involved search and retrieval. Benefits from elaboration.

Mandler distinguishes between simple recognition and identification.

Recognition = evaluation of the familiarity of an entity; context-free judgement of prior occurrence.

Identification = a search and retrieval stage (contextual information) and familiarity evaluation. S&R first provides then uses contextual information – e.g. someone trying to remember a person's name will retrieve their gender first, may know where they see them etc. These contexts help to focus the search of memory.
Assumes familiarity and S&R processes happen in parallel. If you are under time pressure, recognition will rely on simple recognition – as it's faster.

Mandler provides support for **Glenberg et al** and **Rundus** – i.e. free recall derives benefit from relational processing but not much from maintenance rehearsal.

However, item-specific/maintenance rehearsal/type I processing benefits recognition more than it benefits free recall.

Predicting memory performance requires consideration of how encoding, representation and memory tests relate.

Hunt and Einstein – categorised list of 36 words or uncategorised list to two groups of participants. Assumption – categorised list participants would relationally process; uncategorised list participants would use item-specific processing spontaneously.

Free recall and recognition tested for both lists – after participants were asked to sort words into categories (relational processing) or rate for pleasantness (item-specific).

Distraction task administered for 1 min.

Results:

Free recall of categorised list > after item-specific processing than after relational processing.

Free recall of unrelated list > after relational processing than after item-specific processing.

=> ***Free recall benefits from task processing that differs from the type of list***

Results for recognition do not replicate the free recall data as recognition of categorised list > after item-specific processing (as for recall), but no difference for recognition of unrelated lists after either type of processing.
=> Further item-specific processing is redundant for free-recall but continues to benefit recognition.

Memory stores and systems

Store = representation
System = representation + processes

Research focus has been mostly on systems, rather than stores

Multiple memory systems

Tulving et al – proponents of multiple memory systems. **Schacter and Tulving** argue for five LTM systems and eleven subsystems. Focus here is just on episodic and semantic memory however.

Episodic – a record of someone's experiences – both objective and (**Wheeler et al**) subjective.

Semantic – our general knowledge store.

Distinction between the two is present in the research focus – e.g. **Collins and Quillian** on semantic memory. They converted a computer system model into one of human knowledge and examined its psychological reality. Established this as a distinct research topic.

Criticism of **Tulving**'s distinction between the two types of memory is that substantial communication between the two is required.

Tulving addresses by suggesting episodic memory is embedded within semantic memory. **Anderson and Ross** used sentence verification and sentence recognition tasks to test semantic and episodic memory respectively. Five conditions. In four conditions, episodic information about categories and exemplars presented in the form of simple sentences that had to be learnt – e.g. a plumber pets a dog; a spaniel is a dog (dog = category; spaniel = exemplar). In the control condition no information about the category or exemplar was given.

Results: time taken to verify a sentence (make a semantic judgement about) affected by the nature of

the episodic information => no distinct separation between the tow as episodic information affected retrieval from semantic memory.

The need to transfer information from the semantic to episodic memory system led **Tulving** to suggest episodic memory was embedded within semantic memory; **Anderson and Ross** results require an information flow from episodic to semantic memory. So are they really separate systems in the first place?

McKoon et al, Neely et al criticise the model as lacking theoretical development – in particular, the manner that different variables affect the operation of semantic and episodic memory has not been specified.

e.g. Anderson demonstrated the 'fan' effect - recognition times increasing for a concept as more information is acquired about it (a test of episodic memory). It is not observed in tests of semantic memory. So although it could be argued it shows a distinction between the two types, there is no theoretical basis for predicting it to occur in episodic memory alone. The opposite result could also argue there is a distinction between the two types – i.e. *the model is not specified sufficiently if either of two contradictory observations could be taken as evidence to support the model!*

A second criticism of multiple memory systems models is the lack of agreement as to how systems and sub-systems are classified – e.g. **Johnson and Chalfonte** say episodic and semantic memory are two sub-systems – not two separate systems. Lack of such criteria may lead to a non-parsimonious model – criticism of **Roediger et al**. Similar confusing evidence from neuro-imaging – **Nyberg and Cabeza** – interactions between "systems" raises questions about what makes up a "system".

Neuropsychological data from amnesiacs suggest a distinction between episodic and semantic data. **Tulving** – amnesiac syndrome due to a severe deficit in episodic memory + an intact semantic memory.

e.g. the case of HM (**Milner**) – brain surgery to remove the anterior 2/3rds of the hippocampus thought to be responsible for his subsequent amnesia. Re-read books as if they were new; met people as if they were strangers even if he'd worked with them earlier on in the day etc.

However – **Gabrieli** et al noted HM carried on using common verbal expressions of the 1950s (date of operation) and found it difficult to explain new words and phrases; poor at matching such words to their definitions. (Semantic memory required here).

Grossman – also reports similar problems in amnesiac patients with Korsakoff's syndrome (similar brain damage to HM).

Amnesiac syndrome cannot therefore taken to support a distinction between semantic and episodic memory. A simpler explanation could be that semantic memory abstracts episodic experience. Common parts of episodic experience will be well learned and remembered, thus facilitating retrieval. The specific contexts will fade (e.g. **Baddeley; Hintzman**). Support for this view also comes from connectionist models – **McClelland et al**.

Declarative and procedural memory

Cohen and Squire – accounted for amnesiac syndrome by the proposition that two LTM systems – declarative and procedural memory are operating.

Declarative = 'knowing that' e.g. I know Cardiff is the capital of Wales

Procedural = 'knowing how' e.g. I know how to ride a bike.

Amnesiacs show normal learning on a variety of tasks – e.g. time taken by HM to complete the same jigsaw declines with practice. **Squire** organises as skills and habits, priming, conditioning and non-associative learning. But, can't remember having done the task.

Therefore, it's a failure of the declarative memory system that produces amnesia. The continuing operation of procedural memory however explains the learning that amnesiacs can do.

Retrieval

Definition: Finding, activating and sometimes using additional processing on a memory representation.

Encoding specificity and transfer appropriate processing

Tulving (and Osler) – encoding specificity (ES)
Bransford et al – transfer appropriate processing (TAP)

ES – ***focus is on the information*** provided at encoding and used at retrieval. From a study of the role of cues in memory retrieval. Target in uppercase (e.g. MUTTON) followed by 0,1 or 2 weakly associated lower case words (e.g. fat, leg). Participant told lower case words may help them to remember the target word.

Found: A single weak associate aided recall if presented at learning – one or two weak associates did not help recall if not presented at learning.

Concluded: Specific retrieval cues help recall if and only if they and the relationship to the target is stored during learning. Successful retrieval of a target is greater if there is an overlap between what is in memory and what is used to help retrieval.

TAP – also acknowledges the overlap between encoding and retrieval – but the ***focus is on the processes*** involved at each stage. Predicts retrieval will be facilitated if the processes used at encoding transfer in an appropriate manner to retrieval.

Morris et al – participants presented with word lists. Half of the participants given orienting questions based on phonetic processing – e.g. does the word (CAT) rhyme with hat? Other half given semantic questions – e.g. is (CAT) an animal?

Following day, half of each group were asked to identify which words had been presented to them the day before by giving a semantically oriented recognition test and half of each group were asked which words rhymed with ones previously seen.

Those originally given the semantic test did less well with the rhyming question than semantic recall and vice-versa. Supports TAP prediction of recall being better if the process used at encoding and retrieval is matched.

Implicit Memory

Free recall, cued recall, recognition tests are explicit test of memory – as clear to participants that their memory is being tested.

Roediger et al – learning tasks are either incidental or intentional; memory tests are either explicit or implicit.

Perceptual and conceptual implicit memory

Perceptual implicit memory test tasks need participants to resolve impoverished displays. Examples - word-fragment tasks (**Tulving et al***); word-stem completion; anagrams; lexical decisions.

Conceptual implicit memory tests require participants to use their semantic knowledge. Examples include word association; category instance generation; answering general knowledge questions.

Regardless of test type, implicit memory is demonstrated if better performance happens with recently presented items compared with older ones.

***Tulving et al** – Participants asked to learn 96 words. 1 hour later, recognition/completion test with 24 words from the 96; 24 distractors; 24 word fragments; 24 word fragment distractors. 7 days later, the remaining 48 originally presented words and 48 distractors (24w; 24d;24wf;24wfd) tested.

Word fragment task was administered without the participants knowing they had seen half of them before on the original list of 96 words => implicit test of memory. Result: more word fragments completed if the word had been on the original list of 96 – known as a word repetition priming effect.

Results also showed that while the success of the explicit test of memory declined over the week; the wf test results did not. This means participants were unlikely to have realised the wf were on the original word list – as performance of implicit memory did not decline over time, whereas explicit memory performance did.

Accounts of implicit memory

Distinction between explicit and implicit memory tasks is a description – not an explanation of what someone's psychological experience of memory is (**Schacter**). Research with TAP and memory systems accounts therefore attempt to explain the phenomena.

TAP account

Roediger et al – strongly advocate applying **Morris et al's** TAP account to explain the difference between performance on implicit and explicit memory tests.

Important distinction is not between implicit/explicit retrieval from different stores, but that the type of processing (conceptual/perceptual) that occurs when retrieval is tested. Most expts on implicit memory have the processing at retrieval confounded with the processing at encoding. Therefore, TAP predictions on performance on conceptual implicit tests are the same as for explicit tests. Also, performance on implicit conceptual tests should match free recall (the definitive conceptual test – top-down conceptual processing required.)

Criticisms – **Hunt et al** – orthographic distinctiveness (perceptual) affects both perceptual implicit test and free recall performance.

McDermott and Roediger – conceptual repetition through presentation of either words or pictures related to a target did not enhance the results of a category exemplar generation test but did enhance free recall. Contradicts TAP prediction of equivalent memory performance.

Roediger et al – proposed **components of processing** account (modified TAP).

Performance on different memory test involves different sets of processes. Tests may share some processes – however, different components employed by any two tests that dissociate.

Other criticism – the circularity of the TAP account – e.g. repetition priming occurs when there is appropriate transfer of processing – however, appropriate transfer of processing is identified by repetition priming occurring.

Memory systems accounts

Differences between explicit and implicit memory test performance is attributed to different memory systems being involved.

Squire – explicit memory test performance = characteristics of declarative memory and implicit memory test performance = characteristics of procedural memory (which is much more highly fractionated => this account therefore has more in common with TAP than it might seem.)

As more memory systems are postulated, the difference between TAP and this account lessens – as a 'system' has to be more than simply a structure in the brain. **Crowder** – identifying where a process is run does not distinguish between the processing perspective and the multiple memory systems perspective. Neuroanatomical n/w analysis shows the highly interactive nature of brain structures involved in memory – not standalone systems – therefore differences between accounts lessens further.

Implicit memory and amnesia

Poor performance on explicit tests; close to controls on implicit tests shown by amnesiacs. **Graf et al** – word lists – judgement on how much a word was liked required. Four later memory tests used. Three explicit – free recall/cued recall/recognition; one implicit – word stem completion. Amnesiacs only performed as well as controls on the implicit test.

Vaidya et al – no difference in performance between amnesiacs and controls on perceptual implicit (word fragment) and conceptual implicit (word association) tasks.

Such results present a problem for TAP – as it argues amnesiac performance should be worse on conceptual implicit tasks due to impaired conceptual processing. Also, as amnesiacs exhibit poor performance on all types of explicit tests it suggests the distinction between implicit/explicit tests far more important than perceptual vs conceptual processing.

Cermak et al – explanation in terms of dual memory processes – normal performance expected if items processed on the basis of familiarity (usually the case for implicit tests) rather than context-based (explicit tests). Perceptual tasks similarly can often be done through item familiarity vs conceptual tasks – context based processing is required.

Jacoby's process-dissociation framework

Argues it is difficult to investigate specific memory processes as they are likely to be contaminated to some degree by other memory processes.

e.g. a participant might convert an implicit test of memory, such as a word-fragment completion test, into an explicit test if they realise that it corresponds to a word they were shown during learning.

Jacoby investigated – his assumption is that implicit performance is based on automatic (familiarity based) processes, whereas explicit memory is dependent on conscious recollection.

Jacoby et al – presented participants with words under full attention and distracted attention conditions. Later provided with two sets of word stems – for one they had to reply with a previously seen word that matched; if they were unable to do so they replied with any word that matched; for the other set the inverse was required.

Results consistent with automatic processes being unaffected by changes in attentional resources at processing, as full and divided attention conditions produce similar outcomes; however, conscious processing is affected. In the divided attention condition for recollective processes, the ability to do the task is severely affected.

Other work questions Jaocby's claim that automatic and recollective processes are separate – e.g. **Joordens and Merikle** – only automatic processes can retrieve items from memory – i.e. recollective processes are redundant in relation to automatic processes (not just independent of them).

Remember and know judgements

Tulving – first to distinguish between items recalled due to remembering it vs knowing it was presented.

Remembering = retrieval from episodic memory – autonoetic (self-knowing)
Knowing = retrieval from semantic memory – noetic

Tulving – word pairs (category – EXEMPLAR – e.g. fruit – PEAR) presented. Participants then given three memory tests – free recall, category cued recall, category and letter cued recall. Probability of a participant giving a response they defined as remembered was 0.9, 0.7, 0.45 (approx) respectively. **Tulving** concluded free recall items had greatest episodic memory (recalled without any cues.)

Tulving's second expt – same tasks, half participants tested immediately, the other half 8 days later. The probability of a remember judgement decreased with the gap – consistent with the view that remember/know judgements reflect rich information available in episodic memory (which lessens over time).

Most other studies use recognition – as it is presumed remember/know judgements are relevant to the dual process account of recognition and only recognition tests provide a good proportion of know judgements (recall experiments bias towards remember).

Criticisms: Remember/know judgements are subjective – in a recall expt it is made after an item has been recalled by a participant. Recognition (one or two step) means the judgement can be given anyway and be more objectively assessed – the experimenter knows which words have/have not been presented.

Different groups may obtain identical recognition scores but differ in their remember/know judgements (**Gardiner and Richardson-Klavehn**) – so they argue participants should be given an opportunity to state if they guessed – without that, guesses default to the 'know' category.

Gardiner identifies four types of variables and their impact on remember/know judgements:
(i) Those that increase remember responses alone (e.g. levels of processing)
(ii) Those that increase know responses alone (e.g. suppression of focal attention during stimulus presentation)
(iii) Increase know/decrease remember – (e.g. nonword vs word presentation)
(iv) Similar impact on both (e.g. long/short response deadlines)

Therefore he argues distinct memory processes must underlie know/remember responses because different variables have different effects.

Do remember and know judgements reflect different response criteria?

Donaldson – argues for this view in his **detection theory**, instead of qualitatively different memory processes being responsible. Remember/know judgements are attributed to different criteria points on a single dimension of memory strength.

Donaldson's model argues strongest memories => remember judgements.

Gardiner and Conway contradict – 'knowing' – a natural state accompanying answers to semantic memory questions (conscious recollection of encoding rarely accompanies such retrievals). Therefore, how could semantic memory have 'less strength' than episodic memory?

Conway et al – naturalistic study of psychology undergraduates acquiring knowledge of the subject.

A three-alternative multiple choice test taken by participants six months apart. The correct answer had been presented directly in a lecture – the other two answers were plausible but wrong.

Participants selected an answer and indicated:

(i) If they remembered the learning episode the answer came from
(ii) If the 'just knew' the answer was right
(iii) Neither (i) nor (ii) , but felt it to be the answer
(iv) The answer was a guess

Response probabilities for correct answers in tests 1 and 2 were:

Remember	0.39 (test 1) -> 0.14 (test 2)
Know	0.19 (test 1) -> 0.43 (test 2)
Familiar	0.25 (test 1) -> 0.26 (test 2)
Guess	0.17 (test 1) -> 0.17 (test 2)

Shift from remember to know most pronounced in those getting the highest marks. The result is therefore contrary to **Donaldson**'s account.

Remember -> Know shift – indicates how memories lose detail and a more abstract version remains as conceptual knowledge in semantic memory.

Also provides support for **Tulving**'s idea that episodic memory is embedded within semantic memory.

Conclusions

Mandler, Tulving, Morris, Bransford and Franks have demonstrated good memory performance relies on the interaction between encoding, representation and retrieval (and not just LoP).

Tulving's description of separate semantic and episodic memory systems have influenced later research – partly as techniques in connectionism and neuro-imaging have advanced to enable this kind of research.

More research has been recently performed on retrieval operations – due to interest in implicit memory and remember/know judgements.

Jacoby et al have provided insight into process-dissociation and has generated new methods of investigating memory.

Retrieval research has to confront the difficult issue of consciousness.

All these accounts have contributed to improving our overall knowledge of how memory might work.