DOCUMENT RESUME

ED 343 392 FL 020 071

AUTHOR	Service, Elisabet
TITLE	Applying the Concept of Working Memory to Foreign Language Listening Comprehension.
PUB DATE	87
NOTE	11p.; In: Equality in Language Learning. Proceedings of the Nordic Conference of Applied Linguistics (5th, Jyvaskyla, Finland, June 4-7, 1987); see FL 020 065.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Applied Linguistics; *Cognitive Processes; *Language Processing; Language Research; *Listening Comprehension; *Memory; *Recall (Psychology); Second Language Learning; *Second Languages; Theories

ABSTRACT

Memory research has recently moved from looking at performance in highly artificial laboratory tasks to examination of tasks in everyday life. One consequence is the development of the concept of "working memory." For the learner, foreign language comprehension makes great demands on working memory capacity. Comprehension of a message requires knowledge of the results or progress of earlier or parallel information processing stages such as phonological analysis, word recognition, parsing, etc., as well as of expectations. One theoretical framework for working memory provides a starting point for investigation of how the language learner can cope with temporarily storing enough information to comprehend a message in a language not yet mastered. The theory helps to differentiate between different kinds of working memory capacity, and suggests three areas for further study: (1) how comprehension is impaired when different memory systems are suppressed; (2) how different compensatory strategies aiming at optimizing working memory capacity use affect understanding of the message; and (3) how important it is for the learner to be able to generate quickly the appropriate articulatory and orthographic representations of words. A brief bibliography is appended. (MSE)

APPLYING THE CONCEPT OF WORKING MEMORY TO FOREIGN LANGUAGE LISTENING COMPREHENSION

ELISABET SERVICE
Department of Psychology
University of Helsinki

ABSTRACT

Memory research has recently moved from looking at performance in highly artificial laboratory tasks to increasing inspection of tasks occurring in everyday life. One consequence of the new emphasis is the development of the concept of "working memory". For the learner, foreign-language understanding is a task that places high demands on working memory capacity. Comprehension of a heard message requires, at every point in time, knowledge of the results or progress of earlier or parallel information processing stages, like phonological analysis, word recognition, parsing, etc., as well as of expectations. The working memory framework proposed by Baddeley and Hitch (1974; Baddeley 1983) provides us with a starting point for asking questions about how the learner can try to cope with temporarily storing enough information to be able to comprehend a message in an incompletely mastered language.

1. Introduction

Cognitive psychologists have been accused of having replaced the behaviourist black box with more or less complicated flow charts of equally vague boxes usually given labels ending in "store" or "processing". These boxes are connected with even more mysterious objects marked with innocent-looking arrows (cf. Allport 1980). On the whole this criticism is not totally unwarranted, but an attempt will be made here to show that a system of boxes with all its question marks can still be a useful starting point for asking questions eg. about foreign language understanding. More precisely an attempt will be made to show that the working memory framework developed by Alan Baddeley and Graham Hitch (eg. Baddeley and Hitch 1974; Baddeley 1983) can serve as a basis for research in how we deal with a message communicated orally in a foreign language.

The most popular view of human information processing in the 1970's was one based on a three-box memory system. Referring to Murdock, Alan Baddeley has called it and its derivatives the modal model. It assumes that all sensory information is first stored in a more or less "raw" form in a sensory register. The visual register, called iconic memory, decays in half a second, while the auditory store or echoic memory can hold a trace for several seconds. The original sensory trace is then filtered, categorized and associated with information already in the memory before it is entered into the next box, called short-term memory (STM). By now a considerable amount of information has been lost. STM is characterized by limited capacity originally estimated in "chunks" of information of any kind (ie. units like letters, digits, words, or the like) (Miller 1956). Material can stay there for up to 30 seconds unless it is pushed out by new material. It can also be re-entered by rehearsal an unlimited number of times. Rehearsal has been thought to enhance transfer to long-term memory (LTM), a more or less permanent memory store (Atkinson and Shiffrin 1971. Information in LTM can be reactivated in STM when needed.

The problem of finding the material wanted cannot, however, always be solved, at least in the time allocated for retrieval. This is the main (if not only) reason for forgetting from LTM. The prototype of the modal model of memory can be seen in Figure 1. Most text-books in cognitive psychology describe a variant of this model, though nearly all of its original assumptions have now been qualified. A major change in emphasis has, for instance, led to the postulation of "top-down" arrows to show that information in LTM probably affects stimulus analysis.

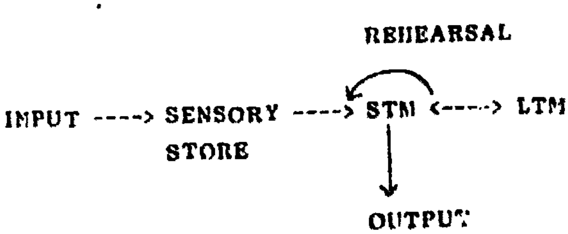

Figure 1. A prototype model of information flow between memory components.

2. Objections to the view of STM as a limited-capacity general processor

The modal model of memory makes STM with its limited capacity an obvious bottle-neck for all information processing. As it has also been generally assumed that STM can be equated with the memory working space needed for performing tasks requiring temporary storage of information, STM has gained a central position in the model as the place where it all happens. In the 1980's however, a number of the assumptions concerning STM have been questioned or simply proved not to hold.

Allport (1980), for instance, has convincingly argued that there is little evidence for the existence of general capacity of the kind that STM has been assumed to possess. Instead, capacity seems to be more or less content-specific (how content-specific remains, however, unanswered).

The capacity limits of STM, at least for the storage of verbal material, do not seem to be set by the number of chunks, but rather by processing time (Baddeley, Thomson and Buchanan 1975). The more units it is possible to process (eg. mentally rehearse) in a limited period of time, the more units there is room for.

Nor does STM seem to meet the requirements of being a working memory. Temporary memory required in many tasks does not show typical STM characteristics (eg. Klapp, Marshburn and Lester 1983).

Lastly, one of the best-known effects thought to depend on STM, ie. the tendency to remember the last members of a list better than the middle ones, appears not to be a STM phenomenon at all (eg. Crowder 1982) but possibly something to do with the size of retrieval search sets based on order information (Glenberg and Swanson 1986).

3. Working memory as a central coordinator and a set of slave systems

A constructive attempt to try to reconcile memory theory with recent experimental data is the working memory model put forward by Baddeley and Hitch (1974; Baddeley 1981; Baddeley 1983). Basically the model consists of a limited general attentional capacity unit called the central executive working with a number of content-specific systems. The central executive can be used for control processes, strategy selection, and possibly additional storage. Its precise characteristics are, however, left open, as it is empirically difficult to study it in isolation.

The central executive controls a number of 'slave systems' consisting of active and passive components. The active components are defined as those involving active rehearsal. This makes it possible to keep their contents in store by continually refreshening the trace. Traces in passive stores, on the other hand, fade as a function of time or get pushed out by incoming material. Active stores do, however, feed into passive stores making it possible to use them as rehearsal components in loops comprising an active and a passive component.

At the moment the most investigated slave system is that termed the articulatory loop. It is assumed to consist of a passive phonological input store and an active subvocal rehearsal system. This two-component verbal working memory system can be used to explain a number of well-documented processing phenomena (see Baddeley 1983). It accounts for the finding that phonologically similar-sounding letter names or words are harder to remember than more dissimilar-sounding material (Conrad and Hull 1964). Presumably, keeping the traces of different but similar-sounding items distinct is a problem.

The articulatory loop also accounts for the fact that the number of words that can immediately be repeated depends on their length (Baddeley, Thomson and Buchanan 1975). Shorter words can be pronounced more quickly, which means that more words fit into the time-limited articulatory loop and can subsequently be reproduced.

The articulatory loop can also be used to explain why unattended speech requiring no response seems to disturb the reading of visually presented material. Apparently it interferes with the translation of visual representations into phonological representations for subsequent rehearsal.

The investigation of the articulatory loop system relies heavily on experimental techniques using articulatory suppression. The subjects are asked to continuously repeat a syllable or count to a certain number concurrently with the performance of the experimental task. This is assumed to prevent subvocal articulatory rehearsal, ie. block the articulatory loop. The effects of this procedure can then be observed as compared with unconstrained performance on the task.

Experiments using the articulatory suppression technique have revealed a number of phenomena of interest. The effect of unattended speech on visually presented material disappears under articulatory suppression. This presumably means that the phonological code that is disturbed during reading is created by articulatory translation, while another route is used under articulatory suppression. The word-length effect on immediate verbal memory span practically disappears as well, which suggests its articulatory origin. The phonological similarity effect is abolished with visually presented material but not with aurally received material. This can be interpreted as supporting the conclusion that a phonological representation with visually presented words is created via an articulatory one, whereas heard material has direct access to the phonological store (Salamé and Baddeley 1982; Baddeley, Lewis and Vallar 1984).

Another slave system that has attracted attention and research effort is what is called the visuo-spatial scratch-pad. It is supposed to be a system specializing in temporary storage of visuo-spatial information. Interference techniques to study the visuo-spatial scratch-pad involve making the subjects look at, or make judgments about, abstract check patterns (eg. Logie 1986). Possibly this slave system could also be used to hold orthographic representations of words, though this has not to my knowledge been looked at. An educated guess can, however, be based on experiments showing interference between visually presented verbal material and mental images compared to aurally presented sentences and visual images (Glass, Millen, Beck and Eddy 1985). Tasks assumed to tax visuo-spatial scratch-pad capacity have also been shown to interfere with the processing of visual images connected to pairs of words (Baddeley and Lieberman 1980).

In addition to the articulatory loop and the visuo-spatial scratch-pad, other slave systems can also be conceived of. My own rather wild guess is that there is some temporary store for representing eg. rhythm, possibly connected to a motor output store or the articulatory loop. There might also be a store for non-speech sounds or for non-spatial visual information like colour. Reisberg, Rappaport and O'Shaughnessy (1984) have gone as far as suggesting that an unlimited number of motor systems with a feedback component can serve as additional working memory slave systems. In the name of parsimony it seems, however, sensible to proceed by analysing tasks using a minimum number of postulated systems to see what they account for. Assuming a number of new slave systems on loose grounds obviously makes the explanatory value of the model rapidly crumble.

4. What happens in foreign language understanding? some speculations

The working memory model was developed to explain and predict performance in everyday information processing tasks (cf. Baddddeley 1983). For it to be useful in any one case, we have to describe the structure of the task to seen what kind of demands it might place on working memory capacity. Language understanding is a complicated and far from fully understood task. The lack of understanding is revealed in eg. the inadequacy of present attempts to explain different defects in speech and text understanding caused by brain damage.

One way of learning more about the cognitive processes involved in language understanding could by by looking at the similar task of understanding a foreign language when it is still not very well mastered. The two tasks can be described using some widely accepted assumptions about human information processing. The task descriptions can then be used to predict differences in performance of the two tasks.

Text and speech in the native language are characterized by a high degree of redundancy. Years of intensive practice with production and reception have probably resulted in the internalization of the distribution of co-occurences on the phonological, morphological, lexical, syntactic and semantic levels of language as well as in prosody. In other words, native speakers are familiar with the patterns of their language and know how common they are. Command of a foreign language, on the other hand, suffers from gaps in knowledge on all these levels. In addition, the frequency representations for co-occurring units are based on too small and often unrepresentative samples of the foreign language.

High redundancy makes it possible for native language understanders to heavily rely on top-down processing, ie. on using their knowledge of language structure to predict what they should hear next. This way internal models of language can be seen to guide the identification of speech units. Consequently the need for absolutely accurate analysis of the physical stimulus is diminished.

The internal models representing knowledge of a foreign language, however, would be far from complete or accurate for an intermediate-level learner. This should entail a considerably greater dependence on bottom-up analysis starting from the acoustic features of the speech signal. As some units, eg. words, of the speech signal would lack an internal representation altogether, ie. be unfamiliar to the listener, understanding of the message would depend on less information available than in the case of understanding utterances in the native language. Consequently the learner can be assumed to be under pressure to attempt identification of eg. every word in an utterance, as some of the attempts are bound to fail and it is crucial for the learner to recognize enough words and syntactic cues to be able to guess utterance and discourse meaning. Additional difficulty in foreign language understanding could derive from the learner's top-down processing going wrong. Backtracking is a time-consuming process and depends on an accurate record of the received speech signal.

Native language understanding could then be roughly described as a process dominated by top-down hypothesis testing based on overlearned representations, the handling of which is extremely fast and mostly unconscious. Consequently interpretation of the speech signal demands little processing capacity and the listener can concentrate on understanding the message. This can, for instance, be described in terms of building a mental model to represent the information (cf. Johnson-Laird 1983).

Understanding something said in a less well learned language, on the other hand, would be dominated by storage of intermediate results of the interpretive process and maintenance of a true-to-life representation of the "raw" signal to win time for slow analysis and make reinterpretations possible when necessary. Probably longer stretches of language including only partly recognised material would have to be temporarily stored before an attempt at a final interpretation of them could be made. This would lead to constant overloading of the working memory, which would then be seen eg. in interference between mental model building reflecting understanding of the message and lower-level speech processing. Lastly, setting up an internal representation for the received signal is in itself probably slower and more capacity demanding in a less familiar language.

It seems then that successful comprehension is much harder in an incompletely mastered language than in one's own. This is, of course, what every language learner knows. The description makes it possible, however, to predict what kind of language should be especially difficult. It also makes it possible to ask questions about the strategies the language learner could use to cope with the situation.

5. What has Baddeley's working memory model to do with foreign language processing?

From the description above it is clear that the foreign language understander is in trouble. The acute difficulty is at least partly caused by his/her working memory being overloaded. If the language understander were given unlimited time, as in normal reading, the task would probably be easier. Reading comprehension can, however, not be compared with listening comprehension, as the low-level stimulus analysis needed in spoken word recognition does not have to be carried out in decoding written language.

Baddeley's working memory model helps us to differentiate between different kinds of working memory capacity. We can use it to ask questions about which slave systems the foreign language understander uses to cope with ON-LINE tasks. Finding answers involves using selective blocking techniques like articulatory suppression or some visual task to see how performance in a language understanding task is impaired when a particular slave system is put out of action. Another way is to compare the effects of selective blocking on native and foreign language comprehension. If, for instance, foreign language understanding depends on the use of orthographic representations of words in order to add visuo-spatial-scratch-pad capacity to the articulatory-loop capacity possibly already used up, a visual interference task might interrupt foreign language comprehension more than native language understanding. If the language understander, on the other hand, resorts to some form of simultaneous translation to be able to rely on the more automatized handling of the native language, performance could be enhanced by a presentation of native language translation equivalents of keywords in the heard utterance. The effect of these could be compared with that of keywords written in the foreign language or that of differently spelt homonyms.

Another line of questions has to do with how different compensatory strategies aiming at optimizing use of working memory capacity affect the understanding of the message. One might assume, for instance, that reliance on orthographic representations of words would slow down processing of sentences conveying visual information.

A third set of questions arises from the results that point to capacity being time-limited (Baddeley Thomson and Buchanan 1975). How important is it to be able to quickly generate articulatory and orthographic representations of words? Do these abilities have a direct connection with listening comprehension and other language tasks? Answers to these questions are quite important when decisions are made on what aspects of language should be stressed when tuition first begins.

BIBLIOGRAPHY

Allport, D.A. 1980. Attention and performance, in G. Claxton (ed.). Cognitive psychology: new directions, London: Routledge & Kegan Paul.

Atkinson, R.C. and R.M. Shiffrin 1971. The control of short-term memory, Scientific American 224, 82-89.

Baddeley, A.D. 1981. The concept of working memory: a view of its current state and future development, Cognition 10, 17-23.

Baddeley, A.D. 1983. Working memory, Philosophical Transactions of the Royal Society of London B, 302, 311-324.

Baddeley, A., V. Lewis, G. Vallar 1984. Exploring the articulatory loop. Quarterly Journal of Experimental Psychology 36 A, 233-252.

Baddeley A.D. and K. Lieberman 1980. Spatial Working Memory. in R. S. Nickerson (ed.), Attention and performance VIII, Hillsdale, N. J.; Erlbaum.

Baddeley, A.D., N. Thomson and M. Buchanan 1975. Word length and the structure of short-term memory, Journal of Verbal Learning and Verbal Behavior 14, 575-589.

Conrad, R. and A. J. Hull 1964. Information, acoustic confusion and memory span, British Journal of Psychology 55, 429-432.

Crowder, R. G. 1982. The demise of short-term memory, Acta Psychologica 50, 291-323.

Glass, A. L., D. R. Millen, L. G. Beck and J. K. Eddy 1985. Representation of images in sentence verification, Journal of Memory and Language 24, 442-465.

Glenberg, A.M. and N.G. Swanson 1986. A temporal distinctiveness theory of recency and modality effects, Journal of Experimental Psychology: Learning, Memory and Cognition 12, 3-15.

Johnson-Laird, P.N. 1983. Mental Models. Cambridge: Cambridge University Press.

Klapp, S.S., E.A. Marshburn and P.T. Lester 1983. Short-term memory does not involve the "working memory" of information processing: the demise of a common assumption, Journal of Experimental Psychology: General 112, 240-264.

Logie, R.H. 1986. Visuo-spatial processing in working memory. Quarterly Journal of Experimental Psychology 38A, 229-247.

Reisberg, D., I. Rappaport and M. O'Shaughnessy 1984. Limits of working memory: the digit digit-span, Journal of Experimental Psychology: Learning, Memory and Cognition 10, 203-221.

Salamé, P. and A. Baddeley 1982. Disruption of short-term memory by unattended speech: implications for the structure of working memory. Journal of Verbal Learning and Verbal Behavior, 21, 150-164.