



Short-Term Memory in EFL Listening Comprehension

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Abstract

This paper relates the definition of STM, the difference between STM and LTM, and theoretical and empirical researches on STM. On the basis of this analysis, the paper draws a conclusion that using good listening skill will make EFL listener retain the material in STM for a longer time and skillfully activate knowledge in LTM to enter STM; STM plays an important role in listening comprehension.

Keywords: Listening comprehension, Short-term memory, Long-term memory, EFL (English as a Foreign Language)

1. The definition and nature of STM

A very important event in the history of cognitive psychology was the development of a theory of STM (short-term memory) in the 1960s. Jack C. Richards, John Platt and Heidi Platt (2000: 283) define STM as: "Short-term memory refers to that part of the memory where information which is received is stored for short periods of time while it is being analyzed and interpreted. Once the message or information in an utterance is understood the data may become part of permanent memory (or long-term memory). The utterance itself is now no longer needed and may fade from short-term memory."

STM is transient memory. It has a limited capacity—it can only retain about seven or so unrelated chunks (a chunk is a meaningfully coded unit) once. LTM (long-term memory), on the contrary, is the place where more permanent information is stored. It is unlimited in capacity and holds information over a much longer interval, but it often takes a fair amount of effort to get information into it. LTM serves as a data base into which information is inserted through STM, and from which information is retrieved to be used in STM. STM plays the role of a gateway into LTM. In Call's (1985) view, memory is made up of three parts: sensory store, short-term memory and long-term memory. Information comes in from the environment through a series of sensory memory systems (iconic and auditory memory) from which it is lost unless attended. The transitory sensory store preserves information for a few hundred milliseconds; its characteristics are for the storage of visual information. Then the information goes into an intermediate STM where it has to be rehearsed before it can go into a relatively permanent LTM. Information is lost within 20-30 seconds if it is not rehearsed in STM. If the item leaves STM before a permanent LTM representation is developed, it will be lost forever. One can't retain information in STM forever since new information would always be coming in and would push out old information from the limited STM. STM can combine information from both the environment and LTM whenever a person tries to learn new information, make decisions, or solve problems. Once in STM, an item can be retained there by rehearsal. As an item is rehearsed, information about it is transferred to LTM. As soon as rehearsal of an item is brought to an end, the item soon will be displaced by a new incoming item and thus lost from STM.

By the late 1960s, a range of models began to appear in which STM and LTM were conceptualized as separate systems. The most influential of these was the Atkinson and Shiffrin (1968) model, which became known as the *modal model*, as shown in Figure 1.

The fact that STM is needed when we perform most cognitive tasks describes its important role as a working memory that maintains and manipulates information. Baddeley's working memory model gives a more complete account of STM by proposing a phonological loop for maintaining and manipulating acoustic information, a visual-spatial scratchpad for maintaining and manipulating visual/spatial information, and a central executive for making decisions—a supervisor who decides which issues deserve attention and which will be ignored. Functionally the phonological loop and the visual-spatial scratchpad appear somewhat similar to the concept of STM because they retain respectively verbal and visual information. Cowan (1995) and Engle (1998) have distinguished between working memory and STM by propounding that STM is a component of working memory; working memory has the ability to process and store the information simultaneously that distinguishes it from STM. The important function of STM is to maintain the activated-memory codes through the use of the phonological loop and visual-spatial scratchpad. The important function of the central executive is to control attention, strengthening a tighter link between capacity theories of attention and theories of working memory.

We should also realize the difference between STM and LTM. Being aware of distinction can facilitate the information to be retained in STM for a longer time. The distinction between STM and LTM has long been a part of psychology's history:

- (1) STM is brief, maintained by rehearsal. LTM is more durable.
- (2) STM has a limited capacity (7 ± 2 chunks), holding at most a few items, whereas the capacity of LTM is assumed to be virtually unlimited for all practical purposes.
- (3) STM is said to code items in a verbal form. We seem to verbally rehearse in STM. The encoding stage favors an acoustic code in STM, but one based on meaning in LTM. That is to say, STM preserves verbatim content, whereas LTM preserves meaning.
- (4) Forgetting occurs from STM when the contents of storage are displaced (and replaced) by later-occurring items. Forgetting doesn't easily occur from LTM.
- (5) STM serves to transfer information into LTM. Rehearsal in STM keeps information available longer for encoding into LTM.
- (6) Retrieval from STM is thought to be more or less error-free whereas retrieval from LTM appears to be error-prone and a major cause of forgetting.

2. Review of the researches on STM

From 1950s-1970s, the study of STM, the retention of small amounts of information over brief time intervals, formed a major component of the development of cognitive psychology. The research achievements in STM appeared one after another. The following part will offer the review of the theoretical and empirical achievements in STM research and the application of STM to language learning.

2.1 Theoretical and empirical researches on STM

1) We should believe that George A. Miller is the founder in STM. In 1956, a paper by G. A. Miller entitled "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information." As the title proposes, Miller pointed out that on average it is possible to retain seven separate items of information in short-term storage at a time. Miller judged his proposal by experiments in which testees heard long lists of words, digits, or letters and then endeavored to recall as many items as possible. These studies indicated that testees always were able to recall five to nine items accurately. Such results proved that this was the maximum number of items a testee could retain in STM immediately. The finding was confirmed by many experiments later.

2) We should not ignore the importance of the *Atkinson-Shiffrin Model*. (1) The theory transferring information from STM to LTM put forward by Atkinson and Shiffrin (1968, 1971) placed emphasis upon the interaction between STM and LTM. They were particularly interested in how people could transfer information from STM to LTM. However, it is not always easy to enter new information into LTM. They suggested several control processes that could be used in an effort to learn new information. The control processes are strategies that a person uses to help the acquisition of knowledge, including rehearsal, coding, and imaging (three of the primary ways of learning). Because there are so many control processes to study, Atkinson and Shiffrin (1968) decided to concentrate their research on only one-verbal rehearsal. Verbal rehearsal is usually regarded as a form of rote learning (learning by repetition rather than through understanding) because it means simply repeating information again and again until we think we have learned it. It can be useful when the material seems rather abstract and we can't use strategies such as coding or imaging. Therefore, the learning of abstract and meaningless material encourages the use of rehearsal. The effect of rehearsal is to transfer information into LTM. (2) The *Atkinson and Shiffrin Model* explains that the serial position effect is the ability to recall words at the beginning and end of a list better than words in the middle of the list. Primary effect, the better recall of words at the beginning of a list, can be explained by their storage in LTM; that is to say, since early words are rehearsed more often than the other words, they should have a higher probability of being retrieved from LTM. Recency effect, the better recall of words at the end of a list, can be explained by their storage in STM; that is to say, the words at the end of the list are still in STM when a person begins the recall.

3) For the researches on the information coding in STM, from 1963 to 1976, Conrad (1972), Wickelgren (1973), Winkens (1976) and Shulman (1972) had carried out repeated experiments from the different angles at the different periods and put forward different coding modes successively, summing up to 2 kinds of coding: acoustic and semantic coding. Acoustic (speech-based) codes based on the sound of the stimulus are the predominant memory codes in STM. Semantic (meaning-based) codes based on the meaning of the stimulus are the predominant codes in LTM.

Kintsch and Buschke (1969) reasoned by performing the experiment that if STM was verbal in character, there would be a lot of acoustic interference if the words in the list sounded alike—for example, *see* and *sea*. If participants were asked what followed *see*, they might recall the word that followed *sea*. Such acoustic confusion would be a particular problem for words at the end of the list, which were supposed to be in STM. On the other hand, words from the

beginning of the list might cause semantic confusion if they were synonyms, such as *sea* and *ocean*, because these words were in LTM, where the coding was supposed to be semantic. Kintsch and Buschke discovered that recall for the last few words in the list was impaired if the words were homophones (similar sounding) and that memory for the first words of the list was impaired if the words were synonyms (similar meaning). It proved that STM is acoustic (sound-oriented) and LTM is semantic (meaning-oriented).

4) Craik and Lockhart (1972) propose the *depth of processing theory*. They think if the rehearsal is just a matter of rote repetition, it is not very effective; forgetting begins with the moment that the repetition stops. Rote rehearsal might be suitable for phone numbers dialed once, but it has main weaknesses when we want to remember information for longer periods of time. Sheer rehearsal is not enough to guarantee good LTM. Rehearsal improves memory only if the material is rehearsed in a deep and meaningful way. In order to transfer information to the relatively permanent LTM, it is indispensable to use elaborate rehearsal; that is, a deeper level of processing. Forgetting is relatively rapid in STM studies because the items have been analyzed only to a relatively shallow acoustic (or visual) level. Similarly, persistence in LTM is attributed to deeper processing of the items, particularly to analyzing the item's meanings (Craik and Lockhart, 1972). The more deeply processed words are better remembered. The more we can relate current experiences to previously stored information, the better we will remember them. The depth of processing theory disconfirmed the original Atkinson and Shiffrin theory of STM, which suggested that the information was transferred to LTM as a function of verbal rehearsal.

5) Recent evidence shows that two separate verbal-processing rates influence a person's memory span (Cowan, Wood, & Keller, 1998). One is the speed at which a person can pronounce the items on the list used to test the memory span. The other is the speed at which a person can retrieve the items from STM. Both rates decide how many items a person can keep active in STM. There is an interesting relation between memory span and verbal rehearsal. Cowan discovered this in a developmental study: both pronunciation rates and retrieval rates correlated with memory span but did not correlate with each other; that is to say, students who had fast pronunciation rates recalled more than students who had slow pronunciation rates, and students who had fast retrieval rates recalled more than students who had slow retrieval rates, whereas students who had fast pronunciation rates did not necessarily have fast retrieval rates.

6) Waugh and Norman (1965) tested whether the loss of information from STM is caused mainly by decay or by interference. Interference theory refers to "forgetting occurs because other material interferes with the information in memory" (Stephen K. Reed 2000: 85). Decay theory means "information is spontaneously lost over time, even when there is no interference from other material" (Stephen K. Reed 2000: 85). The findings proved that interference is the important reason of forgetting. If information spontaneously decays from memory, we can't stop its loss. If the loss of information is by interference, we can improve retention by structuring learning in order to reduce interference to a minimum. Two kinds of interference—proactive interference and retroactive interference exist. Retroactive interference means forgetting that happens because of interference from material encountered after learning; proactive interference means forgetting that happens because of interference from material encountered before learning. A phenomenon named *release from proactive interference* explains how interference can be minimized by reducing the similarity among items.

2.2 Application of STM to language study

To date, only a few studies have investigated the relationship between STM and language learning in the foreign countries and in China.

The result of Glicksberg (1963) was the first of these investigations. The findings suggest that STM span for linguistic input reveals a positive correlation with target language LC (listening comprehension); STM for random digits makes little contribution to the process of LC, even when it approaches the capacity of native language memory for the same type of input.

Lee (1964) also studied the relationship between STM and target language proficiency. She researched into target language memory span for long and grammatically complex sentences. The results offer evidence that long sentences are more difficult to recall than shorter ones; more proficient learners have learned to take advantage of increasingly complex syntactic patterns to chunk linguistic data coming in efficiently; complex grammatical structures impede beginners but facilitate advanced students and native speakers to recall spoken language.

St. Jacques (1964) found that differences in the lengths of native and target language STM span were a better predictor of overall language achievement than the length of the span for target language input itself. The result also states that individual differences in length of target language memory span are important only when they are very different from the length of the individual's native language span.

Harris (1970) investigated the relationship between scores on a measure of STM for target language input and scores on subtests of English proficiency. The findings suggest that measures of STM can clearly indicate a student's proficiency in the target language.

Levy (1978) proposes that although we can understand the meaning of words without subvocalization, subvocalization

is helpful in aiding the detailed recall of information. The results of Levy's experiment displayed that participants performed poorly when they had to count from 1 to 10 to suppress subvocalization while reading. They were not as accurate in identifying when changes occurred, regardless of whether there were lexical changes or semantic changes. However, suppressing subvocalization did not interfere with performance when the subjects listened to the sentence. This reveals that suppression interfered specially with reading, not with language comprehension in general. The difference between listening and reading is that the listener receives an acoustic code rather than a visual code. The fact that counting interfered only with recall following reading proposes that translating visual material into an acoustic code facilitates to retain detailed information in the text. A popular explanation of these findings is that subvocalization makes it easier to keep words in STM until they can be combined with others words in the sentence or paragraph (Conrad, 1972; Kleiman, 1975).

Wang Chuming (1990: 141) points out there are only two researches worth a mention on STM which are all conducted by foreign scholars: Cook (1977) and Call (1985).

In an experiment on memory, Cook (1977) compared foreign language learners with native speakers in memory for digits and other words. The findings indicate that memory span for random digits is not a good indicator of overall language proficiency; adult English learners are similar to English native adults in the ability to memorize digits in English. However, memory for other words, such as the names of objects exists the difference. Cook distinguishes two aspects of memory: primary memory and speech-processing memory. Primary memory is not highly dependent on language and is therefore easily transferred from the native language to the target language, whereas speech-processing memory is highly dependent on language. The foreign language learner's speech-processing memory is limited by a lack of facility in using the syntax of the target language. As compared with the names of objects, the words which stand for digits are very limited and are easily identified by foreign language learners. We need to make use of the deep-level information in LTM to recognize the name of the object, whereas the deep-level information including background knowledge is usually lacked by the foreign language learner. Cook suggests that the processing patterns of STM for the foreign language and the native language are the same although STM for the foreign language is very inferior; that is to say, STM operates on target language input in the same way that it operates on native language input, even though STM has a smaller capacity for target language input. This means that both foreign language learners and native language speakers need to process and interpret the information in STM as quickly as possible by using the knowledge in LTM. The important difference between foreign language learners and native language speakers lies in:

- (1) The former's language knowledge in LTM is not as sufficient as the latter's.
- (2) A lack of familiarity causes the decrease in processing language speed.

The difference reflects the processing ability in STM. Therefore, STM and LTM are interdependent, pin down each other and influence language learning and information processing together. Research on STM facilitates to know a learner's proficiency in the foreign language.

Call's (1985) experiment endeavored to study the relationship between STM and foreign language listening. The result shows that STM is the important component of LC; memory for syntax will be good predictor of listening skill; trying to understand the foreign language material when syntactic structures are unfamiliar might be the same as trying to recall foreign language words arranged in random order. Call points out many textbooks lay emphasis on listening for the meaning of the passage rather than listening for the linguistic structure. She stresses that it is the structure that forms the meaning; only possessing vocabulary knowledge is not sufficient to make learners improve listening proficiency; learners must also learn to make use of syntax to help recognize the relationships among the words and to retain utterances in STM for a longer time so as to make sense of them. In Call's view, it is indispensable to do the specialized exercises of identifying syntax. The experiment reminds us of emphasizing the role of syntax in listening.

In China, Professor Chen Jitang did four experiments from 1998 to 1999 to prove that the listening content, quantity of listening content and listener's experience knowledge have direct influence on the quality and quantity of STM. The experimental results indicated that listening content and people's experience knowledge are the important factors that cause the bottleneck phenomenon. The findings try to prove the inner links between STM and English LC (listening comprehension), to discuss how to improve the capacity of STM and to tackle the problems of listening materials, teaching and learning methods.

3. STM and EFL Listening Comprehension

If you want to be clear about the role that STM plays in LC (listening comprehension), we should first know a succession of processes through which the sounds related to a particular utterance are transformed into meaning in the act of listening to and comprehending a spoken language. When the auditory system of the listener receives the sounds, a transient sensory store called echoic memory holds them for about one second. At this moment, the listener gives order to this series of sounds by using formerly learned patterns which group the sound stream of the language into meaningful units. As soon as the patterns that the sounds organize have been identified, they enter STM in the form of

words. If we define units in terms of syntax, they usually refer to words, phrases or clauses and change with the type of input and also with the listener's prior experience. As soon as sounds have passed into STM and have been organized into appropriate syntactic units, they are held only long enough to be interpreted in the meaning before they are removed from memory so as to vacate for new incoming sounds. Although the information that they conveyed will or will not enter LTM, the precise words in which the information was transmitted are rarely held for a long period of time. As soon as the meaning has been taken out, the precise words are forgotten.

Although both listening and reading are considered as receptive skills, aural comprehension is more difficult than reading. In reading one can look back at what was read before and also look ahead to get an idea of what is coming. The listener, however, can't do this and any inattention to what is being said at the moment may easily cause him or her to lose an important part of the message, or even all of it. Thus memory becomes important. Keeping in mind what they have heard as much as possible becomes many EFL listeners' goal. Since listeners have a limited memory capacity for the target language, they should make full use of different listening comprehension skills to facilitate them to acquire, store, extract, and use memory. Especially EFL listeners are usually deficient in language proficiency, and have immature vocabulary. Using good listening skill will make EFL listener retain the material in STM for a longer time and skillfully activate knowledge in LTM to enter STM. In a word, carefully designed listening strategy instruction programs can improve the performance of the learners and facilitate to promote the learner's autonomy.

Therefore, from the cognitive perspective, I approach the concept of STM as an important factor that may affect EFL listening comprehension.

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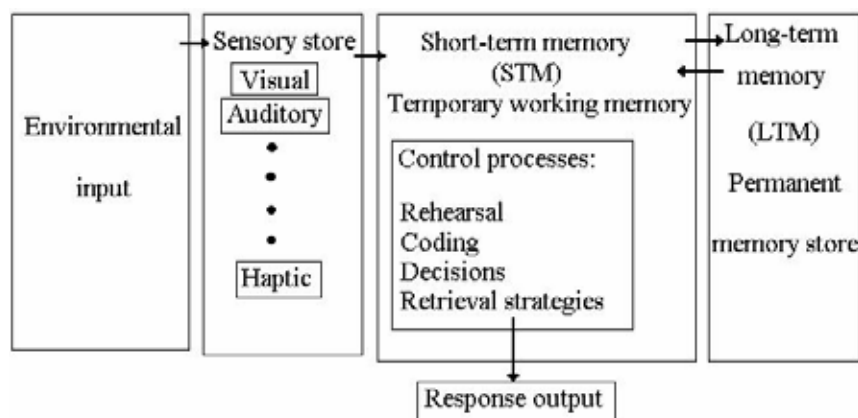


Figure 1. Atkinson and Shiffrin Model