

INTEGRATING APPLIED LINGUISTICS AND  
COGNITIVE  
SCIENCE: A STUDY ON HUMAN MEMORY AND  
L2 ORAL FLUENCY

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*Abstract: This study investigated whether working memory capacity could account for individual differences in oral fluency in English as a second language (ESL). Working memory was assessed by the Speaking Span Test (SST) which taxes the processing and storage functions of working memory during language production (Daneman and Green 1986; Daneman 1991). ESL fluency was assessed by means of a speech generation task in which subjects had to talk about a picture. Working memory capacity was significantly correlated to oral fluency in ESL, thus corroborating Daneman's (1991) finding of a significant correlation between individual's working memory capacity and fluency in first language (L1).*

### Introduction

In the past few years cognitive processes involved in second language acquisition and use (henceforth SLA/use) have gained increased importance on the part of researchers. The complexity of the phenomena involved in both the acquisition and use of second languages require that researchers look for answers to their problems in related areas of study such as first language

acquisition/use, psycholinguistics, and sociolinguistics. More recently, however, the need for the integration of SLA/use into the research of cognitive science has been advocated by a number of researchers since the former seems to be one of the areas which has yielded the greatest advances as regards human cognitive behaviour.

Cognitive science is an interdisciplinary field of research which seeks to understand and explain the processes involved in human thought, in a number of cognitive tasks such as perceiving, remembering, understanding, learning, and reasoning (Ashcraft, 1994; Stillings et al., 1987). In trying to understand the human mind cognitive scientists draw on research developed in diverse areas, among which artificial intelligence, the neurosciences, linguistics, psycholinguistics, and cognitive psychology stand as the most significant. Language, as a fundamental human capacity, as well as its relationship with thought has received massive attention on the part of cognitive scientists. Nevertheless, as Tomlin and Gernsbacher (1994) point out, second language phenomena, at either the acquisition or use levels, have not been an item of relevance in the research agenda of cognitive science.

Cognitive psychology, a branch of psychology, is one of the fields contributing to research in the cognitive sciences and has been the area of research which has stimulated SLA/use theoreticians in their attempt to understand cognitive processes learners carry out when performing tasks in the second language. Cognitive psychology is concerned with the experimental study of human information processing in various modalities such as

attention, pattern recognition, learning, memory, language processing, problem solving, and reasoning.

The objective of this study was to verify whether working memory capacity, a construct of cognitive psychology could account for individual differences in fluency in ESL. This study draws heavily on Daneman (1991), who found a significant correlation between working memory capacity and L1 fluent speech production.

## 1. Fluency in SLA/use

One of the most important aims of second language (L2) teaching is to develop oral fluency in students. For most students, being able to speak fluently in the language they are learning is their main objective. However, neither teachers nor students know exactly what it means to be fluent in a L2, and the literature in the area is still lacking consistency, in spite of the importance of the notion in L2 instruction, especially in oral proficiency tests.

As regards L2, fluency is generally defined in two senses, as Lennon (1990) claims. In its broader sense, it is equated to proficiency, the individual's global ability in the language. In a narrower sense, Lennon argues, fluency in a L2 is one component of oral proficiency, as opposed to other components such as lexical range, pronunciation, correctness, appropriateness, and relevance. This narrower sense of fluency is generally related to the flow of speech or speech rapidity and is contrasted to the notion of accuracy --"a command over the grammatical and syntactical structures of the target language" (Davies, 1980:99). Apart from the two senses in which fluency is

generally understood in the second language field, Lennon (ibid.) defines the term as the perception we have, when hearing someone talk, that the speaker's psycholinguistic processes involved in speech planning and production are working easily and efficiently (ibid., p.391). In line with this view, Schmidt (1992) defines fluency as an automatic procedural skill (cf. Carlson, Sullivan, and Schneider, 1989). For him, "fluent speech is automatic, not requiring much attention or effort" (ibid., p. 358), in contrast to nonfluent speech, which is effortful and which demands focused attention on a number of processes involved in the various stages of speech production. For the purposes of the present study, and following Eijzenberg (1995) and Lennon (1990), fluency is operationalized as the perception the listener has that the speech being produced is continuous, smooth, with few pauses or few hesitations, and adequate to the context. This notion of fluency seems appropriate to the present study because the focus is on the cognitive processes involved in fluent speech production.

Lennon (ibid.) suggests that the study of L2 fluency has been done from two main perspectives. The first one implies an assessment by description and quantification of fluency variables and makes no reference to the psycholinguistic processes which might be involved in speech production -- this is the descriptive/quantitative approach. In the second, the temporal approach, researchers attempt to assess second language fluency by the study of a set of temporal variables in order to verify which psycholinguistic processes take place during speech production.

## 2. Working memory

It is now widely accepted that memory is composed of two major systems -- the long-term and the short-term memory-- although there is still some controversy on how these systems should be conceptualised. With respect to short-term memory, this notion is generally referred to as working memory, as proposed by Baddeley and Hitch (1974) and Hitch and Baddeley (1976) in their elaboration of a previous influential model by Atkinson and Shiffrin (1968). Contrary to Atkinson and Shiffrin's view of a passive unitary short-term memory system, Baddeley and Hitch's working memory is a tripartite model, composed of a central executive, which functions as an attentional controller, and two slave systems-- the phonological or articulatory loop, responsible for speech-based information, and the visuospatial scratchpad, which controls visuospatial material. The evidence for the phonological loop comes mainly from a variety of laboratory findings, such as the phonological similarity effect, the word length effect, and the articulatory suppression. The evidence for the existence of a visuospatial scratchpad, which is also assumed to have a brief store and control processes, is far less than that for the phonological loop. Finally, the central executive, which stand as the most important and interesting component of this model, is the least studied and understood, since the other two components seem to show, as Baddeley says (1992a), more tractable problems.

While Baddeley and Hitch's tripartite working memory model is a more sophisticated alternative to the traditional short-term store, it was developed mainly to account for neuropsychological evidence. As Baddeley (1992b) suggests, research on working memory has been

developed along two main lines. The first one, the psychometric correlational approach, is concerned with the correlations existing between working memory capacity and the performance of complex cognitive tasks. Within this approach working memory is defined as the system which stores and manipulates information concurrently. Thus, theorists attempt to devise task in which both storage and processing of information are necessary, and subsequently use the individual's results of performance on these tasks to predict his/her skills in other cognitive tasks. The second approach, although also defining working memory as the system which temporarily stores and manipulates information necessary for complex cognitive tasks, focuses on the analysis of the structure of the system. In this case the methodology consists of the application of dual tasks and the study of neuropsychological evidence.

Daneman (1991, and elsewhere) and her colleagues take the first approach to investigate the extent to which working memory capacity predicts verbal skills, particularly reading. Their hypothesis is that individuals with small working memory capacities perform weakly on cognitively demanding task, while individuals with larger capacities tend to perform better. In this respect, Daneman and Green (1986) devised a speaking span test which taxes individuals' working memory capacity in first language production. Daneman (1991) expands this study and shows a correlation between individuals' working memory capacity and first language fluency.

### 3. Methodology

As has been noted earlier, the aim of the present study was to verify whether the correlation Daneman (1991) found between working memory capacity, the capacity to store and process information in the performance of complex tasks, and L1 fluency was also true when the focus shifted to L2 fluency. Daneman's (1991) methodology was adapted and seven experiments were carried out. From these, only the results of the Speaking Span Test in English (SSTE), aimed at assessing subjects' working memory capacity, and the Speech Generation Task (SGT), aimed at assessing their fluency, will be reported.

The 16 subjects who participated in this study were graduate students taking their MA in English Language or Literature at the Federal University of Santa Catarina (UFSC). From the 16 subjects, 12 were women and 4 were men, ages ranging from 22 to 39 with a mean of 27.5, thus a predominantly young adult sample.

The SSTE was constructed with 42 one-syllable unrelated words, arranged in two sets each of two, three, four, five, and six words. Each word was presented on the middle line of a computer video screen for 1 second and was accompanied by a beep. Subjects were instructed to read the words silently. Ten ms after the word had been removed, the next word in the set would appear beside the place the previous word had been presented, on the same line. This procedure was followed, each word slightly further to the right, until a blank screen signalled that a set had ended. Subjects were then required to produce orally a grammatical sentence for each word in the set, in the order they had appeared and in the exact form they were presented. A subject's speaking span was his/her total

performance on the test, i.e., the total number of words for which a grammatical sentence was produced.

In the SGT subjects were presented with a picture and required to describe it as well as make comments about it for the duration of 1m and 30s. The picture, adapted from an ESL textbook and painted in water-colours on a 20x25 cm card, portrayed a detailed scene of a middle-class family at home. In the living-room, there were five members of the family, each one doing a different activity. In the kitchen the family maid was involved with the housework. Subjects were explicitly instructed to give as much information as they could about the picture in their descriptions as well as in their comments. The main measure of fluency was that used by Daneman in her 1991 study, the total number of words produced during the time allotted, or their speech rate. As several researchers have pointed out (Ejzenberg 1995, Riggensbach 1991, Lennon 1990, Möhle 1984, among many others), speech rate seems to be a reliable indicator of fluent speech.

All data were collected individually with each subject in a small room, in two sessions which took place on different days for each subject. In the first session, subjects' working memory capacity was assessed through the application of the four span tests. In the second session subjects' SL fluency was assessed through the two other tasks.

#### 4. Results and discussion

The means and standard deviation for the SSTE were [M=21.43 and SD=2.8] and for the SGT [M=165.81 and SD=37.15]. A significant correlation was found



between individual's working memory capacity, as measured by the SSTE, and ESL fluency, as measured by the number of words produced in the SGT [  $r(16) = 0.64$ ,  $p < 0.01$ ].

The SGT is assumed to reflect the two general stages of speech production, namely the planning and execution stages (Clark and Clark, 1977). In order to speak we have to plan what to say, temporarily store these plans, and execute them as words, phrases and sentences (Daneman, 1991). In addition, execution may begin at any moment of the planning stage which means that the processes in these two stages can be carried out in parallel. Apart from the conceptual and linguistic processes being carried out in speech production, the speaker has to attend to information from the context such as the level of shared knowledge between the speaker and his/her interlocutor, the level of background knowledge on the topic the interlocutor has, the social distance between the speaker and his/her interlocutor, among other aspects. Speaking is a cognitively demanding task which involves complex and skilful coordination of processing and storage of information.

Daneman (1991) and colleagues assume that the human cognitive component responsible for this coordination is working memory. The larger the individual's capacity of this system, the more fluent his/her speech will be since he/she is more efficient in coordinating the processing and storage requirements of the task. The results of the present study are consistent with earlier findings that working memory capacity is related to oral fluent production (Daneman 1991; Daneman and Green, 1986).

## 5. Conclusions

The research in individual differences in working memory seems to be a promising one. However, one should bear in mind that because research in this area is still exploratory, results have to be interpreted with caution. The experiments reported here assess only one component of fluency, namely, the number of words produced in the allotted time. Future research can indicate whether working memory capacity is also related to more refined measures of L2 fluency. As Ejzenberg has pointed out, L2 fluency seems to be sensitive to task structure and context, two variables likely to affect the L2 learner speech production.

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