VERBAL SEQUENTIAL MEMORY IN APHASIA

Register No: 05SLP014

RUCHI AGRAWAL

A Dissertation Submitted in Part Fulfillment of
Final year M.Sc (Speech Language Pathology),
University of Mysore, Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
NAIMISHAM CAMPUS, MANASAGANGOTHRI
MYSORE-570006

DEDICATED TO

MY LOVING

PAPA N MUMMY

&

BHAIYA N BHABHI

Whose love, care & affection got me to acme of all endeavours….

CERTIFICATE

This is to certify that this dissertation entitled *"Verbal Sequential Memory in Aphasia "* is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech Language Pathology) of the student (Registration No. 05SLP014). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysore

April, 2007

Dr.Vijayalakshmi Basavaraj
Director
All India Institute of Speech and Hearing
Naimisham Campus
Manasagangothri
Mysore-570 006.

<u>CERTIFICATE</u>

This is to certify that the dissertation entitled *"Verbal Sequential Memory in Aphasia"* has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

Guide

Mysore

April, 2007

Dr .S.P .Goswami
Reader
Department of Speech Pathology,
All India Institute of Speech and Hearing,
Mysore-570006.

<u>DECLARATION</u>

This is to certify that this dissertation entitled *"Verbal Sequential Memory in Aphasia"* is the result of my own study under the guidance of Dr.S.P.Goswami, Reader, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted in any other university for the award of any diploma or degree.

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INTRODUCTION

Aphasia has been traditionally defined as a language-based impairment (Benson, 1994; Grodzinsky, 1990). A number of researchers (Wright, Newhoff, Downey & Austermann, 2003) have reported that deficits in memory capacity add to language processing difficulties in individuals with aphasia. Aphasia is also viewed as an upshot of reduced efficiency in cognitive processes which are thought to support language behavior (Luria, 1966; Martin 1981). These cognitive processes may include attention, memory, perception, problem solving. Chapey, 2001; Helm-Estabrooks, 1998, 2002 reinforced the notion of aphasia as a primary, but not exclusive, language deficit and underscore the need to attend the basic cognitive skills in clinical intervention.

Memory generally refers to the ability to retain processed information. The quality of one's memory has traditionally been characterized in terms of the quantity of ideas or the number of aspects of events that are recalled. Memory is not a unitary process, one differentiation has been made based on storage duration and the other important differentiation is between verbal and visuo-spatial memory. These components can be selectively impaired by brain damage. Dworetzky (2001) has reported various causes for memory problems such as stroke, tumors, infections, anoxia or excessive use of alcohol. Abnormal disruption of any form of memory has great impact upon a person's life and also upon attempts to rehabilitate or compensate for these deficits. Memory impairments may negatively influence the functional communication abilities and response to treatment of adults with aphasia. Therefore, speech-language clinicians must be cognizant of the types of memory problems that may occur in these patients. Atkinson & Shiffrin (1971) proposed three storage components in memory.

Each component were distinguished according to capacity, duration and form of information in the component. Figure-1 depicts the framework of memory. The various components of memory depicted are-

1. **Sensory Registers /Memory-** It hold a vast array of sensations for less than a second in modality specific form such as an "echoic" representation of sounds.
2. **Short term store/ Memory** (STS/M)-The attended information goes to STM which has a small capacity and can retain information for about 20 seconds.
3. **Long term Memory** (LTM)-The contents are transferred to LTM which is storehouse for semantic, includes the experiences and knowledge of an individual.

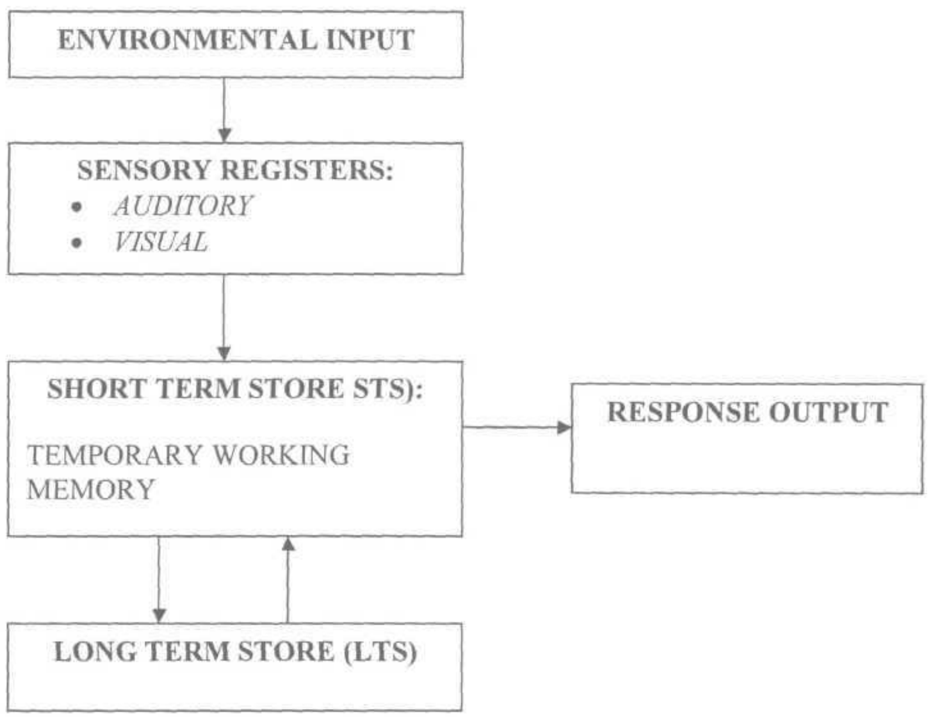


Figure-1: Framework of memory. (Atkinson & Shiffrin, 1971)

STM or working memory (WM) refers to a complex set of interacting processes that allow for the temporary storage and maintenance of information (Baddeley, 1992). Baddeley & Hitch (1974) proposed a division of working memory into three components, as depicted in figure-2:

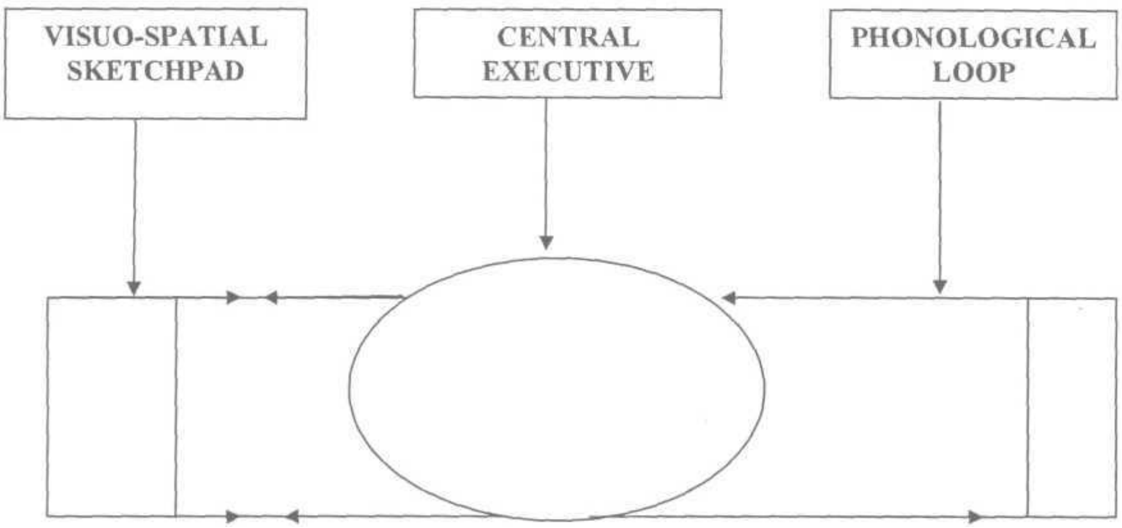


Figure-2: Division of working memory. Baddeley & Hitch, 1974

Part of the system is the central executive, which forms an interface between long term memory and two or possibly more slave systems. Separate slave systems are dedicated to storing and maintaining different types of information. One of these systems is visuo-spatial scratchpad which is specialized for maintaining visuo-spatial information while verbal information is held using phonological or articulatory loop.

The central executive is assumed to be responsible for the selection and operation of strategies and for maintaining and switching attention as the need arises. It is assumed to be associated with the operation of the frontal lobes and is found to be sensitive to the frontal damage (Baddeley, 1986; Baddeley & Wilson, 1988).

The visuo-spatial sketchpad is assumed to be a system that can hold and manipulate material of a visual or spatial nature. It is associated with a number of structures in the right hemisphere (Farah, 1988; Jonides 1993).

The phonological loop is a system that comprises a brief acoustic store, coupled with an articulatory rehearsal process. The phonological store receives directly any information auditorily presented. The articulatory process is capable of both maintaining information in the store by continued rehearsal and also transferring visually presented material to the store by means of sub vocal naming.

Another method of classifying STM is-

- **Verbal short term memory**- Typically assessed by presenting an individual with a sequence of verbal items which they have to repeat in correct serial order verbally. Baddeley, 1966; Conrad & Hull, 1964 reported that verbal short term memory spans are smaller for words which sound alike or are phonologically similar than words which are phonologically dissimilar.
- **Non-verbal short-term memory**- It includes learning of material in different forms such as visual, visuo-spatial, perceptual, figural. Bansal (2006) reported significant difference between aphasics and normal in digit span and non-meaningful stimuli on a non verbal task.

Long Term Memory- It is the type of memory which holds the information for long periods of time. Squire (1992) proposed components of long-term memory which is shown in figure-3.

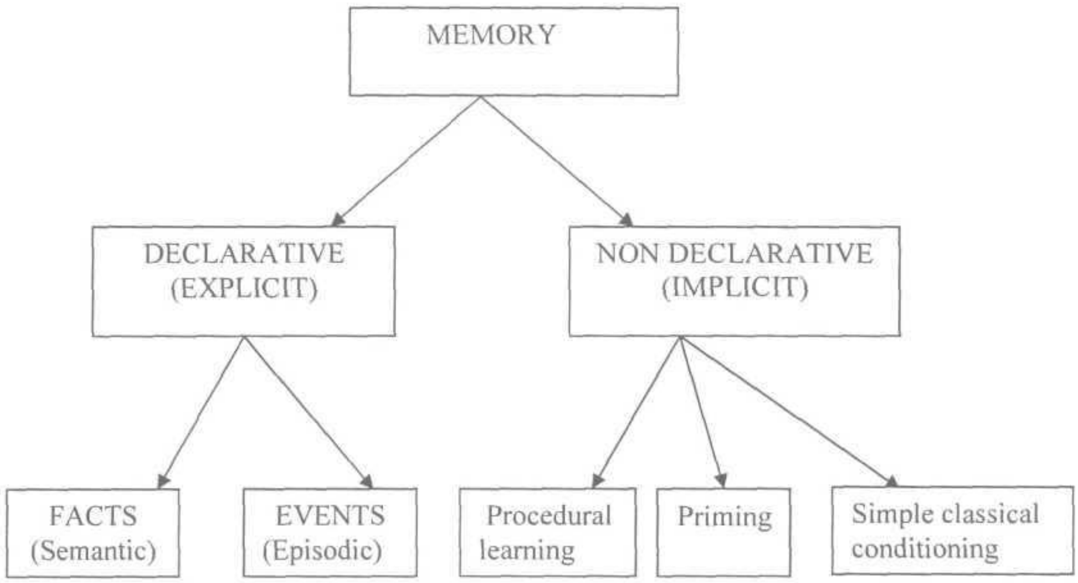


Figure-3: Components of long-term memory (Squire, 1994)

1. Declarative Memory

2. Non-declarative Memory

1. **Declarative Memory- It** encompasses the acquisition, long-term retention, and retrieval of events, facts and concepts (Squire, 1994). Such knowledge can be retrieved at will and is used in a variety of contexts. It can be sub-divided into two subsystems:-

a. ***Episodic Memory*** - It refers to the system involved in recollecting particular experiences or episodes. It enables the individuals to recollect conscious experiences from past (Tulving, 1983). Episodic memories are characterized by perceptual, conceptual, and affective components that are placed within an ongoing context of personally relevant events.

b. *Semantic Memory* - It refers to the acquisition and retention of generic factual information that is not referenced to specific learning context. (Varfaellie,2000). Semantic knowledge encompasses a wide range of information, including facts about the world, meanings of words and concepts. The process of education could be regarded as the gradual building up of semantic memory.

2. Non-Declarative Memory- It is considered as a cluster of learning systems which are independent of episodic memory i.e. they are capable of accumulating information, but retrieval or pulling out and identifying specific episodes is not possible. The various kinds of non declarative phenomena include priming, procedural learning, associative and evaluative conditioning.

   Role of memory has been understood by the researchers for carrying out the activities in day-to-day life and for effective communication. Thus it is imperative to study the verbal memory in aphasics for various tasks in Indian context too.

NEED OF THE STUDY

A very few studies have been reported in Indian context to evaluate verbal memory in aphasia. From the review of literature it is apparent that the memory is an important cognitive component which contributes to language deficit in aphasics. Bansal (2006) have studied the non-verbal sequential memory deficits in Broca's aphasia in her study, and reported that there are obvious memory deficits in these patients. With this knowledge, the need also arises to explore the memory of aphasics on verbal tasks. Also, the difference between aphasics in terms of various verbal and non verbal memory tasks is not known, the present study aimed to evaluate all these areas in aphasics.

AIM OF THE STUDY

The aim of the present study is to compare various aspects in aphasics which are -

1. To study the verbal sequential memory span in aphasics
2. To compare verbal sequential memory span of aphasics and normal individuals.
3. To study the effects of stimulus characteristics on quantitative and qualitative aspects of verbal sequential memory.
4. To compare the performances of different aphasics in verbal memory task
5. To know whether there are any obvious deficits in non-verbal and verbal memory.

REVIEW OF LITERATURE

Memory is considered to be one of the important components for cognition. Aphasia is considered the result of reduced efficiency in general cognitive processes which are believed to support language behavior (Luria, 1966). One of the important cognitive processes which includes is memory. A preserved working memory system is crucial for language processing. Following are the sections under which the various aspects of memory and the influence of memory impairment in aphasia are being elaborated:

- Neural correlates for working memory
- Memory impairments and aphasia
- Long term memory and aphasia
- Short term memory and aphasia
- Non -verbal short term memory and aphasia
- Verbal short term memory and aphasia

NEURAL CORRELATES FOR WORKING MEMORY

Memory is both distributed and localized with a multitude of neural structures and pathways making unique contributions to various memory functions (Squire, 1987).

Working memory is a feature of cognitive processing, therefore its place in the brain is distributed and is intrinsic to each of the areas active while a task is being performed. Dworetzky (2001) reported that there are several types of memory systems which are controlled by different brain areas. The prefrontal cortical region is found to have functional neuronal circuitry connected to the basal ganglia which is involved in cognitive operations (Alexander, DeLong & Strick, 1986; DeLong & Georgopoulos, 1981). Functional neuroimaging techniques, such as functional Magnetic Resonance Imaging (fMRI) and Positron Emission-Tomography (PET) have been used to identify neural activation patterns occurring during working memory tasks. These techniques have indicated that brain activations accompanying verbal working memory are found in dorsolateral prefrontal, inferior frontal, supplementary motor, premotor, and parietal cortices. Frontal regions including dorsolateral prefrontal cortex (DLPFC) and Broca's area were found to be the neural correlates for the phonological loop. Newman, Just & Carpenter (2002) hypothesized that DLPFC is associated with the active maintenance of information and found that as the memory load increases the involvement of DLPFC also increases which suggested that this area is involved in maintaining information while additional information is processed. Broca's area has also been activated and its role is believed to be mediating in verbal rehearsal (Smith, Jonides, Marshuetz & Koeppe, 1998). Jonides, Lauber, Awh, Satoshi & Koeppe (1997) found that posterior parietal cortex also helps in mediating storage of verbal material which has also been supported by other researchers.

Other studies in anatomical correlation assessed phonological short-term memory by auditory-verbal span and the lesion data indicated the supra-marginal gyrus of inferior parietal lobule as the crucial region for the function of phonological STS (Warrington, 1979). PET activation study has established that activation of the left supramarginal gyrus is associated with the phonological storage system and activation of Broca's area with the sub-vocal rehearsal system (Paulesu, Frith & Frackowiak, 1993). In addition activation was also found in the right cerebellum when subjects were performing tasks which relied on rehearsal process (Fiez, Raife, Balota, Schwartz, Raichle & Peterson, 1996). Traditionally neurological studies have shown that cerebellum coordinates skilled movements and controls tone, posture and gait (Dolan, 1998), but recent neuroimaging techniques have shown that cerebellum is implicated in higher cognitive functions such as language, memory, executive functions. Therefore, it can be concluded that there are various areas which are responsible for activation of verbal memory and damage to these areas can cause varied degree of memory impairments.

To infer, these neuroanatomical findings have significant implications for adults with aphasia who have brain damage in the left frontal or left parietal cortices and thus might demonstrate a working memory deficit which in turn can be reflected to their linguistic capabilities.

MEMORY IMPAIRMENTS AND APHASIA

Memory impairment associated with aphasia has been predominantly characterized as a reduction of immediate serial recall, or span memory, for verbal material (Albert, 1976; Butters, Samuels, Goodglass & Brody, 1970; De Renzi & Nichelli, 1975; Goodglass, Gleason & Hyde, 1970; Gordon, 1983; Heilman, Scholes, & Watson, 1976). Until mid-1960s, memory was considered as a single unitary system but as a result of neuropsychological evidence, it has been found that memory is composed of interrelated system. Milner (1971) reported that performance in many memory tasks relies upon effective verbal coding when material is pictorially presented. Cermak & Butters, 1976, Goodglass, Denes & Calderon, 1974, Goodglass, Gleason & Hyde (1970) found that patients with impaired language functions suffer from material specific memory deficit for words or verbal labels. The functional communication abilities of the patient are also reported to be influenced negatively by memory impairments (Risse, Rubens & Jordon, 1984). Because of the dispersed neuroanatomic representation of memory, brain damage often compromises memory abilities as well and hence, the professionals who assess and treat these patients should have an understanding of the various memory functions and the methods used to identify these impairments.

Aphasia has been described as a class of memory disorders (Alport, 1986). Various short term and long term memory deficits are found in these patients. Thus, the knowledge about such impairment can help speech language pathologist to look for subtle deficits in these areas which might go overlooked if, they are unaware about it.

LONG-TERM MEMORY AND APHASIA

Long-term memory (LTM), another important component of memory is considered to be of unlimited capacity and relatively permanent and covers a very wide range of memory durations i.e. from several minutes to many years. Although the investigators have long pondered the role of long-term memory in aphasia, the nature of long-term memory deficits and their neuroanatomical correlates in patients with aphasia has not been investigated systematically. Only few investigations have focused on the LTM abilities of the aphasic patients.

Schuell, Jenkins & Jimenez- Pabon, (1964); McNeil, (1982) reported that LTM is intact in individuals with aphasia because of their relatively preserved autobiographical memory. However, Risse, Rubens & Jordon (1984) examined individuals with aphasia due to anterior lesions and reported impairment in LTM on a verbal learning task. This study is also supported by Glosser & Goodglass (1990) who found that the aphasic individuals with frontal lobe lesions were significantly more impaired on Wisconsin Card Sorting Test and on additional experimental tests of executive functions. Similar findings were also reported by Risse et.al (1984) and Beeson, Bayles, Rubens & Kaszniak (1993) investigated LTM capacities of normals and aphasics and reported that patients with anterior (frontal cortex, anterior deep white matter) lesions had more severe verbal LTM deficits than patients with posterior (parietal cortex, superior and middle temporal gyri) lesions.

Frontal lobe lesions are reported to impair the executive control of memory processes and individuals with frontal lobe damage particularly the dorsolateral region are found to have difficulty in planning, organization, attention and problem solving (Luria, 1966; Milner & Petrides, 1984; Schacter, 1987; Stuss & Benson, 1987). Petrides & Miller (1982) found that the individuals with excisions within the frontal lobe, excluding Broca's area were impaired on verbal and non-verbal LTM tasks.

Thus, one can infer that there is a growing demand of research in LTM in order to establish the cause and the effect of the impairment in the functioning of aphasics.

SHORT-TERM MEMORY AND APHASIA

Short-term memory (STM) is a system for temporarily storing and managing information required to carry out complex cognitive tasks such as learning, reasoning, and comprehension and is involved in the selection, initiation, and termination of information-processing functions such as encoding, storing, and retrieving data.

Short-term memory deficits have been found in every subtype of aphasia (De-Renzi & Nichelli, 1975; Cermak & Tarlow, 1978; Goodglass, Denes & Calderone, 1974). Agrammatic Broca's aphasias have shown very restricted short-term memory spans (Goodglass, Gleason & Hyde, 1970; Cermak & Tarlow, 1978) and also have difficulties in the syntactic analysis of sentences (Schwartz, Saffran & Marin, 1980). Span performance is the ability to reproduce a sequence of words or digits is considered as the standard measure of STM and patients with poor repetition are reported to have pathologically decreased spans. Span performance depends primarily on phonological store and therefore the STM deficit is due to limitation in phonological store.

Span size usually varies depending on the nature of items to be recalled. Brener (1940) reported that the normal span is greater for digits than words and span for words are greater than for non-words. Hulme, Maughan & Brown (1991) measured short-term memory ability in adults with mild aphasia by using digit and word span task and found the short term memory was impaired. A progressive impairment in the span size of aphasic patients on a digit task was reported as the digit load increased (Baddeley & Hitch, 1974). The task for the patients was to hold the sequences of digits from zero to eight.

Short-term memory is generally assessed by calculating the memory span and drawing serial position curve. The curve demonstrates two effects:

- Primacy effect
- Recency effect

Primacy effect is the ability of an individual to recall the initial items of the list whereas the recency effect is the ability of an individual to recall the items in the late part of the list and not the items from middle of the list. (Capitani, Sala, Logie & Spinnler, 1992). Also, primacy effect is thought to reflect those items which are maintained by rehearsal while increased retention of final items i.e. the recency effect is thought to reflect the items being maintained in sensory storage (Crowder, 1976). Therefore, a disruption of rehearsal results in a decreased primacy effect. (Heilman, Scholes & Watson, 1976).

As the working memory is reported to be an essential aspect for higher intellectual functions of language, perception and logical reasoning (Baddeley & Hitch, 1974), it is necessary to evaluate the verbal as well as the non verbal component of the working memory in aphasic patients in order to plan for the further effective management program.

Although investigators have explored the cognition aspect, there is dearth of studies in verbal and non-verbal memory. Few studies have been done which are elaborated in the following sections.

NON-VERBAL SHORT-TERM MEMORY AND APHASIA

Although the non-verbal short-term memory plays an important role in various cognitive tasks, there is dearth of research in this aspect (Heathcote, 1994). The memory impairments in aphasics can be exhibited as general deficit rather than as a consequence of deficit in language processing. Taylor & Swinney (1970) reported that the non-verbal tasks provide meaningful insight to the verbal task and as the memory deficits are found on non verbal tasks, it should also be evaluated on verbal tasks in order to know the various types of deficits present in different types of the population.

Goodglass, Gleason & Hyde (1970) evaluated immediate memory in Broca's and conduction aphasics using pointing span task. Subjects were asked to listen a series of words and had to point to the pictures in the same order, they reported that Broca's aphasics performed significantly poorer than the conduction aphasics.

Bansal (2006) conducted a study on Broca's aphasics to evaluate non-verbal sequential memory using digit span task, meaningful and non-meaningful stimuli. The following illustrates the findings -

- Performance of both Broca's aphasics and normals decreased when the complexity of the task was increased for all the three types of stimuli. However the rate of decline was more in aphasics when compared to normals.
- A robust primacy effect was reported both in the aphasics as well as the normals in digits suggesting presence of sub-vocal rehearsal but the strength of the primacy effect was found to be less in aphasics when compared to the normals suggesting that language impairment can affect covert rehearsal also.
- No significant difference was found between aphasics and normals in meaningful stimuli task which suggested that presentation of semantically loaded stimuli activated underlying intact concepts. However, a strong primacy effect was seen.
- Also, the aphasics and the normals did not differ on non-meaningful stimuli which suggested that memory and language is independent but may be inter-related in some aspects. Primacy effect was also seen but was not as robust as was seen in other two tasks.

Thus, conclusion can be drawn that there is presence of non-verbal memory deficits in different varieties of aphasia which suggests that there is a need to emphasize on cognitive functioning of the patient during evaluation which can give better insight about the linguistic capability of the individual. This in turn would help Speech Language Pathologist to decide the type of task to be used with the patient during evaluation.

VERBAL SHORT-TERM MEMORY AND APHASIA

Working memory involves the storage and manipulation of limited information for a brief time. Verbal working memory appears to play a significant role in language comprehension and problem-solving (Jonides, 1995). According to influential model (Baddeley, 1992), verbal working memory has three components:

1. Buffer to store phonological codes.
2. Rehearsal process to refresh those codes.
3. Set of executive processes to manipulate the contents of the buffer in the service of higher cognitive demands.

Ostergaard & Meudell (1984), Martin & Ayala (2004), Goswami (2004), Bansal (2006) suggested that sub-vocal or covert rehearsals are important for maintaining the information in short-term memory. Miller (1956) found that an individual's verbal short-term memory span is about seven items. Baddeley, Thomson & Buchanan, (1975) have studied the temporal aspect of the word and found that the spans were shorter for longer words as compared to the words which are spoken for shorter duration. Results of another study revealed smaller spans for words which were phonologically similar than phonologically dissimilar words (Baddeley, 1966, Conrad & Hull, 1964). This was taken as evidence that information is stored in a phonological code in verbal short-term memory (Baddeley, 1986).

There are few studies which have been done to evaluate the verbal memory in aphasics. Cermak & Butters, 1976; Goodglass, Denes & Calderon, 1974; Goodglass, Gleason & Hyde, 1970 reported that patients with impaired language functions suffer from memory deficit for words and found that the patients with good comprehension performed normally on short term retention of non-verbal tasks but were severely impaired on verbal material. Goodglass, Denes & Calderon (1974), Warrington & Shallice (1969) performed a phonemic feature analysis and reported impairment of retention of verbal information in aphasics and concluded that impairments in linguistic abilities results in impairments in verbal working memory. Tzortzis & Albert (1974) evaluated three conduction aphasia, one Broca's aphasia and one with Wernicke's aphasia and reported that conduction aphasics had a severely impaired memory for sequences when the stimulus was auditorily presented. Another study by Heilman, Scholes & Watson (1976) found impairment in retaining the information on the verbal task in Broca's and conduction aphasic. This was attributed to the difficulty in repetition which led to decreased primacy effect.

Ronnberg, Larsson, Fogelsjoo, Nilsson, Lindberg & Angquist (1996) evaluated short term memory function on digit and word span tasks in adults with mild aphasia and found that aphasic patients recalled one digit or word less than the normal subjects. Renzi & Nichelli (1975) reported similar results and found that aphasics had a significant shorter verbal span than non-aphasic on digit forward test.

Verbal short-term memory is typically assessed by presenting an individual with a sequence of verbal items such as spoken digits, which they have to repeat in correct serial order. Albert (1976) reported that the retention of order information was selectively and significantly impaired among aphasics. It was found that aphasics had selective deficit in memory for sequences, this selective deficit has special characteristics i.e. at low information load levels, the major form of memory deficit in aphasics is "omission type" and as information load increased, memory for sequences became critical for linguistic performance of aphasics.

The verbal memory deficit in aphasia has been variously interpreted. De-Renzi & Nichelli (1975) reported that aphasics retain only two item strings of words or pictures which suggested that they were unable to hold more items in proper order or were unable to use phonemic recirculation or rehearsal (Cermak & Moreines, 1976; Kelter, Cohen, Engel, List & Strohner, 1977) and therefore, the verbal mediation which would help in retaining the words was reported to be absent (Cermak & Butters, 1976).

Thus, it is evident from the above studies that memory plays an important role in reception and expression of language. Therefore, there is a need to delineate the nature of memory problems in aphasia and also to know the extent to which these deficits may affect the language abilities and treatment responses of the aphasic patients.

METHOD

The present study intended to appraise the sequential memory in aphasics through verbal tasks. Experimental and control group formed the basis for this study. Following ethical issues were considered -

- Each participant who participated in the study was explained about the aims, method, duration of the test, implication of the study in the language they were able to comprehend.
- An informal verbal consent was taken from the care-givers/spouses of all the participants and also from the normal individuals.

Inclusionary criteria:

Experimental group-

a) Nine participants diagnosed as Aphasia voluntarily participated in the study with an informal consent from the participants and or care-givers/spouses.

b) A total of five males and four females were taken up for the study.

c) Dexterity- All the subjects were right handed individuals.

d) The age range of the participants was 23-82 years with a mean age of 43.1 years.

e) Participants were diagnosed by Speech-Language Pathologists and /or Neurologists.

f) Participants with a history of single episode of stroke due to Cerebro-vascular accident were considered for the study.

g) Participants with no known significant history of pre-morbid neurological, psychological and or any other organic deficit, sensory deficit such as visual

(Visual neglect, Visual agnosia) and/or auditory deficit were taken up for the study.

The demographic data of the aphasic participants is depicted in the table-1

Table-1: Demographic data of the aphasic participants

S. No	Name	Age/ Gender	**Education**	**Post stroke evaluation**	Type of Aphasia
1	A	50Yr/F	SSLC	1 Year	Conduction Aphasia
2	B	29Yr/M	SSLC	10 Months	Conduction Aphasia
3	C	56 Yr/F	SSLC	1.6 Years	Conduction Aphasia
4	D	29 Yr/F	PUC	1 Year	Anomic Aphasia
5	E	23 Yr/M	PUC	1.6 Years	Anomic Aphasia
6	F	44 Yr/M	B.A.	2 Years	Anomic Aphasia
7	G	31 Yr/M	B.E.	1 Year	Anomic Aphasia
8	H	82 Yr/M	B.Com	8 Months	Anomic Aphasia
9	I	44 Yr/F	SSLC	6 Months	Anomic Aphasia

CONTROL GROUP

Nine participants matched with experimental group for age, education, gender and dexterity were included in the study.

Tools Administered: - The following tests were used **-**

a) **Western Aphasic Battery** (Kertesz & Poole, 1974; Kertesz, 1979). The test was used to evaluate the patients in different domains and Aphasic Quotient (AQ) was obtained. The domains used to obtain AQ were spontaneous speech, auditory comprehension, repetition and naming. This was used to diagnose the type of aphasia.

b) Stimuli for experimental task (Bansal, 2006): Following were the stimuli for both the groups:

1. **Digit Task**
2. **Meaningful word Task**

1. Digit Task - The stimuli consisted of nine digits from I to 9 which were presented in different trials in randomized order. This task consisted of 6 trials in which first trial consisted of 2 digits (3, 8) and as the number of trials was increased, one digit was increased per trial, the last trial i.e. the 6th trial had 7 digits.

2. **Meaningful word** Task-Frequently occurring nouns were used, ranging from 2-7 units per presentation. This section consisted of 6 trials in which first trial consisted of 2 nouns (Cup, Bus) and as the number of trials was increased, one noun was increased per trial. So, the last trial i.e. the 6th trial had 7 meaningful nouns.

PROCEDURE

a. Using a laptop, power point presentation was used to present the stimuli.

b. Participants were seated in front of the laptop placed one and a half feet from eye level.

c. Presentation of stimuli consisted of digits and meaningful words.

d. Digits- Two digits were presented in the first trial, three digits in the second trial and the presentation continued till seven digits in the last trial.

e. Meaningful words - Two nouns were presented in the first trial, three nouns in the second trial and the presentation continued till seven nouns in the last trial.

f. Stimulus appeared on screen for 2 seconds (Swinney and Taylor, 1975) with an inter-stimulus interval of 0.7 seconds.
g. Subjects were instructed to say the items in the same order as the stimuli appeared on the laptop screen.
h. Subjects used their native language to respond verbally to the task.
i. Subjects were seated comfortably in a quiet room while carrying out the test.

SCORING

A two-point scale (1& 0) was used to score the responses.

1 - For verbally responding to each presented unit in the same sequence.

0 - Unable to respond the presented unit in the correct sequence.

Hence, a maximum score of 2 was possible for trial-1 and a score of 7 for trial-6 for all the tasks.

STATISTICAL ANALYSIS

The data obtained was tabulated and was subjected to statistical analysis. SPSS software (version 10) was used to perform the analysis. The raw scores which were obtained were converted to percentage scores. Further, mean and standard deviation was obtained for both raw and percentage scores. Graphs were also plotted using percentage score for different tasks.

An independent t-test was done to compare the scores obtained by normals and aphasics for both the tasks (digits and meaningful word task). A paired t-test was done to compare the within subject performances for digits and meaningful word task.

RESULTS AND DISCUSSION

The aims of the present study were -

1. To study the verbal sequential memory span in aphasics.
2. To compare verbal sequential memory span of aphasics and normal individuals.
3. To study the effects of stimulus characteristics on quantitative and qualitative aspects of verbal sequential memory.
4. To compare the performances of different aphasics in verbal memory task.
5. To know whether there are any obvious deficits in non-verbal and verbal memory.

A total of eighteen participants in which nine individuals were diagnosed as fluent aphasics (six anomic aphasia, three conduction aphasia) and nine normals with age, gender, education, language and handedness matched participated in the study. Brain attack was reported to be the cause of aphasia for all the subjects. Participants were not reported to have any sensory deficit at the time of testing. The stimuli used for assessing the verbal memory were

1. Digits
2. Meaningful words

The data obtained was subjected to statistical analysis. The raw scores were converted to percentage scores. Graphs were drawn based on percentage scores for normals and aphasics. Independent t-test was administered to compare the performances on various trials of digit task and meaningful word task in aphasics and normals. Data was subjected to paired t- test to compare the performances for digit and meaningful word task within normals and within aphasics. The statistical analysis was done using SPSS (version 10.0) software (Garrett & Woodworth, 1979). The results are tabulated and discussed under the following sections:-

1. Memory Span for Aphasics and Normals in Digit Task.
2. Memory Span for Aphasics and Normals in Meaningful word Task.
3. Comparison of digit and meaningful word task within normals and within aphasics using paired t-test.
4. To compare the performances of aphasics in verbal and non-verbal tasks.

1. Memory Span for Aphasics and Normals in Digit Task

The memory span for normals and aphasics for the digit task across various trials were obtained using raw scores. Table-2 shows the mean and standard deviation of the raw scores for normals and aphasics. The normals obtained a mean value of 2.00, 3.00, 3.89, 4.56, 3.78 and 4.44, the aphasics on the other hand had a mean of 2.00, 2.00, 2.11, 1.22, 1.11, and 1.44 from trial-1 to trail-6 respectively. The results show that the performance of normals deteriorated from trial-3 to trial-6 whereas in aphasics, impairment in recall began in trial-2 and the performance was found to be poorer when compared to normals.

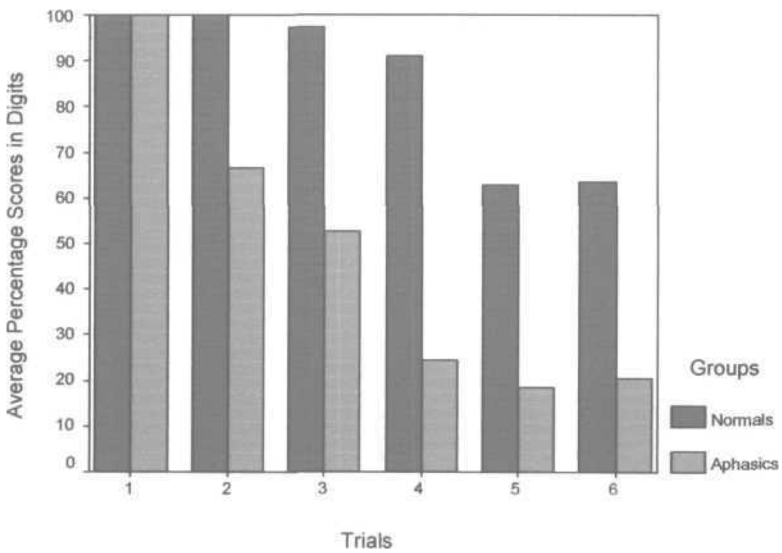
Table-2: Mean and Standard Deviation of raw scores across different trials in digit task in normals and aphasics.

Trials	Groups			
	Normals		Aphasics	
	Mean	Std. Deviation	Mean	Std. Deviation
T-l	2.00	0.00	2.00	0.00
T-2	3.00	0.00	2.00	1.12
T-3	3.89	0.33	2.11	1.62
T-4	4.56	1.01	1.22	1.30
T-5	3.78	2.28	1.11	1.17
T-6	4.44	2.55	1.44	1.59

The raw scores were converted to percentage scores for both normals and aphasics. Table-3 shows the mean and standard deviation of percentage scores for normals and aphasics.

Table-3: Mean and Standard Deviation of percentage scores across different trials in digit task for normals and aphasics.

Trials	Groups			
	Normals		Aphasics	
	Mean	Std. Deviation	Mean	Std. Deviation
T-l	100.0000	00.0000	100.0000	00.0000
T-2	100.0000	00.0000	66.6667	37.2678
T-3	97.2222	8.3333	52.7778	40.3973
T-4	91.1111	20.2759	24.4444	26.0342
T-5	62.9630	37.9855	18.5185	19.4444
T-6	63.4921	36.4993	20.6349	22.7128



Graph-1: Comparison of normals and aphasics across various trials in digit task.

Table-3 shows the percentage scores across various trials in digit task. From the results it is evident that the performance decreased from 100% to 63.49% in normal participants from trial-1 to trial-6 whereas the aphasics showed more deterioration in their performance from 100% to 20.63% in all the trials.

Also, from the graph-1 it is evident that deterioration is observed in normal participants from trial-3 and continued till trial-6 whereas in aphasics the deterioration began at trial-2 and continued till trial-6. Therefore, it can be concluded that there is deterioration in the performance both in normals and aphasics as the load on the memory increases, but the amount of deterioration is more and begins from early trials in aphasics than the normals. These results are in accordance with the reports of Ronnberg (1996) who studied short-term memory function on digit and word span tasks in adults with mild aphasia and found that aphasic patients recalled one digit or one word less than the normal subjects. Also, De-Renzi, Nichelli (1975) reported similar results that aphasics had a significant shorter verbal span on digit forward test.

These results also suggest that there is involvement of some anatomical regions which helps in recalling the information i.e. digit or the word. This notion is supported by Newman, Just & Carpenter (2002) who hypothesized that an area called dorsolateral prefrontal cortex (DLPFC) in the frontal lobe is associated with the active maintenance of information and found that as the memory load increases, the involvement of DLPFC also increases and therefore, this area is involved in maintaining information while additional information is processed. Also, Paulesu, Frith & Frackowiak (1993) performed a PET activation study has established that activation of the left supramarginal gyrus is associated with the phonological storage system and activation of Broca's area with the sub vocal rehearsal system. Therefore, one can conclude that damage to these anatomical areas will impair the storage and the rehearsal components of short term memory of the individual which would manifest in memory problems and thus will be reflected in the impairment of linguistic capabilities of the individual.

In the present study, different types of aphasics were taken, the mean and standard deviation for raw scores were computed. Table-4 shows the mean and standard deviation of the raw scores for normals and different types of aphasics across different trials in digit task. A mean of 2.0, 3.0, 3.89, 4.56, 3.78, 4.44 was obtained in normal individuals whereas anomic aphasics obtained 2.0, 2.17, 2.50, 1.50, 1.00, 1.67 and conduction aphasics had a mean of 2.0, 1.67, 1.33, 0.67, 1.33, 1.0 for the entire six trials.

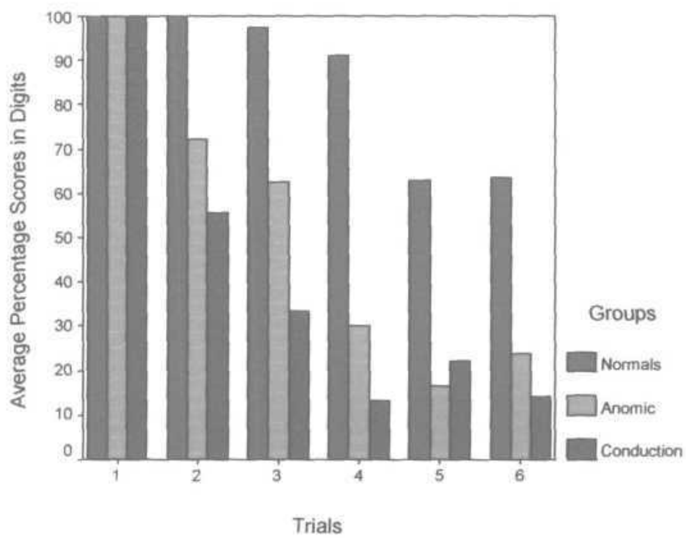
Table- 4: Mean and Standard Deviation of raw scores across different trials in digit task in normals and different types of aphasics.

Trials	Groups					
	Normals		Anomic		Conduction	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
T-l	2.00	0.00	2.00	0.00	2.00	0.00
T-2	3.00	0.00	2.17	1.17	1.67	1.15
T-3	3.89	0.33	2.50	1.76	1.33	1.15
T-4	4.56	1.01	1.50	1.38	0.67	1.15
T-5	3.78	2.28	1.00	1.26	1.33	1.15
T-6	4.44	2.55	1.67	1.86	1.00	1.00

Further the percentage scores were calculated from the raw scores for both normals and various types of aphasics. Table-5 shows the mean and standard deviation of percentage scores for normals and different types of aphasics across various trials in digit task.

Table-5: Mean and Standard Deviation of percentage scores across different trials in digit task in normals and different types of aphasics.

Trials	Groups					
	Normals		Anomic		Conduction	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
T-l	100.0000	00.0000	100.0000	00.0000	100.0000	00.0000
T-2	100.0000	00.0000	72.2222	38.9682	55.5556	38.4900
T-3	97.2222	8.3333	62.5000	44.0170	33.3333	28.8675
T-4	91.1111	20.2759	30.0000	27.5681	13.3333	23.0940
T-5	62.9630	37.9855	16.6667	21.0819	22.2222	19.2450
T-6	63.4921	36.4993	23.8095	26.5986	14.2857	14.2857



Graph-2: Comparison of normals and various types of aphasics across various trials in digit task.

Table-5 shows the percentage scores across various trials in digit task in different types of aphasics. From the results it is evident that the performance decreased in normals (100% to 63.49%) from trial-1 to trial-6. On the other hand, when different types of aphasics were considered, they showed deterioration in performances in different patterns. Anomic aphasics deteriorated from 100% to 23.8%, conduction aphasics deteriorated from 100% to 14.28%.

Also, from the graph- 2 it is evident that there is deterioration in normals which began from trial-3 and continued till triaI-6 whereas in anomic and conduction aphasics the deterioration began at trial-2 itself and continued till trial-6. However, the trend of deterioration shown by the aphasics differs, anomic had shown better performance than conduction. This can be attributed to better rehearsal system in anomic than conduction aphasics. Conduction aphasics have a core problem in repetition due to impairment in rehearsal system and thus their scores are affected. This kind of deterioration was also reported by Heilman, Scholes & Watson (1976) who proposed that Broca's and conduction aphasics had difficulty in repetition since they were unable to rehearse and therefore they were unable to retain the information for the verbal task which resulted in a decreased primacy effect. The similar trend was noticed in the present study when conduction aphasics were compared with the anomic. Thus, the result of the present study is forming further corroborative evidences for the presence of sub-vocal rehearsals and its importance in improving comprehension, production and cognitive abilities in aphasics.

Therefore, it can be concluded that there is decline in the memory performance on digit task in various types of aphasics which signifies the importance of employing memory tests during evaluation and the same goals to be taken up for the therapy.

The performance of aphasics was compared with normals for each trial. Table-6 shows the t-values and significant values for aphasics and normals across various trials for the digit task.

Table-6: Comparison of aphasics and normals across various trials in digit task

Trials	t-value	df	Significance (2- tailed)
Trial-2	2.683	16	.016*
Trial-3	3.232	16	.005**
Trial-4	6.061	16	.000***
Trial-5	3.125	16	.007**
Trial-6	2.991	16	.009**

* Significant at 0.05 level.

** Significant at 0.01 level.

*** Significant at 0.001 level.

Table-6 shows the results of t-test which indicates statistically significant difference across trial-2 ($p<0.05$), trial-3, trial-5, trial-6 ($p < 0.01$) and trial-4 ($p<0.001$). These results shows that as the number of trials were increasing there was a decline in the performance of aphasics which also implies that the damage to various neuroanatomical areas in the brain leads to a cognitive decline and thus results in poor performance. Similar results of progressive impairment in the performance of aphasic patients on a digit task as the digit load increased were also reported by Baddeley & Hitch (1974). Therefore, the obtained outcomes highlighted the significance of the role of memory in carrying out various tasks and its influence on the performance of an individual.

The serial position curves have been widely used as one of a measure of memory functions in clinical practice. Figures 1 -5 depicts the serial position curves from trial-2 to trial-6 in digit task for normals and aphasics.

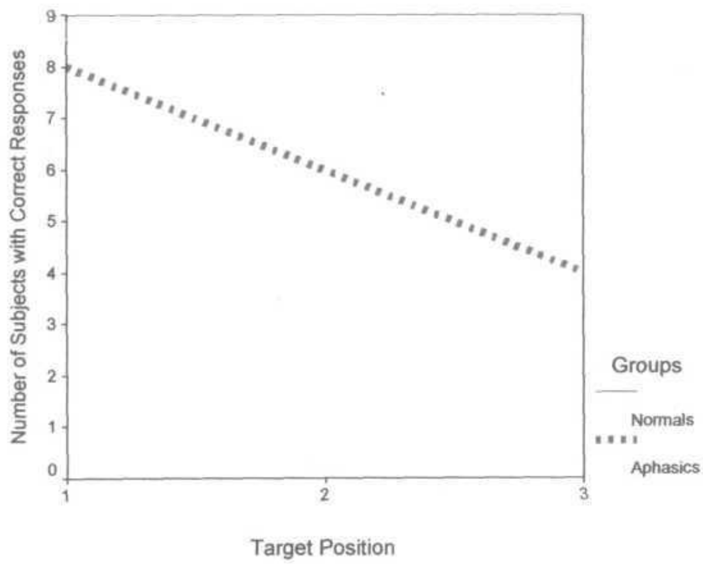


Figure-3: Serial position curve for trial-2

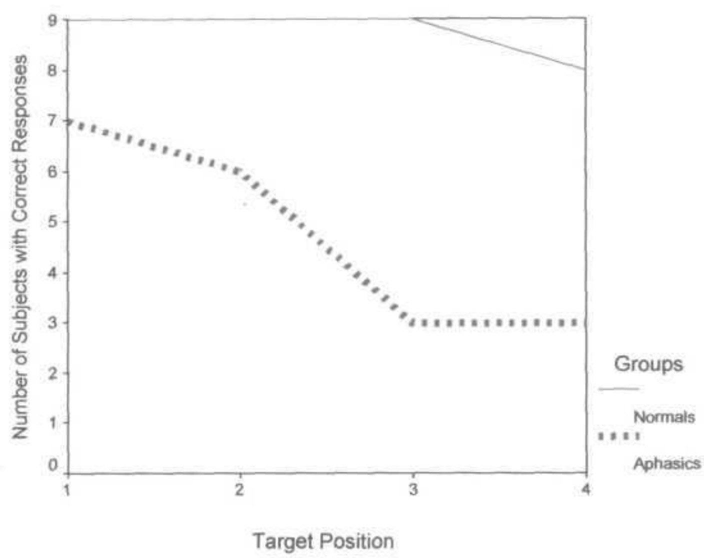


Figure-4: Serial position curve for trial-3

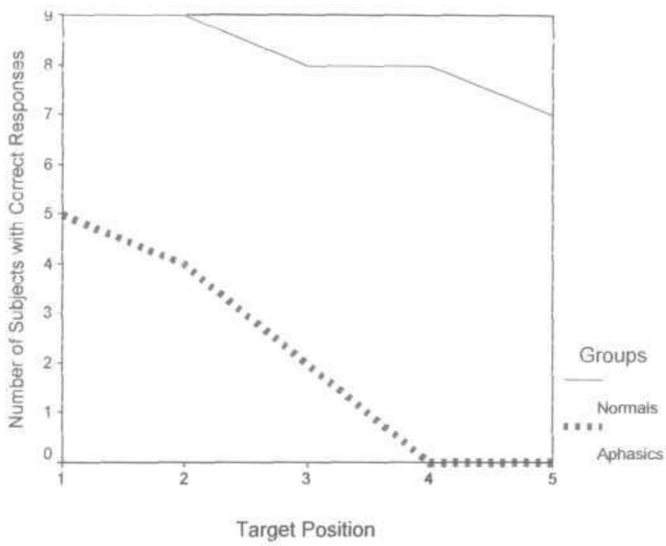


Figure-5: Serial position curve for trial-4

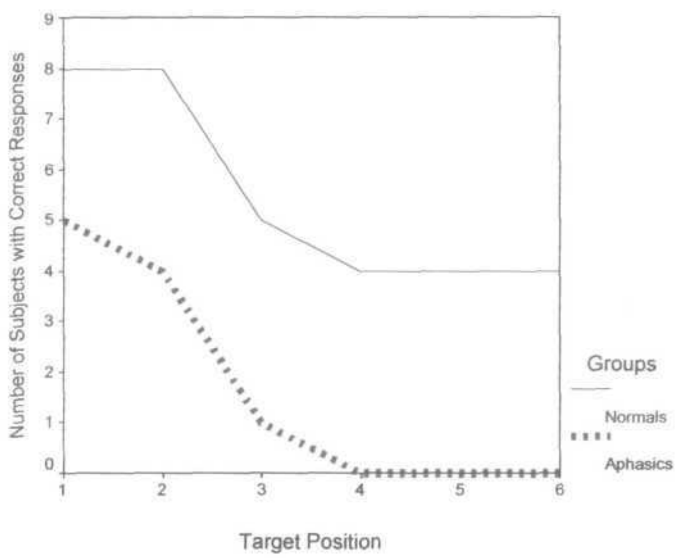


Figure-6: Serial position curve for trial-5

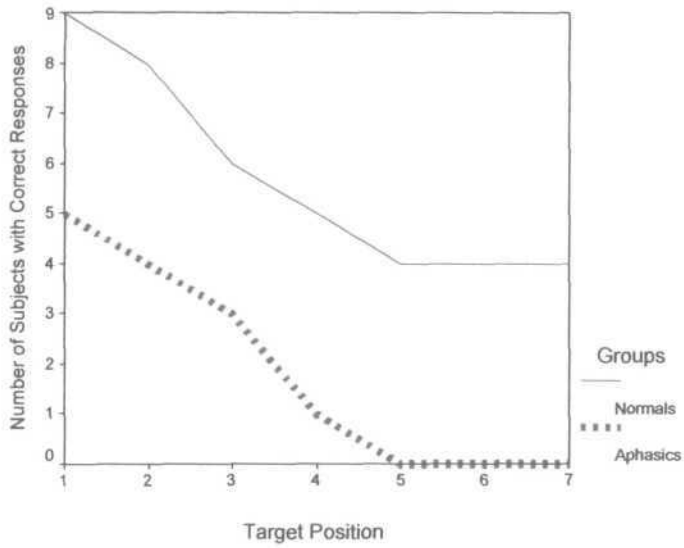


Figure-7: Serial position curve for trial-6

From the figures 1-5, the primacy effect is evident in both normals and aphasics. However, strong primacy effect is seen in normals till trial-4. Trial-6 has more number of fluctuations since it has got maximum number of digits and due to less sub vocal rehearsals and more load on the memory, the normals might not be able to retrieve in correct order. The significance of sub- vocal rehearsals is also reported by Ostergaard & Meudell (1984), Martin & Ayala (2004) that these rehearsals are important for maintaining the information in short term memory.

In aphasics, a primacy effect is seen till trial- 6 but is not as strong as normals. Primacy effect is thought to reflect those items which are maintained by rehearsal (Crowder, 1976) and as sub- vocal rehearsals are weak in these patients they do not exhibit a strong primacy effect and therefore, a disruption of rehearsal results in a decreased primacy effect. (Heilman et. al, 1976).

To summarize, the results of digit task revealed that there is a decline in memory capacity in normals as well as in aphasics as the number of items increases with each trial. However, the aphasics show drastic impairment due to the damage in various areas in brain which are responsible to carry out memory tasks. The present study included two groups of aphasics i.e. conduction and anomic aphasia, different trend in their performances were obtained. Anomic aphasics obtained better scores than the conduction aphasics which can be attributed to their better rehearsal system. However, when serial position curves were drawn, it revealed that the impairment in the aphasics begins from earlier trials when compared to normals. Also, the primacy effect (recall of early presented items) which can be clearly understood from the graph shows the presence of weak effect in aphasics as compared to normals.

Thus, these results exhibited a reduced score in digit span in aphasics when compared to normals. Therefore, from this study, the significance of sub-vocal rehearsals is highlighted which has also been stated by other researchers. The results also gives an evidence that inspite of the adequate language ability, there is deterioration in memory in normals which suggests that the language abilities and the memory of an individual are controlled by two different systems but are related to each other which reflects the overall performance.

2. Memory Span for Aphasics and Normals in Meaningful Word Task

The memory span for normals and aphasics in the meaningful word task across various trials were obtained using raw scores. Mean and standard deviation for the raw scores were computed in normals and aphasics and is tabulated in Table-7. The table shows a mean of 2.0, 2.78, 3.78, 3.67, 3.67, 1.89 for normals and 1.67, 2.22, 2.0, 0.56, 0.89, 1.0 in aphasics. It is evident from the results that the performance of normals deteriorated from trial-2 to trial-6 whereas in aphasics, impairment in recall began in trial-1 and the performance was found to be poorer when compared to normals.

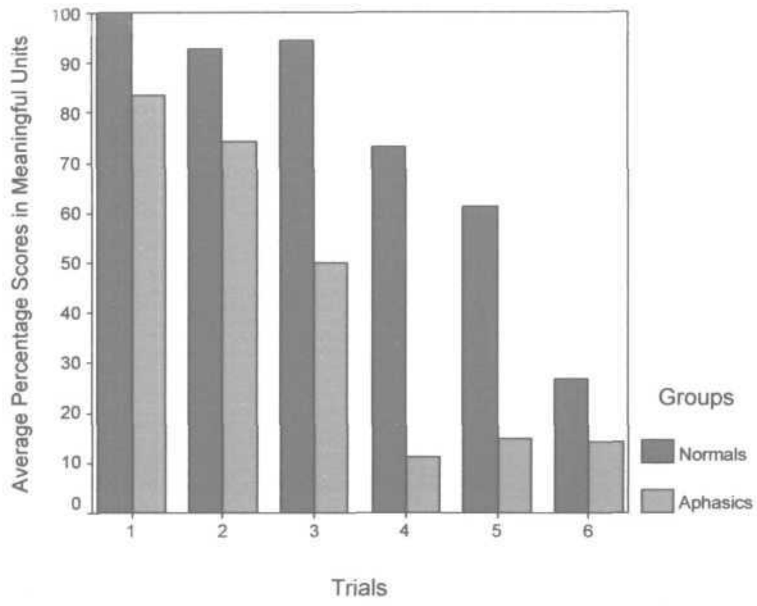
TabIe-7: Mean and Standard Deviation of raw scores across different trials in meaningful word task in normals and aphasics.

Trials	Groups			
	Normals		Aphasics	
	Mean	Std. Deviation	Mean	Std. Deviation
T-l	2.00	0.00	1.67	0.50
T-2	2.78	0.44	2.22	1.30
T-3	3.78	0.44	2.00	1.50
T-4	3.67	1.41	0.56	0.73
T-5	3.67	1.58	0.89	1.36
T-6	1.89	0.93	1.00	0.87

Additionally the raw scores of both normals and aphasics were converted to percentage scores. Table-8 shows the mean and standard deviation of percentage scores for normals and different types of aphasics across various trials in meaningful word task. The same is also represented graphically.

Table-8: Mean and Standard Deviation of percentage scores across different trials in meaningful word task in normals and aphasics.

Trials	Groups			
	Normals		Aphasics	
	Mean	Std. Deviation	Mean	Std. Deviation
T-l	100.0000	00.0000	83.3333	25.0000
T-2	92.5926	14.6986	74.0741	43.3903
T-3	94.4444	11.0240	50.0000	37.5000
T-4	73.3333	28.2843	11.1111	14.5297
T-5	61.1111	26.3523	14.8148	22.7371
T-6	26.9841	13.2566	14.2857	12.3718



Graph-3: Comparison of normals and aphasics across various trials in meaningful word task.

Table-8 shows the percentage scores across various trials in meaningful word task in aphasics. From the results it is apparent that the performance declined in normals (100% to 27.14%) and aphasics (83.33 to 14.28%) from trial-1 to trial-6. Also, from the graph 3 it is evident that there is decline in normals which begin from trial -2 and continues till trial-6 whereas in aphasics the deterioration started at trial-1 and continued till trial-6. Thus, there is weakening in the performance both in normals and aphasics as the load on the memory increases but the amount of deterioration is more and begins from early trials in aphasics than the normals. The results obtained are similar to digit task and also draw the support from the study by Ronnberg (1996) who studied short-term memory function and reported poor performance of aphasics on both digits as well as word task. Cermak & Butters (1976); Goodglass, Gleason & Hyde (1970) also reported that patients with impaired language functions suffer from memory deficit for words or verbal labels and found that the patients with good comprehension were severely impaired on verbal material.

Therefore, these results also suggests the involvement of some anatomical regions which helps in recalling the information i.e. digit or a word and insult to these areas bring about deterioration in memory performance. Also, as there is decline in memory performance in normals but the extent is not as severe as aphasics, it suggests that language and memory are independent of each other.

Further, mean and standard deviation for raw scores were also computed for different types of aphasics. Table-9 shows the mean and standard deviation of the raw scores for normals and different types of aphasics across different trials in meaningful word task.

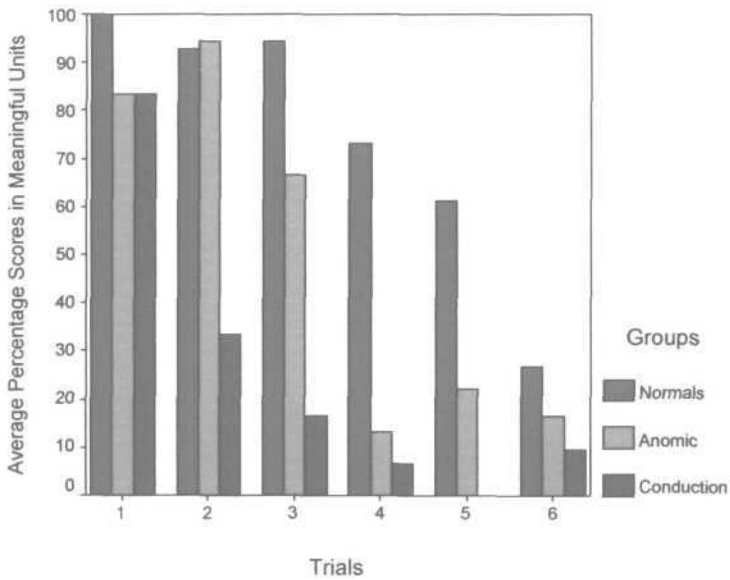
Table-9- Mean and Standard Deviation of raw scores across different trials in meaningful word task in normals and various types of aphasics.

Trials	Groups					
	Normals		Anomic		Conduction	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
T-l	2.00	0.00	1.67	0.52	0.58	00.0000
T-2	2.78	0.44	2.83	0.41	1.00	1.73
T-3	3.78	0.44	2.67	1.37	0.67	0.58
T-4	3.67	1.41	0.67	0.82	0.33	0.58
T-5	3.67	1.58	1.33	1.51	0.00	0.00
T-6	1.89	0.93	1.17	0.98	0.67	0.58

Later, the percentage scores were obtained for both the normals and various types of aphasics. Table-10 shows the mean and standard deviation of percentage scores for normals and different types of aphasics across various trials in meaningful word task. The same data is depicted in Graph-4.

Table-10: Mean and Standard Deviation of percentage scores across different trials in meaningful word task in normals and various types of aphasics.

Trials	Groups					
	Normals		Anomic		Conduction	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
T-l	100.0000	00.0000	83.3333	25.8199	83.3333	28.8675
T-2	92.5926	14.6986	94.4444	13.6083	33.3333	57.7350
T-3	94.4444	11.0240	66.6667	34.1565	16.6667	14.4338
T-4	73.3333	28.2843	13.3333	16.3299	6.6667	11.5470
T-5	61.1111	26.3523	22.2222	25.0924	0.0000	0.0000
T-6	26.9841	13.2566	16.6667	14.0456	9.5238	8.2479



Graph-4: Comparison of normals and various types of aphasics across various trials in meaningful word task.

Table-10 shows the percentage scores across various trials for meaningful word task in different types of aphasics. From the results it is evident that the performance decreases in normals (100% to 26.98%) from trial-1 to trial-6. On the other hand, when different types of aphasics were considered, they showed deterioration in different patterns. Anomic aphasics deteriorated from 83.33% to 16.66%, conduction aphasics deteriorated from 83.33% to 9.5%.

Also, from the graph-4 it is evident that deterioration in normals began from trial-2 and continues till trial-6 whereas in anomic and conduction aphasics, the deterioration began at trial-1 which continued till trial-6. However, the trend of deterioration shown by each of them is different. Among them, anomic aphasics had shown better performance than the conduction aphasics. This could be due to their better coding systems by means of rehearsals which have also been reported by Milner, 1971 who stated that performance in memory tasks relies upon effective verbal coding when material is pictorially presented which suggests that anomic aphasics had better verbal encoding of the material than conduction aphasia.

Further, the performance of aphasics was compared with normals for each trial. Table-10 shows the t-values and significant values for aphasics and normals across various trials for the meaningful word task.

Table-11: Comparison of aphasics and normals across various trials in meaningful word task.

Trial	t- value	df	Significance (2- tailed)
Trial-1	2.000	16	.063*
Trial-2	1.213	16	.243
Trial-3	3.411	16	.004**
Trial-4	5.870	16	.000***
Trial-5	3.990	16	.001**
Trial-6	2.101	16	.052*

* Significant at 0.1 level

** Significant at 0.01 level

*** Significant at 0.001 level

Results from table-11 indicates that a statistically significant difference was obtained in Trial-1 and Trial-6 ($p<0.1$), Trial-3 and Trial-5 ($p<0.01$) and Trial-4 ($p<0.001$). Thus it is evident that as the number of items increases, there is impairment in the recall of the items. Similar results are also reported by Albert (1976) who found that the retention of order information was significantly impaired among aphasics and as the information load increased, memory for sequences became critical for linguistic performance of aphasics. Therefore, the linguistic abilities of the individual also play a role in memory tasks which in turn influences the performance.

The primacy and recency effects for a given memory tasks are well depicted by the serial position curve. Figures 6-11 depicts the serial position curves for normals and aphasics in a meaningful word task.

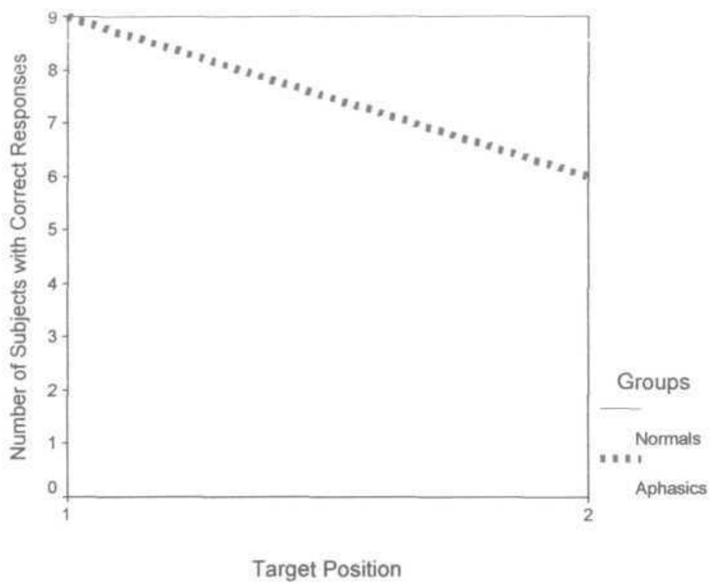


Figure-8: Serial position curve for trial-1

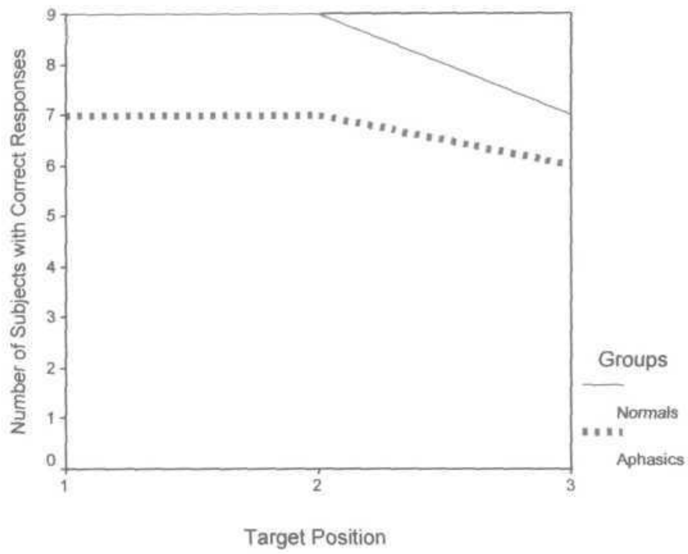


Figure-9: Serial position curve for trial-2

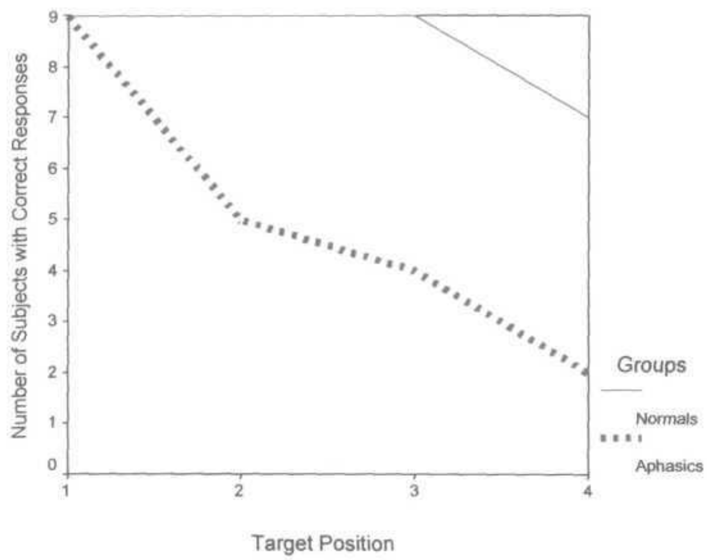


Figure-10: Serial position curve for trial-3

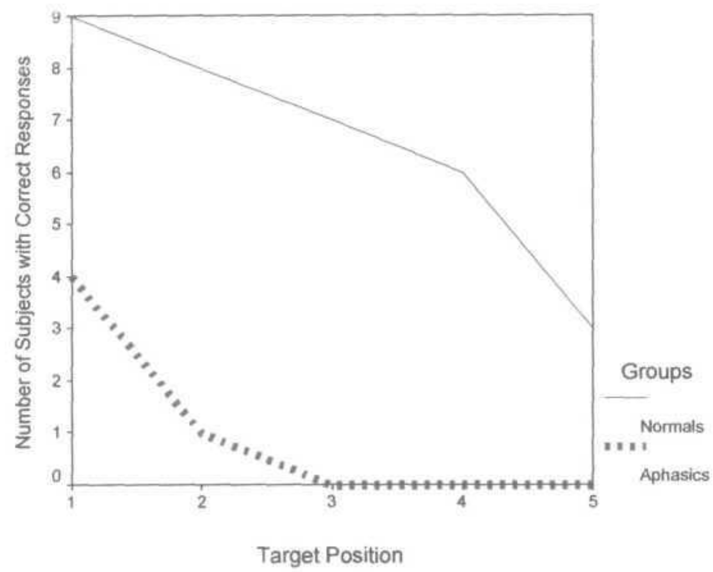


Figure-11: Serial position curve for trial-4

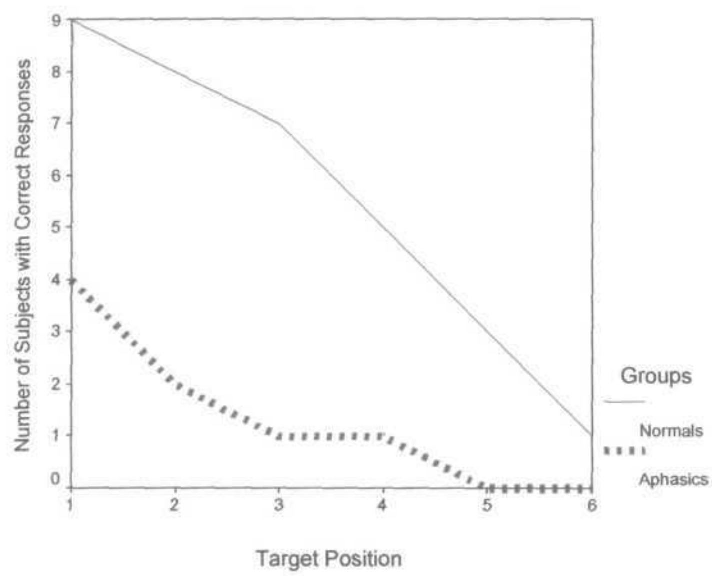


Figure-12: Serial position curve for trial-5

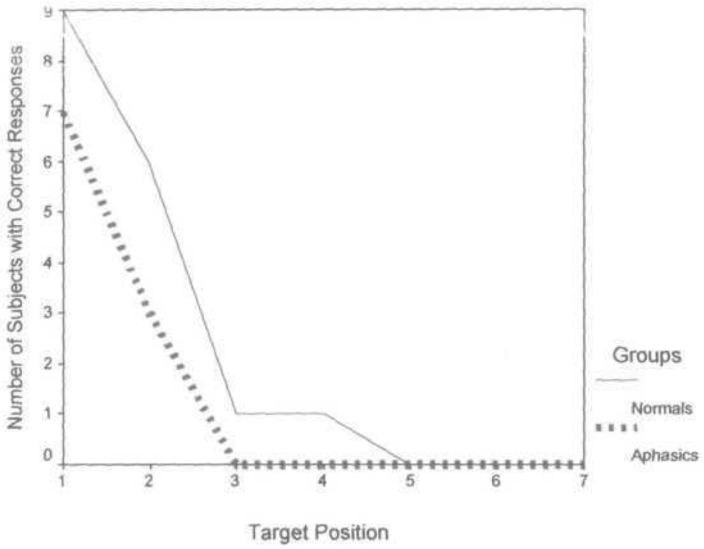


Figure-13: Serial position curve for trial-6

From figure 6-11, primacy effect is evident for aphasics and normals till trial- 6 for meaningful word task although there is a sudden decline in aphasics after trial-3. Also, as the complexity increased, the recall of items is affected in normals and aphasics which is clearly evident in Trial-4, Trial-5, and Trial-6. This decline can again be attributed to the semanticity and familiarity with the items. The results of the present study are also in accordance with the study of Ronnberg, Larsson, Fogelsjoo, Nilsson, Lindberg, and Angquist (1996) measured the short-term memory ability in adults with mild aphasia by using digit and word span task and found that the verbal short term memory was impaired.

To conclude, normals and aphasics exhibited more deterioration in meaningful word task when compared to digit task which indicates that the memory performance also depends on the linguistic ability of an individual. As there is more redundancy and automatcity in the digits, better performance is exhibited.

3. Comparison of digit and meaningful word task within normals and within aphasics.

The raw scores of normals and aphasics for meaningful word and digit task were obtained. Table-12 shows the mean and standard deviation of total raw scores for normals and aphasics for both the tasks.

Table-12: Mean and standard deviation of total raw scores across digit and meaningful word task for normals and aphasics.

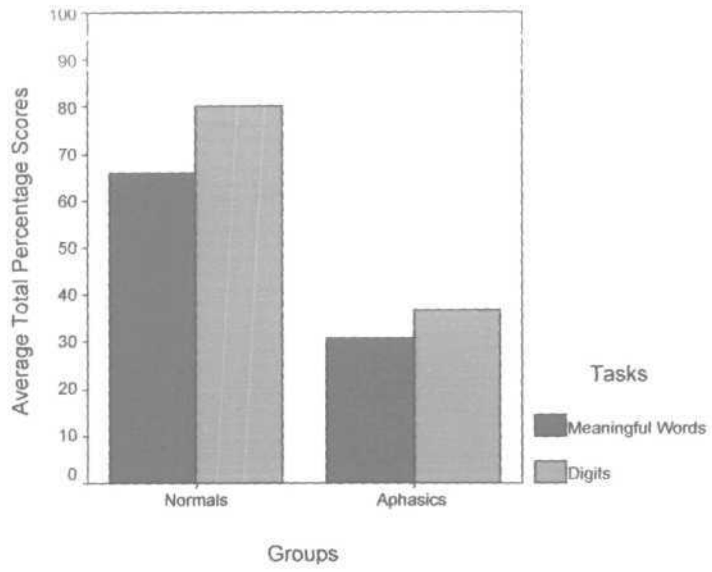
GROUPS		MW task*	Digit task
Normals	Mean	17.77	21.66
	Std. Deviation	3.59	4.84
Aphasics	Mean	8.33	9.88
	Std. Deviation	4.41	5.39

Further, the raw scores were converted to percentage scores. Table-13 depicts the total percentage scores obtained by normals and aphasics for both the tasks. The same scores are represented in graph-5.

Table-13: Mean and standard deviation of total percentage scores across digit and meaningful word task for normals and aphasics.

GROUPS		MW task*	Digit task
Normals	Mean	65.8436	80.2469
	Std. Deviation	13.3253	17.9544
Aphasics	Mean	30.8642	36.6255
	Std. Deviation	16.3551	19.9832

Foot Note:
* Meaningful Word Task



Graph 5: Comparison of average total percentage score in normals and aphasics between the digit and meaningful unit task.

From the graph-5, it is clear that normals also had shown difficulty in recalling both the tasks but the scores were found to be better for digits (80.24%) when compared to meaningful words (65.5%), But in aphasics the recall performance was poor for both the tasks when compared to normals. It was found to be 36.62% for digits and 30.86% for meaningful word task. These results also suggest that the type of task employed also affects the performance of the subjects. Since, digits are easy to recall because of chunking and more redundancy, it helped the subjects to recall better.

Paired t-test was used to compare the performances in digit and meaningful word task within the subjects. A significant difference was obtained between the tasks in normals {t (8) = 0.027, $p < 0.05$} which suggested that the performance of an individual depends on the complexity, familiarity of the task. However in aphasics no significant difference was obtained between the tasks {t (8) = 0.369, $p > 0.05$} which significant difference was obtained between the tasks {t (8) = 0.369, p>0.05) which suggested that the task was equally complex from them. Although digits have more redundancy, and are easier to recall than the meaningful words the performance was similar to that of meaningful word task. This can be attributed to the lack of functioning of articulatory rehearsal system in phonological loop due to the linguistic impairment which is also supported by Ostergaard & Meudell, (1984), Martin & Ayala, (2004), Goswami, (2004), Bansal, (2006). Therefore, the stimulus employed to tap the memory deficits becomes equally complex in aphasics during the verbal task irrespective of the type of stimulus used. Therefore, the semanticity as well as the familiarity of the stimulus should be kept in mind while evaluating the memory as these factors can also affect the performance in aphasics.

4. PERFORMANCES OF APHASICS IN VERBAL AND NON-VERBAL MEMORY TASKS

In the present study, verbal memory was evaluated and it was found that the performance was deteriorated both in normals and aphasics for both digit as well as meaningful word task. Although there was decline in performance of aphasics for both the tasks but the decline for meaningful words was comparatively more than the digits. However, using paired t-test, there was statistically no significant difference found between the two tasks in aphasics which suggested that they had equal level of difficulty in both the tasks. On the other hand, in normals, paired t-test revealed significant difference between the performance in meaningful words and digits. The scores obtained for digits were better than the meaningful words which confirms that the redundancy in digits and semanticity and familiarity of the stimulus affects the storage and thus the recall.

Bansal (2006) evaluated non-verbal memory in Broca's aphasics in both normals and aphasics and reported that there was a significant difference in the aphasics and normals in digit task but not in meaningful word and non-meaningful tasks. Also, it was reported that the kind of stimuli employed had an effect on the performance of the participants. A difference was found between digits and non-meaningful task and between meaningful and non-meaningful tasks in normals, but in aphasics the difference was found between meaningful and non-meaningful task.

Therefore, from the above results, one can infer that there are memory deficits in verbal and non-verbal tasks in aphasics but the performance differs depending on the task employed. The linguistic ability of the subject, semanticity and the familiarity of the stimulus are the various aspects which influences the performance on a memory task and therefore, these variables should be considered while evaluating an aphasic patient in order to obtain the desirable responses which would help in framing the further management program of the patient.

SUMMARY AND CONCLUSION

The present study was designed to study the verbal sequential memory in aphasics. Nine aphasic patients (six anomic, three conduction) and nine normal individuals participated in the study. All ethical considerations were taken into account while carrying out the study. The subjects were presented with the stimulus through laptop and the task for the subjects was to recall the items in the same order of their presentation. The stimulus consisted of two tasks-

- Digit task
- Meaningful word task

The tasks consisted of six trials each and the number of items in each trial was increased by one i.e. the first trial had two items, second trial had three items and so on till sixth trial. Therefore, the complexity of the task was increased from simple to difficult task. A two-point rating scale (0 and 1) was used to score the responses. A score of 1 was given for each correct response in a trial and therefore it was possible to obtain a score ranging from 0-7.

Data analysis was done using SPSS software. Mean and standard deviation was obtained using raw scores and percentage scores. Bar graphs were drawn using raw scores to recognize the differences between normals and aphasics. Line graphs illustrated the level or position in the trial at which deterioration began to occur. Further, paired t-test was done to compare the performances for digits and meaningful word task within normals and within aphasics. The results obtained in the study can be summarized as-

- There was a difference in the performance of aphasics and normals in the two tasks (Digit and Meaningful word task).
- A significant difference was obtained for digit task in normals and aphasics across various trials. Normals obtained better scores than aphasics due to their intact widespread anatomical regions for memory in the brain.
- A strong primacy effect was seen in normals and in aphasics for digit task but the effect was weak in comparison to normals .This could be attributed to the poor sub vocal rehearsals in aphasic subjects.
- No significant difference was obtained in meaningful word task in aphasics and normals which suggested that the stimulus were highly semantically loaded and familiar which helped the aphasics to retrieve from some intact areas in the brain.
- Strong primacy effect was observed in meaningful words task till trial-4 in normals whereas the influence of this effect on the performance of aphasic patients was weak and was found till the trial-3 which suggests that as the load on memory increases the rate of decline in performance occurs rapidly.
- There were different trends of deterioration seen in different types of aphasics. In digit and meaningful words task, the performance of anomic was found to be better than the conduction aphasic suggesting better rehearsal abilities.
- Paired t-test revealed a significant difference was obtained in normals between meaningful word task and digit task whereas no significant difference was obtained in aphasics for both the tasks which suggested that the type of task employed also affects the performance.

Thus, it is evident from the results that there is an obvious memory deficit existing in aphasic individuals. Although there is deterioration in normal individuals, the aphasic patients exhibit the deficit to a greater extent in both digits as well as meaningful words. However, different types of aphasics have shown different performances. Few of them showed deficit in rehearsal ability which added on to their existing linguistic deficits and lead to poor performances which suggests the significance of covert rehearsal in memory.

To conclude, the present study has shed light on the less explored aspect of cognition in aphasics which emphasizes that it is essential for Speech Language Pathologist (SLP) to focus their goals on cognition especially the memory aspect during evaluation as well as therapy. All rehabilitation and compensatory techniques requires some form of learning and learning cannot take place without memory and therefore it is necessary for SLP's to take care of the cognitive aspect too during the management program.

Implications of the Study-

The present study has showed the obvious memory deficits in aphasics. Though these are the subtle deficits which get overlooked, this study has shown the influence of memory on the overall communication abilities of an individual. Therefore, it is imperative to sensitize SLP about the importance of evaluating the verbal memory in aphasics and the integration of memory in the goal/s of language therapy for the successful management.

Limitations of the study-

- As the numbers of participant were less, the results should be generalized with caution.
- Similar studies should be taken up with large number of patients to study the memory in each kind of fluent aphasic through verbal task which can give in-depth information about each type of aphasia.

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APPENDIX-I

Trial No	Digits
Trial-1	3,8
Trial-2	5,7,2
Trial-3	9, 4,1, 5
Trial-4	6, 3, 8, 2, 7
Trial-5	1, 9, 7, 5, 4, 3
Trial-6	2, 3, 8, 4, 6,1, 5

1	2
3	4

5	6
7	8

APPENDIX-II

Trial No	Meaningful Words
Trial-1	Cup, Bus
Trial-2	Watch, Scissor, Cup
Trial-3	Cow, Scissor, Rose, Bucket
Trial-4	Peacock, Cycle, Comb, Tomato, Fan
Trial-5	Umbrella, Tomato, Ship, Dog, Shirt, Tree
Trial-6	Banana, Table, Lock, Pen, Knife, Shoes, Cat


SCHOOL BUS
SCHOOL BUS