2011 International Conference on Social Science and Humanity
IPEDR vol.5 (2011) © (2011) IACSIT Press, Singapore

Serial order in short-term memory: A comparative study between dementia patients and normal subjects

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Abstract— **The present study is designed to investigate the impact of three different types of short term memory models on serial recall. It also aims to see the impact of these different memory models on different levels of neurological functioning.54 demented patients were selected from Khyber teaching, Lady Reading and Mental hospitals of Peshawar ,Pakistan. Mini Mental State Examination was used for screening as well as for measuring the intensity of dementia. On the basis of these score patients were bifurcated into two experimental groups of an equal number portraying severe dementia and moderate dementia. The control group (n=27) was selected from the normal population having no neurological dysfunction, and was matched on age, education and socioeconomic status .t test was used to explore the difference among the groups. Our results indicated a significant (P.001) among the groups, which subsequently supported the hypothesis framed for this study.**

Keywords-Short-term memory;Positional models;Dementia patients;Correct Recall.

I. INTRODUCTION

Memory is essential for all daily activities in people's lives. It plays significant and ever present roles in all functions human beings perform. However, its role is often overlooked, and the only time most people pay attention when it fails. Memory is a place in which memories are stored. Nevertheless, memories do not exist before they are revived or recalled (Wechsler, 1963). There are two storages to distinct each memory system in clinical settings are; short term and long term memory (Bradley & Kapur 2006). Short term memory/working memory refers to the every day episodic events of few hours, days, or weeks duration. In contrast Long term memory is for events, which have occurred many years ago. The current study aims to focus on the short term memory/working memory difficulties in people with progressive neurological conditions in order to manage every day problems faced by them.

Recall in serial order from short term memory is one of the most widely studied tasks in cognitive psychology. Howevere, Lashely (1951) revealed the inability to recall in serial order in short term memory and considered it a serious difficulty in working memory. Subsequently, this difficulty could be observed in many aspects of the daily activities such as, dialing a familiar telephone number after attending to operator or movement finger of a skilled typist, or order of words in sentence etc. Numerous studies in the past were conducted to understand this problem in depth problem and consequently contemplated different models of understanding for short-term memory. However, the current study focuses on the three theories of positional coding such as 'temporal,'absoluet', and 'relative codes (Henson, 1999) to explore in roads to this problem.

According to temporal coding of position each item is associated with its time occurrence relative to the start of the sequence (Brown et al 2000). It means that rewinding the clock or resetting the oscillators can trigger the recall. In the absolute coding position items are associated with their absolute position from the start e.g. first, second and third etc, which suggest that window of activity changes only when a new item is presented irrespective of the delay between successive items Burgess& Hitch (1992).

In relative coding of position the items are coded with reference to both the start and end of a sequence and therefore named as start-end model (Henson 1999). By supposing that start marker that is strongest at the start of a sequence decreases in strength and end marker that is weakest at the start increases in strength towards the end. The relative strength of this start and end marker provides

two-dimensional code for each position in a sequence. This means once the encoding process is over our next concern is about quality and quantity of retention (Houghton (1990).

To recap people store and retrieve information in short-term memory considering the above three coding positions in order to perform day to day activities. Hence there are more chances of errors in utilizing short-term memory particularly those suffering from neurological disorders. It is therefore important to find out ways and means through which one can manage or minimize these difficulties. So in this study an attempt has been made to explore working mechanism in case of neurological dysfunction and the coding positions that are adversely affected as the neurological degeneration gradually progress.

II. HYPOTHESIS

A significant difference will occur between the responses of normal and dementia patients on three models (temporal, absolute and relative) of short- term memory

III. METHOD

A. participants

Fifty-four in patients were randomly selected from the psychiatric and neurology wards of three hospitals i.e. Khyber Teaching hospital, Lady Reading hospital and Mental Hospital Peshawar who presented with memory difficulties. These patients were assessed on Mini Mental State Examination to investigate the severity of memory level. The patients were further classified into two groups that is, severe dementia and moderate dementia and were included for this study of an equal number of 27. Furthermore the researcher selected another group (n=27) called control group from normal population who did not demonstrate any neurological dysfunction. The control group was matched with the experimental group in terms of predetermined criteria, that is, age (age range of subjects was between 50-75 years), education, and socio economic status. All these subjects had studied up to Secondary School Certificate level and come from low socio economic status.

B. INCLUSION AND EXCLUSION CRITERIA

- The consent (Davies, 2001) of the patients or their near relatives to participate in the study was obtained.
- Patients with brain damage/ brain injury or substance abuse and patients who were unable to recognize objects comprising test material were excluded.

C. INSTRUMENTS

- Mini Mental State Examination is the practical method for grading the cognitive state of patients for clinicians. It was developed in by Folstein (1975). It is easy to administer and is a very popular for screening cognitive impairments. Due to growing need of this test for cognitive assessment few changes (Aziz, 2001) were made compatible to our culture.
- In the preparation of this list the pictures of common items were collected. In order to equate the independent variables these items were then randomly assigned to three different conditions i.e. temporal, absolute and relative. Six items were selected for temporal coding of position, eighteen items comprising three lists were selected for absolute coding of position, and for relative coding of position two lists of five items were selected.
- In temporal presentation the lists with six items was presented. Each item was shown separately with constant timing e. g first item was presented at 4:00 o'clock, second item was presented at 4:05 and third item was presented at 4:10 and likewise. Each subject was given instructions individually. The following instructions were given "the time will be shown to you on the clock followed by an item, your task will be to recall each item in relation with that specific time". Remember you will be shown the time only and not the items and you have to recall the items in their correct position. In this experiment the time was used as a cue e.g. by resetting the oscillators the order of item was to be recalled.
- In absolute coding of position three lists were shown. First list consisted of five items while second list, comprised of six items. The third list, likewise, after the addition of yet another item comprised of seven items. By including these additional items the degree of accuracy of recall memory was noted. For this experiment the following instructions were given "you will be shown three lists of items and your task will be to recall them in their correct position".
- In relative coding of position two lists were shown each having five items. Second list was the same but shown in reverse order. For this experiment the following instructions were given "I will show you two lists of items and your task will be to recall these items in their correct position"

D. DESIGN

In the present research 3x3 factorial design was used having two independent variables each with three levels .The first independent variable was serial learning with its three manipulated levels i.e, temporal, absolute and Relative coding of positions. The other independent variable was neurological functioning having severely disturbed, moderately disturbed dementia patients and normal subjects with no neurological deficits. Number of errors in immediate serial recall was the dependent variable.

E. PROCEDURE

In order to carry out this study, the researchers submitted the plan of this research to the departmental ethical committee and subsequently approved, which was endorsed by the advanced research board. A copy of the research proposal plan was sent to each referral sources in order to insure the availability of subjects for our study. Consequently the patients suffering from memory impairment were referred to us either by neurologist or psychiatrics. Their consent was obtained in the first session. Moreover, the normal group (n=27) was matched in gender,

age, education, residential area, socioeconomic background and the non-existing of neurological dysfunction. Those who were willing to participate in this study were interviewed for demographic data and administered Mini Mental State Examination. The scores obtained on Mini Mental State Examination helped in bifurcating the patients into two groups i.e. severely disturbed dementia patients and moderately disturbed. These patients were then assigned to three levels of serial learning namely temporal absolute and relative and administered the Indigenous Lists of Visual clips according to the standard instructions. This list was administered in flexible time interval keeping in mind the subjects age and severity of illness. Once the data was collected the standardized scoring procedure as per requirement of different models was adopted. The data was analyzed using t-test and two-way ANOVA , tabulated and depicted in the next section.

TABLE I. TWO- WAY ANOVA SHOWING INTERACTION BETWEEN NEUROLOGICALFUNCTIONING AND POSITIONAL MODELS OF SERIAL LEARNING

Source	***Type III of sum of squares***	***df***	***Mean square***	***F***	***Sig***
Corrected Model	3.855	8	.482	19.419	.000
Intercept	16.178	1	16.178	651.960	.000
N-functioning	2.988	2	1.494	60.214	.000
Positional models	.605	2	.302	12.184	.263
N.Functioning* Positional models	.262	4	.0065	2.639	.041
Error	1.787	72	.0025		
Total	21.820	81			
Corrected Total	5.642	80			

Result shows that there is an interaction between neurological functioning (i.e. severe dementia moderate dementia and normal subjects) and three level of serial order learning (i.e. absolute, relative and temporal), [F = 2.639, p < .041]. Two-ways analysis of variance was conducted on a number of correctly recalled items under nine different conditions. Both main effects were statistically significant. Analysis of simple main effect was significant for neurological functioning [F=59.40, P<.000].there was also significant simple main effect of positional models [F=12.79, P<.000].There was a high mean effect (.8444) of normal with relative coding of position, while moderate dementia patients higher mean (.5556) was with Absolute coding of position. The higher mean effect (.2889) of severe dementia was also with absolute coding of position.

TABLE II. ONE-WAY ANOVA SHOWING DIFFERENCE AMONG THREE POSITIONAL MODELSTHREE LEVELSOF NEUROLOGICALFUNCTIONING

		N	***M***	***SD***	***F***	***P***
SEVERE DEMENTIA	RELATIVE	9	.222	.2048		
	ABSOLUTE	9	.2667	.1871	.916	.414
	TEMPORAL	9	.1556	.1236		
MODERATE DEMENTIA	RELATIVE	9	.5000	.2062		
	ABSOLUTE	9	.5556	.0073	7.903	.002
	TEMPORAL	9	.5556	.0073		
NORMAL SUBJECTS	RELATIVE	9	.8444	.1014		
	ABSOLUTE	9	.6556	.0088	11.432	.000
	TEMPORAL	9	.5556	.1810		

Results in tableII suggest that severe & dementia patients perform better on absolute model while normal group performed better on relative model. The significance differences among three Neurological functioning also vary with the intensity of the diseases.

IV. DISCUSSION

Correct recall is a big problem of both short-term and long-term memory. The focus of present research was just the short-term memory. In case of short-term memory correct retrieval is dependent upon brief exposure of stimuli, and therefore, chances of error are profound. Psychologists have been trying to formulate such models or ways through which error either could be diminished or eliminated. The models were formulated in order to understand the mechanism of encoding, storage and retrieval. It also emphasized the process of minimizing the errors. The results of the current study revealed that certain models have advantage over the others in term of lesser number and different types of errors. Henson (1999) classified eight different types of errors i.e. omission, transposition, intrusion, confusion, protrusion, association, Repetition and interposition. However Kalsoom, Jahangir, and Khan (2006) indicated four types of errors i.e. omission, transposition, intrusion and confusion when studied demented patients and normal subjects.

Our hypothesis assumed a significant difference in the responses of normal subjects and dementia patients on three models of short-term memory (i-e temporal, absolute and relative).

The two-way ANOVA (Table 1) results indicate that responses of normal subjects and dementia patients were different on three positional models. The difference between severe dementia patients and normal subjects on correct recall was very obvious but negligible between moderate and

normal subjects. The cognitive abilities of severely disturbed dementia patients were very poor and some of them could hardly recognize common items/ objects. Their cognitive map indicating different memory routs might have been fully garbled. In certain cases these patients could not even recognize their own children. A neuroimaging study (Plaulesu et al. 1993) using positron emission tomography (PET) to image which part of the brain involve in item recognition, concluded that activated areas was bilateral inferior prefrontal cortex (Broca's area) and bilateral inferior parietal cortex (Superamarginal gyri). In our case these patients must have been suffering from similar level of deterioration but due to our limitation we could not support these observations with similar kind of PET scan etc.

There was a greater detrimental effect of dementia disease on the performance of participants. Table 2 results show that severely and disturbed demented patients performed better on absolute coding of position. Absolute model is followed by repetition of items in its essence which is in accordance with Heb's(1961) repetition effect. It also shows the positive effects of repetitive exercise on memory recall of severe dementia patients.

The difference between moderate patients and normal subjects on correct recall however, was not significant. The most likely reason can be the subjects included in this group were borderline patients. The most fascinating fact about these results was that their performance though was not significantly different but showed similar trends, that is, both the patient groups displayed better on absolute coding of position. As mentioned above it is once again reiterated that repetitions have positive effects in sustaining the memory of patients suffering from dementia.

Normal group performed better on relative coding of position, supporting the earlier study conducted by Henson (1998).While both experimental and control group remained sensitive to temporal model which is based on clock analogy of Oscillators-based Associative recall (OSCAR) model and required active exercise of cognitive functioning. In dementia the core symptoms are cognitive degeneration which was the main cause of poor performance secondly noise (Brown, Preece&Hume, 2000) can also effect the retrieval. In the present research the author could not eliminate completely the noise factor because the study was done in hospital setting where the complete control on noise was not possible.

A neuropsychological study (Henson, 2000) indicates that left dorsolateral premotor cortex is responsible in the maintenance of temporal order. The poor performance on temporal model then tell us that once the cognitive degeneration starts the left dorsolateral premotor cortex area gets effected right from the beginning. Since the performance on temporal model was very poor. We can safely assume that the involvement of this brain area is obvious. Not only in disease condition but also in normal subjects. It is possible that before the commencement of the disease the age itself is a degeneration factor. Because normal group was also between 50-75 years. The role of disease may not be contributing to extent as in case of recognition memory.

IV CONCLUSION

To conclusion our findings indicated that severely & moderately disturbed dementia patients responded better on absolute coding of position, while control group responded better on relative coding of position. Both semantic & episodic memory was impaired in severely disturbed patients', while only episodic memory was impaired in moderately demented patients. This suggests that the early diagnosis of incipient dementia would anticipate at first rather to wait for complexity. In addition the authors suggest more researches are needed to elucidate the application of temporal model.

V LIMITATION

The present research would have been more authentic scientifically had there been resources available for PET, CAT, &FMRI scan because brain images can reveal which area of the brain was more active or deteriorated in dementia. Moreover, it could have provided more profound conclusion that why different levels of neurological functioning affected differently on different positional models.

The study was done in hospital setting, the environment and other factor must have affected the outcomes of the result.

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