

# Learning, Memory & Executive Function in Female BPO Employees Exposed to Regular Shifts

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## ABSTRACT

**Background:** Women constitute 24 percent of the workforce in India, which boasts of one the largest working populations in the world. Information Technology industry is one such industry where women constitute a significant percentage of employees. BPO sector is a major part of IT industry with around 4.5 million employees of which 35 % are women. These women employees are subjected to high work stress, odd working hours and frequent shift changes apart from environmental & domestic stressors leading to increased physical and mental health problems.

**Aims & Objective:** To study the cognitive functions – Learning, Memory & Executive function in female BPO employees exposed to regular shifts.

**Materials and Methods:** 50 female BPO employees exposed to regular shifts were assessed for cognitive functions of learning, memory & executive function. They were compared with 50 female non BPO employees not working in shifts. Data was analyzed by t-test and Mann-Whitney test using SPSS V.13.0.

**Results:** BPO employees performed poorly compared to their controls in tests for learning and memory, response inhibition & visual working memory. No changes were seen between groups in tests for verbal working memory.

**Conclusion:** cognitive functions are impaired in female BPO employees exposed to regular shift changes.

**Key Words:** BPO; Cognitive Functions; Female; Shift work

## INTRODUCTION

Business processing outsourcing (BPO) industry is one of the rapidly developing sectors with companies coming up with increasing pace even in tier 2 cities. According to NASSCOM (National Association of Software and Service Companies), Strategic Review 2011, the Indian outsourcing sector along with the Information Technology (IT) is expected to make substantial contribution to annual GDP and is likely to create more than 14 million employment opportunities by the year 2015. Recent NASSCOM survey has found that around 5 million employees are working in BPO and related sectors and 35 % of them are women. The geographical time difference with the US and the UK gives Indian industry one of the biggest advantages to remain a dominant player in the BPO. Hence the employees have to work in nights for long hours. Any average BPO employee puts in 11-12 hours of work per day and at times it reaches 14 hours in case of companies that encourage overtime. BPO sector demands odd working hours, long travel time, insufficient breaks and frequent shift changes leading to high levels of stress among its employees. This is compounded by the fact that most of the women need to put extra hours of work at home apart from their regular work at office which makes them more vulnerable to stress and related disorders.

IT professionals face continuous stress due to job deadlines which are compounded by environmental and domestic stressors. During stressful situations, concentration, awareness on posture, dexterity during work and many neuro-physiological changes occur in the body leading to drop in work performance. Adverse effects on learning and memory, following intense stress have repeatedly been found.<sup>[1-3]</sup>

Cognitive efficiency is found to be reduced in people whose circadian rhythm have been disrupted.<sup>[4]</sup> A variety of adverse biological, psychological and social effects of shift work on the workers have been reported by many studies. These include effects on sleep, eating, behavior, neuropsychic and cardiovascular functions,

menstrual cycle, work accidents, absenteeism and many others.<sup>[5]</sup> Long working hours, sleep deprivation, irregular dietary habits, etc which are common to sectors like transport, health & heavy industries may have a negative effect on cognitive performance in individuals.<sup>[6]</sup>

India is a forerunner in the IT world and therefore there is an urgent need to understand the health problems of millions of people employed in BPO sector. Failure to identify the health related issues of this population may lead to problems compounding to reach epidemic proportions. Literature available on this problem is in the west with very few studies done in an Indian setup and almost no studies done in female population.

Our previous study done on male BPO employees showed a significant decrease in majority of the cognitive functions tested.<sup>[7]</sup> The present study is therefore aimed at evaluating the cognitive functions of female BPO employees, the influence of shift work on learning, memory & executive functions.

## MATERIALS AND METHODS

The present study was conducted on female employees of various BPOs of Bangalore city. The study was approved by institutional ethical committee. Informed written consent was obtained from every subject after explaining the study protocol. Subjects in the age group of 25-35 yrs who were on compulsory rotating night shifts were selected for the study. BPO employees who had a minimum work experience of six months in the field and working on computers for at least five hours per day or 25 hours per week were considered for the study. Subjects with good physical and mental health were chosen after obtaining a detailed history and doing relevant clinical examination. Individuals with history of preexisting conditions like diabetes, hypertension and sleep disorders, those who were on medication for any illness and smokers were excluded from the study.

Fifty female BPO employees selected from

various BPOs across Bangalore formed the study group. They were compared with fifty age matched individuals working in non BPO sectors and did not have any night shifts who formed the controls. Mean age of study subjects was  $27.82 \pm 2.36$  years and that of controls was  $28.58 \pm 2.42$  years. All the subjects were assessed for cognitive functions at the end of their work.

The following cognitive function tests were administered in a fixed order, one right after the other, during a single session in a quiet room. The tests were administered according to the instructions provided in the NIMHANS Neuropsychology battery.<sup>[9]</sup> The order of tests administered was as follows:

Domain	Function	Test
Learning and Memory	Verbal	Auditory Verbal Learning Test
Executive Function	Response Inhibition	Stroop Test
	Working Memory	Verbal N Back Test
		Visual N Back Test

### Auditory Verbal Learning Test (AVLT)

The Rey's Auditory Verbal Learning test<sup>[9]</sup> consists of words designating familiar objects like the vehicles, tools, animals and body parts. There are two lists A and B, with 15 words in each list.

Words in list A were presented at the rate of one word per second during three successive trials. The words were presented in the same order in every trial. Each trial consisted of the presentation of all 15 words, immediately followed by the recall of the same. In each trial, after the presentation, the subject was asked to recall the words but no cues were given. The response was noted down. After the completion of all trials of List A, words in List B were presented once and an immediate recall was taken for the same. The presentation of List B serves as interference and prevents the subject from recalling words from List A subsequently from immediate memory. This was followed by immediate recall of words from List A. After a delay of 20 minutes words from List A were again recalled to form the delayed recall score.

Following delayed recall, recognition of the words in list A was tested. The words in List A were randomly mixed with 15 new words. The new words were either phonemically or semantically similar to words in List A. The words were called out one at a time and the subject indicated whether each word belonged to list A or not. Hits and errors were recorded.

The number of words correctly recalled in each of the three trials of List A as well as the total number of words recalled over all the three trials form the learning score. The number of words recalled correctly in the immediate recall trial, delayed recall trial and the recognition trial form the memory score. In the recognition trial, the hits are scored separately.

### Stroop Test - NIMHANS Version

The colour names Blue, Green, Red and Yellow are printed in capital letters on a paper. The colour of the print occasionally corresponds with the colour designated by the word. The words are printed in 16 rows and 11 columns.

The stimulus sheet was placed in front of the subject. The subject was asked to read the stimuli column wise as fast as possible. The time taken to read all the 11 columns was noted down. Next, the subject was asked to name the colour in which the word was printed. The time taken to name all the colors in column wise was noted down. The reading time and the naming time were converted into seconds. The reading time was subtracted from the naming time to get the Stroop effect score.

### N Back Tests (Verbal and Visual)

The 1 back and the 2 back versions of the N back test<sup>[10]</sup> were used. The 1 back version requires verbal storage and rehearsal, while the 2 back version requires in addition to the above, manipulation of the information. Therefore the 1 back version would involve the articulatory loop in the verbal modality and the visuospatial sketchpad in the visual modality. The 2 back version would involve the central executive in both modalities.

**Verbal Working Memory N Back Test**

Thirty random ordered consonants were presented auditorily at the rate of one per second. Nine of the 30 consonants were repeated. The consonants, which were repeated, were randomly chosen. In the 1 back test the subject responds whenever a consonant was repeated consecutively. In the 2 back test the subject responds whenever a consonant is repeated after an intervening consonant. The number of hits and errors forms the scores in each test.

**Visual Working Memory N Back Test**

Visual Working Memory was tested using N back test with 1 back and 2 back versions. It consisted of 36 cards each of which had one black dot placed randomly along a circle imagined to be on the card. The dimensions and location of the imaginary circle on each card remained constant in all cards. Each card was individually presented to the subject.

The subject was told to respond whenever the location of the dot repeated itself. In the 1 back test the subject was told to respond when the location of the dots was consecutively repeated and in the 2 back test was told to respond whenever the location of the dot was repeated after one intervening card. The number of hits and errors in each test formed the score.

**Statistical Analysis**

The data was analyzed using t-test and Mann-Whitney test. The difference was considered statistically significant whenever  $P \leq 0.05$ . SPSS V.13.0 was used for analysis of data.

**RESULTS**

Our results show a significant difference between female BPO employees and controls in majority of the cognitive function tests performed. BPO employees performed poorly compared to their controls in auditory verbal learning test, stroop test and visual N back tests. However no statistically significant difference was observed in verbal N back tests.

**Table-1: Cognitive Functions in Female BPO Employees and Controls**

Test	BPO Employees	Control	Mean Difference	t	P Value
AVLT	Learning Score 33.48 ± 4.49	36.76 ± 4.79	3.280	-3.308	< 0.001
	Memory Score 32.24 ± 3.93	35.84 ± 3.77	3.600	4.677	< 0.001
Stroop Test	153.30 ± 36.69	121.12 ± 12.36	-32.180	-5.200	< 0.001
Verbal N Back Test	17.72 ± 0.54	17.70 ± 0.61	0.020	-.009	0.993
Visual N Back Test	16.68 ± 1.38	15.96 ± 1.51	-0.720	-2.382	0.017

Data presented are mean ± SD

**DISCUSSION**

In majority of the cognitive function tests administered in the present study, Female BPO employees performed poorly when compared to their controls.

Auditory Verbal Learning Test was used to assess verbal memory of the subjects. Declarative memory, a form of long term memory can be stored in visual or verbal forms and can be voluntarily recalled. Significant difference was found in learning and memory score ( $P < 0.001$ ) between BPO employees and control group. Sleep deprivation is known to disturb the functioning of frontal brain areas.<sup>[11]</sup> This causes impairment of cognitive functions that depend on pre frontal cortex. These include higher functions such as language, executive functions, divergent thinking, and creativity.<sup>[12]</sup> There is also considerable evidence that cognitive performance changes under stress. Chronic stress can produce deleterious cognitive changes, including problems with thinking, memory, concentration and behavior.<sup>[6]</sup>

Stroop test measures response inhibition. Response inhibition measures the ease with which a perceptual set can be shifted in accordance with changing demands as well as by suppressing a habitual response in favor of an unusual one. Prefrontal areas are essential for response inhibition. BPO employees performed poorly compared to their control group in this test. This decreased response in BPO employees may be attributed to impairment of cognitive performance that depends on pre frontal cortex.

Working memory is the capacity to hold and manipulate information for the ongoing processes. Our results showed a mixed response in working memory pattern in female BPO employees. There was significant decrease in the visual part but no difference was seen in the verbal part. This may be due to the fact that visual and verbal parts of working memory are processed in entirely different areas of the brain. The visual part is mainly processed in the prefrontal and right frontal areas<sup>[10,13]</sup>, whereas the verbal part is process in the temporal areas of the brain<sup>[14]</sup>.

## CONCLUSION

BPO employees recorded lower scores in tests of learning & memory, response inhibition and visual part of working memory. This decreased performance is possibly due to the nature of their work involving long working hours, frequent shift changes, pressure to meet deadlines and monotonous nature of work. Also Cognition is negatively affected by sleep deprivation, excessive stress and fatigue. Together, these factors would have contributed to a decrease in cognitive performance among the BPO employees.

## REFERENCES

1. Rutledge T, Stucky E, Dollarhide A, Shively M, Jain S, Wolfson T, et al. A real-time assessment of work stress in physicians and nurses. *Health Psychol.* 2009;28(2):194-200.
2. Stenfors CU, Magnusson Hanson L, Oxenstierna G, Theorell T, Nilsson LG. Psychosocial working

- conditions and cognitive complaints among Swedish employees. *PLoS One.* 2013;8(4). E60637.
3. Proctor SP, White RF, Robins TG, Echeverria D, Rocskay AZ. Effect of overtime work on cognitive function in automotive workers. *Scand J Work Environ Health.* 1996 Apr;22(2):124-32.
4. Rouch I, Wild P, Ansiau D, Marquie J. Shift work experience, age and cognitive performance. *Ergonomics.* 2005; 48(10): 1282-1293.
5. Costa G. The impact of shift and night work on health. *Appl Ergon.* 1996; 27: 9-16.
6. Elovainio M, Ferrie JE, Manoux A. Cumulative exposure to high-strain and active jobs as predictors of cognitive function: the Whitehall II study. *Occup Environ Med.* 2009; 66(1): 32-37.
7. Shwetha B, Sudhakar H. Influence of shift work on cognitive performance in male business process outsourcing employees. *Indian J Occup Environ Med.* 2012;16:114-8.
8. Rao SL, Subbakrishna DK, Chandramouli BA, Nair RG, Kumar S, Pillai S. NIMHANS Neuropsychol Battery for Head Injury.2004 (in press).
9. Schmidt M. Rey auditory verbal learning test. A hand book. Los Angeles, Western Psychological services. 1996.
10. Smith EE, Jonides J. Storage and executive processes in the frontal lobes. *Science.* 1999; 283(5408): 1657-61.
11. Alhola P, Polo-Kantola P. Sleep deprivation: Impact on cognitive performance. *Neuropsychiatr Dis Trea.* 2007; 3(5): 553-67.
12. D'Esposito M, Postle BR. The dependence of span and delayed response performance on prefrontal cortex. *Neuropsychologia.* 1999; 37: 1303-1315
13. Henson RN, Burgess N, Frith CD. Recording, storage, rehearsal and grouping in verbal short term memory. An MRI study. *Neuropsychologia.* 2000; 38: 426-440.

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