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A comparative study of auditory and visual reaction time in males and females staff during shift duty in the hospital.

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Abstract

Auditory reaction time (ART) and visual reaction time (VRT) between males & females during shift duty in hospital employees have been compared. ART and VRT were studied in 286 hospital employees (141 males and 145 females) during day and night shift duty in the age group of 20 to 60 years. Subjects were presented with two auditory stimuli, i.e. high pitch and low pitch sound and two visual stimuli, i.e. red and green light. The significance of difference of ART and VRT during day and night shift duty among males and females were compared with the use of standard error of difference between two means. The statistical difference was determined by 'z' test. ART during day shift in males (215.15 ± 47.52) were less than ART during day shift in females (233.97 ± 44.62), VRT during day shift in males (224.01 ± 30.43) were less than VRT during day shift in females (238.98 ± 29.69). ART during night shift in males (219.96 ± 48.51) were less than ART during night shift in females (237.28 ± 44.01), VRT during night shift in males (229.20 ± 31.92) were less than VRT during night shift in females (240.60 ± 31.71). Our results indicate that in the female, ART and VRT are greater than the male during the day shift and night shift, and the difference was found to be statistically significant. Although the reaction time is found to be more during the night shift as compared to day shift, yet the difference is not significant.

Key Words:- Shift duty, Auditory reaction time, Visual reaction time, Hospital employees.

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Introduction

Reaction time, the time interval between the onset of stimulus and the initiation of response under the condition that the subject has been instructed to respond as rapidly as possible [1] is a measure of function of sensorimotor association [2] and performance of an individual [3]. It has physiological significance and is a simple and non-invasive test for peripheral as well as central neural structures [4]. Two studies have reported that reaction time in the female is longer as compared to males [5,6].

Skandhan, Mehta, Mehta, Gaur [7] reported that girls from the age of eight years and above have mental alertness superior to the boys of comparable age. The girls seem to have intellectual abilities, which are at least one to two years ahead of the boys [7]. Shenvi, Balasubramanian [2] also found the reaction time is significantly higher in boys than in girls. Reaction time can be taken into consideration in neurological and behavioural assessment of women as it is significantly prolonged during the premenstrual and menstrual phase and also in designing the research protocols [3].

Because of economic globalization and in response to demand of 24 hour society, males and females both are involved in shift duty, which is important because of a need of continuous availability of essential services like medical, police, military, transport, electricity, etc. Night shift workers are required to stay awake when their circadian rhythms are preparing them for sleep, and to sleep when preparing for wakefulness.

Most of the earlier studies were done on medical students and did not study on the hospital employees. We report a larger, controlled study by taking sample of hospital employees (security guard, nurses and resident doctors), both during the day and night duty keeping in view the conflicting reports about the reaction time among the male and female subjects.

Material and Methods

The study was carried out in the premises of K.E.M. Hospital and Seth G.S. Medical college. Prior consent was

sought from the Dean of the institute, the Heads of concerned departments and Ethical committee.

286 hospital employees (141 males and 145 females) physically normal, without any hearing, visual or muscular disorder in the age group of 20 to 60 years,who were working in shifts, were selected randomly for study. They were screened for any other major illness and regarding consumption of alcohol and tobacco in any form. The subjects were briefed about the study protocol and informed consent was obtained from them.

The apparatus used in this study was the portable research reaction timer with two response choices latest manufactured in March 2004 and was purchased from Anand agencies, Pune – 2, which can measure Visual Reaction Time (VRT) and Auditory Reaction Time (ART).

Specifications of reaction timer

1. Inbuilt chronoscope – 4 digit chronoscope with least count of 1/1000 seconds.
2. It works on – 230 volts AC.

All the subjects were thoroughly acquainted with apparatus and the reading were taken in relatively quiet room. Three practice trials were given every time before taking the reading. The four stimuli *i.e.* red & green light and high pitch & low pitch sound were then presented at random. Shift duty in K.E.M. Hospital is divided in 3 shifts of 8 hour system i.e. morning (7am to 3pm), afternoon (3pm to 11pm) and night (11pm to 7am). We have taken 2 readings of the same employee during the morning shift which is from 7a.m to 3p.m and 2 readings during the night shift of the same employee which is from 11p.m to 7a.m, the time when the readings were taken were just after beginning of the duty and just before the end of the duty which was convenient to the hospital employees.

To test whether there was any significant difference during day and night shift duty in males and females with reference to Auditory reaction time (ART) and Visual reaction time (VRT), standard error of difference between two means were applied. The statistical difference was determined by 'Z' test.

A comparison was made between

i) ART and VRT to different stimuli in males during day and night shift duty.
ii) ART and VRT to different stimuli in females during day and night shift duty.
iii) Comparison of ART and VRT to different stimuli during day shift and night shift between males and females.

Results

There was no statistically significant difference between ART for high pitch, low pitch and both combined during day and night shift in males; although ART for high pitch, low pitch and both combined were more during night [Table 1].

Table 1. Comparison of ART and VRT (msecs)(Mean ± SD) to different stimuli in males during day and night shift.

Various Stimuli	During day shift	During night shift	S.E. of diff.	Z value	P value
ART (high p) (n = 141)	203.93 ± 48.56	209.26 ± 50.40	5.89	0.90	> 0.05
ART (low p) (n = 141)	226.37 ± 50.77	230.66 ± 51.63	6.10	0.70	> 0.05
ART (comb.) (n = 141)	215.15 ± 47.52*	219.96 ± 48.51**	5.72	0.84	> 0.05
VRT (green l) (n = 141)	224.54 ± 34.01	231.01 ± 35.22	4.12	1.57	> 0.05
VRT (red l) (n = 141)	223.48 ± 31.28	227.39 ± 31.85	3.76	1.04	> 0.05
VRT (comb.) (n = 141)	224.01 ± 30.43*	229.20 ± 31.92**	3.71	1.40	> 0.05

**S.E.=4.75,Z=1.87, P>0.05; **S.E.=4.89,Z=1.89 P>0.05*
(high p = high pitch, low p = low pitch, comb.= both high & low pitch sound combined)
(green l = green light, red l = red light, comb.= both green & red light combined)

Table 2. Comparison of ART and VRT (msecs)(Mean ± SD) to different stimuli in

Females during day and night shift.

Various Stimuli	During day shift	During night shift	S.E. of diff.	Z value	P value
ART (high p) (n = 145)	219.58 ± 44.99	223.83 ± 44.23	5.24	0.81	> 0.05
ART (low p) (n = 145)	248.36 ± 52.80	250.73 ± 52.95	6.21	0.38	> 0.05
ART (comb.) (n = 145)	233.97 ± 44.62*	237.28 ± 44.01**	5.20	0.64	> 0.05
VRT (green l) (n = 145)	241.14 ± 37.09	242.36 ± 38.90	4.46	0.27	> 0.05
VRT (red l) (n = 145)	236.81 ± 29.19	238.84 ± 30.33	3.50	0.58	> 0.05
VRT (comb.) (n = 145)	238.98 ± 29.69*	240.60 ± 31.71**	3.61	0.45	> 0.05

**S.E.=4.45,Z=1.13, P>0.05; **S.E.=4.50,Z=0.74 P>0.05*
(high p = high pitch, low p = low pitch, comb.= both high & low pitch sound combined)
(green l = green light, red l = red light, comb.= both green & red light combined)

Table 3. Comparison of ART and VRT (msecs)(Mean ± SD) to different stimuli during day and night shift duty between males & females .

Various Stimuli	Males (n=141)	Females (n=145)	S.E. of diff.	Z value	P value
During Day Shift					
ART (hp)	203.93 ± 48.56	219.58 ± 44.99	5.54	2.82	< 0.05
ART (lp)	226.37 ± 50.77	248.36 ± 52.80	6.12	3.59	< 0.05
ART (cb)	215.15 ± 47.52	233.97 ± 44.62	5.45	3.45	< 0.05
VRT (gl)	224.54 ± 34.01	241.14 ± 37.09	4.21	3.94	< 0.05
VRT (rl)	223.48 ± 31.28	236.81 ± 29.19	3.58	3.72	< 0.05
VRT (cb)	224.01 ± 30.43	238.98 ± 29.69	3.56	4.21	< 0.05
During Night Shift					
ART (hp)	209.26 ± 50.40	223.83 ± 44.23	5.61	2.60	< 0.05
ART (lp)	230.66 ± 51.63	250.73 ± 52.95	6.18	3.25	< 0.05
ART (cb)	219.96 ± 48.51	237.28 ± 44.01	5.48	3.16	< 0.05
VRT (gl)	231.01 ± 35.22	242.36 ± 38.90	4.39	2.59	< 0.05
VRT (rl)	227.39 ± 31.85	238.84 ± 30.33	3.68	3.14	< 0.05
VRT (cb)	229.20 ± 31.92	240.60 ± 31.71	3.76	3.03	< 0.05

(hp = high pitch, lp = low pitch, cb= both high & low pitch sound combined for ART)
(gl = green light, rl = red light, cb= both green & red light combined for VRT)

1. There was no statistically significant difference between VRT to red light, green light and both combined during day and night shift in males; although VRT to red light, green light and both combined were more during night.
2. ART during day shift and ART during night shift were less than VRT during day shift and VRT during night shift respectively in males, but difference between ART and VRT were not statistically significant during day and night shift both in males.

As shown in Table 2, there was no statistically significant difference between ART for high pitch, low pitch and both combined during day and night shift in females; although ART for high pitch, low pitch and both combined were more during night. There was no statistically significant difference between VRT to red light , green light and both combined during day and night shift in females; although VRT to red light, green light and both combined were more during night. ART during day shift and ART during night shift were less than VRT during day shift and VRT during night shift respectively in females, but difference between ART and VRT were not statistically significant during day and night shift both in females.

Both ART and VRT showed a significant increase in Females with comparison to Males in all the categories i.e. ART for high pitch, low pitch and both combined and VRT to red light , green light and both combined during day shift as well as night shift. Reaction time in Females was greater than males during day shift and night shift, and the difference was found statistically significant [Table 3].

Discussion

In the present study, there was no significant difference in ART during day shift & night shift and VRT during day shift & night shift in males (Table 1) & in females (Table 2) separately. It shows that Shift duty has no effect on Reaction Time (Auditory & Visual), in other words it has no effect on sensorimotor performance. This finding is consistent with study of Bartle, Sun, Thompson, Light, McCool, Heatson (1988), that acute sleep deprivation of less than 4 hours alters mood state but does not change performance in test situations in which concentration, clear thinking, and problem solving are important [8]. Lack of 4 hours of uninterrupted sleep within the previous 24 hours does result in increased subjective fatigue and is associated with decreased motivation. However this effect does not necessarily lead to a decrease in performance. Surgical residents appear to be able to compensate when sleep deprived and there is no significant impairment in the ability to learn and retain new material [9].

Binks, Waters, Hurry [10] found that 34-36 hours of total sleep deprivation did not affect performance on any of the cognitive tests. The results of Pilcher, Huffcutt [11] confirm that sleep deprivation has a significant effect on human functioning and mood was much more affected than either cognitive or motor performance.

In contrast, McCarthy, Waters [12] revealed significant effects of sleep deprivation on both cognitive and physiological measures including reaction time. Their findings indicated that sleep deprivation decreased subject's attentional responsivity to new information and simultaneously reduced the efficiency of their cognitive processing.

Our findings could be explained on the basis of observations that adaptation to reduced sleep is possible. Various factors modulate adaptation to shift work. Workers who choose shift work for reasons such as schooling, childcare, or pay differential are likely to adapt more easily. However Individuals vary in their ability to adjust to shift work. Many individuals suffer few or transient problems. Some are unable to adjust at all; a phenomenon termed as shift work intolerance.

In our study, difference between ART during day shift and night shift were less than VRT during day shift and night shift respectively in males (Table 1), in the same way difference between ART during day shift and night shift were less than VRT during day shift and night shift respectively in females (Table 2), but difference were not statistically significant in males & females both. Botwinick, Brinley (1962) studied auditory reaction time and visual reaction time in males and females in the age groups of 21 – 30 and found that visual reaction time was greater than auditory reaction time [13].

Reaction times are increasingly longer for responses evoked by proprioceptive, auditory, and visual stimuli respectively [14] The cause of visual reaction time being greater than auditory reaction time is not very clear though almost all of the research done in reaction time has reached the same conclusion. Most likely it is due to the fact that the visual reaction time involves chemical changes in its occurrence [15]. Also the visual pathway involves many collateral pathways to various association areas and hence a greater delay in comprehension of visual stimulus as it is interpreted in a more complex and elaborate fashion. Some degree of difference in type of receptor and the manner in which the receptor gets stimulated i.e. the retina versus the organ of corti.

In contrast, Shenvi, Balasubramanian (1994) found in a study conducted in males and females within the age groups of 17 to 18 years, that auditory reaction time is greater than visual reaction time and rationalized that the auditory pathway must be more polysynaptic as compared to visual pathway. They felt that conduction time is greater from the cochlea to the auditory cortex as compared to the time from retina to visual cortex [2].

Auditory and Visual Reaction time in Females was greater than males during day and night shift, and the difference was found statistically significant (Table 3).

Pathak, Dixit, Rao (1962) observed that normal visual reaction time in the female is little longer as compared to the males [5]. Venkatesh, Ramachandra, Suresh, Rajan (2002) observed that females had a longer reaction time when compared to males [6]. Various independent research studies have yielded controversial results as regards the effect of gender on reaction time. Noble (1964) noted that the males showed a shorter reaction time than females in every age group except 10 – 14 years and the oldest age group [16]. Taimella from Helsinki Research Institute for Sports and Exercise Medicine conducted a study and observed that males are faster than females in both reaction and movement [17].

Skandhan, Mehta, Mehta, Gaur [7] reported that girls from the age of eight years and above have mental alertness superior to the boys of comparable age. The girls seem to have intellectual abilities, which are at least one to two years ahead of the boys. Shenvi, Balasubramanian [2] also found the reaction time is significantly higher in boys than in girls. These observations have been contradicted by earlier workers [5,6].

Our observation are consistent with the observations of the other workers [5,6]. In the present study, it has been observed that females had a longer reaction time when compared to males. Bruce and Russel (1962) explained it on the basis of varying level of sex steroids during different phases of menstrual cycle which have sodium and water retaining effect. This retention o f salt and water could modify the axonal conduction. It is also suggested to alter the availability of the neurotransmitter at the synaptic level. This modulation of neurotransmitter coupled with altered rate of impulse transmission due to fluctuation in the levels of hormones affect the sensory motor association with the processing speed at the Central Nervous System [18].

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