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NEUROERGONOMICS OF ANIMAL MODEL: RAT EXPOSED TO TEXTILE ENVIRONMENT

Sanandam M. R.

PG Coordinator & A.P, Department Of Biotechnology,
Kit's College Of Engineering, Kolhapur.416234
E-mail: sanandammonica@gmail.com

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ABSTRACT

Cotton textile industry constitute the single largest industry employing lacs of worker, not much attention has been paid to the comfort, health status and safety of the powerloom workers. The animal model developed by our laboratory has been found to be useful in identifying the occupational hazards and diseases in the industry. The animal model: rat exposed to the powerloom environment of the textile industry showed following neuroergonomial responses which are compared with control. The histopathological and histochemical observations showed significant changes of olfactory lobes and brain with congestion and inflammatory filtrates of phagocytes, of rats exposed to this microenvironment. The total activity of the experimental rats was recorded by Animal Activity Monitor, both with and without manually introducing cotton dust into the Acrylic Chamber of the Animal Activity Monitor. It has been seen that cotton dust exposed animals enter the partial hypoxic state in half as much the time. And the severity of the response is reduced on subsequent exposures to the stressful microenvironment.

Key words : Brain, olfactory lobes, Cotton dust, endotoxin, Behaviour, Textile industry

1. INTRODUCTION

The cotton textile industries in India with its powerlooms in various textile mills are very old, outdated with poor maintenance, generating high noise and vibrations. The work place microenvironment is very hot and humid, with poor illumination, and ventilation loaded with thick cloud of cotton flydust (fibers) of < 5 μm size, with associated endotoxins. The machines design and their workplace layout is not ergonomically designed and hence the workers have to work under this added stress (Narde 1964, Patil 1990, Kanbarkar 1992). The occurence of respiratory and other diseases are very high in the textile industries (Rostogi et al. 1986, Mathur et al. 1988, Parikh et al. 1989, Bhat and Panchal 1994, Abeba and Seboxa 1995, Murlidhar et al. 1995, Niven et al. 1997).The neuroergonomics of these workers is of much importance and hence is been investigated in the present study, by using an animal model.

2. MATERIAL AND METHODS

2.1 Experimental Animals :

The animals used for the present research were adult male albino rats (*Rattus norvegicus*) weighing about 220 -250 gms. The rats were kept in metallic cages with enough space for free movements and kept in the animal house which has sufficient ventilation and light. The temperature of the room was maintained at $25^0C \pm 2^0C$. The cages were cleaned everyday and the husk beds replaced after cleaning. The animals were fed with standard pellet feed (Mfd. By Amrit Feeds, Nav Maharashtra Chakan Oil Mills, Sangli, Maharashtra, India) and water *ad libitum*. *All experimentation was done using INSA ethical guidelines for use of animals in scientific research.

2.2 Experimental protocol :

The rats were divided into 2 groups :

1. Control group
2. Experimental group

The experimental group consist of 4 sets, with 3 rats/ set. The individual sets were labelled as R_1, R_2, R_3 and R_4 respectively and as per the period of exposure, as E_1, E_2, E_3 and E_4. The rats from all 4 sets of experimental group were exposed to cotton dust and other hazardous agents prevailing in the powerloom sector. 10 such experimental groups were exposed at a time, as per the schedule of exposures.

The schedule of rat exposures were as follows :

Exposures :

1. Set - I : Rats were exposed to cotton dust in powerloom sector for 1, 2 and 3 days respectively, for a period of 6 hours/ day.
2. Set - II : Rats were exposed to cotton dust in powerloom sector for 1, 2 and 3 days respectively for 6 hours/ day and 15 day recovery following exposure.
3. Set - III : Rats were exposed to cotton dust in powerloom sector for 1, 2 and 3 days respectively for a period of 6 hours/ day with two exposures and 15 days recovery following each exposure.
4. Set - IV : Rats were exposed to cotton dust in powerloom sector for 1, 2 and 3 days respectively, for a period of 6 hours/ day with 3 exposures and 15 days recovery following each exposure.

Behavioural Study :

The behaviour of the animal on introducing into the powerloom sector of textile industry were observed, depending upon the duration of exposures, and the sets of the rats.

Post exposure behaviour was also monitored to study the effect of exposure on the feeding behaviour, etc.

Animal Activity Monitor (AAM) :

The animal activity was recorded by animal Activity Monitor (Mfd. By Electronic Engineering Co-operation, Madras, 41, India).

The rats were introduced into the Acrylic chamber of the AAM and the activity was recorded as number of beeps. The readings were taken both at high sensitivity and low sensitivity of the AAM. The reading were taken, with and without cotton dust, in the powerloom sector of textile industry.

The rats of all 4 sets and also controls were killed by cervical dislocation.

Histopathologic Study:

The spleen from the rats of all 4 sets and controls were taken after killing the rats by cervical dislocation. The olfactory lobes and brain were fixed in NBF (Neutral buffered formalin) washed with water, dehydrated in ethanol, cleared in xylene and embedded in paraffin wax blocks (M.P. 58-60°C) sectioned with microtome and wax ribbons spread on glass slides. The sections stained by Hematoxylin – eosin and observed under microscope.

Total Protein (tissue):

Total tissue protein were estimated by Lowry's Method (1951).

3. RESULTS AND DISCUSSION

The animal model : rat exposed to the powerloom environment of the textile industry showed following neuroergonomial responses which are compared with control. Fig No. 1 & Table No.1.

The histopathological and histochemical observations showed significant changes of olfactory lobes and brain with congestion and inflammatory filtrates of phagocytes, of rats exposed to this microenvironment .

The exposed rats during the exposure in the powerloom environment exhibited behavioural changes such as urination and defecation was observed immediately within five minutes. The rats tried to escape from their cages and get away from the stressful powerloom microenvironment, failing to do so, the rats become very restless and active and moved continuously in the cages. They continuously sniffed the air scratched its nose and fur, sneezed and during the latter period of exposure, hiccups were seen, deep heavy breathing was observed. Restless active behaviour continued for approximately one hour with piloerections. After 1 hour the rats went into partial hypoxic state for rest of the exposure period, with complete lack of activity, except heavy breathing, but became active once or twice with sudden jerks. The feeding behavior 2 days post-exposure showed total non consumption of food. The colour texture and odour of the faces was changed during this period of altered feeding behaviour.

The total activity of the experimental rats was recorded by Animal Activity Monitor, both with and without manually introducing cotton dust into the Acrylic Chamber of the Animal Activity Monitor. It has been seen that cotton dust exposed animals enter the partial hypoxic state in half as much the time. And the severity of the response is reduced on subsequent exposures to the stressful microenvironment. (Sanandam & Sawant,2006)

The textile industry employs a large number of industrial workers, but the development in textile industry has not been accompanied by improved health and occupational conditions of workers as observed in several other industries. The adverse environmental conditions are a great concern in this industry. The variation in susceptibility to these health effects of toxicants due to normal host attributes generally is studied in animals and considered in estimation of human health risk. A solid database on human is lacking, in a large part because involving disease subjects in clinical research is likely to be complicated by their inherent variability and by ethical concerns. Also preventive measures may not be introduced at all. Neuroergonomical Studies involving animal model, on the other hand, offer more control on both host and environmental variables.

Ellakkani et al., 1985 and Castronava et al., 1996 reports increase in breathing rate, in guinea pig animal model on exposure to cotton dust, and this has been viewed as the hallmark of the guinea pig animal model. However, Castranova et al., 1988 reports an insignificant increase in the breathing rate and this lack of response may be due to the relatively low exposure concentration (1.5 mg/ m^3). Robinson et al., 1988 have reported the concentration dependence of pulmonary responses to cotton dust and have demonstrated that the breathing response was not discernible at low doses (> 2 mg/m^3). It has been observed that the severity of the behavioural response was slightly reduced in rats from Set III and IV indicating their adaptibility on repeated exposure and recovery.

Earlier studies showed that the powerloom environment is highly hazardous with noise levels above 80 dB, loaded with cotton dust of respirable size (> 5 um), with dust concentration < 21 mg/ m^3, high temperatures (38-40^0C) high humidity and moisture content, poor lighting, cotton dust contaminated with allergic fungal spores, gram negative and gram positive bacteria etc. which have various adversive effects on the powerloom workers (Dubal 1995)

In conclusion, the data presented in this investigation using rat animal model deals with the neuroergonomical response of life in workplace stress situation. The study focussed on development of animal model for study of physiological, morphological, biochemical and immunological alterations (Sanandam, 2006,2008,2009,2010,2011). Changes in the behavioural responses reveal the importance of coping, a physical and mental process, in modifying the body's response to stress. The relevance of these results is to provide ergonomic solutions for health and occupational diseases in industry.

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Fig. No. 1 T.S of Brain and Olfactory lobes(H & E, 40x)

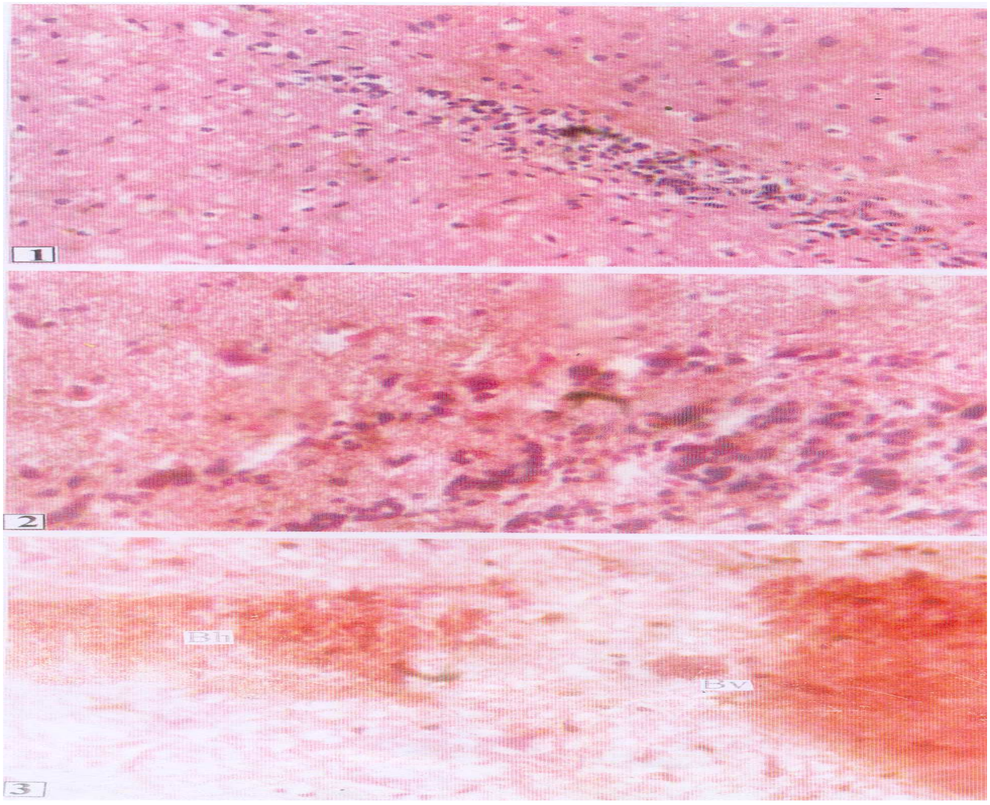

TABLE - I

BEHAVOURAL RESPONSE BY 'ANIMALACTIVITY MONITOR'

Times in Minutes	Exposure - I	Exposure - II	Subsequent Exposure
5	8	32	30
10	4	14	22
15	3	46	11
20	11	18	31
25	10	10	17
30	4	8	20
35	2	7	46
40	0	10	33
45	1	11	5
50	0	12	6
55	0	12	12
60	10	10	5