Short Communication

Morris Water Maze performance of growing Wistar rats exposed to telephone mast base stations

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This study assessed the possible harmful effects of close exposure to telephone mast base stations on the behaviour of growing Wistar rats. Animals were exposed to the vicinity of base stations, closely monitored and observed. At the end of the exposure period, behavioural studies were undertaken using the Morris water maze. Results showed conspicuous hair loss and slight pigmentation on the skin of experimental animals. Behavioural studies on Morris water maze showed that control rats performed slightly better than the experimental ones. In conclusion, close exposure of growing rats to telephone mast base stations may have damaging effects.

Key words: Telephone mast base stations, behaviour, Morris water maze, Wistar rats.

INTRODUCTION

There has been an increasing need for fast and convenient communication in Nigeria, Especially since the introduction of the Global System of Mobile (GSM) communication handsets in the beginning of the new millennium. This has necessitated the spread of GSM handsets. The spread is even more rampant because the outright flamboyancy of the Nigerian culture is making people acquire more handsets. This increase has led to high customer competitions among telecommunication industries. To meet up the challenge, these industries are setting up more cell site or base station without much regard to safety issues.

A cell site is a term used primarily in North America for a site where antennas and electronic communications equipment are placed on a radio mast or tower to create a cell in a cellular network. A synonym for "cell site" is "cell tower", although many cell site antennas are mounted on buildings rather than as towers. In GSM networks, the technically correct term is Base transceiver station (BTS), and colloquial British English synonyms are "mobile phone mast" or "base station". The term "base station site" might better reflect the increasing co-location of multiple mobile operators, and therefore multiple base stations, at a single site.

There are concerns being expressed in several countries over the possible health hazards of such close exposure to microwave radiation emanating from the phones and their base stations (Repacholi et al., 1997; Akdag et al., 1999; Laurence et al., 2000; AGNIR, 2001; Cranfield et al., 2001; Di Carlo et al., 2002; Leszczynski et al., 2002; Cranfield et al., 2003). The established effects include thermal damage (Gandhi et al., 1996; AGNIR 2001), teratogenicity (Akdag et al., 1999; Di Carlo et al., 2002) and predisposition to cancers (Blackman, 1990; Repacholi et al., 1997; Carlo, 2000; Cranfield et al., 2003). Similarly, behavioral deficiency has been reported in animals exposed to these microwaves including reduction in reproductive efficiency in some animals kept close to mast base stations (Laurence et al., 2000; Cranfield et al., 2001; Cranfield et al., 2003; Balmori, 2005). A similar study, using questionnaires, revealed that people living in the vicinity of base stations report various complaints mostly of the circulatory system, but also of sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea, lack of appetite, headache and vertigo (Bortkiewicz et al., 2004; Santini et al., 2002).

There are also concerns that exposures to these stations may affect the normal functioning of the central nervous system, especially in reduction in memory potential (Nwoha et al, 2009) and memory loss (Santini et al., 2002). This necessitated the need for the present study. This study assessed the behavioural performance of young Wistar rats on the Morris water maze that have been exposed to the vicinity of telephone mast base station.

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MATERIALS AND METHODS

Animal management

Fifteen Wistar rats, obtained from the Animal holding of the department of Anatomy and Cell Biology, Obafemi Awolowo University, were used for this work. The animals were randomly grouped into three groups of five each, as follows:

Group A- Control group
Group B- Weaned group (Experimental)
Group C- After birth group (Experimental)

The control and experimental animals were housed in cleaned plastic cages and fed with laboratory chow. Water and food was provided *ad libitum*.

The experimental animals were kept in a small hut (built specifically for this purpose) midway between three telephone mast base stations which were 29.6 m from the house where the animals were kept. The control animals were kept in a similar shelter, about 2 km far from the nearest telephone mast base station.

The animals in groups A and B were taken out, 26 days after birth, after they had been weaned from the mother. The animals in group C were taken out five days after birth and allowed to be weaned on site.

The animals were kept under observation for a period of 70 days for those in groups A and B (Nwoha et al, 2009), and those in group C were kept for a period of 85 days, to allow the rats mature to young adult rats. At the end of the exposure period, animals were weighed, observed and their performance on the water maze was studied. All experimental procedures would follow recommendation provided in the guidelines for animal research as detailed in the NIH Guidelines for the Care and Use of Laboratory Animals (NIH Publication, 1985).

Morris Water Maze study

The Morris Water Maze was used to study behavioural differences in the animals. The Morris water maze is one of the most widely used tasks in behavioral neuroscience for studying the psychological processes and neural mechanisms of spatial learning and memory. The Morris water maze has advantages over conventional mazes such as the elimination of local cues, like scent traces, and the fact that there is no fixed escape formula. Animals, usually rats or mice, are placed in a large circular pool of water and required to escape from water onto a hidden platform whose location can normally be identified only using spatial memory.

The apparatus consists of a large circular pool (tank) about 6ft in diameter and about 3ft deep. The inside of the tank was painted white and the outside brown. It was filled up with tap water, measuring about 25℃. A platform of 24cm high and 10cm in diameter was placed at one quadrant of the pool. During training, it was exposed 1 inch above the water. This teaches the rat that there is a platform, and that it is the way to get out of the water. Later, after the animal is trained and ready for testing, the escape platform was 1 inch below the water, and the water was made opaque by adding milk. Pre-training and learning phase (training) was done across a single day.

Each animal underwent three consecutive trials during training. During training, each animal underwent four sessions of three consecutive trials per session. All animals completed a session before another session is carried out. The latency (time taken to reach the platform) was recorded manually with a stopwatch. If the animal failed to climb onto the platform within 60 s, the trial was stopped and the animal was removed from the water and placed on the platform. The inter-trial interval was 10 s, the animal remaining on the platform during this period before beginning the new trial. At the end of the three trials, the animal was removed and placed under a lamp for warmth. The inter-session interval was 1 h. One probe trial was performed after training on the same day, in which the platform is removed from the pool. The probe trial was performed to verify that the animal understands of the location of the platform and the strategy that the animal follows when it discovers the platform is not there (Pierre and Debouzie, 2000). The number of times the animal crossed the position of the removed platform was counted as probe trial value.

Statistical analysis

One-way ANOVA was used to analyze data obtained from behavioural studies. Primer for windows (McGraw-Hill, version 4.0.0.0) was the statistical package used to analyse data. Results are expressed as mean ± standard error of mean. $P<0.05$ was taken as accepted level of significant difference.

RESULTS AND DISCUSSION

Body morphology

A significant observation that was seen in the experimental groups was the loss of hair from their body. Hair loss was very conspicuous in the fifth week of exposure in Group C animals. Hair loss was mainly on the head and lower part of the body. In two of the animals in that group, the head was almost completely bald by the sixth week of exposure. Slight hair loss was also observed on the animals in Group B by the fifth week of exposure. The hair loss observed was not permanent, as there was re-growth of hair on all the animals. Though slight loss of hair was re-observed during the final week of exposures in two of the animals in Group C, there was little pigmentation on the body of all the animals in Group C and four of the animals in Group B. There was no pigmentation, nor loss hair observed in the control animals.

Water maze test

Table 1 shows the behavioural pattern of the animals in the water maze. Though the mean latency value indicates that the control animals had shorter latency period when compared to the experimental groups statistical analysis using ANOVA, revealed that there was no significant different. However, the probe trial revealed a statistically significant difference in the number of times the control animal crossed the position of the platform when compared to the experimental groups.

Various reports exist, indicating the adverse effects of exposures to the vicinity of phone mast base stations. The difficulties encountered in successful replication of these findings have indeed brought about increased controversies as to the adverse effects of exposures to radiation from phone mast base stations.

The hair loss and pigmentation in the experimental rats in the present study, suggest a lethal effect on the skin of

Table 1. The behaviour of animals on the water maze.

Behaviour	Group A (control)	Group B (weaned)	Group C (after birth)
Latency (s)	5.28± 1.25	9.37 ± 2.13	12.27 ± 3.54
Probe trial value	6.00 ± 0.84	3.00 ±0.77*	3.00 ± 0.55*

Values are mean ± standard error of mean (SEM) of data from the animals. * implies significant effect at $P<0.05$ when compared to control. Level of significance was accessed using ANOVA.

the young rats exposed to phone mast base stations. Hair growth and skin coloration are brought about by keratinocytes and melanocytes respectively. These cells are located in the epidermis of the skin. In essence radiation from base stations may be affecting the epidermis of the experimental rats. Previous studies have shown that animals exposed to microwaves have high possibility of skin cancer (Repacholli, 1997).

Behaviour on the water maze indicates a slightly better performance of the control group to the experimental groups. This may be related to effect on the memory potential of the rats, as the water maze is used to study the psychological processes and neural mechanisms of spatial learning and memory. This may probably indicate injury to the hippocampus which is involved in spatial/relational memory (Kesner et al., 1987; Jarrard et al., 1984). Smaller organisms (children, birds, small mammals, etc.) are especially vulnerable to microwave radiations, as absorption of microwaves emitted from base stations is greater as a consequence of the thinner skull of these organisms; the penetration of radiation into the brain is greater (Magras et al., 1997).

Conclusion

This study has shown that close exposure of young Wistar rats to the vicinity telephone mast base stations affects these organisms by causing hair loss and slight pigmentation. Also, such exposure may slightly reduce the memory potential of the animals. It is recommended that telephone base stations be located far away from residential areas. Also, further studies into the effects of exposure to phone mast stations on the micro-anatomical, biochemical and physiological well-being of animals and humans is necessary and recommended, to fully understand the possible damaging effects of exposure to telephone base stations.

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