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An Investigation of Road Accidents in Australia in relation to Geomagnetic Activity

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Daily data on the number of road accidents recorded in Melbourne and Sydney (Australia) during 1973-74 and 1974-75, respectively, are statistically analyzed and studied month by month against the corresponding daily geomagnetic activity index ΣK_p, according to East Australian time. Monthly mean values of the daily data on road accidents, geomagnetic activity index ΣK_p and planetary magnetic average ranges A_p, and the sunspot numbers R_z, are also investigated for a possible correlation, assuming that the human error caused by geomagnetic disturbances might lead to increased number of road accidents everywhere in the world. The correlation coefficients, however, between the daily data computed separately for the 48 months, as well as between their monthly mean values for each of the four years, are not found to be statistically significant. It is, therefore, concluded that the influence of geomagnetic activity, if any, on the electromagnetics of the human brain and the nervous systems, is masked by various other dominant causes of road traffic accidents, and cannot be separated and demonstrated with the help of the daily data on road accidents.

1 Introduction

Vladimirskii *et al.*[1] carried out laboratory experiments on animals like rabbits and dogs after irradiating them to artificially generated electromagnetic pulsations as are observed during natural magnetic storms (pc 2 type) and found that the cardiovascular and nervous systems of weak and sick animals (ECG and EEG) worsened during such disturbances. More recently, Baker[2] has discussed the possibility of involvement of a magnetic sense (sixth sense) in blindfolded humans, which helped them to orient themselves towards home after long-distance displacement. This magnetic sense gets distorted if a bar magnet is worn on the humand head.

One way of studying the electromagnetic response of the human brain and the nervous system, particularly of the weaker subjects during intense magnetic storms, would be to examine the day-to-day number of road accidents at different places in the world against the corresponding daily geomagnetic activity index.

Srivastava and Saxena[3] studied the daily road accidents recorded in the twin cities of Hyderabad and Secunderabad (India) during the high sunspot year of 1978 and failed to find any significant correlation with daily planetary geomagnetic activity index, ΣK_p. This also revised the earlier results of Bhaskara Rao and Srivastava[4], and Srivastava and Bhaskara Rao[5], based on faulty road accident data. Verma *et al.*[6] discussed the daily road accidents recorded in Ahmedabad for four years (1972-75) in relation to geomagnetic activity and found both positive and negative correlations for individual years.

In order to further examine this question in a different part of the world, it was decided to investigate the road accident data recorded in Australia. Accordingly, xerox copies of the relevant pages of the record books, containing details of all the road accidents recorded in Melbourne State in 1973 and 1974, and in the Sydney metropolitan traffic area in 1974 and 1975, monthwise and datewise, were obtained through the courtesy of the Australian Traffic Police Department. The total numbers of daily road accidents of all types recorded in Melbourne and Sydney have been studied separately month by month, against the corresponding daily sums, ΣK_p (according to East Australian time) of the planetary three-hour-range geomagnetic activity indices K_p taken from *IAGA Bulletins Nos* 32d (Ref. 7), 32e (Ref. 8) and 32f (Ref. 9). The results of these computations with the Australian data are discussed in this paper.

2 Data Analysis and Results

The well known statistical formulae were used for the computation of the correlation coefficients and their standard errors between the daily sums of the three-hourly geomagnetic activity indices (ΣK_p) and the daily numbers of road accidents. The correlation coefficients have been computed for Melbourne State month by month for 1973 and 1974 and for Sydney metropolitan area for 1974 and 1975. These results are given in Table 1, along with the correlation coefficients between the monthly mean values of the parameters.

Figs. 1 and 2 give plots of the daily road accident data for Melbourne against daily geomagnetic activity

Table 1—Correlation Coefficients (R) between the Daily Sums according to East Australian Time of Three-hourly Planetary Geomagnetic Activity Indices (ΣK_p) and the Daily Numbers of Road Accidents in Melbourne and Sydney (Metropolitan Area) in Australia during 1973-75

Month	Melbourne 1973 R±S.E.	Melbourne 1974 R±S.E.	Sydney 1974 R±S.E.	Sydney 1975 R±S.E.
Jan.	+0.22±0.17	+0.37±0.16	+0.11±0.18	−0.16±0.16
Feb.	+0.08±0.19	+0.01±0.19	−0.25±0.17	−0.03±0.19
Mar.	−0.09±0.19	+0.37±0.16	+0.11±0.18	−0.59±0.12
Apr.	−0.01±0.19	+0.18±0.18	+0.32±0.17	−0.13±0.18
May	−0.16±0.18	+0.17±0.18	+0.09±0.18	+0.37±0.16
June	−0.07±0.19	+0.12±0.18	+0.30±0.17	−0.30±0.17
July	+0.04±0.18	+0.06±0.18	−0.44±0.15	+0.21±0.17
Aug.	−0.24±0.17	−0.07±0.18	−0.05±0.18	−0.02±0.18
Sep.	−0.43±0.15	+0.03±0.19	−0.02±0.19	+0.06±0.19
Oct.	−0.17±0.18	+0.03±0.18	−0.20±0.18	−0.18±0.18
Nov.	−0.004±0.19	+0.06±0.19	−0.42±0.15	−0.03±0.19
Dec.	+0.14±0.18	+0.10±0.18	+0.20±0.18	−0.55±0.13
With monthly mean values:				
	−0.10±0.30	+0.16±0.29	+0.55±0.21	−0.70±0.15

data (ΣK_p), month by month for 1973 and 1974. Figs. 3 and 4 give plots of similar data for Sydney for 1974 and 1975, respectively. The correlation coefficients are also given in each diagram. The monthly mean data for Melbourne for 1973 and 1974 are shown graphically in Fig. 5 along the mean sunspot numbers and A_p values of magnetic activity. Fig. 6 gives similar plots of monthly mean solar, geomagnetic and road accident data for Sydney for 1974 and 1975.

The average values of the daily numbers of road accidents in Melbourne and Sydney for different levels of geomagnetic activity (ΣK_p) during 1973-75 are given in Table 2. Table 3 gives the annual mean values of the sunspot numbers, geomagnetic activity indices and road accident data for Melbourne and Sydney for periods of two years each.

3 Discussion

With the exception of two or three marginally significant correlation coefficients out of a total of 48, between the daily geomagnetic activity index and the road accidents in Melbourne and Sydney, all the correlation coefficients are not found to be statistically significant (Table 1 and Figs. 1-4). Even the correlation

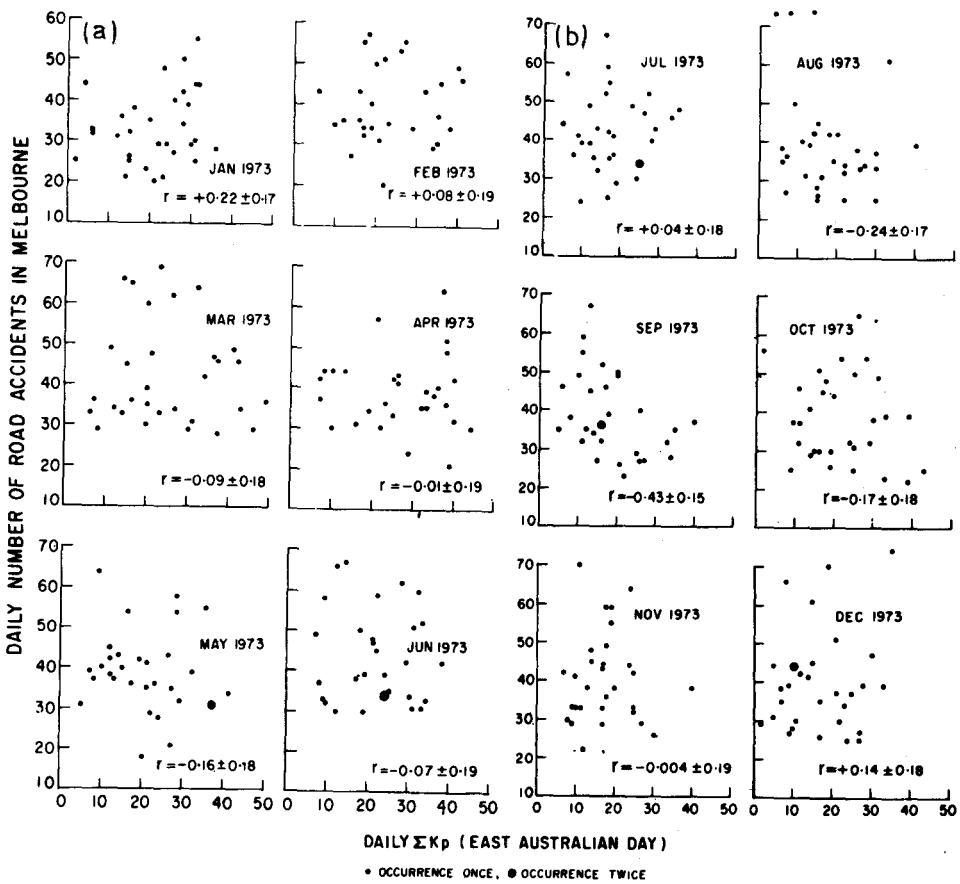

Fig. 1—Plots of the daily number of road accidents in Melbourne State, Australia, against the daily geomagnetic activity index ΣK_p according to East Australian time, for: (a) Jan.-June 1973; and (b) July-Dec. 1973

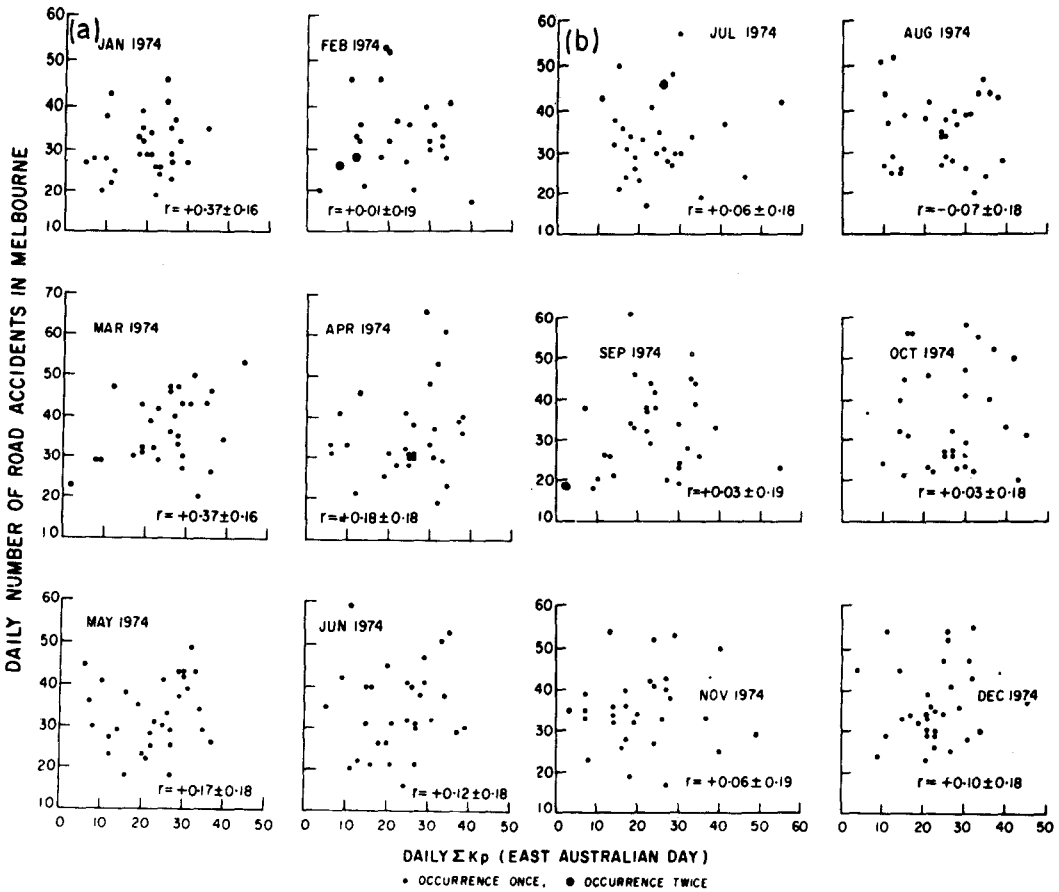

Fig. 2—Plots of the daily number of road accidents in Melbourne State, Australia, against the daily geomagnetic activity index ΣK_p according to East Australian time, for: (a) Jan.-June 1974; and (b) July-Dec. 1974

coefficients between the monthly mean values are not found to be consistent and significant (Figs. 5 and 6).

This confirms the findings of Srivastava and Saxena[3] in respect of Hyderabad and Secunderabad that the correlation between the daily geomagnetic activity data and the daily number of road accidents as well as their monthly mean values along with the monthly mean sunspot numbers, is very poor. Chapman and Bartels[10] pointed out the lack of general correlation even between sunspot numbers and geomagnetic activity on individual days.

An examination of Table 2 shows a tendency for the average daily number of road accidents in Melbourne and Sydney to peak around the activity level as defined by $\Sigma K_p = 31\text{-}40$, as in the case of Hyderabad and Secunderabad, which may correspond to a peak in pc 2 pulsation activity. Except for the Sydney data for 1975, the geomagnetic activity may account for an increase of 5 to 15 per cent in the daily road accident data, treating the accident data for $\Sigma K_p = 0\text{-}10$ as that for a magnetic quiet day.

The average data given in Table 2, are further analyzed following the method of Verma *et al.*[6], and the results are presented yearwise graphically in Fig. 7 for both Melbourne and Sydney. It will be at once noticed that the standard deviations of the mean daily values of the road accidents for different levels of daily geomagnetic activity (ΣK_p) centred at the mid-point of the class-intervals, are quite large. In the case of Melbourne, the straight lines fitted by the method of least squares to the mean values for 1973 and 1974, are almost parallel to the X-axis, showing thereby the constancy of the Y-values. In other words, no significant change occurs in the daily number of road accidents with increasing magnetic activity. The poor correlation coefficients also reflect the same result. For Sydney, the correlation coefficients are found to be negative for both the years 1974 and 1975 and the fitted straight lines once again show little slopes with the X-axis.

It will be seen from Table 3 which gives the annual mean values, that the number of daily road accidents in Melbourne decreased from 1973 to 1974 following the sunspot number, while the geomagnetic activity index registered an increase.

In the case of Sydney metropolitan area, the daily number of road accidents showed a marginal increase from 1974 to 1975 corresponding to a decrease in the

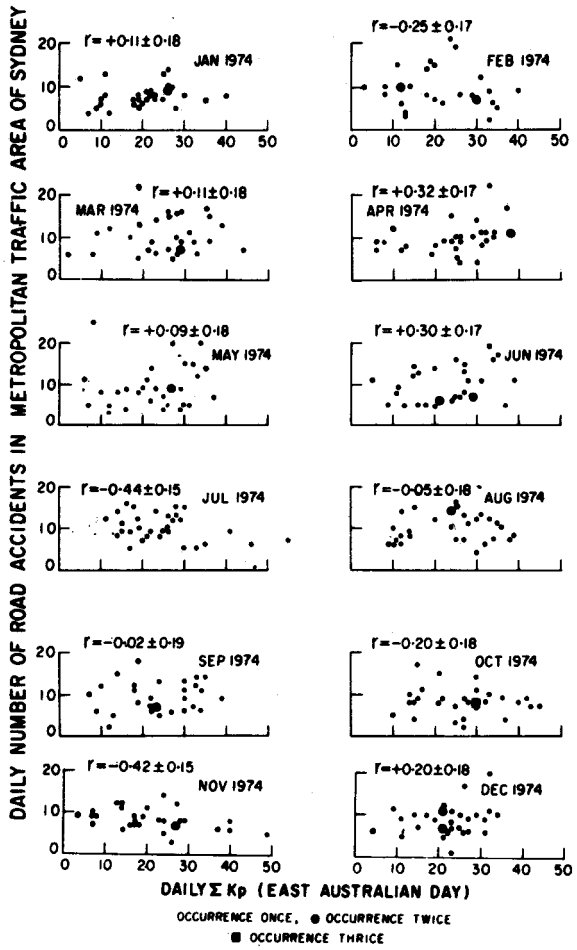

Fig. 3—Plots of the daily number of road accidents in Sydney (Metropolitan Traffic Area), Australia, against the daily geomagnetic activity index ΣK_p according to East Australian time, for Jan.-Dec. 1974

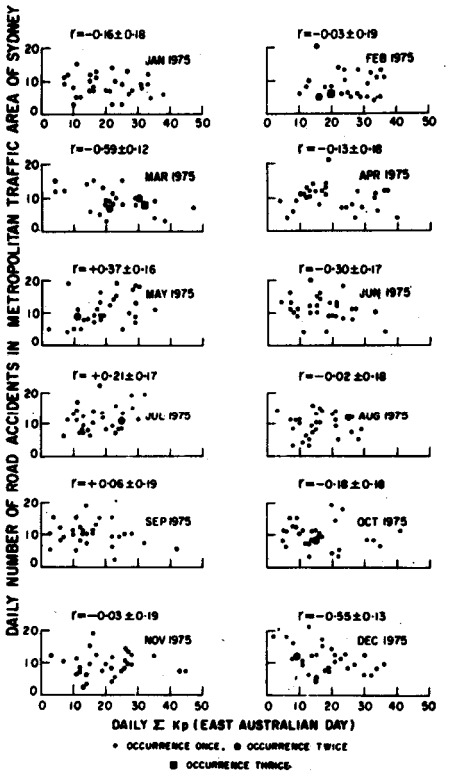

Fig. 4—Plots of the daily number of road accidents in Sydney (Metropolitan Traffic Area), Australia, against the daily geomagnetic activity index ΣK_p according to East Australian time, for Jan.-Dec. 1975

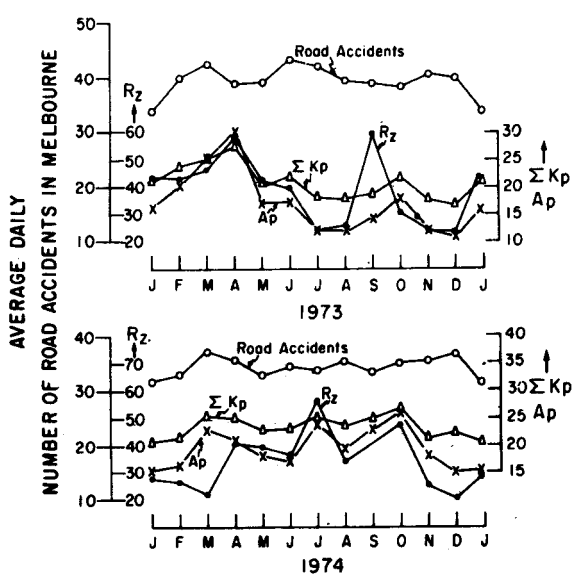

Fig. 5—Monthly mean values of the daily number of road accidents in Melbourne, the geomagnetic activity parameters ΣK_p and A_p and the Zürich relative sunspot numbers R_z for 1973 and 1974, showing a poor correlation

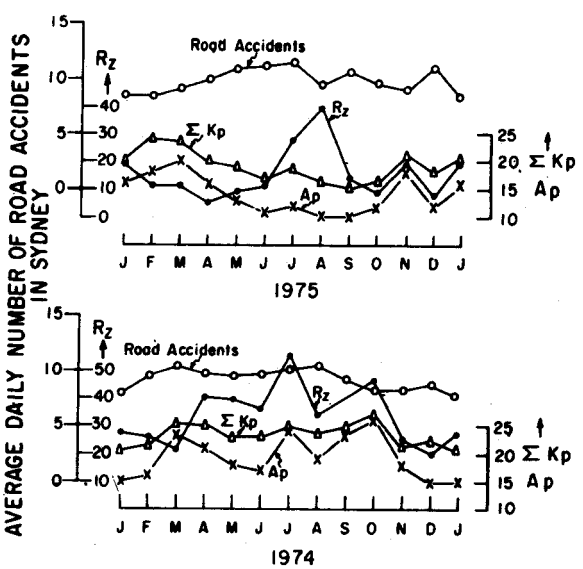

Fig. 6—Monthly mean values of the daily number of road accidents in Sydney, the geomagnetic activity parameters ΣK_p and A_p and the Zürich relative sunspot numbers R_z for 1974 and 1975, showing a poor correlation

Table 2—Average Values of Daily Numbers of Road Accidents in Melbourne State and Sydney Metropolitan Area for Different Levels of Geomagnetic Activity (ΣK_p)

Year	No. of road accidents for ΣK_p values in the range					
	0-10	11-120	21-30	31-40	41-50	51-60
			Melbourne			
1973	39.7	41.0	38.1	40.2	35.4	42.0
1974	31.9	34.0	34.0	37.0	34.9	32.5
			Sydney			
1974	8.7	9.2	9.3	10.2	7.1	6.0
1975	10.4	10.1	9.8	8.8	8.0	—

Table 3—Annual Mean Values of the Zurich Daily Sunspot Numbers, Geomagnetic Activity Indices and Road Accidents

Year	Sunspot number (R_z)	ΣK_p	A_p	Number of daily road accidents	Total number of road accidents
			Melbourne		
1973	38.0	20.9	17.0	39.7	14,485
1974	34.5	23.4	19.6	34.4	12,542
			Sydney		
1974	34.5	23.4	19.6	9.3	3,423
1975	15.5	19.1	13.9	10.3	3,650

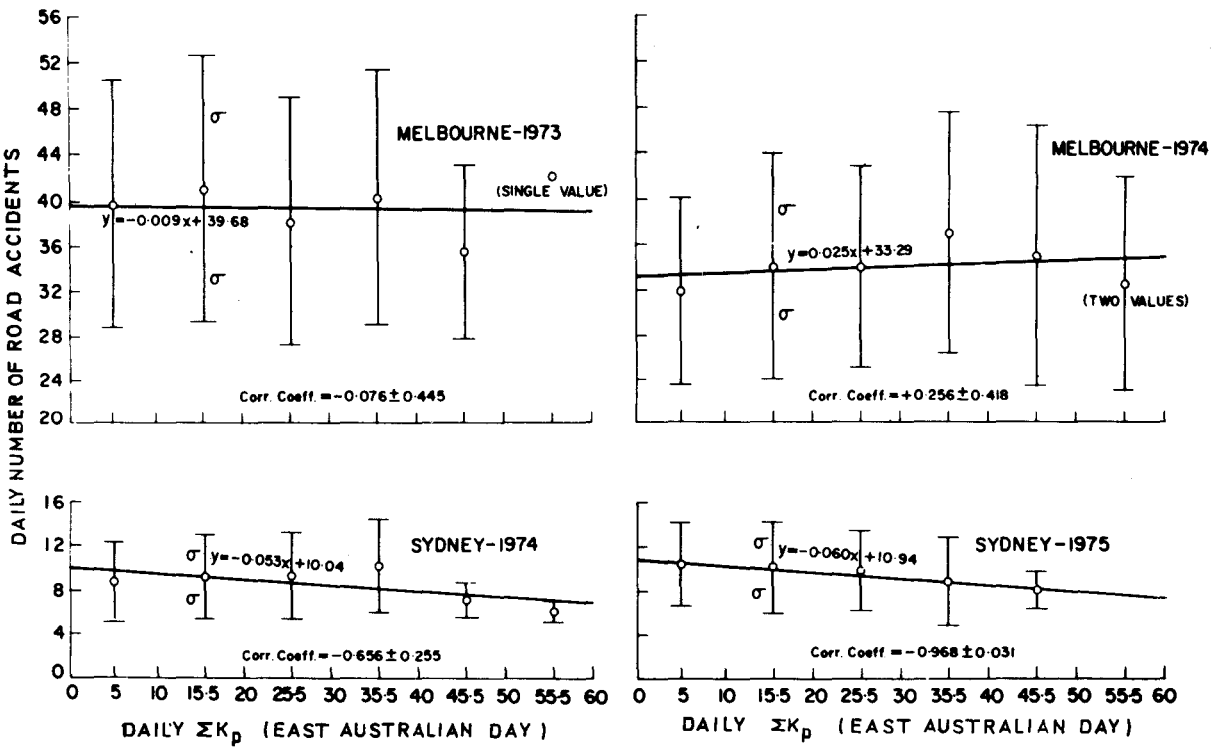

Fig. 7—Average numbers of daily road accidents plotted against different levels of daily geomagnetic activity figures ΣK_p, for Melbourne during 1973 and 1974, and Sydney during 1974 and 1975, showing large standard deviations and poor correlation

sunspot number as well as in the geomagnetic activity indices ΣK_p and A_p. It has been assumed that the number of automobiles on the roads of Melbourne and Sydney remained fairly constant during the respective two years at both places.

However, Masamura[11] found that the annual number of road accidents per 1,000 automobiles in Tokyo and several other cities of Japan revealed 11-yr solar cycle variation. Again, Mita Rajaram and Mitra[12] who examined the annual percentage of patients with convulsive seizure in the Neurology Department of the Bangur Institute of Neurology, Calcutta, found that these values are significantly correlated with the annual mean values of sunspot numbers and geomagnetic activity indices A_p and C_i for the period 1955-71 (corr. coeff. $> +0.54$). It, therefore, appears that the annual mean values of biomedical data may show a good correlation with the corresponding solar and geomagnetic activity parameters, although the monthly and daily values may not.

4 Conclusions

The daily geomagnetic activity index ΣK_p and the daily number of road accidents in Melbourne and Sydney during 1973-74 and 1974-75, respectively, month by month, do not give statistically significant correlation coefficients. Nor do the monthly mean

values of these parameters and the sunspot numbers yield any good correlation.

It appears, therefore, that the influence of geomagnetic activity on the electromagnetics of the human brain and the nervous system which could possibly trigger an increased number of road accidents, is masked by the more dominant causes of road traffic accidents (mechanical failures, rash driving, abnormal weather conditions, road conditions, drunkenness of drivers, etc.), and cannot be directly demonstrated with the help of the daily data on road accidents. A rough estimate shows that geomagnetic activity could bring about an increase of only 5 to 15 per cent in the number of road accidents recorded on a magnetically quite day ($\Sigma K_p = 0\text{-}10$).

Obviously, the subject has a lot of academic and scientific interest and there is ample scope for conducting laboratory experiments on animals and humans under fluctuating electromagnetic conditions as during magnetic storms. But it is not possible to establish these fine results with help of statistical data on road accidents, since the various other causes of road accidents are considerably greater and more dominant.

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References

1 Vladimirskii B M, Volynskii A M, Vinogradov S A, Brodovskaya Z I, Temur'yants N A, Achkasova Yu N, Rozenberg V D & Chelkova Zh D, cited in *Effects of solar activity on the earth's atmosphere and biosphere*, edited by M N Gnevyshev & A I Ol'. (Israeil Program for scientific translations into English from Russian), 1977, 259.

2 Baker R R, *Science (USA)*, **210** (1980) 555.

3 Srivastava B J & Saxena S, *Indian J Radio & Space Phys*, **9** (1980) 121.

4 Bhaskara Rao D S & Srivastava B J, *Bull NGRI*, **8** (1970) 39.

5 Srivastava B J & Bhaskara Rao D S, *Indian J Radio & Space Phys*, **3** (1974) 384.

6 Verma S D, Singhal K P & Vijaya Sinha, *Indian J Radio & Space Phys*, **6** (1977) 120.

7 *Geomagnetic Data* 1973 (*indices, rapid variations, special intervals*), *IAGA Bulletin No.* 32d, 1974.

8 *Geomagnetic Data* 1974 (*indices, rapid variations, special intervals*), *IAGA Bulletin No.* 32e, 1975.

9 *Geomagnetic Data* 1975 (*indices, rapid variations, special intervals*), *IAGA Bulletin No.* 32f, 1976.

10 Chapman S & Bartels J, *Geomagnetism (GB)*, **1** (1940) 376.

11 Masamura S, cited in *Effects of solar activity on the earth's atmosphere and biosphere*, edited by M N Gnevyshev & A I Ol', (Israel program for scientific translations into English from Russian), 1977, 238.

12 Mita Rajaram & Mitra S, *Neurosci Lett*, **24** (1981) 187.