EFFECTS OF 60 Hz ENVIRONMENTAL ELECTRIC FIELDS ON THE CENTRAL NERVOUS SYSTEM OF LABORATORY RATS

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Groups of 10 male albino rats were exposed to vertical 60 Hz electric fields of 0 (ambient), 50, 500 and 1000 V/m for a period of 30d. Duplicate tests were run of 0, 500 and 1000 V/m exposures. Subjects lived in a plastic test facility for 7d prior to exposure and for 7d following the 30th d of exposure.

Throughout the 44d experiment the subject's body weight, water consumption, food consumption, urine output and general activity were measured. Urine from 6 animals was obtained by a fraction collection and all samples for selected days were tested by atomic absorption analysis for levels of K, Na, and Ca. Following completion of the experiment subjects from the 500 V/m and 1000 V/m conditions were sacrificed; thyroid and adrenal tissues were removed and weighed; intracardiac blood samples were taken and fully analyzed.

Most measures in this large pilot experiment showed no statistically significant differences between experimental subjects and control subjects or between experimental subjects exposed to the various field strengths.

Two activity measurements, however, showed field correlated effects: 1) The relative size and duration of the late night acitvity bout was considerably reduced in the 1000 V/m condition, as compared to the 500 V/m and control conditions during the first days of field exposure; 2) Relative activity during the 0900-1000 period, was consistently but not significantly greater in the 1000 V/m condition than the 500 V/m and control conditions throughout the field exposure field (binomial test, 4 of 5 1000 V/m sessions greater, $p = .188$).

These effects were taken as indicating 1) a possible 'on' effect associated with the 1000 V/m field, and 2) an enhanced sensitivity to external stimuli associated with the 1000 V/m condition.

Urine analyses were closely correlated between sham and irradiated animals, including initial field exposure days associated with altered periodicity in circadian movements. These urinary electrolyte data did not suggest altered steroid excretion as a result of field exposure.

This large pilot experiment examined the effects of simulated high voltage AC power line fields on daily patterns of movement, renal functions, growth, organ weights and blood pictures on rats.

Male rats individually housed in plastic cages were exposed to 60 Hz field gradients of 0, 50, 500 and 1000 V/m. An adaption period of 7 days preceded 30 days of field exposure, followed by 7 days of postexposure study. Exposures at 500 and 1000 V/m and a complete sham exposure were each duplicated, with an interval of about 6 months between paired tests. All tests were conducted on a 12h-light/12-dark schedule. A dual test facility permited exposure of up to 10 animals simultaneously, in two groups of five. One or both systems may be excited at one time, allowing animals in one facility to serve as sham irradiated controls. Caging was designed for continuous collection of urine in 6-hourly samples from any 6 selected subjects. Water intake was measured on a 24h basis.

Movement and metabolic data were extensively analyzed.

a. Movement patterns: Fiber optic systems transmitted two parallel collimated light beams across each cage; movement detection was based on simultaneous interruption of both beams. Movements over 15 min epochs were printed out for each subject. Data were pooled into 1h-counts and analyzed for evidence of circadian and infradian rhythms. Nine out of 44 days were analyzed from the large amount of data. Midweek days (Wed-Thurs) were selected as far as possible to avoid "first day" or "end of week" effects (prefield, Days 2 and 7; field or sham field, Days 2, 9, 16, 23 and 30; postfield, Day 1 and Day 6 or 7). Means and standard deviations of hourly movement counts were calculated for all subjects in each group. (1) Sham irradiations (Mar-Apr 77, n = 10; Sep-Oct 77, n = 5). As for field-exposed animals, there was a steady decline from about 2000 to 1000 movements/24h over the course of the experiment. This correlated closely with increasing body weight. To aid in comparison between different test days, hourly mean activity counts were normalized with respect to the 24h mean for those subjects on that day. There was a well-developed circadian rhythm in all runs at the beginning of the tests. The duration and amplitude of the nocturnal increase in motor activity was used as an indicator of possible field effects. Typically, this increment was above the diurnal mean from 2000 to 0600h. The amplitude and duration of this peak decreased in the course of the test. (2) 500 V/m tests: (Jan-Feb 77, n = 10; Jul-Sep 77, n = 10). These tests were highly consistent throughout. Total movement rates/24h over the first 7 days of field exposure tended to higher levels than in the sham exposures. Thereafter the slope of decreasing daily movement was very similar in field-exposed and sham tests. Examination of circadian periodicity was confined to the second test and showed a shortened nocturnal activity peak on Day of field exposure, lasting only from 0000 to 0700h. This effect resembled findings at 1 kV/m, but did not show a "rebound" to prefield conditions noted on Day 9 of field exposure at 1 kV/m. (3) 1000 V/m tests: (Apr-Jun 77, n = 10; Sep-Oct 77, n = 5). Evidence for a "switching-on" effects not at 500 V/m is supported by findings at 1000 V/m, in possible effects on both total movements/24h and in effects on circadian periodicity. Rats in Test 2 showed increased movement in the first 3 days of field exposure (2100 ± 250/24h) in comparison with no-field in the same room (1890 ± 261) but was followed by a sharp fall to much lower levels around 1300 on Days 4 to 6, and a return to the slope of the overall curve at 1900 movements/24h on Day 7. Animals in Test 1 did not exhibit this "switching-on" effect in total daily movement, but showed marked effects within the 24h cycle. In contrast to preceding no-field days, and to later field-exposure days Test 1 subjects showed a reduction in duration (0200-0400h) and amplitude of the nocturnal activity peak on Day 2 of field exposure, compared with 2000-6000 for two prefield days. Circadian periodicity was less defined for Test 2 subjects, but the nocturnal peak was also shortened on Day 2 of field exposure. This effect in Test 1 subjects was transient and Day 9 of field exposure showed a nocturnal circadian peak similar to preexposure cycles. (4) Arousal responses during 500 and 1000 V/m exposures: For both 500 and 1000 V/m tests, entry of technicians into the test facility at 9 am for feeding and cleaning caused a bigger alerting reaction, as indicated by movement rate than for corresponding days in sham tests. This daily response appeared after the first week of the test in both sham and irradiated subjects and increased progressively. It developed more slowly in sham than irradiated animals and it remained relatively larger in irradiated subjects in the postexposure period.

b. Urine analyses: Na, K and Ca excretion was measured by atomic absorption spectrometry in all 7 tests, using 22h pooled urine samples from the same days as were employed in movement analyses (see above). Daily excretion (μEq day/unit body weight) showed no significant differences between sham and irradiated animals. Most groups showed slightly increased excretion of all ion between prefield and Day 2-exposure/sham exposure levels, followed by a plateau for remainder of test.

c. Analyses of blood and tissue: Averaged weights of wet adrenal tissue was higher (57.8 mg) for 500 V/m and 1000 V/m (50.8 mg) animals than for no-field animals (43.1). No differences were detected, however, in the averaged wet thyroid tissue weights (19.0 mg, no field; 18.5 mg, 500 V/m; 20.3 mg, 1000 V/m).

Complete blood examinations were performed on intracardiac specimens collected under ether anesthesia from all rats in no-field, 500 V/m and

1000 V/m series. These tests included hematocrits, hemoglobins, total WBC and differential white blood cell counts. No significant field correlated changes were found in these data.

In addition to data in the areas mentioned above, measurements of growth, food and water intake were made. No clear pattern of results has emerged from this complex set of data. Two effects in the activity measurements suggested field correlated effects: one was a possible 'on' effect at the beginning of the 1000 V/m condition in the form of a reduced level of late night activity in the first week of this test. The other was a putative increase in sensitivity to environmental stimuli, in the 1000 V/m test. Thus it was suggested that clearer effects of this class might emerge in larger experiments involving these and greater field gradients.