Effect of Magnetic Fields on Reaction Time Performance

In previous investigations[1,2] we indicated some significant empirical relationships between selected geophysical parameters and gross measures of human behaviour. The present investigation attempts to demonstrate the effects of artificially produced magnetic fields on a standard, relatively uncomplicated, psychomotor task, simple reaction time.

In our initial attempt, twin Helmholtz coils, 14·5 in. in diameter, were mounted in a concealing wooden frame to provide an 11·5 in. coil interspace. The frame, vertically movable, was attached to a wooden chair so that seated subjects, using a chin rest, could have the cerebrum approximately at the centre of the transverse magnetic fields. A gaussmeter probe was mounted in the wooden frame so as to monitor constantly the magnetic field at 1–2 in. above the centre of the subject's head. In a darkened room, each subject was instructed to press and promptly release a telegraph key, mounted on a lapboard, as quickly as possible after the appearance of an eye-level red light 7 ft. away. Three experiments were conducted: the first with equipment as described and visual read-out of a timer, the second with equipment as described but with an automatic print-out timer and an added oscillator, and the third with more efficient, commercially fabricated coils and heavier power supply. It should be cautioned that all gauss levels mentioned in these experiments reflect not absolute levels of magnetic intensity to which a subject is exposed, but those levels over and above the naturally occurring magnetic field intensity already extant in the experimental area. Further, because of the lack of field homogeneity in such a large interspace with 14 in. coils and the need to keep the probe 1 or 2 in. above the subject's head, the centre of the force field tended to give field strengths approximately one third greater than was read from the gaussmeter.

In the first experiment, steady state fields of 5 and 17 gauss, levels considerably greater than those required in natural geomagnetic activity for the designation of "severe" storm, were used with eighteen male hospitalized schizophrenic subjects, 22–49 years of age. No statistically significant effects on reaction time performance by application of steady state magnetic fields could be demonstrated, and so this approach was abandoned in favour of modulated fields.

In the second experiment, thirty male clinically normal subjects, 19–32 years of age, were randomly placed in one of three groups of ten subjects each: a control group; a group subjected to a sinusoidally modulated field of 5–11 gauss at 0·1 c/s; or a third group exposed to a similarly modulated field, but at 0·2 c/s. The three groups did not differ significantly in chronological age. The upper limit of 11 gauss was set by the capacity of the equipment used. The modulating frequencies selected were based on observations of (*a*) naturally occurring periods of oscillation in the cerebral direct-current potentials of animal and human subjects undergoing changes in levels of consciousness[3], and (*b*) the enhancement of physiological effect by low frequencies (0·1–10 c/s) when alterations of consciousness have been induced by application of exogenous direct currents[4]. Each subject had two practice reaction time trials followed by fifty trials with 5 sec between them. Modulated fields were obtained by coupling a low frequency sine wave generator to the coil system through a solid state mixer–follower circuit.

In the initial analysis of the findings of the second experiment, the fifty reaction time trials of each subject were divided into five blocks of ten trials each and the median for each block of trials determined. Thus, there were three groups of ten different subjects each, with each subject providing five median scores. The data were submitted to analysis of variance in accordance with designs for multifactor experiments with repeated measurements[5]. Fig. 1 plots the sum of reaction time medians for all subjects in a group as a function of trial blocks. An F-test applied to all fifty trials, the last thirty trials, and the last twenty trials, gave values of 3·26, 2·90 and 2·62, respectively (d.f. 2, 27), which indicated differences approaching significance ($P < 0{\cdot}10$). For the last forty trials and the last ten trials the F's calculated between groups were 3·45 and 3·58 (d.f. 2, 27); they were statistically significant ($P < 0{\cdot}05$). The Scheffé method[5] was applied to test the differences between the means of the three conditions and revealed that the 0·2 c/s condition was significantly different ($P < 0{\cdot}05$) from a combination of the other two. The findings encouraged the use of a more sensitive design using each subject as his own control. Twelve subjects were called back and two additional fifty trial reaction time performances were obtained from each so as provide a counter-balanced design with two subjects in each of the possible six sequences of conditions. A minimum of 24 h elapsed between each condition in a sequence for every subject. The median of each block of ten reaction time trials was obtained for each subject. The sum of the medians provided a single figure indicating each subject's performance in each condition. Fig. 2 shows the performance of the twelve subjects, as a group, in each of the three conditions during each block of trials. The findings were subjected to analysis of variance in accordance with designs for single-factor experiments with repeated measures[5]. For the last thirty trials, last twenty trials, and last ten trials, each combined, F's of 3·75, 4·21 and 4·66, respectively (d.f. 2, 22), indicated statistically significant differences ($E < 0{\cdot}05$). Again, the Scheffé method indicated that reaction time performance means in the 0·2 c/s condition differed significantly ($P < 0{\cdot}05$) from a combination of the means of the other two conditions. For all fifty trials and for the last forty trials combined. F values (d.f. 2, 22) of 3·06 and 3·36 approached statistical significance ($P < 0{\cdot}10$).

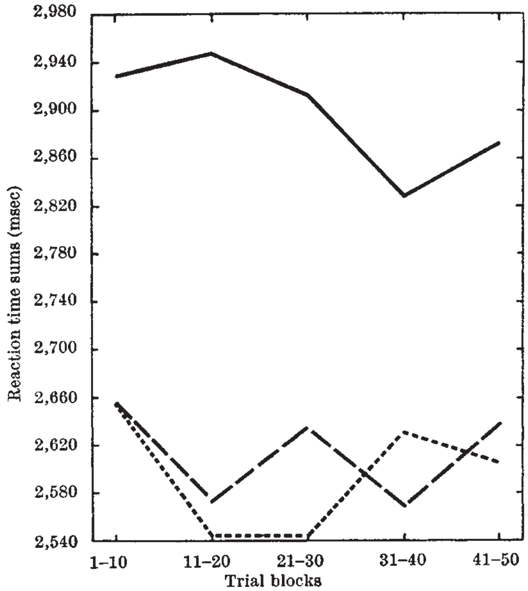

Fig. 1. Reaction time as a function of blocks of trials in male subjects. ——, 0·2 c/s; — —, 0·1 c/s; - - - -, control.

The third experiment replicated the design of the second experiment, but with thirty female subjects, 17–40 years of age. A complete wooden booth held the concealed commercially fabricated Helmholtz coils so as to provide an 11 in. coil interspace. A fixed wooden chair, movable chin rest, and seat platforms of various thicknesses enabled the subject's head to be close to the horizontal centre of the magnetic field. The magnetic probe, concealed in a wooden container in the roof of the booth, was about 2 in. from the subject's head. The coils were powered by a d.c. power supply of 1 kW input and capable of 50 amp, 22·5 V output. Desired modulations could be accomplished by connecting an externally powered oscillator directly to the power supply.

Analysis of the data derived from assigning the subjects randomly to the three groups of ten each indicated that although differences were in the expected direction, they were not statistically significant. Fig. 3 shows the sum of the reaction time medians for all subjects in a group as a function of trial blocks. As previously, the more sensitive design was used by calling back twelve subjects and exposing each to the other two conditions of the experiment. Again, this provided a completely counterbalanced design using each subject as her own control. Fig. 4 shows the performance of the twelve female subjects as a group in each of the three conditions during each block of trials. When the data were subjected to analysis of variance all fifty trials, as a block, yielded an F of 3·49 (d.f. 2, 22) which was statistically significant ($P < 0·05$). The Scheffé method indicated that the effects of the 0·2 c/s condition were significantly different ($P < 0·05$) from those in the 0·1 c/s condition.

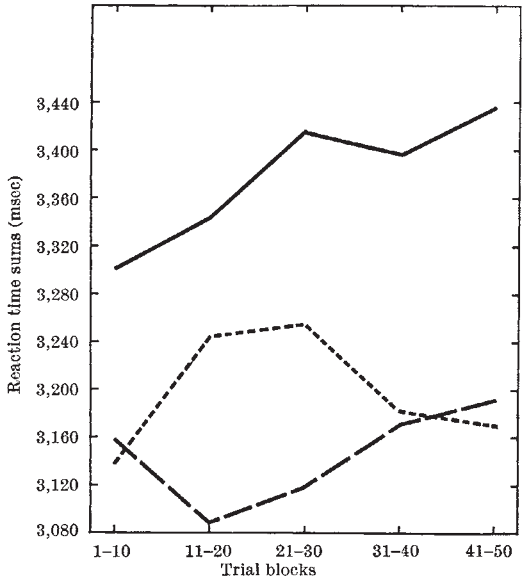

Fig. 2. Reaction time as a function of blocks of trials in male subjects used as their own controls. Symbols as in Fig. 1.

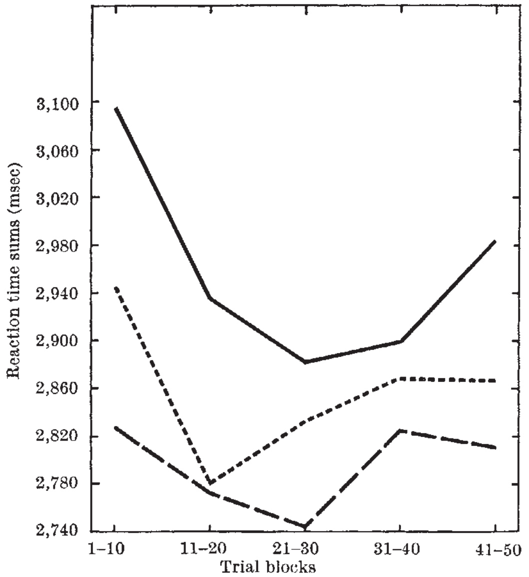

Fig. 3. Reaction time as a function of blocks of trials in female subjects. Symbols as in Fig. 1.

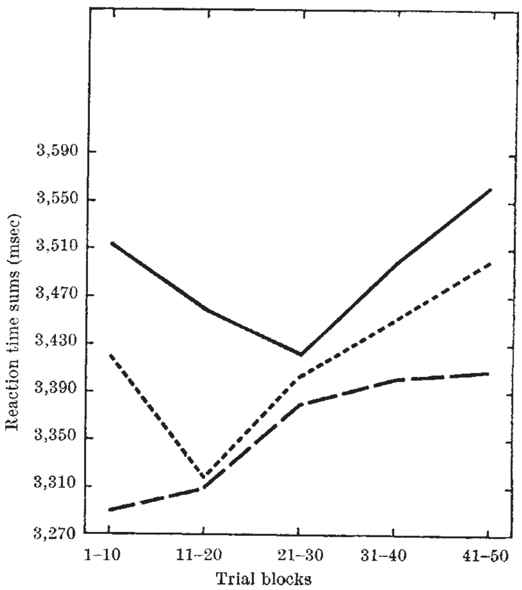

Fig. 4. Reaction time as a function of blocks of trials in female subjects used as their own controls. Symbols as in Fig. 1.

In general, then, the findings indicate that experimentally produced modulated magnetic fields can significantly affect reaction time performance.

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GENERAL

Polyplanar Hip Joint for Use in Lower Limb Bracing

CHILDREN with nervous or muscular disorders affecting the movements of the trunk and lower limb sometimes have great difficulty in walking or learning to walk. External support may be provided by long callipers fitting into the heels of the boots and extending upwards to a padded metal strap around the waist. A simple hinge joint at the level of the hip (joint) allows the legs to swing in one vertical plane only. The complexity of normal walking is highlighted when a child attempts to move in such an apparatus, for the pelvis cannot rotate around a vertical axis through the hip joint of the supporting leg during the swinging phase of the other leg. The patient therefore progresses by pivoting his body around an axis passing through the ball of the supporting foot. This produces the abnormal foot positions relative to the line of march and the pelvis, which are shown in Fig. 1*a* and *b*. Fig. 1*b* shows that the foot bearing the weight (A) must pivot through an angle equal to that of the pelvic swing (BAC). In normal walking (Fig. 1*a*) the position of the foot remains unaltered relative to the line of march, because the necessary rotation of the lower limb has taken place at the hip joint.