infants 8½ months old or younger agree with such an hypothesis: the infants go toward the uncovered eye. That is, a young infant with a patch on the left eye goes to the right, one with a patch on the right eye crawls to the left. Only 15 of the 28 older infants chose the side toward the uncovered eye. Thus, a monocular weakness that depends on the age of the child is revealed, and this weakness is related to data secured on animals. The younger infants can discriminate visual depth, but they are more likely to go toward the side of effective visual stimulation near the threshold depth of 12.7 cm. At greater visual depths, the increased motion parallax overcomes the visual weakness.

The results secured by Eichengreen, Coren, and Nachmias (*11*) can be compared to these. They found that young monocular rats reared in standard laboratory cages (that is, experience "deprived") performed at a chance level on the visual cliff, whereas binocular animals of the same age could discriminate depth; yet, monocular animals of the same age given extra climbing experience discriminated depth. Lore, Kam, and Newby (*12*) found that the handicap of the "deprived" rats (*11*) could be overcome by raising the center board 1.27 cm. Under this condition the monocular "deprived" animals discriminated depth. Likewise, this study shows that monocular infants of all ages can discriminate depth as long as the visual depth is great enough. But, near a threshold the younger infants, with less maturation and (or) less visual and visual motor experience, were handicapped when the eye was facing toward the source of ambiguous stimulation.

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6. Infants who allow the patch to stay on tend to be younger ($\chi^2 = 11.41$, 3 d.f., $P < .01$).
7. The age at onset of crawling is supplied as a possible hint concerning the importance of crawling experience in depth perception, not as conclusive evidence. Amount of crawling experience has been shown before (*4*) to influence depth discrimination: binocular infants who crawl "late" were more easily coaxed across the deep side of the visual cliff with some kinds of visual stimulation than were infants of the same chronological age who crawl "early."
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Functional Asymmetry of the Human Brain

Abstract. *Verbal and nonverbal memorization skills were tested before and after electroconvulsive shocks to the left, right, or both cerebral hemispheres of neurologically normal patients. As predicted, decrements for the left-hemisphere–shocked group were larger on the verbal than nonverbal tasks, while the reverse was true for the right-hemisphere–shocked group. Largest decrements on both tasks were shown by the bilaterally shocked group.*

It is an old observation that damage to structures of the left cerebral hemisphere is linked to the impairment of verbal abilities, at least in right-handed persons; but comparable damage to the right hemisphere does not have the same psychological effects. More recently, evidence has been adduced suggesting that a unilateral relation also exists between the right hemisphere and nonverbal abilities (*1*). To date, these relations between hemisphere and function have been inferred from the cumulative clinical study of persons suffering brain damage due to illness or injury.

In a study of the immediate postictal effects of a single electroconvulsive shock treatment (EST), Gottlieb and Wilson (*2*) found that right-handed mental patients, given EST unilaterally to the left hemisphere, required more postshock time to report correct answers to a nine-item orientation and memory checklist than did patients given right-hemisphere EST. The obtained difference was consistent with the notion of left-hemisphere "dominance" in right-handed persons; but, in the absence of nonverbal test items, the experiment did not test the specific relation of verbal skills to the left hemisphere. That is, nonverbal skills might also have been disrupted in the patients given dominant-hemisphere EST—particularly during the immediate postictal period.

The present study provides a simultaneous experimental demonstration of both asymmetries. We assessed the differential effects, on certain verbal and nonverbal associative learning tasks, of EST administered either to the left, or the right, or both cerebral hemispheres of neurologically normal patients being treated for affective depression (*3*).

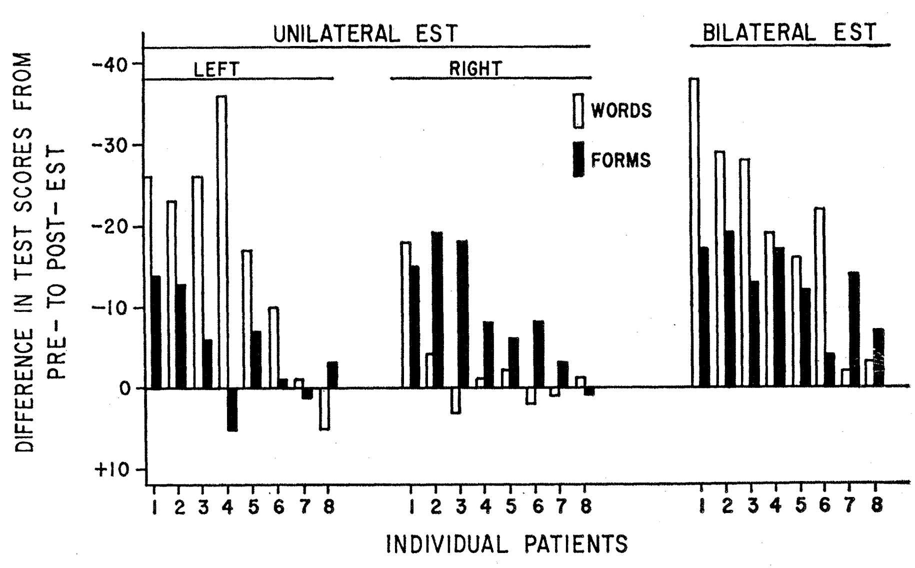

Fig. 1. Individual post-EST decrements in Words and Forms test scores for all patients.

Patients were 24 right-handed females between the ages of 21 and 55 years, admitted for EST to the inpatient service of a private psychiatric hospital (*4*). They were selected on the basis of their admission diagnoses as affectively depressed, with no evidence of schizophrenia, alcoholism, or neurological disease. All were physically healthy as indicated by complete physical examination, routine laboratory tests, electroencephalogram, chest x-ray, and medical history. As patients were admitted who satisfied these criteria, they were randomly assigned to one of three EST groups: unilateral left (L), unilateral right (R), or bilateral (B).

A Medcraft model B-24 EST machine set at 150 volts for 0.6-second duration was used to administer all treatments. The treatments were spaced no less than 2 nor more than 3 days apart. Anesthesia consisted of sodium pentothal. Succinylcholine was also given routinely as a muscle relaxant. Electrode placements were as described by Lancaster *et al.* (*5*). Every patient was judged by the clinician administering the treatment to have had a grand mal seizure.

All patients were given a verbal paired-associates learning task (Words), and a visuographic learning task (Forms) on the day prior to the first of a series of five EST sessions. Between 5 and 8 hours after the fifth treatment all patients were retested (*6*) on both tasks, using alternate sets of items (lists). Within each treatment group, complete counterbalancing was achieved for task orders and lists, pre- and post-EST. The examiners were "blind" with respect to each patient's treatment-group assignment.

On the Words test, patients were required to learn to complete each of seven word-pairs when given the first member of the pair, for example, to respond "whistle" when given the stimulus word "carpet." The lack of a familiar associative connection between the members of a pair was deliberate. Seven trials were made through the list. Following the patient's response to each item he was shown the correct response word. The order of presentation of pairs was randomized so that a different order occurred on each trial.

On the Forms test, patients were required to learn to complete, by drawing from memory, each of seven designs when given a portion of the complete design. The correct completion of each design was chosen so that it did not make any familiar configuration with the given portion of the design. Each test consisted of seven trial runs through the list, using seven different random orders with the correct design completion shown to the patient after each response. Test items were adapted from those described by Stark (*7*).

Table 1. Average Words and Forms test scores of the three treatment groups, pre- and post-EST.

Words			Forms		
L	R	B	L	R	B
		Pre-EST			
41.6	39.5	44.9	39.8	40.0	39.8
		Post-EST			
24.9	37.0	25.3	35.0	30.5	26.9
		Decrement			
16.7	2.5	19.6	4.8	9.5	12.9

A patient's score on a given test was the number of correct responses cumulated over the seven trials of the test. A perfect score, therefore, would be 49. Table 1 presents the average score for the eight patients in each group (L, R, and B) on each of the four tests (Words, pre- and post-EST; and Forms, pre- and post-EST).

Although all groups showed some post-EST decrement on both the Words and Forms tests, there was considerable variation among these average decrements (Table 1). An analysis of variance of these decrements showed a significant effect of treatment group ($F = 3.98$, with 2 and 21 d.f., $P < .05$), and a significant groups by tasks interaction ($F = 6.04$, with 2 and 21 d.f., $P < .01$).

Table 1 indicates that the significant effect of treatment groups can be attributed to the larger decrements, across both tasks combined, shown by group B compared to the unilateral groups.

The group average decrements given in Table 1, and the individual decrements presented graphically in Fig. 1, indicate that the significant groups by tasks interaction was due to the larger Words test decrements in group L contrasting with the larger Forms test decrements in group R. Seven of the eight L patients showed, as predicted, larger post-EST decrements on the Words than on the Forms tests. In contrast, six of the eight group R patients showed, also as predicted, larger Forms than Words test decrements.

The Words test findings, considered alone, were clearly consistent with the anticipated functional asymmetry linking the left hemisphere to verbal skills: whenever the left hemisphere was a treatment site (groups L and B), larger decrements in Words test scores occurred relative to the minimal decrement seen when the left hemisphere was not a treatment site (group R). Also, the Forms test findings, considered alone, were consistent with the second functional asymmetry linking the right hemisphere to nonverbal skills: whenever the right hemisphere was a treatment site (groups R and B) larger Forms test decrements occurred relative to that seen when the right hemisphere was not a treatment site (group L).

As can be seen in Fig. 1, the differentiation between the EST-produced decrements shown by groups R and L on the Forms task was not as sharp as that on the Words task. This is consistent with Heilbrun's (*8*) findings which suggested that verbal tasks were more effective than nonverbal (visuospatial) tasks in discriminating between patients with left and right cerebral lesions. However, other investigators (*9*) have reported results suggesting the reverse tendency. In view of the widely varying types of cerebral pathology represented in these studies, and the diversity of the verbal and nonverbal tasks used, it would seem premature either to interpret or generalize this particular feature of our results. Nonetheless, within the limits of type of cerebral insult (lateralized EST) and types of measures employed, our results provide convincing experimental evidence of the functional asymmetry of the human brain, extend previous results for the same verbal and nonverbal measures obtained from patients with unilateral cerebral pathology (*7*), and illustrate a research model that minimizes uncontrolled sources of interindividual variance that otherwise complicate comparisons among clinically selected groups.

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Orientometer for Study of Insect Behavior

Abstract. *A multidirectional treadmill for the study of insect orientation is described. The movements of an insect throughout 360° can be recorded for periods up to 12 hours. The extent of deviation from randomness serves as a quantitative measure of reaction to a given stimulus.*

Studies of insect orientation have often depended upon releasing an insect on a paper sheet and subsequently recording the direction in which it runs as a measure of reaction to a stimulus (*1*). This method has several drawbacks: (i) fast-moving insects are usually unsuitable for study; (ii) the stimulus has only a short time for effect; (iii) successive stimuli cannot be easily studied; (iv) the immediate response after release may be influenced by handling. To solve these problems, an inexpensive multidirectional treadmill (orientometer) was constructed (*2*) (Fig. 1). The orientometer consists of two portions, the platform and the translator.

The platform consists of a table-tennis ball mounted on three miniature ball bearings (ball-point pen points).

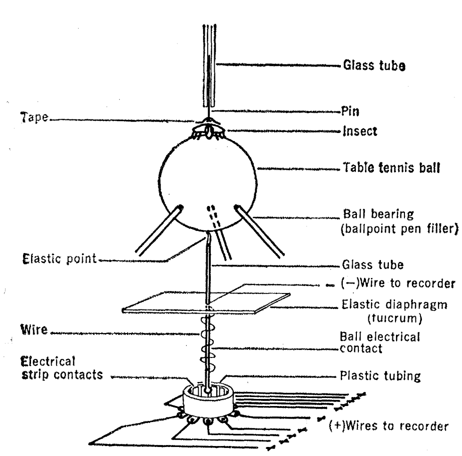

Fig. 1. Schematic diagram of the orientometer.

The insect is held in position on the platform by an insect pin inserted into a vertically mounted glass tube (5 cm by 1 mm) so that the insect can rotate freely through 360°. Attachment, in the case of a cockroach, is by a piece of masking tape pierced by the insect pin, placed on the tergite of the metathorax. The cuticle must be washed by detergent and allowed to dry for a few minutes to ensure adhesion. The ball-point pens are mounted on a ring stand with wax, clay, or glue.

The translator consists of an armature, an elastic fulcrum, and a cylindrical, multipole contact. A glass rod (8 cm by 1 mm) forms the framework for the armature. The upper end has a small piece of flexible rubber (from a rubber band) resting in contact with the bottom of the ball. The lower end has a metal contact (an insect pin with a drop of solder) inserted into it. A thin, flexible wire is soldered to the pin, wrapped around the armature, and led off near the fulcrum to the recorder. If the wire is too stiff, it will hamper the movement of the armature. A rubber diaphragm, constructed from a wide rubber band, supports the armature. The bottom of the armature fits inside a cylindrical multipole contact consisting of a section of plastic tubing with metal strips inserted around the inside. Wire connections lead from each strip contact to the recorder.

The wires from the strip contacts (+) and the lead from the armature (−) are connected to an event recorder, or more simply, to kymograph needles and a kymograph. When the insect moves, the ball rotates and moves the armature against one of the strips in the multipole contact, completing the circuit and signaling insect orientation. The greater the number of strip contacts, the smaller the angular deviation which can be measured and, of course, the greater the cost of the recording system.

A problem exists in that when contact is made there is no difference between active running in one direction and an insect resting oriented in the same direction. In practice, however, movements of the insect caused the armature contact to move on the surface of the strip contact, causing the relay to chatter due to resistance change as long as the voltage was not too great. If a more direct indication is desired, a mechanical transducer can be attached to the glass tube holding the insect since it vibrates as the insect moves.

An experiment demonstrates the use

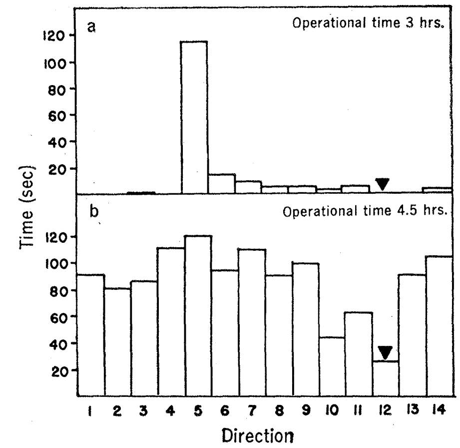

Fig. 2. The effect of light on a cockroach *Gromphodorhina portentosa* as measured by the orientometer. The total time that the cockroach spent running in different directions, distributed among 14 equal angles of about 26° each (14 contacts), is contrasted under two conditions. (a) Negative phototactic effect of a light source of about 65 lu/m² placed 3 m away and aimed at the cockroach. (b) Running orientation in a darkroom. In both cases, glue on contact 12 (triangles) resulted in a response at only one-fourth the rate on the other contacts.

of the orientometer. Theoretically, an insect will move randomly unless it is responding to a stimulus. Introduction of an appropriate stimulus will bias his direction of movement. A nymphal cockroach *Gromphodorhina portentosa* mounted on the device in a darkroom exhibited nearly random movement (Fig. 2b). The same insect displayed a negative phototactic effect in response to a light source of about 65 lu/m^2, placed 3 m away (Fig. 2a).

In addition to measuring phototactic responses, the orientometer has three outstanding general applications: (i) determination of thresholds of response to radiation (electromagnetic, atomic, magnetic); (ii) demonstration of long-term adaptation to radiation or other stimuli; and (iii) measurements of the effects of multiple stimuli, applied successively or simultaneously.

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