discrimination learning in split-brain cats under a new type of training condition. The question of transfer of brightness-discrimination learning in these cats, which has not been studied before, requires further research.

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3. This research was supported by NSF grant No. G-3880 to R. W. Sperry, and by the Frank P. Hixon Fund of California Institute of Technology.
4. At the end of the experiment, the brains of all the operated animals were fixed by perfusion with 10 percent formalin. In most cases macroscopic examination was sufficient to establish the extent of the sectioning. The posterior quarter of the callosum and, roughly, the posterior eighth of the chiasm were found to be intact in the animal eliminated from the split-brain group. This animal had shown a high degree of transfer on both problems.
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7 January 1959

Weathering of Fallout

Abstract. Subjected to weathering by electrodialysis, fallout pellets collected after a nuclear explosion from the area near ground zero released trace amounts of their total beta activity. Airborne fallout collected 612 miles from the test site released 51.8 percent of its Sr^{90} activity. Aircraft-collected fallout released 40.5 percent of its Sr^{90} activity when collected from a tower shot and 86 percent when collected from a balloon shot.

The weathering rate of fallout is of interest because natural decomposition would be the first step in the potential assimilation of fallout and would also be the index to its rate of movement into the biological cycle.

The first set of samples was collected from the surface soil of the Nevada testing site. Fallout of this type has been described by Nishita and Larson (*1*). The particles appear to be glassy and spherical. Most of the particles were larger than 50 μ in diameter. A few ranged up to 2 mm in diameter. The particles used in this study were of sand size (0.05 to 1.0 mm) and were collected from contaminated sand with tweezers.

The second set was collected at Los Alamos, N.M., 612 air miles from the test site. An environmental air sampler equipped with a respiration filter pad was used. The activity build-up occurred 24 hours after a nuclear detonation. The third set was collected in pure cellulose filters that were mounted on aircraft which flew at an altitude of approximately 20,000 ft through the cloud from a nuclear detonation.

Duplicate samples of glass pellets were weighed (50 mg) and placed in small polyethylene bottles, and 12.5 ml of ground water was added. The samples were agitated by shaking intermittently during a period of 8 days, after which the liquid was removed by filtration and the gross beta activity of the liquid determined. The ground water was prepared like a soil saturation extract (*2*) except that porous Bandelier tuff was used instead of soil. The *p*H of the extract was 7.5. The cation content per liter was Na = 0.80 meq; K = 0.09 meq; Ca = 0.02 meq; and Mg = 0.05 meq. The principal anions present were bicarbonate, chloride, sulfate, and nitrate.

After filtration, the glass pellets were transferred back to the polyethylene bottles, and 10 ml of 1-percent ethylenediaminetetracetate (EDTA) (tech. grade, *p*H 10) was added. The samples were agitated by shaking intermittently during a period of 10 days, after which the supernatant liquid was removed and the gross beta activity of the liquid determined.

After the removal of the EDTA supernatant liquid, the pellets were transferred back to the polyethylene bottles and 10 ml of a suspension of H-clay was added. (Clay was removed from a sample of Ten Site soil by conventional methods and converted to the hydrogen system by mixing with H-exchange resin and then removing the resin from the clay with bolting silk. The *p*H of the resulting clay was 3.05.) The samples were agitated by shaking for a period of 10 days. Finally, the clay suspension was made 1*N* with ammonium acetate and centrifuged. The clear supernatant liquid was plated out, and the gross beta activity was determined.

The pellets were removed from the centrifuged clay by filtering through bolting silk and washing with distilled water. The pellets were then transferred back to the polyethylene bottles, and 10 ml of water plus 1 g of H-resin (Amberlite IR-120) was added. The samples were agitated by shaking for a period of 10 days. The mixture was made 1*N* with ammonium acetate and centrifuged. The clear supernatant liquid was plated out, and the gross beta activity was determined.

Table 1. Activity removed from glassy fallout pellets by different agents of weathering.

Agent	Gross beta activity present (10^5 count/min)	Activity removed (%)
Ground water (*p*H, 7.5)	2.17	0.01
EDTA (1%) (*p*H, 10)	2.17	1.08
H-Clay (*p*H, 3.04)	2.14	0.10
H-Resin (IR-120) (*p*H, 2.4)	2.14	2.40

The total gross beta activity of the fallout pellets was determined by counting samples of 50 mg each and taking the average, and by fusing and digesting 50-mg samples and determining the average count of a plated liquid aliquot of the sample. To determine the total Sr^{90} content of the glassy pellets, the samples were fused with Na_2CO_3 in the same manner as that used in analysis of silicate minerals. The Sr^{90} was isolated by ion exchange (*3*).

To study the effect of electrodialysis on the stability of the glass pellets, three fallout samples of 50 mg each were mixed with 100 g of uncontaminated soil. The mixture was placed in the dialysis chamber and dialyzed for 48 hours. The distance between the cathode and the anode electrodes was 2 cm (the voltage was maintained at 100). After dialysis, the extract was analyzed for Sr^{90} by the ion-exchange method.

To study the effect of electrodialysis on the stability of the samples collected

Table 2. Strontium-90 activity removed by electrodialysis from different types of fallout.

Type of fallout	Activity present (disintegration/min)	Removed (%)
Glass pellets Nevada test site	3,015 (per 50 mg)	Trace*
Los Alamos environment, collected by filter	1,547 (per sample)	51.8
Tower shot, collected by aircraft filter	38,780 (per sample)	40.5
Balloon shot, collected by aircraft filter	88,850 (per sample)	86.0

* Less than 5 disintegration/min.

at Los Alamos, three complete filter papers (obtained from the environmental air sampler) were placed in the center chamber of the electrodialysis cell. The samples were electrodialyzed for a period of 48 hours. The distance between electrodes was 2 cm. The voltage was maintained at 100 v. After the dialysis, the extract obtained was analyzed for Sr^{90} by the ion-exchange method (*3*). The filter papers were allowed to dry. They were then placed in a large porcelain crucible and heated slowly to 450°C and held at this temperature until they were ashed. The samples were allowed to cool to room temperature, then 10 ml of 72-percent perchloric acid was added to complete the digestion. The amount of Sr^{90} obtained by ashing the papers was determined by the ion-exchange method (*3*).

To study the effect of electrodialysis on the stability of the fallout collected by aircraft, approximately 2 cm^2 of the collector filter paper was placed in the dialysis cell and dialyzed for 48 hours. The conditions of dialysis were the same as those described above. The Sr^{90} of the dialysis extract and the portion remaining in the filter paper after dialysis were analyzed as described above. The results of the weathering studies of fallout are presented in Tables 1 and 2.

The results of this study show that the glassy pellets which fall in the area around the test site are resistant to weathering. They are so resistant that it is unlikely that more than 1 percent of their activity would enter into the biological cycle in any given year.

The samples collected at Los Alamos contained Sr^{90} in dialyzable and nondialyzable forms. This does not seem unreasonable since some of the glassy pellets are small enough to be transported by wind from the test site to Los Alamos.

The results of the study on the samples collected by aircraft flying through the cloud caused by the nuclear detonation suggest that electrodialysis could be used to evaluate the hazard associated with each type of detonation and that valuable information regarding the rate of entry into the biosphere could be obtained.

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Group Effort in Modern Physics Research

Abstract. In the *Physical Review* for the year 1957, as a sample, multiple authorship appears with greatest relative frequency in communications from government, academic, and industrial laboratories, in that order. For the three types, it appears that research is conducted on the average by groups and not by individuals. These conclusions are at variance with premises assumed recently by R. S. Uhrbrock (*1*).

For the planning and direction of scientific research, it is important to determine the elusive factors that enter into research productivity. The elements affecting the productivity of the *individual* have been studied recently by Shockley (*2*). However, current scientific periodicals show that articles with N authors, where N not infrequently is large relative to unity, are prevalent, whereas such papers were the glaring exception a decade or so ago. It is interesting to examine quantitatively the relative frequency of group and individual efforts in the physical sciences and to determine whether any correlations exist. This report summarizes initial conclusions for one science, physics, based on a sample consisting of all contributions that appeared in the *Physical Review* during the calendar year 1957 (volumes 105–108). This particular journal was selected because of its timeliness in the coverage of active areas of research in modern physics.

In the sample chosen, the names of laboratories of three general types (academic, government, and industrial) appear in the respective by-lines of the contributions (*3*). For each separate category the histogram given in Fig. 1 shows the total number (on a logarithmic scale) of papers and letters to the editor with N authors (*4*) as a function of N. The most striking feature revealed by Fig. 1 is that the number of communications with N greater than unity is relatively, as well as absolutely, greater for government and academic laboratories than for their industrial counterparts. This number is 64, 62, and 48 percent, respectively, of the total number of communications in the three categories, listed in the order given above. Thus, only for industrial laboratories are contributions from single authors not outnumbered by those of joint authorship.

An individual rank in its category was assigned to each laboratory, corresponding to the total number of communications from that laboratory in the sample. In the academic category, the University of California, Berkeley, ranks first, with 112 works; Bell Telephone Laboratories is the corresponding giant (47 works) in the industrial class. The histogram given in Fig. 2 shows the average number of authors per contribution from a laboratory as a function of rank for academic and industrial laboratories, up to rank 50 (three works) for the former. One sees immediately that for the laboratories under consideration, research is conducted, in general, by groups or teams and *not* by individuals. In fact, the mean number of authors per publication over the entire sample considered is 2.1, 2.1, and 1.7 for academic, government, and industrial laboratories, respectively. Comments by Temperley (*5*) indicate that a trend toward a similar situation exists in the United Kingdom.

The conclusions given above are not at all what widely held preconceptions might suggest. It is true that the choice of a different journal of physics would alter conclusions with respect to details (the papers of Fig. 1 with an extremely large multiplicity of authors are all on nuclear physics). Clearly, however, the ubiquity of group effort is the ineluctable concomitant of the explosive growth of

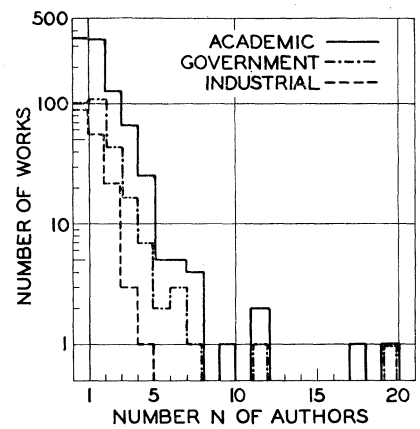

Fig. 1. Number of research communications with N authors in the sample, as a function of the number, N, of authors (the vertical scale is logarithmic).

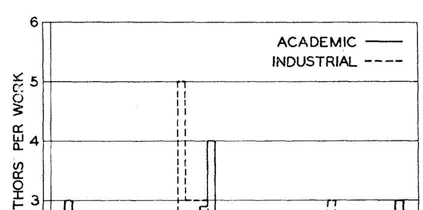

Fig. 2. Mean number of authors per research communication from a laboratory, as a function of the laboratory's rank in research productivity. (Results for government laboratories have been omitted for the sake of simplicity.)