units, four flies yielded 7.2 units, and eight flies yielded 13.7 units when homogenized together. These results indicate that the assay of xanthine dehydrogenase in a single fly as described herein is a valid one. The assay is now being applied to a variety of problems (*6*). With minor modifications—the use of smaller volumes and more sensitive fluorometers—one might hope to assay individual organs of these flies. This method should also prove applicable to the assay of xanthine dehydrogenase in small amounts of tissue from various sources (*8*).

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7. I am grateful to Drs. J. J. Denton and S. Kushner of the Lederle Laboratories for their generous gift of 2-amino-4-hydroxypteridine and isoxanthopterin.
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Strontium-90 Fallout from the 1961 Soviet Nuclear Detonations

Abstract. A steady increase in the strontium-90 concentration in rain was observed at Fayetteville, Arkansas, after the 1961 Soviet nuclear test series. Experimental data indicate that the nuclear weapons tested in 1961 were "cleaner" on the average by a factor of five than those exploded in 1957 and 1958.

After the 1961 Soviet atmospheric test series, it was feared that the Sr^{90} fallout would far exceed the levels previously observed. Judging from the reported explosive powers of some of the super-bombs tested in the fall of 1961, it was thought that the fallout during the spring peak of 1962 would be several times that observed, for example, in the 1959 spring peak period.

It soon became obvious, however, that the yield of fission debris relative to the explosive power of the Soviet bombs was unexpectedly small—the bombs were "clean." We have attempted to compare the ratio of Sr^{90} fallout versus the power (expressed in terms of megaton equivalent of TNT) for the 1961 Soviet tests with the values for previous test series.

We have measured the Sr^{90} concentrations in individual samples of rain and snow collected at Fayetteville and have calculated the monthly average in rain ($\overline{C}$) from the equation:

$$\overline{C} = \Sigma F / \Sigma R$$

where ΣF is the total amount of Sr^{90} (in 10^{-12} curies per square meter) transported by rain and snow during the month period and ΣR is the total rainfall (in millimeters) during the same period.

The experimental results are shown in Figure 1. Prior to the Soviet test series, the concentration in rain was gradually decreasing after the 1961 spring peak, but the trend reversed to a steady increase soon after the tests began in September 1961. The levels during the following several months through March 1962 were intermediate between the levels observed during the corresponding months of 1957–58 and 1958–59. However, a trend indicated that the 1962 peak value might reach or exceed the levels of March and April 1959.

According to the statement issued by the U.S. Atomic Energy Commission on 9 December 1961, the total explosive power for the approximately 50 Soviet atmospheric tests conducted during the months of September and October 1961 is estimated to be equivalent to that of 120 megatons of TNT. Machta and List (*1*) reported that stratospheric injections of Sr^{90}, as estimated by Libby (*2*), were as follows: 1957 spring 3.0, fall 6.0; 1958 winter 3.3, spring 4.0, fall 20.0 (megaton equivalents).

Most of the Sr^{90} injected into the stratosphere appears to be removed during the spring peak of the following year, as first pointed out by Martell (*3*). Hence the level of concentration in rain during the spring peak period of fallout may be considered as roughly proportional to the total amount of Sr^{90} injected into the stratosphere by the major test series during the previous year. Under the above simplifying assumption, the concentration in rain during the spring peak period divided by the total explosive power of the weapons tested during the previous year may be used as a measure of the ratio Sr^{90} production versus the explosive power of the bombs.

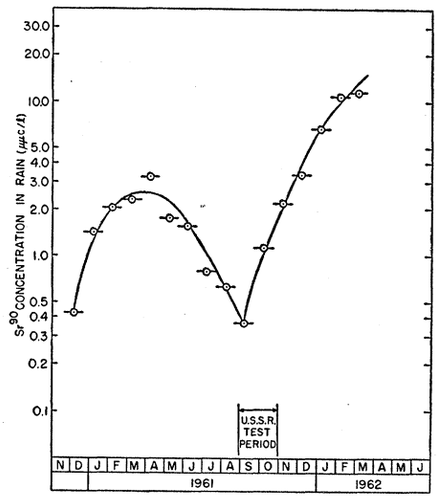

Fig. 1. Variation of the Sr^{90} concentration in rain and snow at Fayetteville, Arkansas.

Figure 2 was obtained by simply dividing the observed monthly values of $\overline{C}$ by the total explosive power of the bombs tested during each year: 9.0 megaton equivalents of TNT in 1957, 27.3 in 1958, and 120 in 1961.

The results indicate that the 1961

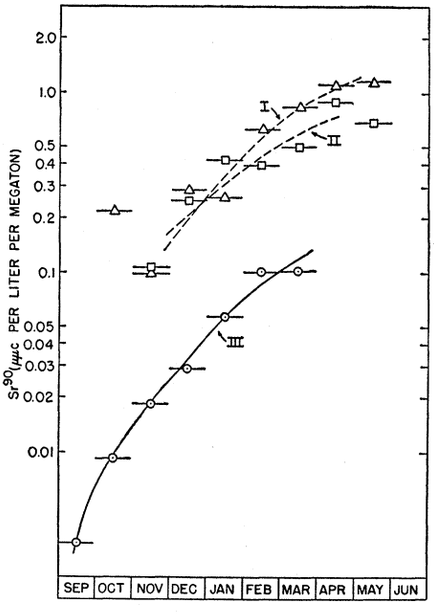

Fig. 2. Comparison of the Sr^{90} concentrations in rain relative to the total explosive power of the bombs exploded in the previous year, expressed in micromicrocuries of Sr^{90} per liter per megaton. Curves I, 1957 to 1958; II, 1958 to 1959; III, 1961 to 1962.

bombs were, by a factor of approximately five, "cleaner" than those tested in 1957 and 1958. This finding seems to agree with the following statement made by the AEC on 9 December 1961: "Of special interest is the small fission yield of the 55–60 megaton test conducted on October 30. The total fission yield for the series is estimated to be about 25 megatons, out of the total yield of about 120 megatons for the approximately 50 atmospheric tests" (*4*).

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Hallucinations in Sensory Deprivation—Method or Madness?

Abstract. Ten-minute observations of visual fields in binocularly patched subjects, and self-observation for dreams yielded visual imagery similar to sensory deprivation hallucinations. The latter probably arise from fragments of normal imagery whose origins are unrecognized because of reduced awareness.

The hallucinations (*1*) of sensory deprivation experiments are poorly understood, partly because of the large number of variables (*2*). In our earlier studies (*3*), reduced awareness was one of the more significant variables. Patients binocularly patched for detachment of the retina and for cataract extraction had hallucinations and other behavioral symptoms with increased frequency while going into or coming out of sleep (*4*). We wondered whether there might have been failure to identify some normal imagery occurring at the time (sleep dreams, hypnagogic hallucinations, and wakeful reveries) as such. We therefore decided to check the hypothesis that sensory deprivation hallucinations consist of fragments of one or more types of normal imagery occurring during reduced awareness.

Ten normal subjects and five patients with eye disease were binocularly patched for 10-minute periods. Instructions and methods of reporting were those utilized in the experiments of Hebb and his group at Montreal (*5*). The subjects were told to report what they saw in their visual fields, including on-going changes, and in particular to describe any visual images. Reporting was contemporary, sporadic, and retrospective (by recall) in randomized experiments for each subject.

The visual imagery recorded in these methodologic experiments was similar to that noted in the Montreal studies on sensory deprivation. It ranged from simple dots, lines, and geometric forms to more complex objects, persons, and scenes. There was a greater tendency toward secondary elaboration in the retrospective reporting. Hebb had commented that although the imagery was usually fleeting, it was at times prolonged and could be described while it was occurring. This "on-the-griddle" feature, as he called it, was duplicated in our "contemporary" recordings. Other less distinctive features reported by the Montreal group, as well as the similarities to hypnagogic imagery emphasized by Freedman and Greenblatt (*6*) and others, were also noted. In our experiments, even without the additional strong positive or negative suggestions utilized by Kandel, Myer, and Murphy (*7*) and by Jackson and Kelly (*8*), imagery of the kind reported in sensory deprivation experiments was obtained. However, these experiences occurred in alert subjects who were not in doubt about the source of the imagery.

In order to ascertain whether reduced awareness obscures the origins of normal visual imagery, one of us (E.Z.), on awakening, recorded self-observations with pad and pencil. Gradual arousals proved more productive than abrupt ones. The content of many of the dreams was forgotten before transcription; in many instances only fragments were recorded. The bizarre imagery of one dream and the normal imagery of another occurred in juxtaposition. On several occasions there were mixtures of kaleidoscopic hypnagogic hallucinations, dream fragments, and wakeful reveries. At times there was uncertainty as to which one or which combination of these mental processes gave rise to the imagery.

The Montreal group also described significant impairment of awareness. At a certain stage the subjects were unable to concentrate on goal-directed thinking. Then they were not sure whether they were daydreaming or sleep-dreaming, awake or asleep, and at times they spoke of being confused or in a dazed state.

Had we been less sophisticated we might not have isolated so readily the different types of normal imagery. Other investigators, who have used the Dement-Kleitman technique (*9*) and have also recorded dreams on arising, have made similar observations (*10*). Klüver (*11*) and Schilder (*12*) have described perceptual fragmentations in eidetic imagery. The former referred also to similar findings in dreams and hallucinations.

It is apparent, therefore, that our two sets of data support the hypothesis that sensory deprivation hallucinations are fragments of normal imagery. Our experiments show that some of the characteristics of sensory deprivation hallucinations are related to the type of instructions and methods of recording, which indeed serve to make much subliminal imagery conscious. Self-observations during arousal establish the fact that reduced awareness can obscure the origins of normal imagery.

The extent to which the increased incidence and duration of such periods of reduced awareness in sensory deprivation situations (*3*) is also necessary in the formation of hallucinations is not known, but these factors may well be contributory. In any event, the conclusion seems warranted that sensory deprivation hallucinations are not mental aberrations but are normal imagery largely, but not entirely, highlighted by methodological procedures. Confusion from reduced awareness obscures the origins and hence had given the impression of a new type of imagery.

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