pneumotoxicity of Newcastle disease virus (*10*) and by the neurotoxicity of influenza virus (*11*).

To the extent that the Rous sarcoma is typical of other virus-induced tumors, it is important that tumor response to at least one chemotherapeutic agent is greatly influenced by the amount of virus used to initiate the tumor.

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On the Intimate Composition of Membranes of the Inner Ear

In 1953 (*1*), autoradiographic studies of radiosulfate incorporation by the inner ear were conducted in our laboratory. This work revealed a relatively high uptake by the membrana tectoria and also by the gelatinous mass of the cupula, while the otolithic membrane of the macula recorded a lower concentration. Radiosulfate ($S^{35}O_4$) was also detected in all three membranes by Ringertz (*2*), who used a similar approach. Furthermore, our ethanol-formalin fixed, undecalcified tissues stained metachromatically with toluidine blue in all the areas that have revealed an uptake of radiosulfate (*3*) including the inner-ear membranes (*1*). These results seemed to indicate that the radiosulfate was retained as newly synthetized sulfomucopolysaccharides.

Recently, Wislocki and Ladman (*4*) have challenged this hypothesis on the basis of studies of decalcified newborn-mouse tissue fixed in lead acetate or Zenker's acetic acid fluid which revealed no metachromasia. On the other hand, those authors have obtained a positive result with the Barrnett and Seligman test for SH_2 and S—S groups and conclude that the uptake of S^{35} which we had observed might be explained by the formation of disulfide groups associated with cystine.

If there was a concentration of sulfur-containing amino acids in the inner ear membranes, such as is encountered in keratinized tissues, S^{35}-labeled cystine or methionine (*5*) would be expected to produce a more intense autoradiographic reaction in these sites than $S^{35}O_4$, for the amount of cystine and methionine biosynthesized from sulfate in mammalian tissue is known to be very small (*6*).

While currently conducting a general survey of uptake of S^{35}-labeled methionine and cystine (*7*), we have had the opportunity to observe several specimens of the inner ear in rats labeled at 8 days of age and sacrificed at intervals of 1, 2, and 6 hours and 1, 2, and 4 days thereafter (*8*). The histoautoradiographic processing has been the same as previously reported for the radiosulfate series (*1, 3*). The tissues that are known to contain keratin—the epidermis, hair, and tooth enamel—revealed a high uptake of labeled amino acids.

Although cystine is the most important sulfur-containing amino acid of the keratins, it has been shown by Tarver and Schmidt (*9*) that when labeled methionine is introduced into an experimental animal, a large proportion of the radioactive sulfur appears in crystallized cystine from hair and skin. This is an indication that there is conversion from methionine to cystine at the level of the tissues. The other structures, synthetizing proteins with a low concentration of sulfur-containing amino acids, showed a much lower graded uptake, which was assumed to be proportional to the local rate of synthesis (*7*).

The inner ear, by comparison with other regions of nonspecific uptake such as the bone (Fig. 1), is definitely an area of low concentration, producing an autoradiographic record only after exposures of several months. Within this structure, certain features such as the area vasculosa and the spiral lamina appear to be more active than the general tissue background. On the other hand, the tectorial membrane (Fig. 1, arrows), the cupula, and the otolithic membrane were constantly negative.

These results must be compared with the large concentration of $S^{35}O_4$ previously reported (*1*) and presumably bound to large polysaccharide molecules. Furthermore, it has been possible to reproduce on the present material, with or without demineralization, the strong periodic acid-Schiff staining of the membranes that was described by Wislocki and Ladman (*4*).

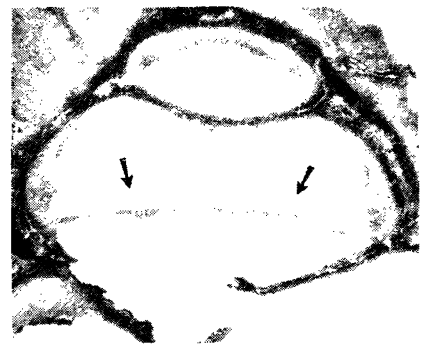

Fig. 1. Integrated autoradiogram of the cochlea of a 9-day-old rat, 24 hr after an injection of S^{35}-methionine (× 29). The organ of Corti shows a general low uptake. The tectorial membrane (arrows) is negative.

It seems evident that the inner-ear membranes contain a large amount of polysaccharides and that these are at least partly sulfated. On the other hand, as compared with the skin, hair, and enamel, the inner-ear membranes synthetize virtually no protein from S^{35}-methionine.

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16 January 1956

Effect of Sensory Deprivation on Learning Rate in Human Beings

Recent theoretical considerations (*1*) concerning brain functioning have so emphasized the necessity for constant sensory bombardment in order to maintain normal, intelligent, adaptive behavior that it is only natural to speculate about the effects of reduced sensory stimulation. As interesting as it might prove to be, it is obviously not possible to stop completely all sensory input and still maintain a responsible observer. It is possible, however, by rigid conditions of confinement, to minimize not only the amount of sensory input but also to bring about a drastic reduction in its variability. Such a condition of confinement, to be

described in detail, has been termed *sensory deprivation,* a term more convenient than accurate.

The first systematic investigation of the effects of confinement on human subjects was carried out at McGill University by Bexton, Heron, and Scott (*2*). In that study the conditions of confinement emphasized the reduction of variability in sensory stimulation. The subjects wore semitranslucent goggles through which they could make out brightness but could not form discriminations. There was constantly present a masking noise which served to minimize the effectiveness of sound from outside the cubicle. Each subject wore cardboard gauntlets that extended from just below the elbow to beyond the fingertips. The subjects were confined under such conditions for various periods of time up to 5 days. It was found that in tests of cognitive ability, continued isolation produced inferior performances, later referred to as deterioration of the intellect (*3*), which fortunately disappeared upon the subject's release from confinement. Confinement also produced in all subjects hallucinations that were mostly auditory or visual, but in one case tactual. Immediately upon being released from confinement, subjects reported difficulty in focusing, as well as a tendency to perceive the environment as two-dimensional, with colors more saturated than usual. They also reported that during confinement there was an inability to sustain extended thought.

The present study is preliminary in nature (*4*) and was not intended as a replication of the McGill study. The confinement conditions are very dissimilar. The Princeton study was conducted in the following manner: Four male college seniors served as subjects under conditions of confinement and isolation for a period of 48 hours. Isolation was provided by a floating room (15 ft by 9 ft), which was lightproof, and through which there was an 80-db sound loss. Subjects were fitted with ear plugs and instructed to make as little noise as possible while they utilized free access to a bed and a chair. The confinement cubicle was only 4 ft by 9 ft, which allowed little activity. Further restriction of activity was provided, as in the McGill study, in the form of cardboard gauntlets. The confinement period was interrupted only for meals, tests, and toilet needs. For meals and tests, subjects were removed from the isolation cubicle to the antichamber of the floating room, where a 15-w red bulb provided illumination when necessary. Lightproof goggles were used when the subjects attended to toilet needs outside the confinement cubicle. During the interruptions, no conversation was allowed except that necessary for the conduct of tests. Smoking was permitted at these times.

Inasmuch as the McGill study had found that confinement affected cognitive ability adversely, it was decided in the present study to test the effects of sensory deprivation on learning rate. The learning tasks were 12-item adjective lists, presented aurally. A subject's ability to learn by the anticipation method with a 2-second interstimulus interval was determined before confinement, after 24 hours of confinement, after 48 hours of confinement, 24 hours after release from confinement, and 48 hours after release from confinement. All tests were conducted in the antichamber of the floating room to render all distractions relatively constant.

Figure 1 presents the effects of sensory deprivation on the ability to learn adjective lists, indicating mean values for the four subjects. The results clearly indicate that the ability to learn adjective lists improves with continued sensory deprivation. That this improvement is not a function of either the particular adjective lists or a learning how to learn is indicated by the performance of a control group.

Attempts to measure the effect of sensory deprivation on suggestion, by the Hull body-sway technique, proved unsuccessful.

Upon release from confinement, the subjects were required to give full accounts of the confinement experience, which was recorded on tape. They were then questioned about any of the following items that they had not mentioned: hallucinations, focusing difficulty, lack of ability to engage in extended thought, increased saturation of hues, and lack of three-dimensional perception. In each case, the subject's report was contrary to the McGill findings.

It would be unwise to stress the differences between the McGill and Princeton findings in view of the few subjects used in the latter case. However, it is possible that the differences in the confinement conditions were in part responsible for the divergent results. For example, it may have been that hallucinations were actually generated in the McGill study by the amorphous visual stimuli or the repetitious masking noise or both. Furthermore, these same stimuli may have served as distractions contributing to the decrease in the general mental performance of the McGill subjects.

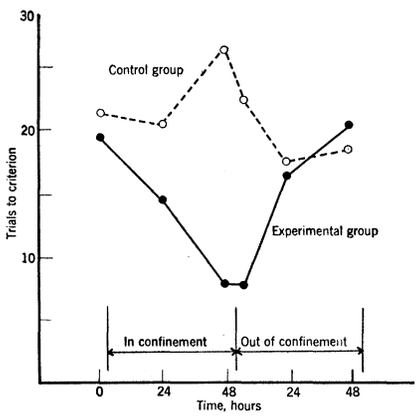

Fig. 1. Effect of sensory deprivation on learning rate in human beings. Each point is the mean value of four subjects.

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2 February 1956

Nature of Protein Synthesis in Sweetpotato Infected with Ceratostomella fimbriata

An increase in respiratory rate is commonly observed in the tissues of seed plants when they are infected by pathogens (*1*), and we have found that in sweetpotato infected with *Ceratostomella fimbriata* (black rot), the rate of respiration of the sound tissue adjacent to the area in which the pathogen has developed is higher than that of a control (uninfected sweetpotato). The increase was accompanied by anabolic events, as shown by the accumulation of organic phosphate (P_o) and the synthesis of protein (*2*).

A description of a possible mechanism for the respiratory increase follows. As a result of the penetration of the fungus, the protoplasm of the sound tissue next to the infected area is stimulated to synthesize P_o and protein, and, concomitantly, the reaction

$$ATP \rightarrow ADP + P$$

is accelerated, resulting in an increase in respiratory rate. The details of this metabolic stimulation and protein synthesis are examined in this report (*3*).

To determine the pattern of protein synthesis, slices (1 cm thick) were cut from sweetpotatoes. Some of the slices were inoculated with a spore suspension of *C. fimbriata*; the rest served as a control sample. The sound tissue adjacent to the infected areas in the inoculated sample, which is referred to as tissue A, was removed after 48 hours. Sound tissue (referred to as tissue B) was also ob-