THE EFFECTS OF PROLONGED VISUAL DEPRIVATION ON THE WEIGHT OF THE SENSORY CORTEX OF THE RAT

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A comparison between those animals raised in an impoverished environment (Experiment 1) and those reared in an enriched somesthetic environment (Experiment 2) indicated that enriched environmental stimulation produced a significant increase in the weight of the somesthetic cortex. The auditory and visual cortex also showed an increase, but the results were not significant.

These results suggest that neither the presence nor the absence of an enriched somesthetic environment can produce an increase in the weight of the sensory cortex of visually deprived animals, a finding contrary to that reported at the University of California. Two procedural differences are offered as a possible explanation of these apparently contradictory results. Although the effects of visual deprivation appear to yield inconsistent results, the present results do confirm the California finding that an increase in the weight of the sensory cortex can occur in animals reared in an enhanced somesthetic environment relative to those reared in an impoverished environment.

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INTRODUCTION AND HISTORICAL BACKGROUND

I. Statement of the Problem

Two recent studies (Krech, Rosenzweig, & Bennett, 1963; Bennett, Diamond, Krech, & Rosenzweig, 1964) have reported a compensatory increase in the weight of the somesthetic cortex of enucleated or dark-reared rats who received considerable environmental stimulation and handling. In view of these results, it is proposed to extend this research in two main directions. First, can this compensatory increase after dark-rearing occur in the absence of enriched environmental stimulation and handling. Second, can a compensatory increase in the weight of the auditory cortex, similar to that observed in the somesthetic cortex, be demonstrated after prolonged visual deprivation.

II. Introduction

Over the years there has been a continuing interest in the behavioral, anatomical, and physiological effects of prolonged visual deprivation, both on the visual system itself and on other sensory systems. This research has tended to employ three main approaches. First, studies of visual deprivation employing blind individuals have primarily concerned themselves with vicariate or compensatory functioning in other sensory modalities, and have involved measuring the blind on a variety of sensory threshold and discrimination tasks. The results, unfortunately, are contradictory in nature, with some studies indicating compensatory increases in sensitivity of other modalities while others have reported no such changes. These contradictory findings probably resulted from the numerous methodological problems which characterize research on the blind.

The second approach, employed at the University of Manitoba, consists in the exposure of human subjects to prolonged periods of darkness or homogeneous illumination. The results of these studies have clearly demonstrated a facilitation or increase in tactual acuity (Zubek et al., 1964a, b) and in auditory discrimination (Duda and Zubek, 1965).

The third general approach consists in the determination of the anatomical and biochemical characteristics of the sensory cortex of peripherally blinded or dark-reared animals. This procedure, which was pioneered by Krech et al. (1963; 1964), has demonstrated an increase in the weight of the somesthetic cortex but no significant change in the weight of the visual cortex of either blinded or dark-reared rats who received considerable environmental stimulation.

The present study is essentially a replication of the work of Krech and his colleagues (Krech et al., 1963; Bennett et al., 1964) on compensatory weight changes in the sensory cortex of dark-reared rats. There are, however, three main differences: (a) use of two different conditions of environmental stimulation and handling, (b) determination of the weight of the auditory cortex in addition to that of the somesthetic and visual cortex, and (c) employment of both albino and hooded strains of rats because of certain anatomical and behavioral differences in their visual systems (Lund, 1965; Sheridan and Shrout, 1965; Lockard, 1963).

III. Historical Background

This review of the literature on the effects of prolonged visual deprivation will be presented in three sections beginning with a brief summary of studies on the blind, followed by a review of human studies on visual deprivation, and finally an examination of the animal research on visual deprivation.

Studies on the Blind

Both the classical and current research on the blind has concerned itself primarily with the notion that when an individual loses the use of one of his modalities, the remaining senses function vicariously to compensate for the loss. Research in this area, however, has proven to be both inconclusive and contradictory (Axelrod, 1959).

One of the earliest attempts to study sensory compensation was by Griesbach in 1899. Studying both blind and sighted humans on measures of hearing, smell and touch, he noted no essential differences between blind and sighted groups. Krogius (1905), however, replicating Griesbach's method of auditory localization, reported that twenty blind female subjects could localize sounds more exactly than seeing subjects.

In a more recent study of the cutaneous sensitivity of the early-blind, Axelrod (1959) found early-blind girls to have poorer light-touch thresholds than sighted girls on the left and right index fingers, and on the ring finger of the preferred hand. Early-blind boys, on the other hand, displayed better light-touch sensitivity than sighted boys on all three fingers. Measurements of tactual acuity for these same skin areas were also recorded using the two-point threshold technique. The early-blind exhibited lower thresholds than the sighted for the right index finger but no differences were found between the two groups for the left index finger and the ring finger of the preferred hand. Contrary results were reported by Wilson, Wilson and Swinyard (1962) who found that the blind possessed a higher two-point threshold on both forearms relative to that of either normal subjects or amputees.

Axelrod (1959) also measured the blind on complex auditory tasks involving tonality, number and temporal sequence. The results showed that early-blind subjects performed significantly worse than did the sighted controls. His study, therefore, offers little support for auditory sensory compensation.

Axelrod (1959), in a review of literature on the blind, offers some current explanations of previous contradictory results. He points out that no consideration or control is provided for the degree of blindness possessed by the subject, the age of onset of blindness, age and sex of subjects, and initial cause of blindness. Because of these factors, it is difficult to arrive at a clear picture of the relationship between loss of vision and vicariate functioning in the other senses.

In addition to these behavioral experiments on the blind, two studies of a physiological nature have been reported. Tilney (1929), in a post-mortem examination of the brain of a blind deaf-mute, observed an overdevelopment of the parietal lobes but atrophy in the visual cortex. On the basis of this finding he postulated that blindness of early onset may produce a "hypertrophy of use" in the parietal lobe. In the second study, Walter (1963) has reported that in some congenitally blind children, the cortical responses evoked by auditory and tactile stimuli are unusually large and spread further toward the occipital regions than in those of sighted children of the same age.

Human Studies on Prolonged Visual Deprivation

Zubek, Flye, and Aftanas (1964) reported that human subjects who were placed in constant darkness for one week, but otherwise were exposed to a normal and varied sensory environment, showed a pronounced increase in tactual acuity and in pain sensitivity. Furthermore, this facilitatory effect was still present several days after the termination of darkness. In a follow-up study involving a week of unpatterned light, similar findings of an increase in tactual acuity of the finger and forearm and an increase in sensitivity to both pain and heat were reported (Zubek, Flye, and Willows, 1964). In the final study, Duda and Zubek (1965) demonstrated a significant increase in auditory flutter fusion frequency, but no change in absolute auditory sensitivity. The facilitatory effect again persisted for several days after the termination of the week of darkness.

These studies from the Manitoba laboratory appear to support Schultz' (1965) sensoristatic model according to which an optimal level of sensory stimulation exists which functions to influence the level of cortical arousal. When the level of variability of sensory input is reduced, central regulation of threshold sensitivities through the reticular activating system will function to lower sensory thresholds and sensitize the organism to stimulation.

Animal Studies on Prolonged Visual Deprivation

There is an extensive animal literature on the physiological effects of prolonged visual deprivation on other sensory areas as well as the visual cortex. The most relevant research, however, is that of Krech and his colleagues at the University of California. In their earliest studies, the authors (Krech, Rosenzweig, and Bennett, 1960; Rosenzweig, Krech, and Bennett, 1962; Rosenzweig, Krech, Bennett, and Diamond, 1962;

Bennett, Diamond, Krech, and Rosenzweig, 1964) demonstrated that sighted rats raised in an enriched environment possessed a greater weight and depth of the cerebral cortex, a greater total cholinesterase activity throughout the brain, and a lower cortical to subcortical ratio of activity per unit weight than did sighted rats reared in an isolated environment.

In two follow-up experiments, Krech et al. (1963), studied the effects of peripheral blinding on the cerebral cortex of rats reared in both a complex and isolated environment. The enriched environment involved animals housed in groups of about ten in large hardware cloth cages provided with toys. Except for the first few days after enucleation, blind and sighted littermates lived in the same cage. Every day the enriched animals were put in a Hebb-Williams maze, with the pattern of barriers changed daily. At about 55 days of age, they were trained successively in the Lashley III maze, the Dashiell maze and the Krech Hypothesis Apparatus. The isolated animals were housed individually in cages with solid walls, and they received a minimum of environmental stimulation and handling. The authors reported that rats blinded at the age of 25 days but raised in an otherwise complex environment for 80 days, showed no significant change in the weight of the visual cortex but a significant increase in the weight of the somesthetic cortex relative to sighted rats raised in the same complex environment. No such differences were found between blinded and sighted rats raised individually in cages and receiving a minimum of environmental stimulation and handling.

Bennett, Diamond, Krech, and Rosenzweig (1964) have also reported that dark-rearing of rats for a period of 80 days produced anatomical changes similar in direction but generally smaller in magnitude than those following blinding.

In interpreting these results, Krech et al. (1963), suggest that the "relatively greater development of the somesthetic cortex among the blinded animals might be a consequence of compensation for loss of sight by greater employment of other sensory modalities. We presume that the blinded animals met the demands of the environment by greater reliance on somesthetic information than did their sighted brothers." Greater neural activity of the somesthetic cortex would then lead to "growth of structure."

Although this interpretation may account for Krech's animal data, it does not account for the increased tactual acuity of visually deprived humans (Zubek, Flye, and Aftanas, 1964; Zubek, Flye and Willows, 1964) since the subjects, who were all university students, received less tactile experience during darkness than they did normally in the course of their studies and other daily activities. Similarly, it does not offer an explanation of the increase in auditory discrimination of humans subjected to darkness for one week (Duda and Zubek, 1965). An alternative and more general explanation which may encompass both the animal and human data, is that the effects of visual deprivation are mediated by the diffuse reticular activating system as indicated in Schultz' (1965) sensoristatic model. This theoretical formulation would predict changes in the activity of both the somesthetic and auditory cortex following visual deprivation.

In addition to this research of Krech and his colleagues, a number of other studies have been concerned with the anatomical and physiological effects of visual deprivation. These results, however, are concerned solely with the effects on the visual system itself rather than on the other sensory modalities.

For example, Hess (1958), studying the cortex of fetal guinea pigs after unilateral eye removal, noted a reduction in fibres in the striate cortex and a loss of cell bodies in the superior colliculus receiving fibres from the deafferentated eye. Similarly, Wiesel and Hubel (1963b), working with infant cats deprived of vision in one eye by the use of occluders, reported that a great majority of cortical cells were actively driven by the non-deprived eye, although normally most of the cells would be dominated by the contralateral or deprived eye. In addition, the cortical potentials evoked from stimulation of the occluded eye showed an initial positive component but the later negative wave, prominent from the normal eye, was almost completely lacking.

Coleman (1966) has reported that cats raised in the dark possessed fewer and shorter dendrites than normally reared cats. In addition, the dendrites of individual cells were less intermingled in the experimental animals.

Similar morphological or degenerative changes following visual deprivation or enucleation have been noted at the retinal (Weiskrantz, 1958; Brattgard, 1952; Chow, Riesen and Newell, 1957; Riesen, 1950, 1960) and geniculate levels (Wiesel and Hubel, 1963a; Polyak, 1957; Cook, Walker, and Barr, 1951; Lindner, and Umrath, 1955; Clark, 1932, 1942; Hess, 1958).

Thus, the work at the Manitoba laboratory on prolonged visual deprivation showing an increase in tactual acuity would suggest that perhaps the compensatory increase in the weight of the somesthetic cortex after dark-rearing of rats may occur in the absence of enriched environmental stimulation and handling. In addition, two lines of indirect evidence suggest that a similar increase may also occur in the weight of the auditory cortex. First, Walter (1963) has reported that in some congenitally blind children, the cortical responses evoked by auditory and tactile stimuli were much larger than those of sighted children of the same age. Second, the studies on prolonged visual deprivation of humans have showed an increase in auditory discrimination.

CHAPTER II

EXPERIMENTAL METHOD AND RESULTS

Experiment 1

I. Subjects:

The Ss were thirty-two albino and thirty-two hooded male littermate rats purchased at day of weaning from the Woodlyn Farms (Guelph, Ontario) and the Quebec Breeding Farms (St. Eustache, Quebec) respectively.

II. Procedure:

At weaning (approximately 22 days of age) the rats of each strain were divided into a control group and a dark-reared experimental group, resulting in four treatment groups, hooded controls, hooded dark-reared, albino controls, and albino dark-reared. Each group consisted of 16 animals. The control animals were raised under a normal light-dark cycle alternating every 12 hours, for an 80 day period. The ambient illumination in the light room was approximately 60 foot-candles. The dark-reared groups were raised for 80 days in a room with black cloth and masking paper around the entrance to ensure a condition of constant darkness. All feeding and cleaning was done for approximately ten minutes per day under a commercially purchased dim 10 watt red light bulb (General Electric, coated, 115 volts, 10 watts). All animals were reared in groups of eight per cage and received an ad lib supply of food and water. The experimental and control groups were not run at the same time but were separated by an interval of approximately three months.

After 80 days of the experimental or control treatment, all rats were killed with ether and the results analyzed under code numbers that did not reveal their behavioral group. Upon removal of the calvarium and dura mater, the demarcation of the visual and somesthetic sample in each hemisphere (see Fig. 1) was done with the aid of a plastic T-square as described by Krech et al. (1963). The auditory sample (see Fig. 2) was located with the aid of the evoked potential maps of Zubek (1951).

The samples were removed from the exposed brain with the use of hollow "core-drill" tubes with an inside diameter of 5/32" for the visual area and 4/32" for the auditory and somesthetic areas. The outer wall of the copper tubing employed was sharpened to facilitate penetration. The tube was inserted in the soft cortical tissue by slowly rotating it until the underlying layer of white matter was reached. Cortical matter surrounding the tube was then peeled away and a section lifter, inserted under the tube, separated the cortical sample from the callossum. The sample was then removed from the tube with a dissecting needle and weighed on a Sartorius chemical balance (model 2-463/2604), sensitive to .001 mg. The weight of a particular sample from the sensory cortex of the two hemispheres was totalled for each rat for analysis. The operative procedure of this study was somewhat different than the procedure employed by Krech and his colleagues, which involved circumscribing and removing the cortical samples with the aid of a scalpel.

III. Results:

Table 1 shows the weight of the somesthetic, visual and auditory cortex in the experimental and control animals of both strains.

It is interesting to note that the hooded animals subjected to visual deprivation showed a lighter somesthetic cortex than did the

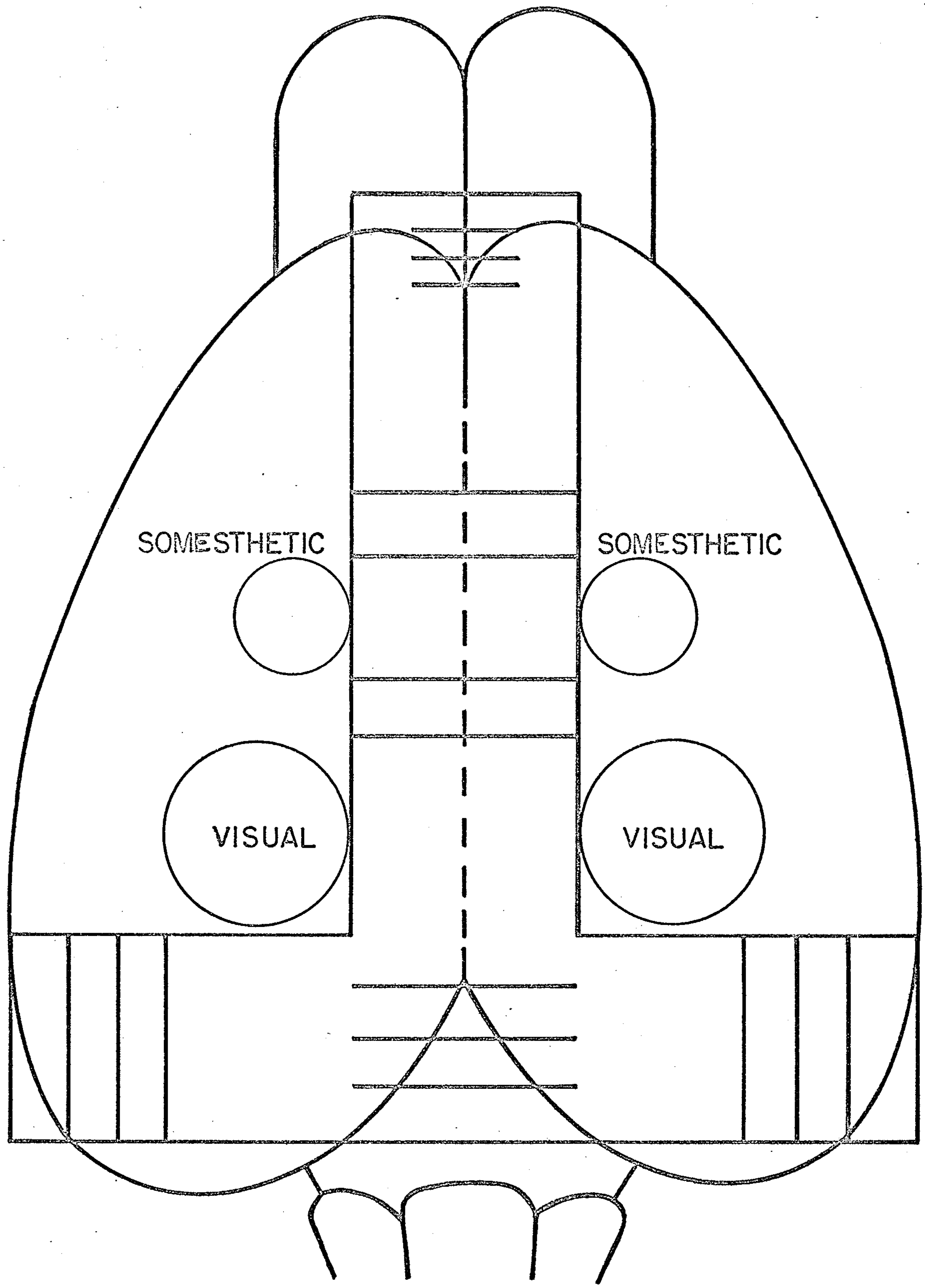

Figure 1. Somesthetic and visual localization.

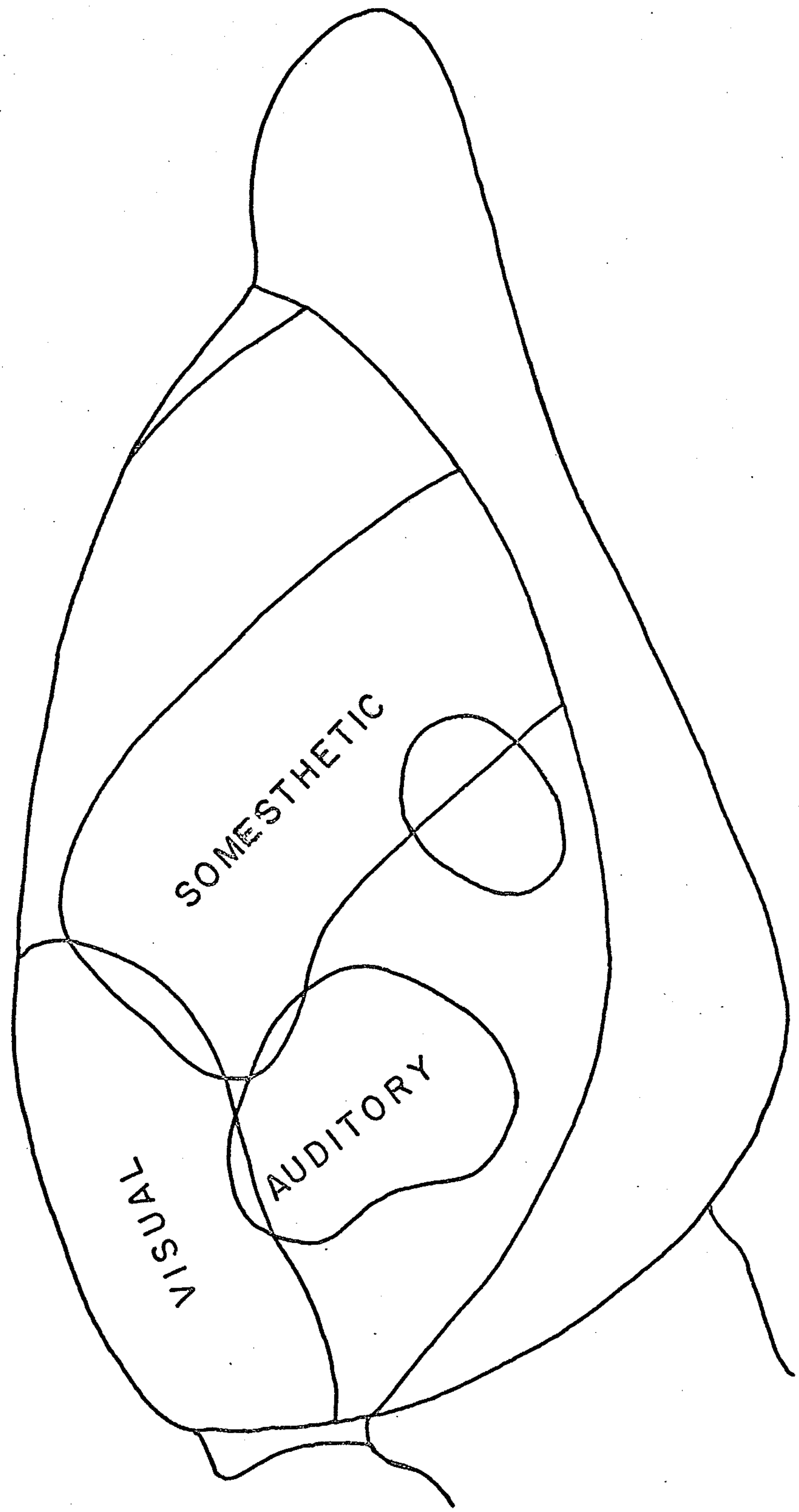

Figure 2. Auditory localization.

TABLE I

WEIGHTS OF CORTICAL SAMPLES (MILLIGRAMS) FOR TWO STRAINS OF EXPERIMENTAL AND CONTROL ANIMALS

Group		Hooded Rats			Albino Rats		
		Somesthetic	Visual	Auditory	Somesthetic	Visual	Auditory
Experimentals	Mean	20.44	22.82	17.98	20.05	22.66	20.09
	S.D.	3.26	3.60	3.32	5.17	5.55	3.17
Controls	Mean	22.12	21.67	19.94	23.84	23.84	23.84
	S.D.	2.12	1.91	2.06	3.57	3.06	3.03
p, exp. vs. cont.		NS	NS	NS	$p < .05$	NS	$p < .01$

control animals. A similar trend for a lighter auditory cortex was also indicated. A type I mixed analysis of variance (Lindquist, 1953) indicated, however, that none of these differences were significant ($F = 1.24$, df = 1/26). A similar trend for a lighter sensory cortex following visual deprivation was observed in the albino rats as well. These differences, however, were significant for the somesthetic ($F = 4.74$, df = 1/26, $p < .05$) and auditory ($F = 9.52$, df = 1/26, $p < .01$) areas, but not for the visual cortex ($F < 1.0$, df = 1/26).

Experiment 2

Since no evidence was obtained for an increase in the weight of the sensory cortex, the entire procedure was repeated but with all animals being exposed to an enriched somesthetic environment similar to that employed by Krech et al. (1963).

I. Subjects:

As in Experiment 1, thirty-two albino and thirty-two hooded male rats were employed.

II. Procedure:

The procedure employed was similar to that of Experiment 1 with an experimental and control group for both the albino and hooded strains. Each group consisted of 16 animals. In addition, however, all rats received daily experience on the Hebb-Williams maze and considerable handling by the experimenter. The pattern of barriers on the Hebb-Williams maze was changed daily. The animals were reared for 80 days in groups of eight in large cages which contained assorted wooden and metal toys. The analysis of cortical weights was performed as in Experiment 1.

III. Results:

Table II shows the weight of the somesthetic, visual and auditory cortex in the experimental and control animals.

Once again the results indicated that visually deprived animals of the hooded strain showed a lighter cortex in all areas sampled. An analysis of the data (Type I mixed design; Lindquist, 1953), however, revealed that none of the differences between the experimental and control animals were significant ($F = 1.29$, $df = 1/26$). A similar trend for a lighter cortex in all sensory areas was observed for the albino rats as well. An analysis of the data, however, revealed that none of these differences were significant ($F = 4.00$, $df = 1/26$).

It is interesting to note that the results of both Experiment 1 and Experiment 2 showed a trend for dark-reared animals to possess a lighter somesthetic and auditory cortex. The difference between

TABLE II

WEIGHTS OF CORTICAL SAMPLES (MILLIGRAMS) FOR TWO STRAINS OF EXPERIMENTAL AND CONTROL ANIMALS

Group		Hooded Rats			Albino Rats		
		Somesthetic	Visual	Auditory	Somesthetic	Visual	Auditory
Experimental	Mean	23.61	22.77	19.29	23.41	23.64	20.30
	S.D.	1.75	4.00	2.78	2.43	2.63	3.39
Controls	Mean	23.76	24.25	21.05	25.21	25.49	22.18
	S.D.	3.19	3.13	2.04	3.02	1.51	2.67
p, exp. vs. cont.		NS	NS	NS	NS	NS	NS

experimental and control animals was less in Experiment 2, however, particularly for the albino strain.

Table III summarizes the data when pooled over the two experiments and strains. It can again be seen that the dark-reared animals possess a lighter somesthetic and auditory cortex than do the control animals.

A type I mixed analysis of the data (Lindquist, 1953) revealed that the differences were significant for the somesthetic ($F = 7.70$, $df = 1/110$, $p < .01$) and auditory ($F = 15.70$, $df = 1/110$, $p < .01$) areas but not for the visual cortex ($F = 1.55$, $df = 1/110$).

In Table IV is shown a comparison between the animals receiving no enriched somesthetic experience (Experiment 1) and those reared for 80 days under a condition of daily maze experience and handling (Experiment 2). It can be seen that enhancing the somesthetic environment

TABLE III

MEAN WEIGHTS OF CORTICAL SAMPLES (MILLIGRAMS) FOR EXPERIMENTAL AND CONTROL ANIMALS WHEN COMBINED OVER EXPERIMENTS AND STRAINS

Group		Somesthetic	Visual	Auditory
Experimentals	Mean	21.88	22.97	19.41
	S.D.	3.78	4.10	3.30
Controls	Mean	23.73	23.81	21.75
	S.D.	3.21	2.86	2.87
p, exp. vs. cont.		$p < .01$	NS	$p < .01$

TABLE IV

A COMPARISON OF THE CORTICAL WEIGHTS (MILLIGRAMS) OF ANIMALS REARED IN AN IMPOVERISHED OR ENRICHED SOMESTHETIC ENVIRONMENT

Group		Somesthetic	Visual	Auditory
Experiment 1 (Impoverished Envt.)	Mean	21.61	22.75	20.46
	S.D.	3.99	3.84	3.62
Experiment 2 (Enriched Envt.)	Mean	23.99	24.04	20.71
	S.D.	2.75	3.12	2.96
p, Exp. 1 vs. Exp. 2		$p < .01$	NS	NS

produces an increase in the weight of all three sensory areas. A statistical analysis of the data (Type I mixed design; Lindquist, 1953), however, revealed that this increase in weight was significant only for the somesthetic cortex ($F = 13.32$, $df = 1/110$, $p < .01$) and not for the visual ($F = 3.76$, $df = 1/110$) and auditory ($F < 1.0$, $df = 1/110$) areas.

An analysis of the cortical weights in terms of unit of body weight revealed essentially similar results since none of the differences in body weight between experimental and control animals were significant.

CHAPTER III

DISCUSSION OF RESULTS

The results of the first experiment indicated that visually deprived animals reared under a condition of minimal somesthetic experience possessed a lighter somesthetic and auditory cortex than did the control animals. Although this decrease in weight was not statistically significant for the hooded rats, it was for the albino strain. A similar pattern of results was also obtained in the second experiment in which the animals received considerable somesthetic stimulation involving daily handling and training on the Hebb-Williams maze. However, the decrease in weight of the somesthetic and auditory cortex was not significant for either the hooded or albino strain. No significant changes in the visual cortex were obtained in either experiment although a trend toward a decrease in weight was observed, particularly in the second study.

The presence of a strain difference in the first experiment, although unexpected, is not too surprising in view of certain anatomical and behavioral differences between hooded and albino strains. For example, Lund (1965) and Sheridan and Shrout (1965) reported an increased number of uncrossed visual fibers in the optic chiasma of hooded rats, a finding which suggests that visually, the hooded rat is more advanced than the albino. A difference also exists in the visual behavior of albino and hooded rats. Lockard (1963) compared the light-dark preference of pigmented Long Evans hooded rats with Sprague-Dawley albinos and found that the hooded rats were much less light aversive than the pink-eyed albinos. Although strain differences in cortical weights might therefore, be expected, it is puzzling that the difference should only appear in the first but not in the second study. This would tend to suggest a possible interaction between strain and type of environmental rearing.

The failure to demonstrate an increase in the weight of the somesthetic cortex under impoverished environmental conditions is understandable since Krech et al. (1963), found that this effect only occurred in visually deprived animals raised in a complex environment and not in those reared in an isolated environment. However, the absence of an increase in the weight of the somesthetic cortex in the second experiment, involving an enriched environmental experience is puzzling. Two procedural differences may account for these apparently contradictory results. The first pertains to the operative technique. Krech and his colleagues circumscribed the boundaries of each cortical section with a scalpel as delimited by a plastic T-square, and then peeled the tissue free from the underlying white matter. Although the use of hollow "core-drill" tubes in this study gave a greater assurance of a constant sample size throughout the experiments, it resulted in smaller cortical samples than were obtained by Krech. The employment of larger samples possibly would increase the probability of detecting any increases in weight. Both techniques, however, are limited in the sense that any observed changes in weight would only reflect changes in depth or density of the cortex.

Perhaps the most important consideration is Krech's use of a more complex somesthetic environment. For the first thirty days the animals were placed daily in the Hebb-Williams maze, and subsequently, for fifty days, they were trained successively in the Lashley III maze, the Dashiel maze, and the Krech Hypothesis Apparatus. Since in the present experiment only the Hebb-Williams maze was employed, it is possible that this somesthetic effect may only occur after a prolonged exposure to a heightened somesthetic environment of a complex and variable nature. A similar explanation may account for the absence of an increased weight of the auditory cortex. The animals in both experiments only received a normal amount of auditory experience.

Clear evidence for the importance of the somesthetic environment in producing anatomical changes is seen when a comparison is made of the weight of the three sensory areas in animals who were subdivided on the basis of rearing in either an enriched or impoverished somesthetic environment. A significant increase in the weight of the somesthetic cortex was present in the animals who were exposed to the enriched somesthetic environment. The auditory and visual cortex also showed an increase but the results were not significant. Essentially similar results have been reported by Krech and his colleagues who also obtained an increase in the weight of the sensory cortex following enriched environmental stimulation. Sighted rats reared in a complex visual and somesthetic environment possessed a heavier visual and somesthetic cortex than did sighted rats reared in an impoverished environment (Krech et al., 1963; Bennett et al., 1964).

Although there appears to be a discrepancy on the effects of visual deprivation, the present results do confirm Krech's finding that an increase in the weight of the sensory cortex can occur following enriched environmental stimulation.

Several suggestions for future research have resulted from this study. First, it might be profitable to repeat the above procedure while employing a more complex somesthetic environment in order to assess the degree of environmental stimulation necessary for compensatory weight changes to occur. Second, certain sensory measures could be included to narrow the gap between the animal studies and the human research on prolonged visual deprivation. Finally, the experimental procedure could be repeated but using animals who were reared in a complex auditory environment.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Several studies at the University of California have reported a compensatory increase in the weight of the somesthetic cortex of enucleated or dark-reared rats who received considerable environmental stimulation and handling. The purpose of this study was: (a) to determine whether this compensatory increase after dark-rearing would occur in the absence of enriched environmental stimulation and handling and (b) to determine whether a similar increase in the weight of the auditory cortex could be demonstrated after prolonged visual deprivation.

In Experiment 1, thirty-two albino and thirty-two hooded rats were each randomly divided into a control group and a dark-reared experimental group at approximately 22 days of age. They were subsequently reared in groups of eight per cage in either a dark-room or under normal light-dark conditions. After 80 days of the experimental or control condition, all rats were killed and the weights of a sample of the auditory, visual and somesthetic cortex were determined. The results indicated that dark-reared animals possessed a lighter somesthetic and auditory cortex than did the control animals. Although this decrease in weight was not significant for the hooded rats, it was for the albino strain.

In Experiment 2, an identical procedure was followed except that all animals were reared in an enriched somesthetic environment involving handling and daily experience on the Hebb-Williams maze. Once again, the results indicated that dark-rearing produced a lighter weight of the sensory cortex in all areas sampled, and in both strains. None of the results, however, were significant.

A final comparison between those animals raised in an impoverished environment (Experiment 1) and those reared in an enriched somesthetic environment (Experiment 2) indicated that enhancing the somesthetic environment of animals resulted in an increase in weight of the somesthetic cortex. Although a similar increase in weight was observed in the auditory and visual cortex, these differences were not significant.

The results suggest that neither the presence nor the absence of enriched environmental stimulation and handling can produce an increase in the weight of the sensory cortex of visually deprived animals. Two procedural differences are offered as a possible explanation of the failure to demonstrate an increase in the weight of the somesthetic cortex of dark-reared animals. First, differences in operative procedure between this study and the California research were discussed. A more important consideration is the use of a more complex somesthetic environment in the California studies. In addition to the Hebb-Williams maze, Krech and his colleagues trained their animals on the Lashley III maze, the Dashiell maze, and the Krech Hypothesis Apparatus. Since in the present study only the Hebb-Williams maze was used, it is possible that an increase in the weight of the somesthetic cortex may only occur after a prolonged exposure to a heightened somesthetic environment of a complex and variable nature.

Although the effects of visual deprivation appear to yield inconsistent results, the present study does confirm the California finding that an increase in the weight of the sensory cortex can occur in animals reared in an enhanced environment relative to those reared in an impoverished environment.

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APPENDIX

APPENDIX - RAW DATA

EXPERIMENT I

Hooded Experimentals					Hooded Controls				
Rat No.	Cortical Weights Som.	Vis.	Aud.	Body Weight gms	Rat No.	Cortical Weights Som.	Vis.	Aud.	Body Weight gms
1	15.24	21.15	11.59	280	1	23.81	21.92	22.52	305
2	16.63	20.75	13.42	298	2	21.37	20.43	20.69	280
3	18.20	21.79	13.53	315	3	25.87	20.60	18.75	300
4	16.43	20.99	16.40	310	4	20.37	20.44	18.48	270
5	22.09	26.12	15.84	300	5	24.47	21.47	19.99	285
6	22.48	17.36	18.50	290	6	21.15	26.51	19.36	260
7	21.65	26.89	19.92	300	7	20.29	19.13	17.14	300
8	16.10	24.30	22.38	230	8	17.75	22.76	20.55	300
9	25.74	20.97	22.13	225	9	20.11	21.80	23.53	270
10	20.80	30.43	20.96	250	10	23.92	23.19	21.93	370
11	25.08	16.53	21.96	310	11	24.17	22.12	16.20	310
12	23.23	25.84	18.08	263	12	22.14	19.65	20.11	330
13	21.66	23.05	18.58	240	13	23.16	23.77	22.06	370
14	20.77	23.24	18.43	278	14	21.04	19.52	17.79	350
15	18.81	21.02	16.32	380	15	21.06	20.71	18.91	270
16	22.07	24.62	19.64	410	16	23.18	20.63	20.97	310

EXPERIMENT I (Continued)

Albino Experimentals					Albino Controls				
Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms	Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms
1	17.53	19.61	16.01	410	1	27.86	28.69	26.17	320
2	10.71	14.32	18.28	290	2	26.73	27.53	27.19	330
3	16.27	24.77	15.64	350	3	30.70	28.82	28.96	340
4	20.72	21.04	19.61	380	4	21.36	22.00	23.12	330
5	14.31	11.27	16.54	360	5	24.65	25.38	23.48	420
6	20.45	20.32	20.18	350	6	22.33	22.99	21.52	340
7	20.89	22.53	18.18	260	7	23.39	24.09	23.46	380
8	23.81	32.68	24.02	325	8	20.26	20.87	20.32	400
9	24.90	21.07	17.07	280	9	20.25	20.16	22.11	325
10	23.67	24.86	22.21	360	10	17.98	19.51	19.84	290
11	32.80	23.53	21.97	305	11	24.26	25.02	23.84	380
12	16.00	21.78	22.38	255	12	20.18	20.78	19.16	340
13	18.81	29.78	26.36	360	13	28.44	26.29	28.36	320
14	19.84	29.72	22.80	360	14	25.39	21.62	26.26	350
15	17.47	19.89	18.50	380	15	25.63	22.31	25.36	280
16	22.63	25.43	21.08	310	16	22.05	25.37	22.32	320

EXPERIMENT II

Hooded Experimentals					Hooded Controls				
Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms	Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms
1	26.71	34.08	19.74	325	1	23.74	24.64	20.89	310
2	21.47	19.66	16.95	385	2	23.56	25.44	20.73	300
3	22.68	20.94	16.14	305	3	28.86	29.17	25.40	280
4	25.05	19.89	20.20	280	4	22.93	24.76	20.18	270
5	22.39	20.91	19.25	265	5	27.46	29.66	24.16	260
6	21.93	21.79	20.69	285	6	23.94	25.86	21.07	290
7	21.82	18.68	16.33	400	7	22.37	21.16	19.69	290
8	22.77	20.27	13.76	275	8	24.78	22.76	21.81	260
9	26.10	25.93	25.46	330	9	21.28	22.98	18.73	330
10	22.16	20.48	20.23	310	10	15.62	16.19	18.19	350
11	26.62	27.72	22.58	350	11	28.42	24.69	22.44	310
12	23.59	22.95	20.23	290	12	21.85	23.59	19.23	260
13	23.92	20.86	19.32	275	13	24.19	24.68	19.16	290
14	23.29	24.67	19.18	265	14	23.59	23.96	23.04	280
15	24.49	24.78	20.68	290	15	22.16	25.82	20.03	330
16	22.73	20.76	17.90	275	16	25.36	22.88	22.07	360

EXPERIMENT II (Continued)

Albino Experimentals					Albino Controls				
Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms	Rat No.	Cortical Weight Som.	Vis.	Aud.	Body Weight gms
1	20.33	22.21	18.36	320	1	34.03	26.92	29.94	320
2	23.54	26.09	17.49	370	2	24.17	27.96	21.27	330
3	23.12	25.83	18.86	395	3	24.45	25.16	21.52	380
4	20.37	20.89	14.57	350	4	24.20	25.19	21.30	400
5	25.32	24.04	22.67	360	5	26.30	27.12	23.14	290
6	27.10	23.17	23.32	440	6	24.38	27.18	21.45	370
7	23.00	22.28	20.18	370	7	25.54	24.69	22.48	310
8	24.22	23.39	22.62	340	8	25.00	24.19	22.06	400
9	23.53	23.23	23.47	360	9	19.54	23.53	17.19	360
10	23.72	24.89	19.66	410	10	25.45	24.16	22.39	350
11	21.61	24.66	19.86	400	11	22.42	23.12	19.73	340
12	19.70	16.53	13.71	350	12	26.99	27.06	23.75	280
13	28.79	26.96	25.61	400	13	26.19	24.26	23.27	380
14	23.36	26.79	23.78	400	14	24.23	26.32	21.09	360
15	24.63	24.96	22.00	320	15	26.72	26.25	23.52	410
16	22.19	22.32	18.60	360	16	23.70	24.73	20.84	390