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THE EFFECT OF SHORT-TERM DEPRIVATION ON THE TACHISTOSCOPIC RECOGNITION THRESHOLD

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The Effect of Short-Term Deprivation on the Tachistoscopic Recognition Threshold

by

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In two short-duration studies it has been reported that either a 5 or a 50 minute period of sensory restriction, involving a reduction in visual, auditory, and kinesthetic stimulation, can result in a lowering of the tachistoscopic recognition threshold. The purpose of this thesis is to determine whether a similar facilitatory effect can occur after the deprivation of only one modality.

Ninety male subjects were divided into six groups, each containing 15 subjects. Two of the groups were control subjects while the remaining four were exposed to 5 minutes of either perceptual deprivation, visual deprivation, auditory deprivation, or kinesthetic deprivation.

The visual recognition threshold for each subject was determined immediately before, and two minutes after the five minute deprivation or control period by presenting, one at a time, eight randomly constructed five-digit numbers, composed of the integers 1, 4, 6, 7, and 9.

An analysis of the pre-post difference scores indicated that none of the resulting increases in sensitivity in the four experimental groups were significantly different relative to the two control groups. The discrepancy between the results of this study and those reported in the literature are explainable in terms of the procedural improvements made in this study.

CHAPTER I

THE PROBLEM, INTRODUCTION, AND HISTORICAL BACKGROUND

I. Statement of the Problem

Two short-duration studies (Friel & Derogatis, 1965; Rosenbaum, Dobie, & Cohen, 1959) have demonstrated that either a 5 or a 50 minute period of sensory restriction, involving a reduction in visual, auditory, and kinesthetic stimulation, can result in a lowering of the tachistoscopic recognition threshold. The purpose of this thesis is to determine whether a similar facilitatory phenomenon can occur after the deprivation of only one modality. Such an effect might be expected since it has been shown that many of the facilitatory changes reported after long durations of sensory restriction can occur after visual deprivation alone.

II. Introduction

The first experimental work on sensory restriction was initiated at McGill University in the early 1950's (Bexton, Heron, & Scott, 1954). Since this pioneer research, considerable interest has been shown by investigators from various disciplines in the psychological and physiological effects of a reduction in the level and variability of sensory stimulation. Furthermore, many different procedures have been employed to reduce sensory input. These procedures are customarily divided into two main categories: sensory deprivation and perceptual deprivation, a two-fold classification first advocated by Kubzansky (1961).

In sensory deprivation, an attempt is made to reduce the level of sensory input to as low a degree as possible, this condition being achieved by requiring the subject to lie or sit quietly in a dark and silent environment. Perceptual deprivation, on the other hand, involves a reduction in the patterning and meaningfulness of sensory stimulation while maintaining the level of input near normal. This is accomplished by providing a constant masking sound (white noise or hum of a fan), covering the eyes with translucent goggles or a white mask which permits diffuse light but eliminates pattern vision, and requiring a minimum of movement from the subject. In the studies employing these two general approaches, the duration of sensory restriction has ranged from 5 minutes to 14 days, the most common periods being either 8 hours or 1, 3, and 7 days.

Since the early McGill studies, research on the effects of sensory and perceptual deprivation has involved the measurement of a wide range of physiological and behavioral processes (see reviews of Schultz, 1965; Zubek, 1964b). The physiological studies have included measures of EEG activity, skin resistance, muscle potential, respiration, blood pressure, basal metabolic rate, and urinary excretion of adrenaline and noradrenaline. The results have indicated a progressive slowing of EEG activity and a decrease in skin resistance (greater arousal) with increasing durations of sensory restriction. In contrast to these positive findings, none of the other physiological measures appear to be affected.

In the study of behavioral changes, a variety of cognitive abilities have been appraised. The measurements largely involve subtests of standard I.Q. tests or tests of primary mental abilities. These have yielded a differential pattern of results e.g., space relations, number facility, and abstract reasoning are impaired whereas digit span, rote learning, recall, and verbal reasoning are unaffected by sensory restriction. An even more complex pattern of results has been revealed in studies employing measures of various sensory and perceptual-motor processes. These investigations have shown that such performance tasks as depth perception, the constancies, brightness discrimination, and c.f.f. are unaffected by deprivation while color perception, different types of illusions, and reaction time are considerably impaired. Certain other measures, surprisingly, have shown a facilitatory effect or improvement after prolonged periods of sensory restriction e.g., tactual acuity, pain sensitivity, taste sensitivity, auditory vigilance, and tachistoscopic acuity.

Although no satisfactory explanation of these perplexing facilitatory phenomena is available, it has been suggested that an essential condition for their appearance is a severe reduction in sensory stimulation from several modalities. Recently, however, a series of studies from the University of Manitoba has demonstrated that similar effects can be produced by visual deprivation alone. Employing a one week period of darkness, significant increases in cutaneous sensitivity, taste sensitivity, and auditory discrimination were observed. Furthermore, these changes persisted for several days after restoration of normal visual stimulation. Unfortunately, no other single modalities were studied to determine whether they would be equally as effective as visual deprivation.

Although facilitatory effects have been demonstrated most clearly after prolonged periods of sensory and perceptual deprivation (1 to 7 days), a handful of short-term studies, employing durations under one hour, have also reported an improvement in performance: a lowered tachistoscopic recognition threshold for words and digits and an increase in pain and auditory sensitivity. However, since no attempts have been made to determine whether these short-term effects can also result from single modality deprivation, further research appears to be warranted. In view of this, the present study was designed to investigate changes in recognition thresholds before and after a brief duration of not only perceptual deprivation but also of visual, auditory, and kinesthetic deprivation alone.

III. Historical Background

Since a voluminous literature exists on the behavioral and physiological effects of sensory restriction (see review of Schultz, 1965; Zubek, 1964b), this historical review will be restricted largely to sensory and perceptual studies reporting facilitatory changes after both multi and single modality deprivation. For organizational purposes, the review will be presented in two sections: the first describing long-duration studies of one day or longer and the second, short-duration studies employing periods of less than a day. In describing the various experiments, a differentiation will be made between sensory and perceptual deprivation as defined in the introduction.

Long-Duration Studies

Multi-modality deprivation. The earliest demonstration of a sensory improvement was made in one of the McGill experiments (Doane et al., 1959) in which two-point threshold determinations were taken from five subjects before,and at intervals of two and three days of perceptual deprivation. A group of 20 controls was used for comparative purposes. The results revealed an increase in tactual acuity of the forehead and upper arm at both time intervals, an effect whichwas significantly greater relative to that of the controls. Furthermore, these facilitatory effects were greater after two days than after three days. No significant changes in acuity were seen on the finger and forearm. Although these two negative results might be attributed to the smallness of the experimental sample, another possibility, at least for the finger, is that the two-point limen technique is not sufficiently accurate to demonstrate increased sensitivity in an area of the skin which normally is highly sensitive.

Using a more sensitive measure of tactual acuity (tactual fusion) Zubek (1964a) reported a significant increase in acuity of both the index finger and forearm after a week of perceptual deprivation. All 12 experimental subjects showed increased forearm acuity, and 11 of the 12 subjects an increased finger acuity on the second threshold determination. In comparison, the controls exhibited a chance distribution of increases and decreases. Similar results have also been demonstrated at a Japanese laboratory after two days of perceptual deprivation. Nagatsuka and Maruyama (1963) reported a significant increase in the tactual acuity of the back of the hand (two-point limen). It is interesting to note that eight of the nine experimental subjects showed the effect. Experimental verification of this phenomenon was provided in a subsequent replication (Nagatsuka & Suzuki, 1964).

An increased sensitivity to pain can also occur but apparently only under conditions of sensory deprivation. Vernon and McGill (1961), measuring the absolute threshold of electrical pain of the earlobe, reported a 42 per cent increase in pain sensitivity after four days of sensory deprivation in contrast to an increase of only 5 per cent in a group of controls. Of the nine experimental subjects, all but one showed this change. In discussing these results in a subsequent publication, Vernon (1963) raised two intriguing questions. First, since a 42 per cent increase was obtained after four days, would one day yield a 10 per cent change? Second, would longer periods lead to an even greater increase in sensitivity? Although a linear increase in pain sensitivity may occur with increasing durations, a more likely possibility is that the greatest increase will occur early in the deprivation period and subsequently diminish with time. Some support for this hypothesis has been provided by Doane et al. (1959), who observed a greater increase in tactual acuity after two days than after three.

Contrary results on pain sensitivity were reported by Zubek et al. (1962), who, using a one week period of perceptual deprivation and a radiant heat technique for eliciting pricking pain, reported a significant decrease in sensitivity. Although this discrepancy might be attributed to the use of a seven-day rather than a four-day period, this appears unlikely since in two subsequent studies at the Manitoba laboratory, using seven days of visual deprivation alone, a significant increase in pain sensitivity was observed (Zubek, Flye, & Aftanas, 1964; Zubek, Flye, & Willows, 1964). A more likely possibility is that this decrease, occurring after perceptual deprivation, resulted from the constant exposure to white noise. Both Gardner and Licklider (1959) and Carlin et al. (1962) have reported that white noise has certain analgesic properties. Furthermore, Licklider (1961) has stated that "Mountcastle has found cells, both in the posterior group nuclei and in the cerebral cortex, which respond to nociceptive stimulation and whose responses are suppressed by acoustic stimulation" (p. 70). It would appear, therefore, that the presence or absence of white noise may be the critical factor. Furthermore, these findings suggest that qualitatively different results may be produced by sensory and perceptual deprivation.

Since significant improvements on various cutaneous measures of performance have been reported, one might expect similar facilitatory effects in other sensory modalities. This appears to be the case. In a study on gustatory sensitivity, the Japanese investigator Nagatsuka (1965) reported a 36 per cent increase in sensitivity to both sweet (sucrose) and bitter (quinine) after one day of perceptual deprivation in contrast to no change in a group of controls. Measures of sensitivity to sour and salty substances, unfortunately, were not taken.

A suggestion of an improvement in visual functioning has also been reported. Doane et al. (1959) appraised visual acuity by means of a horizontal row of 14 vertical black lines (the "lines" test), with each line in the series possessing a small gap of progressively decreasing width. The lines were presented at a distance of 10 feet and the subject was required to indicate where the gap was in each line. The experimental subjects showed an increase in visual acuity after three days of perceptual deprivation in contrast to no change in controls who also received the same test three days apart. Although the results only bordered on statistical significance, the investigators attached considerable weight to this finding in view of a significant increase in tactual acuity present in the same subjects.

In this same study, an appraisal was also made of tachistoscopic perception of a series of black nonsense forms (outlines) presented one at a time on a white screen for approximately 50 msecs. A recognition method of testing was used. No significant changes were observed. The failure of Doane et al. (1959) to demonstrate a significant improvement on either the "lines" test or on nonsense forms, after three days of perceptual deprivation, is puzzling since Suzuki, Ueno, and Tada (1966) recently reported a significant lowering of the tachistoscopic threshold for the Landolt ring after only one day of perceptual deprivation. One possible explanation of this discrepancy is that a significant lowering of the threshold may have occurred in the Doane et al. study if their two measures had been administered after one day rather than after three days when most of the effects may have dissipated.

Finally, an improvement in auditory functioning has also been reported. Smith, Myers, and Murphy (1967) observed a superior performance on an auditory vigilance task after three days of sensory deprivation. Similar results were obtained in a replication study. In these two studies a total of 59 experimental and 76 control subjects were used, a sample much larger than is customarily employed in sensory restriction experiments. In the only other study on auditory vigilance, Zubek et al. (1961) reported no significant changes on this measure after a week of sensory deprivation. This apparent discrepancy in results probably can be attributed to the difference in duration. Various studies (e.g., Doane et al., 1959; Vernon et al., 1961) have indicated that performance on various perceptual measures is often affected more by short than by prolonged durations of deprivation, suggesting a recovery of function with time.

Single-modality deprivation. In the preceding section it has been shown that prolonged durations of sensory and perceptual deprivation can produce a significant improvement in cutaneous, gustatory, visual, and auditory functioning. Recently, five experiments from the Manitoba laboratory have indicated that many of these facilitatory effects can result from visual deprivation alone. An overall reduction in sensory stimulation from several modalities is not essential.

In the first study (Zubek, Flye, & Aftanas, 1964) 16 male subjects were placed, in groups of two, in total darkness for a prescribed period of one week. Apart from the exposure to constant darkness, their environment was quite normal i.e., no gloves were worn and no restrictions were placed on their motor activity or on talking. A radio was available in the room at all times. Measures of tactual acuity were taken from the index finger, palm, and forearm before and immediately after the week of darkness, and subsequently at follow-up intervals of 1, 2, 5, and 7 days. The measures consisted of the two-point threshold and tactual fusion (interrupted bursts of air whose frequency can be increased until a constant sensation of pressure is reported). In addition to these measures, heat and pain thresholds were taken by means of the Hardy, Wolff, and Goodell dolorimeter. A group of control subjects received the same tests and at the same time intervals. The results showed a significant increase in cutaneous sensitivity relative to the control subjects. This increase was shown on all measures, on all skin areas tested, and by all 16 experimental subjects. Furthermore, this increased sensitivity was still present several days after the termination of darkness.

The purpose of the second experiment (Zubek, Flye, & Willows, 1964) was to determine whether effects, similar to those resulting from darkness, will result from prolonged exposure to non-varying homogeneous illumination. The previous procedure, therefore, was repeated with a new group of subjects, but instead of being exposed to darkness, each subject wore a pair of translucent goggles which permitted diffuse light but eliminated all pattern vision. The results revealed an essentially similar picture: an increase in pain and heat sensitivity and in tactual acuity as measured by the tactual fusion method. These results appear to suggest that it is the absence of pattern vision or of changes in visual input rather than an absence of visual stimulation *per se* which is responsible for the increased cutaneous sensitivity.

During the course of these visual deprivation studies, several subjects reported spontaneously that their sense of hearing seemed to be much better. In view of these remarks, two types of auditory tests were used in the third study (Duda & Zubek, 1965). These were administered to a group of 15 subjects before and after a week of darkness. The first involved the measurement of auditory discrimination using an auditory flutter technique (interrupted white noise at a 0.90 on-off ratio). The second consisted in the determination of the threshold of hearing for five different frequencies: 100, 300, 1,000, 5,000, and 9,000 cps. The results revealed an increase in auditory discrimination with the after-effects persisting for one day. All subjects but one showed this effect. On the other hand, the absolute threshold of hearing for the five frequencies was not affected. Furthermore, no trends were evident.

In view of these differential results on auditory functioning, a fourth study (Phelps, 1967) was conducted whose purpose was to determine how general or specific these intersensory facilitatory effects may be. Two other auditory measures were taken, absolute and differential auditory localization, and two cutaneous measures, tactual localization and absolute pressure sensitivity of the finger, palm, forearm, neck, and leg. The results revealed no significant changes on the two auditory measures or on tactual localization, a finding which Phelps states may be related to the strong role that learning and practice plays in these performance tasks. However, a significant increase in absolute pressure sensitivity of the various skin areas did occur.

The purpose of the fifth experiment (Schutte & Zubek, 1967) was to determine whether a week of visual deprivation can produce an increase in gustatory and olfactory sensitivity. If this should occur, it will suggest that prolonged visual deprivation may produce a general enhancement of sensory functioning. Olfactory sensitivity (recognition threshold for benzene) was measured by a power-operated, syringe-type olfactometer. In the determination of gustatory sensitivity, the test stimuli consisted of 21 different concentrations of sucrose (sweet), 20 for NaCl (salt), 22 for Hcl (sour), and 23 concentrations for quinine sulphate (bitter). The results indicated a significant increase in olfactory sensitivity, while gustatory sensitivity showed a differential pattern of results. Sensitivity to salty and sweet substances was increased significantly; a strong trend, though not significant, was observed for sour (11 of the 12 experimentals showed an improvement); and no change occurred for bitter. The failure to demonstrate even a trend toward increased sensitivity to bitter after a week of visual deprivation is puzzling since Nagatsuka (1965) reported that subjects exposed to one day of visual and auditory deprivation showed a 36 per cent increase in sensitivity to bitter (quinine) and sweet (sucrose). One possible explanation of this apparent discrepancy may be that increased sensitivity to bitter only occurs after combined visual and auditory deprivation and not after visual deprivation alone. It is also possible that the difference in the durations of the two experiments may be the critical factor; the effect on bitter sensitivity, though present at one day may have dissipated by the end of one week.

The results of these five Manitoba experiments are significant in two respects. First, they suggest that some of the other facilitatory effects e.g., the improvement in tachistoscopic visual acuity, may also occur after visual deprivation alone. Second, these results are of considerable theoretical importance since they provide experimental support for the sensoristatic model of the nervous system recently formulated by Schultz (1965). According to Schultz, sensoristasis is a condition in which the organism strives to maintain an optimal range of sensory variation, a range which is capable of shifting to some degree as a function of several variables. The monitor serving to maintain the sensoristatic balance is the reticular activating system which Lindsley (1961) conceives of as serving as a sort of "homeostat" or regulator adjusting "input-output" relations. One of the predictions which Schultz derives from his model is that "when stimulus variation is restricted, central regulation of threshold sensitivities will function to lower sensory thresholds. Thus, the organism becomes increasingly sensitized to stimulation in an attempt to restore the balance" (p. 32). The demonstration of an increase in olfactory, gustatory, cutaneous, and auditory sensitivity, following prolonged visual deprivation, appears to support this theoretical prediction. Schultz's model would also predict that auditory, cutaneous, and kinesthetic deprivation, alone, should likewise produce lower thresholds in the non-deprived modalities. Unfortunately, no relevant studies depriving these other modalities of stimulation are as yet available.

Short-Duration Studies

Facilitatory effects have also been demonstrated in several studies employing a short period of sensory restriction. For example, Ormiston (1958) demonstrated that 30 subjects exposed to 30 minutes of unpatterned light and silence showed a greater readiness to perceive apparent motion than did either control subjects or a group receiving 30 minutes of sensory "bombardment". Using an even shorter duration, Glazer and Zenhausern (1966) measured the auditory and pain sensitivity of 32 subjects before and immediately after five minutes of sensory deprivation and subsequently at one minute intervals for four minutes. The results revealed an initial lowering of auditory and pain thresholds (increased sensitivity) immediately after deprivation, an "overswing" to raised thresholds two minutes later, and then a return to the normal pre-deprivation levels at the end of four minutes. The presence of these oscillatory changes was interpreted as indicating a temporary disturbance of some homeostatic regulatory mechanism such as the reticular activating system. These results, although intriguing in nature, are questionable since no control group, tested at the same time intervals as the experimental subjects, was employed.

Finally, two studies directly relevant to this thesis, have demonstrated that a short period of sensory and perceptual deprivation can produce a lowering of the tachistoscopic recognition threshold. In the first study, Friel and Derogatis (1965) determined the visual recognition thresholds for four-letter nouns immediately after the termination of a 50 minute period of perceptual deprivation and motor restriction. A list of 25 different nouns was projected tachistoscopically on a screen six feet from the subject at exposure rates of 1, 3, 6, 10, and 17 msecs. Five nouns were presented at each exposure rate. The results indicated that the 18 perceptually isolated subjects recognized significantly more words and at a faster exposure time than did a group of 18 non-deprived subjects.

In the second study, Rosenbaum, Dobie, and Cohen (1959) obtained recognition thresholds for 13, five-digit numbers after deprivation periods of 0, 5, 15, and 30 minutes. Two groups of 16 subjects were used, one exposed to sensory deprivation and the other to perceptual deprivation. The 16 subjects in each group were arranged in a diagonal 4 x 4 Latin square with four replications on each subject, the visual efficiency of each being tested on four separate days after either 0, 5, 15, or 30 minutes of deprivation. A different list of 13, five-digit numbers was employed at each test session. Several minutes after the termination of deprivation, the threshold was obtained by presenting each number at a 10 msec. duration in a prelighted exposure area, with a cross for a fixation point, and increasing the exposure duration in successive steps of 10 msec. until the number was recognized. The results indicated that both experimental conditions produced an improvement in visual efficiency but that the effect only occurred after the five minute deprivation period. The absence of an improvement with the longer durations is attributed, by the authors, to an "increased boredom and emotional interference accompanying lengthened isolation".

Although this review of the literature has indicated that a facilitatory performance can occur after brief durations of sensory and perceptual deprivation, no attempt, in contrast to the long-duration studies, has been made to determine whether a similar effect can also be obtained after the deprivation of only one modality. The purpose of this thesis is two-fold: (a) to investigate the effect of five minutes of perceptual deprivation on the tachistoscopic recognition threshold for digits and (b) to determine whether the facilitatory effect, if it does occur, can be demonstrated after either visual, auditory, or kinesthetic deprivation.

CHAPTER II

EXPERIMENTAL METHOD AND RESULTS

I. Subjects

The subjects were male university students, with normal vision, who were required to participate in departmental experiments in satisfaction of a course requirement. The sample consisted of 90 subjects randomly divided into six groups, each containing 15 subjects. Two of the groups were control subjects while the remaining four were exposed to perceptual deprivation, visual deprivation, auditory deprivation, and kinesthetic deprivation, separately. Each subject served in one condition only.

II. Deprivation Procedure

Prior to participation each subject was informed that this was an experiment designed to investigate the effect of various forms of relaxation on visual acuity and that all that was required of him was to relax and follow instructions (see Appendix A for detailed instructions). During the five-minute deprivation period the subject reclined in a comfortable chair with his feet on a cushioned stool, in a room illuminated with an overhead light and decorated with colorful travel posters. The perceptually deprived subjects (PD group) wore a white mask which permitted light but eliminated pattern vision, earphones through which they heard white noise, somewhat above the threshold of hearing, had their arms, legs, and torso strapped to restrict movement, and were instructed to move as little as possible; visually deprived subjects (VD group) wore a white mask and received normal auditory stimulation; auditorally deprived subjects (AD group) wore earphones through which they heard white noise and were provided with magazines as additional visual stimulation; kinesthetically deprived subjects (KD group) had their arms, legs, and torso strapped to the chair and were provided with normal visual and auditory stimulation.

In addition, two control groups were employed. The non-deprived reclining group (RC group) was placed for a five-minute period in the same chair as the deprived subjects and provided with magazines and normal auditory stimulation while the non-deprived ambulatory group (AC group) was escorted to a waiting room and provided with reading material.

III. Testing Visual Efficiency

The visual recognition threshold for each subject was determined immediately before, and two minutes after the five minute deprivation or control period by presenting, one at a time, eight randomly constructed five-digit numbers, composed of the integers 1, 4, 6, 7, and 9 in which no number appeared more than once. These five integers, 3 mm. in height, were selected on the basis of a pilot study in which it was shown that these integers were similar in difficulty of recognition. The two-minute interval between the end of the deprivation period and the post-test allowed for visual adaptation in the PD and VD groups. The ascending method of limits was used. Beginning with a tachistoscopic exposure of one msec., a different five-digit number was successively presented, at increasing durations of one msec., until the number was correctly identified. In order to minimize the effect of practice, two lists of numbers were employed, one prior and the other after the five-minute experimental period.

The order of presentation of the five-digit numbers in each list was randomly determined using a table of random numbers. A black dot located in the center of the pre-lighted exposure field of the tachistoscope served as a fixation point. The measure of visual efficiency employed was the mean of the recognition thresholds obtained on each of 10 trials. Subjects obtaining a threshold above 25 msecs. on the practice trial had their initial presentation at 10 msecs. on all subsequent trials while subjects who had a threshold above 30 msecs. on the practice trial were eliminated from the study.

IV. Results

Simple one-way analyses of variance, fixed model (Winer, 1965), for independent measures were used to test the significance of the differences between the amounts of change shown by the four experimental and two control groups. The statistical analyses were made in terms of difference scores, obtained by subtracting the post-treatment from the pre-treatment test scores for each subject. The mean scores obtained by each of the 90 subjects are summarized in Appendix B.

An examination of Table 1 reveals that all six groups of subjects show a lower recognition threshold, of approximately the same magnitude, on the 10 post-treatment trials relative to the 10 pre-treatment trials. Furthermore, this improvement in visual sensitivity is shown by approximately the same number of subjects in each condition. An analysis of variance of the pre-post difference scores indicated that none of the changes were significantly different from each other (see Table 2).

TABLE 1

Recognition Thresholds (in msecs.) of Six Groups of Subjects Before and After a Five Minute Treatment Period - Ten Trials

	PD	VD	AD	KD	RC	AC
Pre	7.14	7.68	6.87	6.46	6.97	6.50
Post	6.19	7.04	6.10	5.72	6.29	5.41
Difference	0.95	0.64	0.77	0.74	0.68	1.09
No. of Ss showing an improvement	11	13	12	13	8	12

TABLE 2

Analysis of Variance of the Pre- and Post-Treatment Results - Ten Trials

Source	SS	MS	df	F
Between Ss	2.24	0.45	5	< 1 *
Error	186.88	2.22	84	
Total	189.12		89	

* Not significant

Table 3 shows the recognition threshold values of the six groups of subjects on the first five pre- and post-experimental trials. Results similar to those based on all 10 trials were obtained. All groups showed a lower recognition threshold on the post-test, with the improvement being shown by the majority of the subjects in each condition. An analysis of variance of the difference scores again showed none of these changes to be significantly different from each other (see Table 4).

TABLE 3

Recognition Thresholds (in msecs.) of Six Groups of Subjects Before and After a Five Minute Treatment Period - First Five Trials

	PD	VD	AD	KD	RC	AC
Pre	7.52	8.28	7.56	7.17	7.95	7.19
Post	5.88	7.56	6.68	6.04	6.63	5.47
Difference	1.64	0.72	0.88	1.13	1.32	1.72
No. of Ss showing an improvement	10	12	10	14	11	13

TABLE 4

Analysis of Variance of the Pre- and Post-Treatment Results - First Five Trials

Source	SS	MS	df	F
Between Ss	12.1	2.42	5	< 1 *
Error	473.2	5.63	84	
Total	485.3		89	

* Not significant

An analysis of variance performed to test the interaction between the various treatments and the 10 post-experimental trials was significant at the .01 level of significance (see Table 5). In view of this significant interaction, it is not possible to test for a trend over trials. However, since an improvement in performance was observed in all six groups it is obvious that a practice effect is operating.

TABLE 5

Analysis of Variance for Interaction of Treatment and Trials

Source	SS	MS	df	F
Between *Ss*			89	
Within *Ss*	3229		810	
B (Trials)	75	8.3	9	
AB	749	16.6	45	5.24*
B X *Ss*, within groups	2395	3.17	756	
Total			899	

* Significant at .01 level

CHAPTER III

DISCUSSION AND CONCLUSIONS

The results of this experiment indicate that a five-minute period of either perceptual deprivation or a deprivation of any one modality does not produce a significant lowering of the tachistoscopic recognition threshold relative to non-deprived control subjects. Since any effect resulting from a five-minute deprivation period would presumably be transitory in nature, it is possible that the length of the post-test session, 15 minutes in duration, may have masked any facilitatory effect. However, the presence of non-significant differences obtained in a comparison of the first five pre- and post-treatment trials, collected in half the time, suggests that a masking effect probably did not occur. The improvement in performance for all groups, is easily explained in terms of a practice effect i.e., an increased familiarity with the test situation and an increased proficiency on the task.

The absence of a lower recognition threshold for five-digit numbers in the perceptually deprived group relative to the two control groups is contrary to the results of Rosenbaum, Dobie, and Cohen (1959) who, in a study also using five-digit numbers, reported "an improvement in visual efficiency following 5 minutes of deprivation". An examination of their experimental procedure, however, suggests several variables that may have led to significant results. Among these are uncontrolled within subject variability, the presentation of the same number until recognition occurred, a large interval between presentation levels, and the use of a Latin square design.

It has been observed that visual recognition thresholds have a high within subject variability over days and even over trials. This is probably due to differential levels of fatigue and motivation which cannot be partialed out or controlled. Since their experimental design required that deprivation and testing be conducted over a period of a week, it is possible that what appeared as an increase in sensitivity due to deprivation was an increase in sensitivity due to high variability resulting from shifts in motivation and fatigue level. Their results are further confounded by the use of the same five-digit number which leads to partial recognition at each exposure duration, a procedure which introduces learning as a factor in the threshold determination. This may be a critical variable in accounting for their facilitatory effect since Jaffee (1966) has reported a significant improvement in learning ability after five minutes of sensory deprivation. The problem of partial recognition was eliminated in this thesis by changing the stimulus after each presentation and by making the numbers so similar that a guess based on partial recognition had a very low probability of being correct. Another possible factor is their use of a wide interval between the presentation levels of the stimulus. The exposure duration was increased in successive steps of 10 msecs. in contrast to the smaller, more precise, 1 msec. interval used in this thesis.

Finally, their most serious procedural error is an improper use of a Latin square design. In discussing practice effects, Winer (1965) warns that "If such effects exist, randomizing or counterbalancing does not remove them; rather, such procedures completely entangle the latter with treatment effects." In view of the strong practice effect observed in both the Rosenbaum and present experiment, the use of a Latin square design by Rosenbaum undoubtedly produced a confounding of results.

The inconsistent finding of an improved performance after five but not after the longer periods of 15 and 30 minutes of sensory and perceptual deprivation make their results even more suspect. This inconsistency is not adequately explained by their statement that an absence of an increase in sensitivity in the longer durations is due to "increased boredom and emotional interference accompanying lengthened isolation." If this explanation was valid, no facilitatory effects should occur after prolonged deprivation periods of one to seven days, a finding contrary to the experimental literature. Furthermore, a lower recognition threshold should not have been obtained by Friel and Derogatis (1965) after 50 minutes of perceptual deprivation.

In view of the fact that perceptual deprivation does not increase tachistoscopic sensitivity, it is not surprising that a deprivation of only one modality should also produce no facilitatory effect.

Recently, an increasing number of investigators have begun to doubt many of the behavioral and physiological results that have been reported in the short-term deprivation studies (e.g., Jackson & Pollard, 1962; Schultz, 1965; Zubek, in press). Among them is Cameron et al. (1961) who concluded that "Periods of exposure of less than one day probably do not produce changes properly attributable to reduction in input" (p. 236).

The results of this study substantiate this statement and lead to the conclusion that a five-minute deprivation period does not affect the tachistoscopic recognition threshold. Furthermore, in the other short-term studies in which significant findings were reported the effects probably resulted from inadequate experimental procedures or from such subject variables as expectancy and set which are known to affect deprivation results (Jackson & Pollard, 1963).

BIBLIOGRAPHY

Aftanas, M., & Zubek, J. P. Effects of prolonged isolation of the skin on cutaneous sensitivity. Percept. mot. Skills, 1963, 16, 565-571.

Doane, B. K., Mahatoo, W., Heron, W., & Scott, T. H. Changes in perceptual functions after isolation. Canad. J. Psychol., 1959, 13, 210-214.

Duda, P. D., & Zubek, J. P. Auditory sensitivity after prolonged visual deprivation. Psychon. Sci., 1965, 3, 359-360.

Cameron, D. E., Levy, L., Ban, T., & Rubenstein, L. In B. E. Flaherty (Eds.), Psychophysiological aspects of space flight. New York: Columbia Univer. Press, 1961. Pp. 225-237.

Carlin, S., Ward, W. D., Gershorn, A. J., & Ingraham, R. Sound stimulation and its effect on dental sensation threshold. Science, 1962, 138, 1258-1259.

Friel, C. M., & Derogatis, L. The effect of nonpatterned sensory deprivation on visual recognition thresholds. Psychon. Sci., 1965, 3, 163-164.

Gardner, W. J., & Licklider, J. C. R. Auditory analgesia in dental operations. J. Amer. Dent. Assn., 1959, 59, 1144-1149.

Glazer, S., & Zenhausern, R. The effects of short-term sensory deprivation on auditory and pain thresholds. Paper presented at the annual meeting of the Eastern Psychological Assn., April, 1966.

Jackson, C. W. Jr., & Pollard, J. C. Sensory deprivation and suggestion: A theoretical approach. Behav. Sci., 1962, 7, 332-342.

Jaffee, C. L. The effect of short-term sensory deprivation on rote learning. J. Psychol., 1966, 64, 127-133.

Kubzansky, R. E. The effects of reduced environmental stimulation on behavior: A review. In A. D. Biderman and J. H. Zimmer (Eds.), The manipulation of human behavior. New York: Wiley, 1961. Pp. 51-95.

Licklider, J. C. R. On psychophysiological models. In W. A. Rosenblith (Ed.), Sensory communication. Cambridge, Mass.: MIT Press, 1961. Pp. 49-73.

Lindsley, D. B. Common factors in sensory deprivation, sensory distortion, and sensory overload. In P. Solomon et al. (Eds.), Sensory deprivation. Cambridge, Mass.: Harvard Univer. Press, 1961. Pp. 174-194.

Nagatsuka, Y. Studies on sensory deprivation. III. Part 2. Effects of sensory deprivation upon perceptual functions. Tohoku Psychologica Folia, 1965, 23, 56-59.

Nagatsuka, Y., & Maruyama, L. Studies on sensory deprivation. I. Part 2. Effects of sensory deprivation upon perceptual and motor function. *Tohoku Psychologica Folia*, 1963, *22*, 5-13.

Nagatsuka, Y., & Suzuki, Y. Studies on sensory deprivation. II. Part 2. Effects of sensory deprivation upon perceptual and motor functions. *Tohoku Psychologica Folia*, 1964, *22*, 64-68.

Ormiston, D. W. The effects of sensory deprivation and sensory bombardment on apparent movement thresholds. *Dissert. Abstracts*, 1958, *18*, 2200-2201.

Phelps, J. Effect of prolonged visual deprivation on various cutaneous and auditory measures. Unpublished M.A. Thesis. University of Manitoba, October, 1967.

Rosenbaum, G., Dobie, S. I., & Cohen, B. D. Visual recognition thresholds following sensory deprivation. *Amer. J. Psychol.*, 1959, *72*, 429-433.

Schutte W., & Zubek, J. P. Changes in olfactory and gustatory sensitivity after prolonged visual deprivation. *Canad. J. Psychol.*, 1967. *21*, 356-362.

Schultz, D. P. *Sensory restriction*. New York: Academic Press, 1965.

Smith, S., Myers, T. I., & Murphy, D. B. Vigilance during sensory deprivation. *Percept. mot. Skills*, 1967, *24*, 971-976.

Suzuki, Y., Ueno, H., & Tada, H. Studies on sensory deprivation. V. Part 6. Effect of sensory deprivation upon perceptual function. *Tohoku Psychologica Folia*, 1966, *25*, 24-30.

Vernon, J. *Inside the black room.* New York: Clarkson N. Potter, 1963.

Vernon, J. D., & McGill, T. E. Sensory deprivation and pain threshold. *Science*, 1961, *133*, 330-331.

Vernon, J., McGill, T. E., Gulick, W. E., & Candland, D. K. The effects of sensory deprivation on some perceptual and motor skills. In P. Solomon et al. (Eds.), *Sensory deprivation*. Cambridge, Mass.: Harvard Univer. Press, 1961. Pp. 41-57.

Winer, B. J. *Statistical principles in experimental design*. New York: McGraw-Hill, 1962.

Zubek, J. P. Behavioral changes after prolonged perceptual deprivation (no intrusions). *Percept. mot. Skills*, 1964, *18*, 413-420. (a)

Zubek, J. P. Effects of prolonged sensory and perceptual deprivation. *Brit. Med. Bull.*, 1964, *20:1*, 38-42. (b)

Zubek, J. P. (Ed.), *Sensory deprivation: Fifteen years of research*. New York: Appleton-Century-Crofts. In Press.

Zubek, J. P., Aftanas, M., Hasek, J., Sansom, W., Schludermann, E., Wilgosh, L., & Winocur, G. Intellectual and perceptual changes during prolonged perceptual deprivation: Low illumination and noise level. Percept. mot. Skills, 1962, 15, 171-198.

Zubek, J. P., Flye, J., & Aftanas, M. Cutaneous sensitivity after prolonged visual deprivation. Science, 1964, 144, 1591-1593.

Zubek, J. P., Flye, J., & Willows, D. Changes in cutaneous sensitivity after prolonged exposure to unpatterned light. Psychon. Sci., 1964, 1, 283-284.

Zubek, J. P., Pushkar, D., Sansom, W., & Gowing, J. Perceptual changes after prolonged sensory isolation. Canad. J. Psychol., 1961, 15, 83-100.

APPENDIX A - TEST INSTRUCTIONS

General Test Instructions Read to Subject Prior to Experiment

This is an experiment designed to determine the effect of various forms of relaxation on vision. It is a very simple and fairly short experiment. You can be a big help if you just relax and carefully follow instructions. You will be given a vision test, followed by five minutes of a relaxing activity followed by another vision test.

I am going to put a five-digit number into the viewer. It will briefly appear above the dot you see in the viewer. You are to tell me what this number is as soon as you can see it. If you think you can identify it, but are not sure, take a guess. If you do not correctly identify the number, I will present a different number at a longer duration. We will follow this procedure until you can correctly identify the number. We will then begin again. Before presenting the number I will say "ready". Are there any questions? The first trial will be a practice trial. Be alert and do your best. Now look into the viewer and we will begin.

Specific Test Instructions for the Six Conditions

Perceptual Deprivation. I am going to place a white mask over your face and have you listen to a constant sound for five minutes. I will also place these straps around you and ask that you remain absolutely motionless until I tell you the time is up.

Visual Deprivation. I am going to place a white mask over your face for five minutes. I will tell you when the time is up.

Auditory Deprivation. I am going to have you listen to a constant sound for five minutes. I will tell you when the time is up. Here are some magazines you may read.

Kinesthetic Deprivation. I am going to place these straps around you, and ask that you remain absolutely motionless for five minutes. I will tell you when the time is up.

Reclining Control Condition. Just relax in the chair for five minutes. Here are some magazines you may read while you wait.

Ambulatory Control Condition. Please wait in this room for five minutes. Here are some magazines you may read.

APPENDIX B - ADDITIONAL EXPERIMENTAL DATA

Individual Mean Score by Group - First Five Pre and Post Trials

PD		VD		AD		KD		RC		AC	
Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
3.8	5.0	19.0	17.0	6.6	6.2	6.2	5.6	9.4	6.8	8.6	7.8
5.6	4.2	9.8	5.8	5.4	7.2	5.2	3.8	9.8	11.4	5.8	5.6
9.6	7.8	4.6	3.4	14.8	8.2	9.8	6.8	6.4	5.0	12.6	7.6
7.0	7.4	12.0	10.0	12.8	14.8	18.6	16.6	7.4	5.2	5.8	4.0
10.2	6.4	8.8	7.0	11.0	7.0	7.6	7.6	9.6	5.6	4.8	4.0
22.6	15.2	6.6	6.4	6.2	6.2	5.6	4.8	6.0	7.8	4.2	3.2
9.2	4.8	6.8	5.6	6.8	6.4	6.2	4.6	7.2	7.2	10.8	4.8
4.6	4.0	7.0	6.6	3.4	4.0	6.4	4.2	4.0	4.2	5.8	7.0
4.2	3.0	4.6	5.4	6.2	4.4	7.2	6.4	7.0	5.6	8.8	5.2
4.0	4.8	5.2	4.0	7.4	5.8	6.4	5.2	6.4	7.4	9.4	7.0
12.4	4.4	7.2	6.0	10.6	8.6	5.8	4.4	9.2	8.6	5.2	5.4
6.0	5.4	8.2	4.4	8.6	7.8	5.4	6.2	8.0	6.8	5.8	5.2
4.2	5.0	4.6	4.2	4.8	5.2	6.0	5.4	18.6	8.8	4.6	3.8
6.0	4.6	4.8	5.4	4.0	4.2	6.2	4.8	4.2	4.0	10.6	6.8
3.4	6.2	15.0	22.2	4.8	4.2	5.0	4.2	6.0	5.0	5.0	4.6

Individual Mean Score by Group - 10 Pre and 10 Post Trials

PD		VD		AD		KD		RC		AC	
Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
4.8	5.1	18.3	17.8	7.0	5.4	6.5	5.8	8.5	6.2	8.6	9.1
5.0	4.4	8.7	5.7	13.2	8.3	5.3	3.9	8.2	9.8	5.6	5.4
8.5	7.7	4.0	3.3	12.4	12.2	8.5	6.1	5.8	4.9	10.3	7.1
6.3	7.1	10.6	9.6	8.8	6.5	16.2	15.4	6.1	4.9	5.0	4.0
7.9	6.0	7.8	6.9	5.5	5.5	7.1	6.8	7.3	5.2	4.3	3.8
20.7	17.3	6.1	5.8	6.1	5.8	4.2	3.7	5.9	7.0	3.7	2.9
9.1	5.9	6.7	5.1	3.2	3.8	5.0	4.7	6.4	6.6	9.1	5.1
4.6	4.3	6.2	5.5	5.5	4.3	4.4	4.7	4.0	4.6	5.8	5.8
5.3	3.4	4.7	5.2	6.7	6.1	5.8	4.1	6.7	5.8	8.9	5.6
4.6	5.2	5.2	4.1	9.0	7.6	7.5	6.5	5.9	6.0	7.4	6.3
10.9	5.1	6.8	5.8	7.6	7.3	5.3	5.2	7.9	8.5	4.9	5.5
6.0	5.4	5.6	4.7	4.5	4.7	5.1	4.1	7.9	6.3	5.1	5.8
4.4	5.3	4.1	3.6	4.2	4.1	5.2	5.3	14.6	8.6	4.6	4.2
5.6	4.8	5.3	5.2	4.9	6.2	5.5	4.8	3.8	4.4	9.3	6.2
3.4	5.9	15.2	17.3	4.4	3.7	5.3	4.7	5.6	5.6	4.9	4.3