DELAYED RESPONSE TO LIGHT STIMULI IN BINOCULARLY DEPRIVED CATS

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Abstract. Cats binocularly deprived of pattern vision, born and cage-reared in the laboratory, were trained on the delayed response task involving light stimuli with 0-, 5-, and 15-s delay. Control cage-reared animals, also laboratory born were not deprived visually. No significant group difference was found in the delayed response learning, both groups performing poorly, as compared to the earlier data reported on cats reared without environmental restriction. The groups differ, however, in reaction time (RT), as in the visually deprived animals a lower proportion of responses with shorter RT was observed than in the controls. Conversely, for responses to the actual light stimuli a higher proportion of shorter RT was found in the deprived animals than in the controls.

INTRODUCTION

It is widely accepted that binocular deprivation in animals produces learning deficit in tests involving discrimination of visual patterns (5, 6, 8, 21) or objects (28, 30), thus indicating a significant role of early visual experience. However, a retarded performance was not always observed after early visual restriction: when stimuli consisted of different rectangle (21) or stripes (24) orientation, both the deprived and experienced animals solved the task comparably. This might suggest that discriminative deficit is related mainly to complex patterns, including spatially related elements within cues (6). In addition, no difference between visually deprived and control groups was found when two-stage procedure had been applied (32). If the animals were trained first in a preliminary task involving positive pattern vs. no pattern until criterion, and the negative patterns were introduced afterwards, then these two stages of discrimination learning revealed no difference between groups. Therefore, comparatively to electrophysiological findings (see 1) which demonstrate a consistent deficiency in the properties of visual neurons not influenced by early visual experience, behaviorally related visual discriminatory deficit seems less consistent.

The inferior performance of visually deprived animals was not always interpreted as poor discrimination of visual stimuli: some authors ascribed it to the deficiency in visually guided orienting behavior (8) others — to the difficulty in establishing a proper visual association with food reinforcement (30, 32), or to a retardation of complex visuo-motor coordination (see 8), resulting from the division of the apparatus by partition (29, 31).

The present experiment required no pattern discrimination learning. Visually deprived and control cats, both born in the laboratory, were trained in the delayed response task, in which approach responses were signalled by light stimuli placed on feeders. In the first adaptation stage to experimental procedure auditory stimuli were used, to see if the animals were able follow the rules of conditioning with the stimuli that were mostly familiar.

METHOD

Subjects. The experiments were made on 10 cats born in the animal house. When they were 8 days old, in 5 cats began the binocular deprivation period, lasting for 6 months (BD group). Visual deprivation was achieved by covering the cats' heads with linen hoods that gave access to scattered light only and prevented pattern vision; for a more detailed method description see Kossut et al. (12). Five remaining cats constituted a control group (C group). During the first 2 months of life all the cats stayed in cages with their mothers. Next they were separated from the mothers and put into large cages ($3.4 \times 1.15 \times 3.0$ m), where they stayed together with other cats. At the age of 6 months the linen hoods were taken off. Two weeks later the cats were put in individual cages and the experiments began. The cats were fed in the animal house twice a day: in the morning they were given milk and in the afternoon — meat soup with grits plus vitamins.

Apparatus. All the experiments were carried out in a room 4×8 m, lit with a 200 W bulb (10); the room contained three feeders situated on the floor (Fig. 1). In each feeder there were 16 food bowls mounted on a rotating disc. An opening in the feeder box provided access to one bowl in position directly below it. With the exception of the first preliminary training days, the bowl that was accessible at the beginning of the experimental session was empty. The others were baited with food and could be brought into position, one at a time, by a partial rotation of the disc. The rotation of the disc could be activated remotely by the experimenter who was seated at a desk behind the starting platform. The platform was separated from the experimenter's place by a screen 83 cm high.

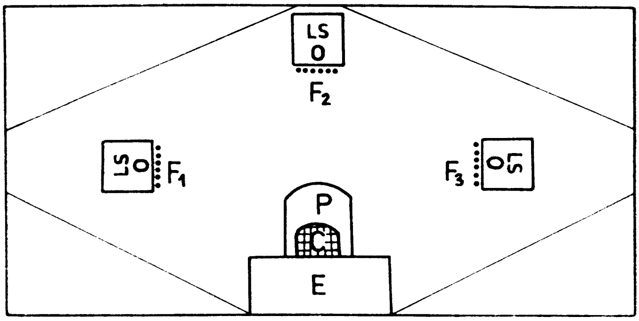

Fig. 1. Schematic diagram of the experimental room. F_1, F_2, F_3, feeders; black points in front of each feeder, photocells; *LS*, source of light and sound stimuli; *E*, place of experimenter; *C*, cage; *P*, starting platform.

Attached to the screen and above the starting platform was a half-round, wiremesh cage (diam. 45 cm, height 50 cm) without a floor, which could be moved in the vertical plane. When the cage was pushed down, its lover edge rested on the platform, thus preventing the animal from leaving the starting place.

On the top of each feeder, about 20 cm from a bowl, a loudspeaker and 24 W light bulb was mounted (Fig. 1), that constituted a conditioned stimulus source. The auditory stimulus consisted of a click series, coming from a square pulse generater set to deliver 50 ms square pulses at a frequency of 5/s. The click intensity measured by Bruel Kjaer Impulse Precision Sound Level Meter, was at the starting platform 46 dB, which was slightly above the background level (41 dB). The visual stimuli consisted of flashes lasting 333 ms at a frequency 1.5 Hz generated by a Voltage stimulator. In front of each feeder a row of photocells was mounted (Fig. 1.). The stimulus onset activated an electronic counter that turned off automatically when the photocells were covered by an animal approaching a feeder. The time between the stimulus onset and turning off the counter is defined as reaction time (RT). In sessions with delay RT is the time between the moment of the animal's release by cage lifting and its approaching the feeder.

The bowls in feeders were baited with raw meat, formed in 5-7 g balls.

Procedure. The preliminary training started with familiarizing the cats with the testing room during 10-20 min session during which the bowl accessible to the animal was baited with food and the animal could receive one bowl of food from each feeder. When during the exploration of the room the food was found and eaten, at the next session the food was delivered successively in all feeders. Each food delivery released a short sound produced by a partial rotation of the disc, which the cats quickly learned to associate with the presence of food in that feeder. Such training was continued in 12-trials sessions until the animal made 12 correct choices in a daily session.

Training with clicks. In the next day's session clicks coming from loudspeakers were introduced. The animal was induced to approach and stand on the starting platform. Clicks from a loudspeaker on one of the feeders were presented and after 3 s food was delivered at that feeder. After eating the animal was permitted to explore the room for a short time and was then induced to return to the starting platform again. After a few such trials the animal learned to approach the correct feeder at the sound clicks alone, prior to food delivery. The clicks were terminated when the animal started eating.

When the animal approached a feeder that was not signalled, the stimulus was terminated, no food delivered and the response scored as an error. The same stimulus was repeated after the usual intertrial interval (correction procedure). If the cat made four successive errors (one initial and three repetitive), the same stimulus was presented for the fifth time and food in the right feeder was presented immediately.

If the animal made no response to the stimulus onset, the maximum stimulus duration prior to food delivery was 20 s. If during that time the cat did not approach the feeder, food was nevertheless delivered in it, and if the cat still would not react, the experimenter helped it to approached the food. Such trial was called a "passive response" trial. If in two successive trials the animal refused to take food, the session was discontinued and the food in the animal house reduced for that day by 50%.

Twelve reinforced trials were presented in a daily session and the three feeders were signalled for 4 trials each, in a pseudo-random order. The trials were separated by 1-2 min intervals. During the intertrial intervals the animal moved freely in the room for a short time and then returned, or it was induced to return to the starting platform again.

The usual criterion of task acquisition was 90% correct responses in 60 trials, i.e. in 5 successive daily sessions. After the criterion with auditory stimulus had been attained, the auditory stimulation from loudspeakers was no more used. Instead — in the next day session a rhythmical light stimulus was introduced.

Training with light stimuli. In these sessions the correct feeder was signalled by a light stimulus. If in the first session with light stimuli the animal did not approach the feeder signalled by a light, the food was nevertheless delivered in it in 10 s of the stimulus duration. As soon as the animal heard the sound produced by a moving bowl and earlier associated with food delivery, approached the feeder and started eating, the light stimulus was turned off. In the next sessions the cats were trained as in the case of the actual auditory stimuli, until they reached the usual criterion.

Cage introduction. As the next step, the cage was introduced on the platform. Before the stimulus presentation the cage moved down preventing the animal from leaving the starting platform. Several seconds later the light stimuls from one of the feeders was presented. After 3 s of stimulus duration the animal was released by cage lifting. Initially, the stimulus was terminated after the animal had reached the feeder, whereas in later trials it was discontinued earlier and finally — immediately after the animal had left the starting platform. When the usual criterion had been reached (90% correct responses in five successive daily sessions), the delay was introduced.

Delayed responses. In the first series consisting of sessions with 0-s delay the animals were released immediately after the stimulus, acting for 3 s, had been turned off. In the second series they were released after 5-s, and in the third one, after 15-s delay. In each of these three successively presented series the cats were trained to a criterion of 90% correct responses in 5 successive sessions, i.e. in 60 trials. In case of an error the stimulus was repeated from the same feeder with 0-s delay. Like in the previous series with responses to the actual stimuli, also in the delayed response trials the rule of maximum 3 repetitive errors was used. If in the series with 5-s delay the animal did not achieve criterion in 25 sessions (300 trials), the training with this delay was discontinued and the series with 15-s delay introduced. The 15-s delay series was continued for 25 sessions, irrespectively of criterion achievements.

RESULTS

Preliminary training

The familiarization of the animals with the experimental situation, which ended with 12 correct responses to the sound of food delivery, lasted in four deprived cats from 3 to 8 days. In the fifth animal, BD146, this criterion was not been reached. Although the animal showed no signs of fear and moved skilfully, within 10 sessions it indicated no signs of learning.

Five control cats required from 4 to 15 sessions for the acquisition of the preliminary training stage. In two cats, C148 and C170, this period lasted 10 and 15 days, respectively, as in the initial days they were fearful, sat motionless and refused to take food.

Training with clicks

When in one session all the responses associated with the sound of food delivery were correct, the rhythmic auditory stimulation from the loudspeakers was introduced. Four deprived cats reached criterion in 5-17 sessions, making errors ranged between 1 and 32 (Table I).

The fifth animal, BD146, who was unable to reach criterion in the preliminary training, was nevertheless included in the present series. There was a possibility that the shortlasting sound which accompanied food delivery in the earlier series could have been too weak for this animal to develop an alimentary approach response. However, it became evident that even with a longer-lasting click presentation cat BD146 failed to develop a conditioned response. In 8 sessions the animal approached the feeders in 7 trials (making 3 errors), dispersed among passive response trials.

The animals in the control group reached the criterion making 1-8 errors. Although in the deprived group cat BD146 did not show signs of response acquisition and BD165 attained the criterion after a relatively high number of 32 errors (Table I), the difference between the deprived and control group was not significant (Mann-Whitney *U* Test).

Training with light stimuli

After the training with clicks, a rhythmic light stimulation was introduced. On the first day, in all BD cats an active approach response to the light stimulus was observed in the first trial. When the light was switched on for the first time, the cats sometimes making stops, approached the feeder while gazing at a flickering light. Then they jumped on the feeder, neglecting the food presented after the approach response, moving first towards the stimulus source and only later to the bowl with food.

Cat BD146 was also included in this series, to check if previous failures to develop alimentary directional responses referred only to auditory modality. In the two first trials the cat jumped on the feeder and approached the flickering lamp, not responding at all to the food. In succeeding trials the animal did not pay attention to the light stimulus and it approached the feeder only with the experimenter's help.

In the course of training of the deprived group three cats (BD168, BD179, BD184) reached the criterion in the first 5 sessions, while the fourth, BD154, needed 2 additional sessions, as in some trials he approached the signalled feeder only when he heard the sound of food delivery. As in the previous series, in the case of no approach response to the light stimulus, food was, as a rule, presented in the signalled feeder in 10 (only during the first session), or 20 s from the stimulus onset.

TABLE I

Number of trials and errors to criterion in individual deprived and control cats in the task with actual stimuli (criterion included)

Cat	Auditory stimuli				Light stimuli				Light stimuli + cage			
	Trials	Errors			Trials	Errors			Trials	Errors		
		initial	repetitive	total		initial	repetitive	total		initial	repetitive	total
BD154 ♂	66	1	0	1	78	5	1	6	60	3	0	3
BD165 ♂	204	26	6	32	60	0	0	0	60	3	0	3
BD179 ♂	60	1	0	1	60	0	0	0	60	1	0	1
BD184 ♀	123	19	0	19	60	0	0	0	60	0	0	0
BD146 ♀	71*				136*							
C148 ♂	68	4	0	4	72	0	0	0	60	4	0	4
C162 ♂	88	5	0	5	60	0	0	0	60	1	0	1
C170 ♂	60	1	0	1	60	0	0	0	60	2	1	3
C174 ♂	60	1	0	1	60	0	0	0	60	2	1	3
C151 ♀	66	8	0	8	60	1	0	1	132	20	1	21

*Passive response trials,

Like in the sessions with auditory stimuli the fifth animal, BD146, did not develop the instrumental response to the light stimulus either, approaching feeders only in passive response trials. During the whole time of training the animal was motorically hyperactive, often refused to take food, which resulted in sessions termination. After 15-sessions with no active responses to light presentation (136 passive response trials), the experiments with this cat were discontinued. It was obvious, that associative deficit in this animal was related both to auditory and visual stimuli.

As opposed to deprived cats, on the first day of training with light stimuli in the control group only three animals reacted with an active response in the first trial. Also, contrary to the deprived group, only one animal (C151) approached in the first trial the stimulus source and then the bowl. In one of the two remaining cats (C162) the first active response to the light stimulus appeared in the third trial, whereas in the other (C148) no active approach responses to the light were observed in the first session.

Four subjects in the control group reached the criterion in the first five sessions (Table I). The fifth animal, C148, in spite of the lack of errors needed one extra session, because on the first day it approached the feeders not to the light onset but only to the sound of the moving bowl.

Thus, the introduction of the light stimulus did not require special training, as most animals in both groups — deprived and controls — were able to reach criterion in the first 60 trials. It should also be noted that 3 deprived and 4 control subjects did not make a single error during this period (Table I).

Cage introduction

After both groups had reached criterion in responding to the actual light stimulus, the cage was introduced and both groups were retrained until criterion attainment. As may be seen in Table I, all the subjects from both groups, apart from female cat C151, reached the criterion in the first 60 trials. Thus, the confinment of the animals on the starting platform at the stimulus onset and responding preceded by cage lifting, produced no deficit in the animals' performance.

Summarizing the results preceeding the delayed response series, it may be concluded that in none of the series in which the animals responded to the actual light stimuli, including the series with cage introduction, any significant differences between the groups were observed (Mann-Whitney *U* Test). In both groups a smaller number of errors was observed in the series with the actual light stimuli than in the auditory

TABLE II

Number of trials and errors to criterion in individual deprived and control cats in the delayed response task (criterion included). Numbers in brackets denote percentage of correct responses in the last 60 trials in animals who did not reach criterion within 300 trials

Cat	0-s delay Trials	0-s delay Errors			5-s delay Trials	5-s delay Errors			15-s delay Trials	15-s delay Errors		
		initial	repetitive	total		initial	repetitive	total		initial	repetitive	total
BD154 ♂	143	28	12	40	72	10	1	11	300	59	5	64(83%)
BD165 ♂	192	40	19	59	300	133	43	176(73%)	300	153	11	164(50%)
BD179 ♂	96	16	8	24	96	17	1	18	120	20	2	22
BD184 ♀	228	31	0	31	300	73	9	82(75%)	300	49	3	52(79%)
C148 ♂	84	10	2	12	300	54	6	60(85%)	84	7	0	7
C162 ♂	60	5	1	6	216	34	0	34	300	65	7	72(73%)
C170 ♂	60	0	0	0	60	3	0	3	168	26	8	34
C174 ♂	252	47	12	59	300	59	7	66(80%)	300	77	9	86(78%)
C151 ♀	499	87	29	116(79%)								

stimuli (Table I), which may be, ascribed to the fact that cliksc were presented at the earlier stage of conditioning.

Delayed responses to light stimuli

The criterion attainment in the series with cage introduction, during which the animal was released with the light stimulus on, directly preceded the series with 0-s delay, in which the animal was released immediately after the light stimulus had been turned off.

Differently from the initial series, reaching the criterion in sessions with 0-s delay was possible after a certain number of errors (Table II). In the deprived group the number of errors ranged from 24 to 59, whereas in the control one from 0 to 59. Cat C151 was the only one who did not reach criterion within 50 sessions and the experiments with this animal were discontinued. His performance score in the last successive 5-session blocks oscillated between 88 and 78% correct responses, but the sessions were usually incomplete because the cat, being in heat, frequently refused food.

After the series with 0-s delay had been completed, the delay was extended to 5-s. Two subjects in each group did not reach criterion in 25 sessions: the percentage of their correct responses in the last 60 trials may be seen in brackets in Table II: the final score of two deprived animals was 73 and 75% correct, whereas that of the control subjects 80 and 85% correct.

The delayed response scores with 15-s delay are presented in Table II. Extending the delay to 15-s revealed that in this series 3 animals in the deprived group and 2 in the control one were unable to reach criterion in 25 sessions. Like in the preceding series, these animals' last performance scores in 60 trials are presented in brackets. As may be seen, with the exception of BD165 whose final score was 50% correct (still above chance under triple choice conditions), the response scores of 4 other animals ranged from 73-83% correct.

As was mentioned before, all the cats in the series with 15-s delay were trained in 25 sessions, irrespective of criterion attainment. Figure 2 presents these results, showing the number of errors in successive blocks, each consisting of 5 successive sessions, i.e., 60 trials. Using the analysis of variance method, for any of the series, i.e. with 0-, 5-, 15-s delay, no statistically significant differences between the deprived group and the control one were noted. The examination of the relationship between the number of repetitive errors and the initial ones (Mann—Whitney U Test) did not indicate differences between the groups, either.

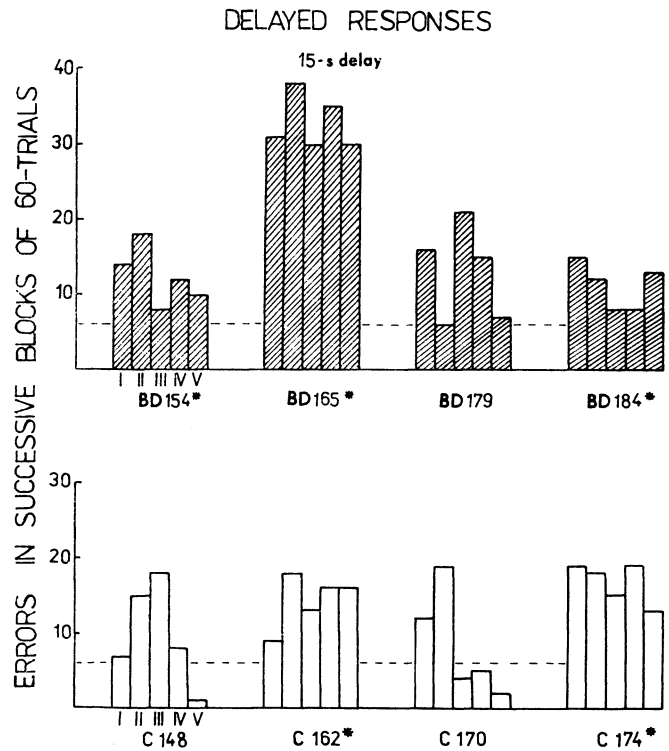

Fig. 2. Performance of individual deprived (BD) and control (C) animals in successive 5-session blocks in the delayed response task with 15-s delay. Asterisk denotes the animals that did not reach criterion.

Reaction time

The comparison of RT in approaching the feeders was evaluated using the Kolmogorov-Smirnov two-tailed test (19) based on cumulative frequency distribution of RT in both groups. The results are shown in Table III and include the data from 5 first sessions with responses to the actual auditory and light stimuli, cage introduction and 5 first sessions with 0- and 5-s delay. The data with 15-s delay include RT from all 25 sessions in both groups.

It became evident that RT distribution in both groups differs significantly in all the series. As may be seen in Table III, the points of maximal and significant difference between cumulative RT distribution (D_{max}) of the deprived and control group for series with actual auditory stimulus, cage introduction, and all delayed response series, are included in a rather short RT class ranging from 3.5-1.0 s. At these points, for those series a higher proportion of responses was found in the control group.

TABLE III

Comparison of deprived and control group in cumulative distribution of reaction time to the actual stimuli and in the delayed response task. $D < C$ denotes lower, and $D > C$, higher proportion of RT shorter or equal to point of D_{max} in the deprived group

Stimulus		Value of D_{max}	Point of D_{max} (s)	Difference		Sessions
Auditory		0.14	3.5	D< C	$P < 0.05$	first 5
Light		0.17	2.5	D >C	$P < 0.01$	,, ,,
Light + cage		0.20	1.5	D< C	$P < 0.001$	,, ,,
Light	0-s	0.27	1.5	D< C	$P < 0.001$	,, ,,
with	5-s	0.20	1.0	D< C	$P < 0.001$	,, ,,
delay	15-s	0.21	1.0	D< C	$P < 0.001$	total 25

However, for trials with actual light stimuli this relation was reversed: only in that series at the point of largest difference, 2.3 s, a higher proportion of responses was revealed in the deprived ($P < 0.01$) and not in the control group. A comparison of RT at the points of maximal difference between groups in the course of training indicated also that RT was shortened from 3.5 s in initial sessions with actual auditory or light stimuli, to 1.0 s in sessions with delayed response trials (Table III).

Response time data are illustrated in Figs. 3-8 by cumulative distributions curves for 4 subjects in the deprived and 4 in the control group.

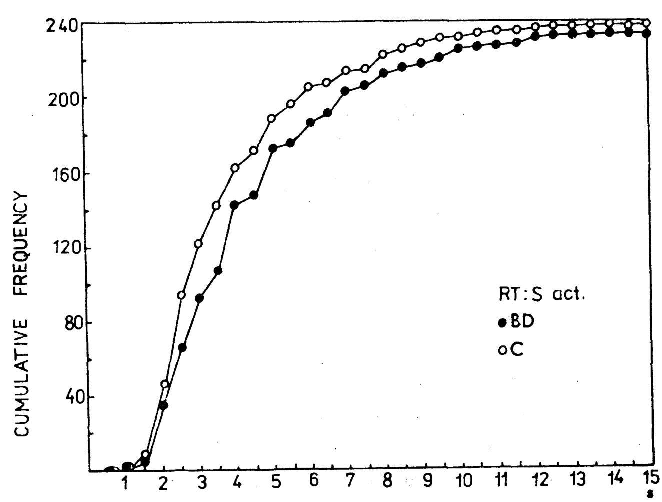

Fig. 3. Response time in binocularly deprived and control group during first 5-sessions with actual auditory stimulus.

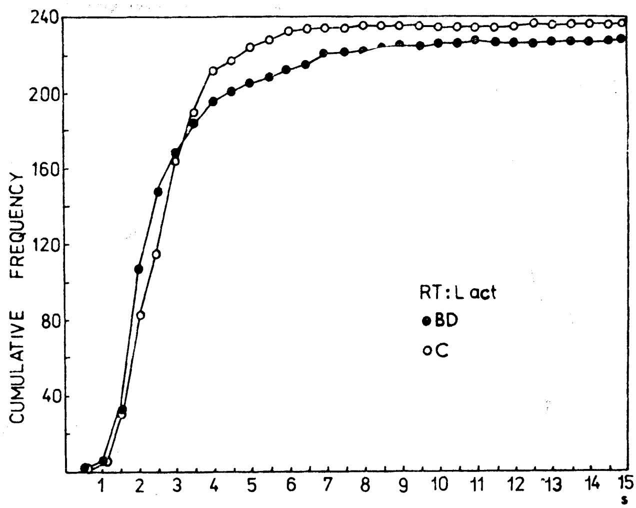

Fig. 4. Response time in binocularly deprived and control group during first 5-sessions with actual light stimulus.

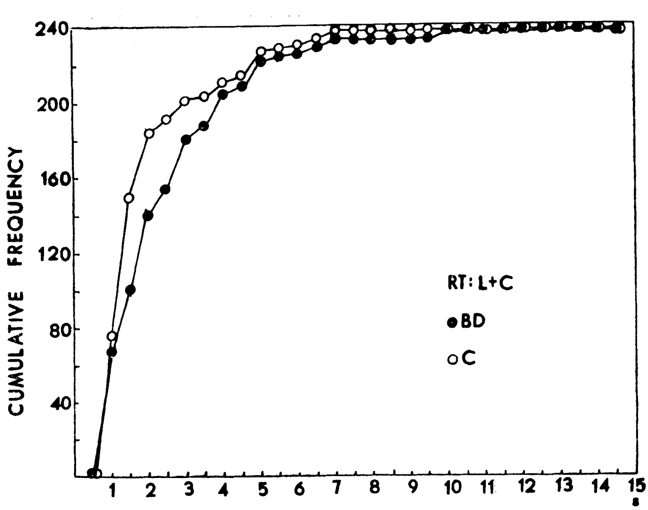

Fig. 5. Response time in binocularly deprived and control group during first 5-sessions with actual light and cage introduction.

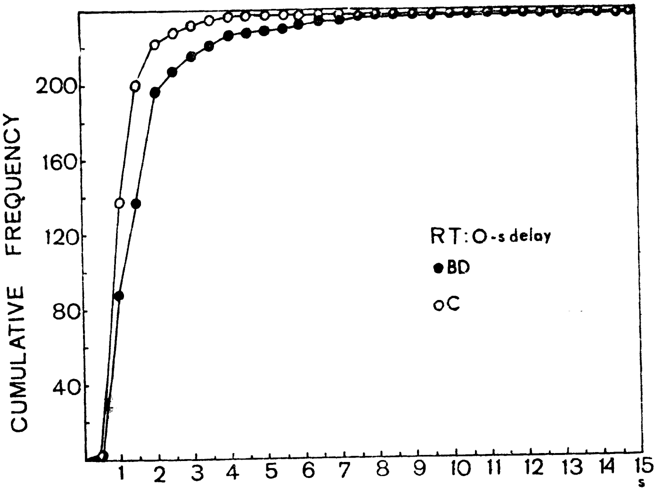

Fig. 6. Response time in binocularly deprived and control group during first 5-delayed response sessions with O-s delay.

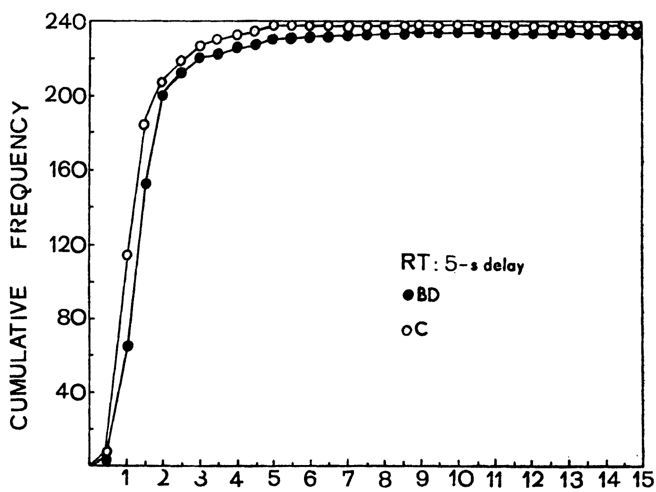

Fig. 7. Response time in binocularly deprived and control group during first 5-delayed response sessions with 5-s delay.

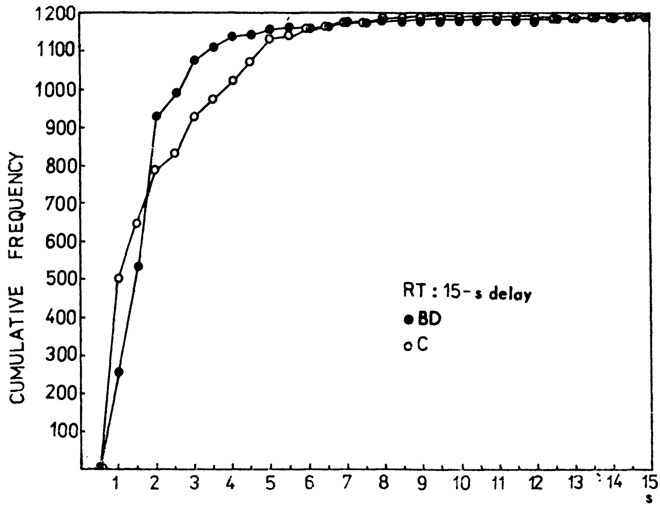

Fig. 8. Response time in binocularly deprived and control group during 25-delayed response sessions with 15-s delay.

It may be seen how very few RTs ranging from 1-1.5 s were observed in the initial series of responding to the actual auditory or light stimuli, as opposed to the RT distribution in the series with delay. This improvement may be the effect of more advanced training, or it may also suggest that cage lifting acquired the properties of a prepotent releasing stimulus (9) reflected in a shorter reaction time of the approach response.

DISCUSSION

The results of the delayed response task involving light stimuli indicate no significant difference in criterion attainment between the visually deprived and control cats. The groups differed in none of the series with 0-, 5-, or 15-s delay (Table II). Thus, it may be concluded that visual deprivation by itself does not produce impairment in delayed response performance. Visually deprived and control groups did not differ also in the earlier stage of training, which required approaching the signalled feeder to actual auditory or visual stimuli in which, unlike as in the delayed response task, both groups were able to reach criterion almost immediately (Table I).

Learning instrumental responses based on the location of stimuli when location cues are spatially contiguous with responses may occur rapidly, because the training does not require differentiation learning (15, 16). An earlier report (18) revealed even the superiority of visually deprived cats over the controls in the learning of spatial discrimination task involving auditory or light stimuli. In the first task of that study (18), irrespective of the modality of stimuli, an immediate criterion achievement was observed in the visually deprived animals, but not in the controls. In the second discrimination task, however, both groups were able to reach criterion immediately. It may be, that higher errors scores observed initially in the control animals were provoked by a relatively short preliminary adaptation period (3-5 days), sufficiently long for the deprived group in which faster habituation was reported (2), but too short for the controls. In the present experiment also a longer adaptation period (10 and 15 days) was required by two control cats.

As opposed to behavior to the actual stimuli, in the delayed response training, where the choice of responses was determined by trace stimuli, many errors were made by the visually deprived and control animals (Table II) with, again, no significant difference between the groups. These results are in striking contrast with the data obtained in the delayed response task on cats raised in free environment, who were able to reach without difficulty the criterion with 30-s (3), or 60-s delay (14, 15). A striking positive difference was also noted during delayed response training in two cats with much earlier natural outdoor experience, which were subsequently included in a cage reared group (25).

The deterioration of the delayed response performance found in our visually deprived and cage-reared control animals, as compared to previously reported results on normally reared subjects, may be the effect of impoverished rearing conditions (see 7, 25). The lack of significant difference between these two groups may indicate that the cage rearing factor, related to both groups, affects in the same degree their delayed response performance. However, although no visual pattern discrimination is involved in the delayed response learning, it cannot be excluded that visual deprivation, which may be also interpreted as a more severe degree of perceptual restriction, might have contributed to the deficiency of visually inexperienced cats. Two poorest performers, BD146, who was unable to master the initial step of learning, and BD165, who made the highest number of errors across training, belonged to the visually deprived group. And conversely, the best performing animal, C170, was in the control group. The rejection of one control cat, C151, was rather unessential since caused not by learning deficit, but by frequent food refusal resulting from being in heat.

Attenuated learning capacity has been often described in animals submitted to different forms of early perceptual restriction (7). It has been reported that kittens raised under reduced stimulation are inferior to controls, exposed to a complex free environment, in task requiring spatial orientation like Hebb-Williams maze (26). Cage reared dogs are inferior to normal controls in a delayed response task (23), detour behavior (27) and spatial reversal (4). Retarded performance in dogs raised in a restricted environment, although not deprived of patterned vision, has been also obtained in a simple visual discrimination task and a successive visual discrimination reversal (17). Also cage-reared cats are impaired in simultaneous visual discrimination learning when compared to normally reared subjects, being, at the same time, superior to visually deprived animals (30).

It is unclear to what degree visual deprivation deficit determined behaviorally and related mainly to discriminatory deficiency within visual modality, may be extended further and include other aspects of conditioning. It has been reported that deprived cats have difficulties in alimentary conditioning of auditory targeting reflexes (2), or that cross modal association of light and auditory stimulus applied during pre-conditioning procedure was less effective in visually inexperienced animals (22). Visual deprivation effect was also reflected in increased locomotor stereotypy, enhancing thus the level of kinesthetic stimulation, interpreted as compensatory mechanism for the deficiency in sensory stimulation of visually inexperienced cats (11).

Reaction time

Although the groups did not differ in delayed response learning, a significant difference was found in RT of both groups, as the deprived subjects performed proportionally fewer responses with shorter RT than the controls. This referred to responses in the experimental series with delays, and to responses to the actual auditory stimulus and cage introduction. However, in the responses to the actual light stimuli series these relations were reversed, i.e. the proportion of responses with relatively shorter RT was higher in the deprived group than in the control one (Table III).

An increased percentage number of shorter RT of the deprived group in responding to the actual light stimulus may indicate a stronger targeting reflex (see 9) evoked in these subjects by the light onset. The deprived cats' tendency, manifested in initial trials with the light signal, to approach the light stimulus source first and the bowl with food afterwards, would also support this possibility.

A similar behavior, manifesting a strong targeting reflex, was observed in an earlier study on puppies a few weeks old, trained in a triple choice situation with buzzers placed on feeders (15). After stimulus onset the puppies climbed the feeder, directly approaching the buzzer and passing over the bowl full of food. It should be added that adult dogs trained in the same experimental situation approached the food directly.

This behavioral difference between puppies and adult dogs suggests that the targeting reflex involved in exploratory behavior (9) occurs in a much more intense form in immature animals. Although in the present experiment there was no age difference between the deprived cats and the controls, the visually deprived cats had much less experience with light stimuli, which might result in a stronger targeting response towards the light stimulus source. Markedly enhanced evoked potentials to the light onset were observed in the EEG recording in light-deprived animals, suggesting an increased excitability of their visual system (13). A higher amplitude of visually evoked potentials was also observed in visual and non-visual cortical areas in cats (20) deprived of pattern vision in the same way, as animals in the present work.

A lower proportion of responses with shorter RT was also observed in deprived cats in another testing situation, which instead of the choice of locomotor response, involved reaching for a meatball, placed at different points outside the wire cage (in preparation). In that test, which required a skilful manipulatory response based on visuo-motor coordination, RT deficiency of visually inexperienced cats was manifested in the limb extension and retraction.

Significantly slower responding in visually deprived cats was recently reported in visual discrimination learning (31) in comparison with a cage-reared or normally reared group. In the cage-reared group, in turn, mean RT was significantly longer than in normally reared subjects. Mean RTs in all these animals decreased as the training was continued, resembling RT decrease at the points of maximal difference in our groups in the successive stages of the experiment.

A difference in mean RTs was also found in detour behavior (23) of restricted dogs, which responded slower in approaching food than normal subjects.

These data indicate that restricting the animals' early experience results in prolongation of their response time in a variety of tasks, in comparison with normally reared subjects. It many be further assumed that the degree of that deficit depends on the severity of the animals sensory restriction, since visually deprived cats were slower than cage-reared controls, and the latters were slower than normally reared subjects (31). However, the direction in RT difference between groups remains still sensitive to experimental conditions, since when our task required an approach response to the actual light source, the performance of visually deprived cats relatively exceeded that of control subjects.

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