

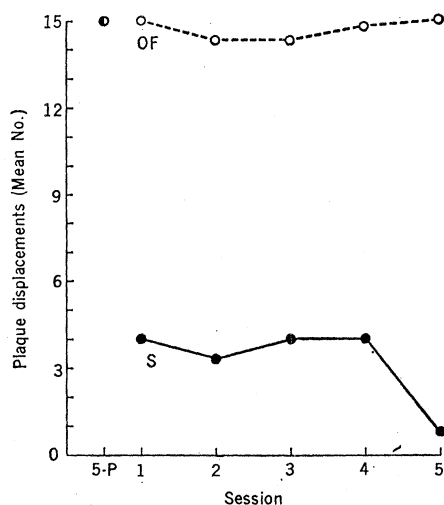


Fig. 1. Mean number of plaque displacements of the sham-operated (S) and orbital-frontal lesioned (OF) groups of monkeys in the last session with food pellets as reinforcement (5-P) and in the subsequent five sessions with capsules as reinforcement.

responded no more than twice on each of the five sessions, while the fourth showed only a slight drop in performance on the first four sessions and then responded only three times on the fifth session. All the lesioned subjects, on the other hand, consistently maintained a high level of responding during all tests with the capsule as reinforcement, and the group difference in frequency of plaque displacement was significant ($F = 17.42$; d.f. = 1/6; $P < .01$). Moreover, the lesioned subjects' response latencies were not consistently altered by changing the reinforcement from pellet to capsule.

These findings indicate that orbital frontal ablation, like amygdalectomy (2), produced increased oral tendencies; however, these oral tendencies were manifested in increased selection of nonfood items, while preference behavior was not affected. This dissociation argues against the view that the increased orality was due to impaired recognition of food versus nonfood, as has been suggested with reference to amygdalectomy (2). Moreover, the lesioned subjects' abnormally heightened selection of nonfood items was not due to increased manipulative tendencies per se, for these animals put into their mouths the nonfood items they picked up. Further, palatability was apparently a factor in the lesioned subjects' selection of nonfood items, since they preferred the cork and the capsule to the bolt.

The lesioned subjects' heightened oral

tendencies were also accompanied by an apparent increase in reinforcement value of one nonfood item; these subjects, unlike the control animals, performed instrumental responses to obtain capsules as readily and as consistently as they had previously to obtain pellets. This persistence in instrumental responding was not due simply to increased resistance to extinction found following orbital frontal ablation (3), for the lesioned monkeys ate the capsules for which they worked so diligently. Moreover, it does not appear that their consumption of capsules was due to increased hunger, for the latencies of their instrumental responses for food pellets were not different from those of the control subjects; nor does orbital frontal ablation increase rates of instrumental responding for food (3).

The finding that lesioned subjects show both heightened selection and heightened reinforcement value of a nonfood item but no alteration in preference behavior suggests that orbital frontal ablation selectively affects control of certain motivational processes while sparing processes involved in discriminative-preference behavior. In other words, it would appear that the suppressive control normally exerted over oral tendencies is impaired and the value of nonfood items is enhanced, whereas the recognition of food-nonfood differences and preferential ordering is spared following orbital frontal removal. This interpretation is consistent with the view that orbital frontal cortex exerts suppressive control over hypothalamic appetitive mechanisms (6). Whether the preferential aspect of oral behavior is controlled by other forebrain structures or is a property of the hypothalamic appetitive mechanism remains to be determined. Finally, the unexpected dissociation between selection of nonfood items and preference following orbital frontal lesions has a parallel in the problem-solving behavior of such lesioned subjects: here, too, the suppression of a variety of response tendencies is impaired, but not the preferential ordering of response tendencies (7).

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27 March 1969

Dark Adaptation: An Interocular Light-Adaptation Effect

Abstract. *Presentation of light to the left eye simultaneously with adaptation of the right eye to light may accelerate dark adaptation in the right eye. The result is that the rod-cone-break and the final threshold of the rods are achieved earlier than when the right eye alone is adapted to light.*

The usual procedure in dark-adaptation studies is to adapt the eye to be tested to light for several minutes. During this period, the other eye is adapted to dark. Consequently, for the greater portion of the dark-adaptation session the adaptation states of the eyes are different. If dark adaptation is completely a peripheral process, as is most frequently supposed (1), then this difference in adaptation state is of no consequence. If, however, the adaptation state involves other processes in which the eyes are not independent, differences in adaptation states may affect the threshold values that form a dark-adaptation curve.

Since Piper (2) first opened the question, it has been debated whether interocular effects exist in dark adaptation. Even when such effects have been supported, they have usually been described as sensitivity losses (3). We have found a situation now in which light adaptation in one eye appears to increase the rate of subsequent dark adaptation in the other eye.

Preliminary light adaptation was for 5 minutes. The left eye saw a circular field subtending a visual angle of 12° and a retinal illuminance of 5.6 log trolands, but saw it only during light adaptation. The right eye was the test eye. During light adaptation it saw a

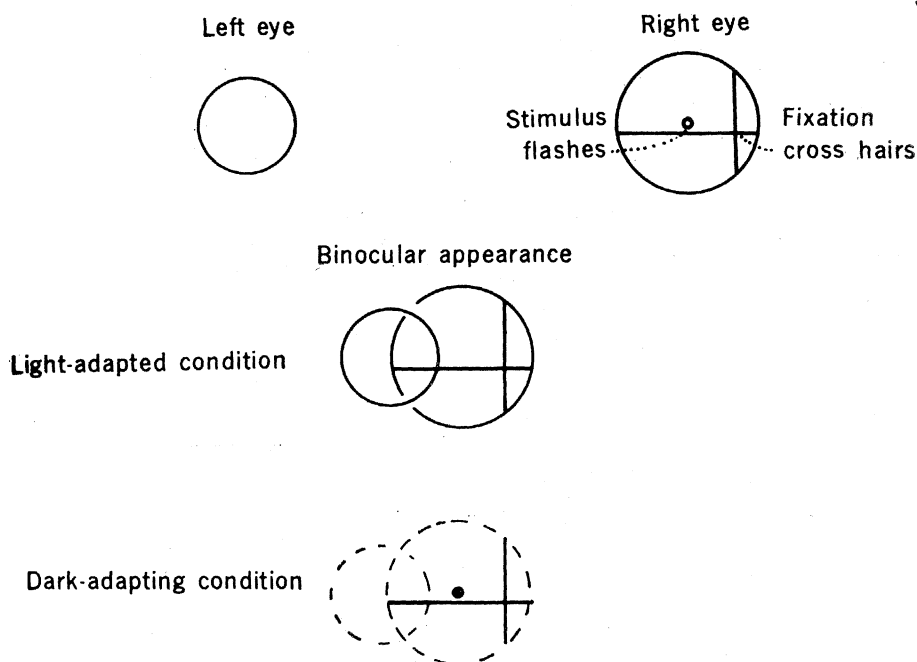


Fig. 1. Appearance of the experimental conditions.

field with a diameter of $17^{\circ}30'$ of arc, with fixation cross hairs 5° from its center (Fig. 1). The binocular appearance during light adaptation is also shown in Fig. 1. The two light-adaptation fields were partially superimposed but not fused. Only the right eye was used during dark adaptation. The cross hairs were illuminated with dim red light, and the stimulus was a flash 1° in diameter and 20 msec long, repeated every $\frac{1}{2}$ second.

Curves of right-eye dark adaptation taken when the adapting fields of both left and right eyes were on during light adaptation were compared with dark-

adaptation curves taken after identical light adaptation of the right eye only.

Threshold judgments were made by the subject adjusting a neutral density wedge until the stimulus flash appeared just perceptible. Judgments were automatically recorded on a Mosely Autograf X-Y recorder. Subjects made and recorded such adjustments throughout 40 minutes of dark adaptation for all experimental conditions. Although no effort was made to control the number of judgments for each session, subjects averaged approximately one judgment every 30 seconds.

Two conditions were used: control, which followed the usual procedure for dark-adaptation studies, and experimental. The subject was comfortably seated in an adjustable chair before the adaptometer, and his head was positioned at the apparatus by an adjustable bite board. In control sessions, the subject's right eye only was adapted to light for 5 minutes before adaptation to dark. Dark-adaptation curves were then recorded during 40 minutes of this adaptation. For the experimental condition, the subject's left eye was simultaneously adapted to light during the same 5 minutes before dark adaptation. Judgments were recorded in the same manner in both experimental and control sessions.

One man and three women participated in the experiment. Except for one woman who could not pass a test for stereopsis, all subjects had essentially normal vision. Before experimentation, each subject was given 10 to 16 dark-adaptation sessions to familiarize him with the apparatus. The effect of the experimental condition was that the dark-adaptation curve shifted laterally so that the rod-cone break and the final rod threshold occurred approximately 3 minutes earlier than in the control condition.

In the graph to the left in Fig. 2, there are two separate curves. The upper curve is the average of seven control curves for subject T.G.L. The lower curve is the average of ten experimental curves for the same subject. Between 4 and 16 minutes into dark adaptation, there is an obvious difference

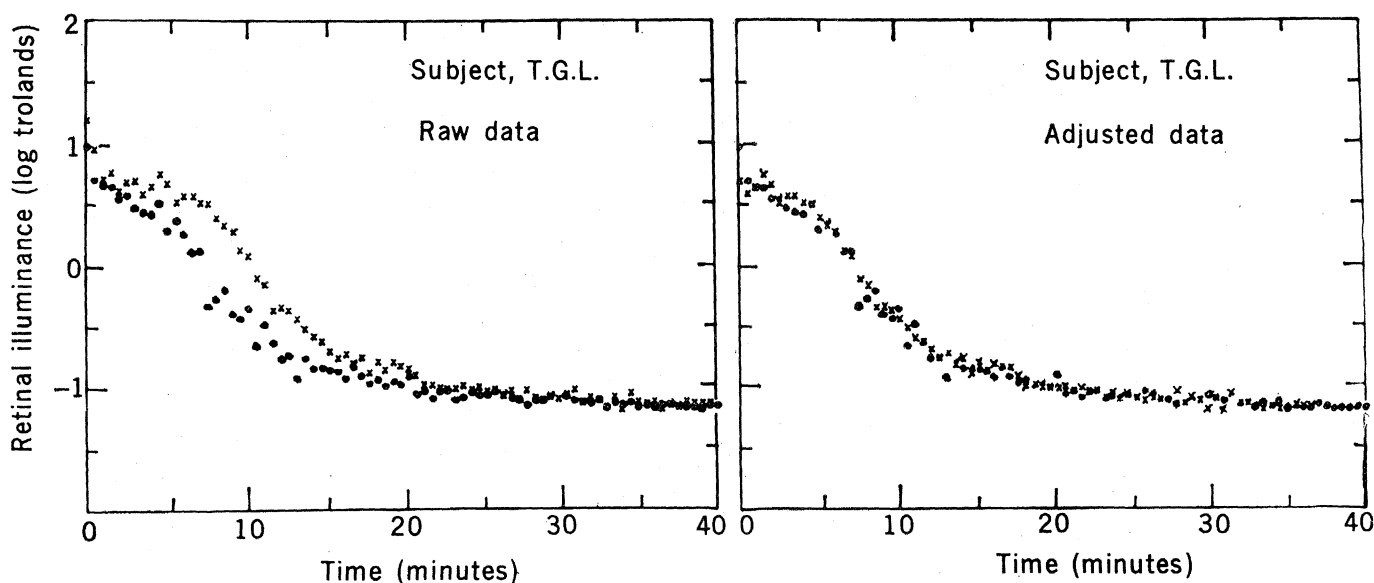


Fig. 2. Averaged threshold judgments for control and experimental conditions. In the left graph, the upper curve (X) represents control threshold judgments; the lower curve (●) represents experimental threshold judgments.

in the amount of retinal illumination required to achieve threshold. The greatest separation occurs at 7.5 minutes, when there is approximately 1 log troland difference.

In one analysis of the data we shifted the curve formed by the control threshold values laterally to 3 minutes earlier (Fig. 2). The shapes of these curves are identical, and the curves essentially are not different. The effect was demonstrated by three of the four subjects. The woman who failed the stereopsis test did not exhibit any effect at all; apparently normal binocular vision is necessary for it (4).

We conducted brief experiments on one subject to determine some of the limits of the effect. We found that light adaptation in the contralateral eye, not only for the 5 minutes of light adaptation but also for the entire 40 minutes of the dark-adaptation period, had no effect on the dark-adaptation curves; this light adaptation was the same as the control.

Since there had been a difference in size and intensity for the light-adapting fields for the left and right eyes in the original study, we determined what, if any, effect equal adaptation states for the two eyes would have. Before dark adaptation, the eyes were simultaneously exposed together for 5 minutes to an adapting field outside the adaptometer. The threshold determinations made under the control and experimental conditions were not significantly different.

Finally, when the inducing field of the contralateral eye was made much brighter (by 1.2 log units) the interocular effect vanished. When the inducing field was dimmed by 0.3 log unit, the time shift appeared unchanged.

The last findings may provide a clue to the nature of the effect. With both of the light-adapting fields similar in luminance but different in size and retinal location, both are clearly seen simultaneously; this is also true when the inducing field was made slightly dimmer. Making the inducing field brighter by 1.2 log units caused rivalry between the fields, and during adaptation to light the subject could see only with one or the other eye alternately. On the other hand, when both dissimilar patterns can be seen superimposed, there is strong local suppression of each light-adapting field by the other. The region where the stimulus will appear is clearly dimmed during light adaptation by local suppression from the inducing field. Dark adaptation is

but a special case of light adaptation—an adjustment to lowered levels of luminance. A light-adapting effect which is directly related to the subjective brightness of the adapting field may be superimposed upon the well-known peripheral light-adaptation processes.

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4. Since the original study was completed, four other subjects have been tested for the facilitating effect. One male subject who had stereopsis did not demonstrate binocular facilitation.
5. We thank Bonnie Lawrence, D. Peeples, and B. Hurley for their assistance. This study was supported by NSF-RPCT GY-2378.

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Communal Nursing in Mice: Influence of Multiple Mothers on the Growth of the Young

Abstract. *Female mice will combine their litters into a communal nest. The young raised in a communal nest show faster rates of growth during the first 20 days than young raised by single females, even when the ratio of mothers to young is the same.*

In certain species of feral rodents (*Mus*, *Peromyscus*), more than one female in a local population may achieve pregnancy at the same time. Under these circumstances, the females may combine their young in a communal nest, which they continue to share for several consecutive litters and often share with the litters of their daughters (1). Findings on albino mice raised in the laboratory have confirmed these observations. On parturition, pregnant mice housed in the same cage would build one nest, combine their litters, and nurse them simultaneously. This phenomenon occurred even when there was a discrepancy of up to 12 days in the age of the young or when the area of the cage was increased several times (2). Because this "socialized" form of maternal behavior occurs so consistently but has not been experimentally analyzed, we determined in what ways communal nursing influ-

ences the development of the young. The results show that the growth rate of mice is enhanced by the presence of more than one mother, even when the ratio of mothers to young is constant.

Nulliparous pregnant mice (inbred strain BALB/c) were removed from community cages 5 to 7 days before parturition and placed in separate cages. On the day of parturition, mothers and their young were combined randomly in various groupings. These consisted of the following ratios of mothers to young: eight litters of one mother with seven pups (1:7); six litters of two mothers with 14 pups (2:14); six litters of three mothers with 21 pups (3:21); six litters of one mother with 14 pups (1:14); and four litters of three mothers with 14 pups (3:14). Seven was chosen as the standard litter size because it approximated the average number of young produced by our primiparous females. The cages (20.5 by 36 by 15.5 cm) contained bedding (Sanicel) and were devoid of any nesting materials (3). The mice were given free access to breeding chow and water. The females and their young were simultaneously introduced into each cage, and the young of each female were placed in separate piles. By the end of their first day together, the females combined their litters into one pile in a corner of the cage. The young in each cage were weighed as a group every other day. The day following parturition was regarded as day 1. Most of the litters were weighed on

Table 1. Body weights of individual *Mus* pups taken at 9 and 19 days of age (mean $\pm$ S.E.).

Group (female: young)	Pups (No.)	Body weights (g)	
		9 days*	19 days†
1 : 14	35	4.59 $\pm$ 0.14	7.98 $\pm$ 0.19
1 : 7	42	5.55 $\pm$ 0.14	10.81 $\pm$ 0.17
2 : 14	70	6.36 $\pm$ 0.10	11.15 $\pm$ 0.10
3 : 21	83	6.77 $\pm$ 0.28	11.96 $\pm$ 0.10
3 : 14	28	7.04 $\pm$ 0.18	12.77 $\pm$ 0.19

* All groups differed significantly ($P < .005$, two-tailed *t*-tests) except for the following: 3:21 and 2:14; and 3:14 and 3:21. † All groups differ significantly from one another ($P < .025$, two-tailed *t*-tests).