probability of reinforcement following the effective response. In the present study, making Ro did not change the reinforcement probabilities, but only exposed S to the stimuli. The results also agreed with Wyckoff's (1952) prediction that Ro formation and the learning of a discrimination must proceed at a common rate so that the greater the discrimination exhibited, the higher the probability of the occurrence of Ro.

The results of the extinction phase of the present experiment disagree with Wyckoff's original analysis. When the discriminative stimuli lost their discriminative function, discrimination broke down, as shown by Fig. 2, above, but the probability of occurrence of Ro remained at its previous (acquisition phase) level. This finding agrees with the results of Kelleher (1958), although he had used only predictive validities of 1.00 in acquisition.

Mackintosh & Holgate (1968) have shown that animals trained on an inconsistently rewarded discrimination (75:25, or directly comparable to Group .75 in the present study) reversed more slowly than those trained on a consistently rewarded discrimination (100:0, or directly comparable to Group 1.00). They report terminal choices of the 100:0 animals as 98.6% to 100% and terminal correct choices of the 75:25 animals as 84.8% to 91.2%. In the present study, Group 1.00 reached a terminal level of 98.7% and Group .75 reached a terminal level of 90% choices of the Ro side. Mackintosh and Holgate explained the faster reversal of the 100:0 group as resulting from a higher probability of attending to the relevant cue at the end of acquisition rather than in terms of a partial reinforcement effect, causing slower extinction of old response tendencies for the 75:25 group. The findings of the present study agree with their analysis.

It would seem, then, that Ro might fruitfully be considered as an alternative for "stimulus analyzer" or "attentional process" in discussions of the overlearning reversal effect. Ro seems to behave in the same way as such intervening variables are thought to behave (Lovejoy, 1968), but is amenable to experimental manipulation and direct measurement and control.

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Prism-induced negative aftereffects without food-reinforced feedback in newly hatched chicks*

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Newly hatched chicks wearing hoods containing 8.5-deg prisms were force-fed a diet of liquified seeds. On the seventh day, the prism hoods were changed to 0-deg control hoods, and those chicks that pecked demonstrated significant negative aftereffects. Since the majority of the group did not peck at seed targets, a subgroup was given 3 additional days of exposure to solid seeds while wearing 8.5-deg prisms. This sample also demonstrated significant negative aftereffects. It was argued that, while passive feeding leads to later failure to recognize or prefer solid-food targets, it did not interfere with negative aftereffect development.

The relative contributions of perceptual information processing and primary reinforcement to prism adaptation in human vision has been the subject of some controversy (Freedman, 1968; Held & Gottlieb, 1958; Taub, 1968). The traditional concepts of reinforcement are challenged by human studies in which actively produced head or body motion within an optically displaced random patterned environment appeared to be the sole necessary antecedent to the development of postprism aftereffects (Held & Rekosh, 1963).

In lower animals such as domestic fowl, this question has not been raised, possibly because of the widespread belief that prism adaptation does not occur in submammalian organisms. However, adaptation to displacing prisms has been clearly demonstrated in domestic fowl (Rossi, 1967, 1968, 1969). It is tempting to assume that such adaptation represents a kind of behavioral shaping contingent on the food reinforcement received. On the other hand, it is equally possible that the chick is demonstrating a general adaptation to its visually displaced environment, which depends primarily on the informative feedback resulting from his entire behavioral pattern. The necessity for food reinforcement would thus be irrelevant to prism compensation in such a lower animal.

The purpose of the present experiment was to determine if adaptation to lateral optical displacement in domestic fowl could be demonstrated in the absence of food reinforcement for pecking responses.

METHOD

Seventy-four newly hatched White Leghorn cockrels (H-56 Stone) were fitted with latex hoods containing binocularly mounted 8.5-deg (15-diopter) prisms. Half were given base-left oriented prisms; half were given base-right oriented prisms. A nonhooded "starter" chick was added to initiate normal interchick social pecking responses, etc. All chicks, including starters, were force-fed by eye dropper a mixture of liquified parakeet seed and water. All chicks had ad lib access to additional water in the rearing cages.

All hooded chicks were tested for pecking accuracy on Days 4 and 7 using Plast-i-clay panels containing single center-mounted parakeet seeds. At the conclusion of the Day 7 tests, the prism hoods were exchanged for matched control hoods containing 0-deg clear blank plates. The Ss again were tested for pecking accuracy.

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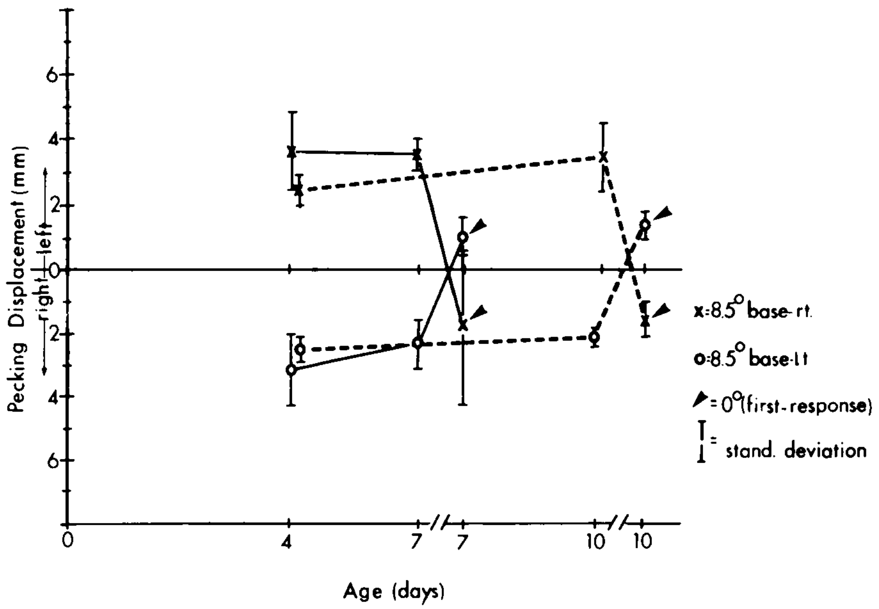

Fig. 1. The solid lines represent the mean lateral displacement pecking errors to seed targets for two prism types during a 7-day exposure period for chicks reared on a passively force-fed diet of liquified seeds, and the mean initial displacement errors to seed targets for the first responses elicited after substitution of 0-deg displacement plates for each prism type. The dashed lines represent the comparable information for a sample of the nonresponding Day 7 chick population which were given 3 days of additional exposure to nonliquified seeds and optical displacement.

Ten chicks which had responded at Day 4 but not at Day 7 were selected for further study. Each chick in the second group was fitted with a new experimental hood of the same prism base configuration as that used in the initial 7-day exposure period. All rehooded chicks were placed in one cage containing bulk parakeet seed and sand. The average surface distribution of the parakeet seeds after daily mixing was 30/6.5 cm^2 of floor area. The latter chicks were retested for pecking accuracy on standardized test targets at Day 10. After the conclusion of the Day 10 test, they were retested with 0-deg control hoods.

RESULTS AND DISCUSSION

The lateral pecking errors found during initial prism exposure at Days 4 and 7 and the initial negative aftereffect for chicks which responded at Day 7 are shown in Fig. 1. These six chicks (four base-right, two base-left) responded with pecking errors in the directions opposite to their initial displacement errors when first wearing 0-deg control hoods. The average negative aftereffect for these chicks was 1.93 mm, which was significantly different from 0 in the optically predicted directions at $p < .05$ ($t = 2.34$; $df = 5$; one-tailed test). The equivalent pecking error for the second group of chicks is represented by the broken lines of Fig. 1. Of these 10 chicks, only 5 (3 base-right, 2 base-left) responded at Day 10. The average negative aftereffect was 1.44 mm, which is significantly different from 0 in the optically predicted directions at $p < .01$ ($t = 4.45$; $df = 4$; one-tailed test).

It has been noted previously (Rossi, 1969) that chicks can demonstrate a significant negative aftereffect without apparent initial adaptation if they continue to grow during the intertest interval.

The fact that 90% of the chicks did not peck at seed targets at Day 7 suggests the development of a food-form preference. Of the 74 chicks which were alive, active, and apparently healthy on Days 4 and 7, 62 responded to the seed targets at Day 4 vs only 7 at Day 7. These results represent a net shift of 55 chicks away from seed targets and 0 chicks toward seed targets. A McNemar test of the significance of changes (Siegel, 1956) indicated a significant shift (towards no responding) at $p < .001$ ($x^2 = 53.01$; $df = 1$; two-tailed test).

As noted above, the dependent variable in this study was the linear error of peck marks impressed in the clay surrounding a solid seed target. It necessarily follows that, if a chick will not or cannot peck at solid seeds, there will be no peck marks to record and no inferences about resulting adaptation. The possibility that the lack of pecking responses at Day 7 was the result of anorexia was rejected. Subsequent tests, consisting of depositing liquified parakeet seed at the side of the chick's beak and observing the rate of self-initiated food removal, revealed that no chick refused to eat the liquified food. The author suggests that the nonresponding chicks had probably also adapted to some extent but had not learned to peck at the solid seed targets. This hypothesis is, in part, confirmed by the fact that subsequent experience with solid seeds (and further prism displacement) in a sample of the formerly nonresponding population led to increased incidence of pecking at solid seeds. As in the earlier cases, all chicks that responded demonstrated significant postprism exposure negative aftereffects.

The results, taken as a whole, suggest that those optically displaced chicks that will respond to solid-seed targets after the first week of age will demonstrate significant negative aftereffects in the absence of food reinforcement. It is thus argued that, while passive feeding led to later failure to recognize or prefer solid food targets, it did not interfere with negative aftereffect development. Thus, pecking for food is not necessary for the development of prism aftereffects.

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