Passive avoidance in chicks as a function of differential rearing

CATHRYN P. BROWN

School of Behavioural Sciences, Macquarie University, North Ryde, N.S.W. 2113, Australia

Chickens were tested, following either communal or isolation rearing, on a passive avoidance task at ages ranging from 12 h to 5 days. Performance was poorer after isolation primarily due to lack of improvement in this group with increased test age. These results confirmed the influence of experience in the development of the maturation-dependent processes underlying passive avoidance. The possible nature of such processes was discussed, and an extension of the generally proposed model based on inhibitory control development was outlined, excessive arousal or stress being implicated in the emergence of such inhibition. The importance of such an analysis for more precise testing of the inhibitory model as previously proposed, and specific predictions from this interpretation based on present results, were discussed.

Performance on passive avoidance tasks, requiring inhibition of "punished" responses has been found in young chickens to be a function of age at testing, with the probability and effectiveness of conditioning increasing with age, from 1 to 3 or 4 days (Fischer, in press; Fischer & Campbell, 1964; Peters & Isaacson, 1963). This trend has been generally interpreted as indicative of maturational development of the inhibitory mechanisms involved in such behavior. Fear conditioning would seem relatively unimportant in this respect, effective active avoidance being apparent in chicks by Day 1 posthatch (Gray, Yates, Vandiver, & Kirwan, 1967; James & Binks, 1963). That inhibition has been observed on Day 1 (Cherkin, 1971; Zolman, Chandler, & Black, 1972) may be due to the fact that shock was not used in these studies. Fischer (in press) argues that further development of inhibitory control may be necessary to override shock-induced arousal or fear developing under passive avoidance procedures.

A considerable body of evidence, originally derived from an epigenetic orientation (Bateson, 1964a; Moltz, 1960, 1963), indicates that certain maturation-dependent processes, for example the termination of the sensitive period for imprinting, may themselves be influenced by early environmental manipulations, with restriction generally retarding development (Bateson, 1964; Guiton, 1959; Moltz & Stettner, 1961; Polt & Hess, 1964; Sluckin & Salzen, 1961). Evidence for the influence of early environment on other primarily maturation-dependent behaviors, such as passive avoidance conditioning, is limited. Of some relevance in this context is the study by Schaller and Emlen (1962) of the development of the capacity for active avoidance of novel or "startle" stimuli in young chicks. No differences were observed between chicks reared in visual isolation and those reared in visual complexity, although the former did demonstrate an increase in final responsiveness relative to the latter. Similarly, Broom (1969) startled chicks at 6 days and found that visually restricted birds showed greater responsiveness for a longer period than did birds raised in more complex environments.

Thus, in view of these previous results, if the development of passive avoidance depends on inhibition of such responsiveness, restricted rearing might well retard development of inhibitory control and thus the emergence of passive avoidance. This experiment considered the effect of environmental manipulation involving visual restriction and isolation on passive avoidance in chicks during the first 5 days posthatch.

METHOD

Subjects

One hundred and five White Leghorn × Black Orpington chicks, a relatively heavy dual-purpose breed, were used. The eggs were obtained from a local hatchery and incubated and hatched in the laboratory. Immediately after hatching, chicks were placed alternately in one of 48 small cardboard boxes (the isolation treatment), or, in order, under one of seven brooders (the communal rearing condition), with eight birds in each of six brood groups and nine in the seventh. Thus, chicks within the community and isolation treatments were approximately matched for time of hatching. Within the former treatment, each brood was roughly equivalent with each other brood in this respect. The nine birds from the seventh community, unfamiliar to all other birds, were used as stimulus birds during testing. This was done in view of the possibility that chicks might develop preferences for, and recognize, other specific chicks.

Apparatus

The individual boxes used for isolation rearing measured 15 × 15 × 15 cm, and the lids of each box were

perforated with 20 small air holes. The floor of each was spread with crumpled and dampened paper towelling. The boxes were placed in tubs under brooder lights, which maintained the temperature at approximately 30°C. All boxes were numbered, and the chicks in the community groups were differentially marked with indelible dye. The hatch time of each chick was recorded. Within each community, all birds were tested at the same age: 12, 24, 38, 72, 96, or 120 h posthatch. An attempt was made to match with these birds, in terms of hatch time, the eight isolates tested at each of these ages.

The test box was a three-compartment Perspex runway, 12.5 cm wide and 25 cm high. The two end boxes, each 30 cm in length and used as the start and goal compartments, were painted white, and the middle box was painted black. The floor of the start- and goalboxes was of chicken wire, and the floor in the middle box was a grid, 25 cm in length, set on the same level as the floor of the startbox floor and 5 cm higher than the goalbox floor. The three boxes were separated by two hand-operated guillotine doors of white Perspex. Clear Perspex lids, into which light globes could be fitted, were placed over the three compartments during testing. Three "stimulus" chicks were placed in the goalbox immediately before testing began. These birds were kept alert and mobile by the hand delivery of a puff of air every 30 sec during test sessions, and thus readily produced approach by the test bird. Testing was carried out in a darkened room, but 100-W globes were suspended in the goal- and gridboxes providing warmth and light. Chicks received an approximately 4-mA electric shock across the grids of the middle compartment, from a constant voltage shock generator, with 18 ohms in series with the animal.

Procedure

The procedures developed by Fischer and Campbell (1964) were followed. Chicks were trained to approach the goalbox with stimulus birds, and were then tested for the speed with which this goal could be "passively avoided" once the approach response was punished. During acquisition training, when the shock was switched off, each chick was placed at the end of the startbox away from, but facing, the middle box. If the test bird failed to enter the middle box within 30 sec, it was prodded into this box, and the procedure was repeated for entry into the goalbox. The test bird was allowed 30 sec in the goalbox. On the second trial, 60 sec was allowed in each box before the test bird was prodded into the next compartment. Acquisition training continued until the chick had reached the goal within 60 sec of placement in the startbox without the need of prodding. Prior to each trial, the chick's feet were dipped in a dish of water. This was found necessary to ensure effectiveness of the shock in avoidance training and, since it was also considered desirable to equate the acquisition and avoidance procedures in variables other than shock delivery, this practice was begun during acquisition.

Passive avoidance training was begun 30 sec after the final acquisition trial, with each chick again placed in the startbox but with the middle box grid now charged. The same procedure was followed as during acquisition, until the test bird had continued to cross the grid for 15 trials, thereby failing to reach criterion, or had remained in the startbox for 5 min, criterion being thereupon reached.

RESULTS

Group means for trials to passive avoidance criterion are presented in Figure 1. Data were treated statistically in a factorial analysis of variance.
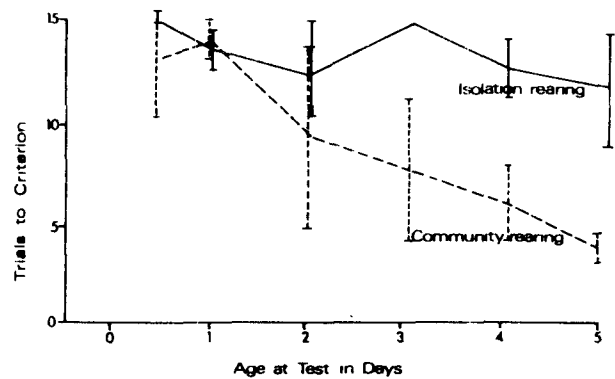

Figure 1. Trials to passive avoidance criterion as a function of rearing. Vertical lines indicate standard errors.

While there was no difference in acquisition performance at the several ages tested, between the two rearing treatments, or as a result of their interaction, both age [$F(5,84) = 7.54$, $p < .001$] and treatment [$F(1,84) = 34.84$, $p < .001$] produced significant differences in avoidance. Although the Age by Treatment interaction did not reach statistical significance, there was a trend towards an increase in the effects of rearing with increased age (Figure 1).

DISCUSSION

The observed absence of change with age in strength of initial approach to the stimulus chicks contrasts with results reported by Fischer and Campbell (1964) and requires some consideration, particularly in view of the fact that age effects in avoidance conditioning in this experiment were found similar to those of the earlier study. The difference in length of runway might be a significant factor in this respect. While that used by Fischer and Campbell (1964) was 4 ft in length, the runway in the present study was 85 cm. Possibly, additional length may serve to maximize age differences in motor capacity, even though the shorter runway fails to differentiate between chicks of different ages on this basis. However, this suggestion is only tentative, particularly in view of the evident motor facility in chicks by 24 h posthatch.

The principal finding of this study relates to the relative retardation in passive avoidance conditioning resulting from visual and social restriction during early rearing. Although there was no difference between the differentially reared groups up to 24 h posthatch, avoidance in communally reared chicks tended to increase progressively after this time, while there was little improvement in avoidance by isolates up to 5 days. The element of environ-

mental stimulation critical to these effects, e.g., general visual complexity, social stimulation, or movement cues, remains to be determined. Such distinctions are, in any case, difficult to draw. In the light of Broom's (1968) results, visual cues to movement present in group rearing conditions are, possibly, more important than stimulus complexity per se, or social behavioral cues. Moving objects may have a greater effect on undisturbed behavior than a collection of stationary objects.

More specifically related to the nature of the mechanism underlying passive avoidance and its emergence, the present findings for passive avoidance parallel reported increases in the persistence of responding in other situations following isolation rearing (Broom, 1969; Schaller & Emlen, 1962). In view of additional evidence for retarded maturation following restricted rearing (e.g., Bateson, 1964a, b; Moltz & Stettner, 1961; Polt & Hess, 1964), the present results confirm the implication of maturation of inhibitory control in passive avoidance. Thus, the observed retardation in passive avoidance development following isolation is best attributable to disruption in the maturation of inhibitory control.

Of additional relevance to this interpretation of passive avoidance, particularly in suggesting further testing of the inhibitory control hypothesis, is an early proposal by Bovard (1959) implicating excessive arousal, fear, or "stress" in response inhibition. It is argued that general inhibition of ongoing and appropriate responses may be the direct result of excessive arousal or stress, leading to nonadaptive behavior generally. This relationship has been confirmed in chicks in studies of pecking (Brown, in press; Brown & Kiely, 1974; Tolman, 1965) and, more relevant, of aversive behavior. Ginsburg, Braud, and Taylor (1974) reported a progressive reduction in general activity, increased freezing, and reduced vocalization under conditions of excessive arousal. Such effects run counter to the normally appropriate behavior, leading to escape or to assistance, produced under moderate levels of fear or arousal.

Extending this argument to passive avoidance, it may be argued, consistent both with previous evidence (e.g., Bateson, 1964a; Guiton, 1959; Polt & Hess, 1964) and with a stress-dependence interpretation, that isolated chicks will show higher levels of arousal in the test situation than will normally reared birds. This greater proneness to stress may prevent the adaptive learning of approach inhibition during passive avoidance testing. As Fischer (in press) argues, additional levels of inhibitory control may be necessary to override the effects of such excessive shock-induced arousal.

In the absence of complete development of such control, social approach will continue.

In the light of the findings reported by Ginsburg, Braud, and Taylor (1974), suggesting behavioral generality in inhibitory effects, an alteration in other responses, e.g., general activity and distress vocalization, might also be apparent following isolation rearing, in conjunction with poorer passive avoidance. Moreover, such responses might be found to be influenced by independent manipulation of arousal levels. Further analysis of this interpretation is clearly indicated in order to establish its usefulness.

REFERENCES

BATESON, P. P. G. Effect of similarity between rearing and testing conditions on chicks' following and avoidance responses. *Journal of Comparative and Physiological Psychology*, 1964, 57, 100-103. (a)

BATESON, P. P. G. Relation between conspicuousness of stimuli and their effectiveness in the imprinting situation. *Journal of Comparative Physiological Psychology*, 1964, 58, 407-411. (b)

HOWARD, E. W. The effects of social stimuli on the response to stress. *Psychological Review*, 1959, 66, 267-277.

BROOM, D. M. Behavior of undisturbed 1-10 day-old chicks in different rearing conditions. *Developmental Psychobiology*, 1968, 1, 287-295.

BROOM, D. M. Effects of visual complexity during rearing on chicks' reactions to environmental change. *Animal Behavior*, 1969, 17, 773-780.

BROWN, C. P. Social facilitation in chickens: Stress as an intervening variable. In M. G. King (Ed.), *The psychobiology of stress*. Sydney: Academic Press, in press.

BROWN, C. P. & KIELY, P. C. The role of early experience and emotionality in social facilitation of pecking in chickens. *Animal Behavior*, 1974, 22, 100-109.

CHERKIN, A. Biphasic time course of performance after one-trial avoidance training in the chick. *Communications in Behavioral Biology*, 1971, 5, 379-381.

FISCHER, J. The behaviour of chickens. In E. S. E. Hafez (Ed.), *The behaviour of domestic animals*. London: Baillière, Tindall & Cassell, in press.

FISCHER, J., & CAMPBELL, G. L. The development of passive avoidance conditioning in Leghorn chicks. *Animal Behaviour*, 1964, 12, 268-269.

GINSBURG, H. J., BRAUD, W. G., & TAYLOR, R. D. Inhibition of distress vocalisation in the open field as a function of heightened fear or arousal in domestic fowl. (*Gallus gallus*). *Animal Behaviour*, 1974, 22, 745-749.

GRAY, P. H., YATES, A. T., VANDIVER, D. R., & KIRWAN, K. A reverse Kamin effect in the escape and avoidance conditioning of newly hatched chicks. *Psychonomic Science*, 1967, 9, 507-508.

GUITON, P. Socialisation and imprinting in Brown Leghorn chicks. *Animal Behaviour*, 1959, 7, 26-34.

JAMES, H., & BINKS, C. Escape and avoidance learning in newly hatched chicks. *Science*, 1963, 139, 1293-1294.

MOLTZ, H. Imprinting: Empirical basis and theoretical significance. *Psychological Bulletin*, 1960, 57, 291-314.

MOLTZ, H. Imprinting: An epigenetic approach. *Psychological Review*, 1963, 70, 123-138.

MOLTZ, H., & STETTNER, L. J. The influence of patterned light deprivation on the critical period for imprinting. *Journal of Comparative and Physiological Psychology*, 1961, 54, 279-283.

PETERS, J. J., & ISAACSON, R. L. Acquisition of active and passive responses in two breeds of chickens. *Journal of Comparative and Physiological Psychology*, 1963, **56**, 793-796.

POLT, J. M., & HESS, E. H. Following and imprinting: Effects of light and social experience. *Science*, 1964, **143**, 1185-1187.

SCHALLER, G. B., & EMLEN, J. T. The ontogeny of avoidance behaviour in some precocial birds. *Animal Behaviour*, 1962, **10**, 370-381.

SLUCKIN, W., & SALZEN, E. A. Imprinting and perceptual learning. *Quarterly Journal of Experimental Psychology*, 1961, **13**, 65-77.

TOLMAN, C. W. Emotional behaviour and social facilitation of feeding in domestic chicks. *Animal Behaviour*, 1965, **13**, 493-496.

ZOLMAN, J. F., CHANDLER, D., & BLACK, D. Visual discrimination learning of the young chick: Key-pecking conditioning with heat-light reinforcement. *Developmental Psychobiology*, 1972, **5**, 181-187.