

The effects of early environmental manipulation on the peck-order hierarchies in domestic chickens

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Chickens were isolated, imprinted, or reared in a group for a 2-week period posthatch. At the age of 9 weeks, the two most dominant Ss as well as the two most submissive Ss were selected from each group. Paired encounters were staged between all the dominant Ss and between all the submissive Ss. The dominant-imprinted and group-reared Ss scored more wins than did the dominant-isolated Ss. In the submissive group, isolated and imprinted Ss scored more wins than the group-reared Ss.

Guhl (1958) has reported that in the domestic hen, a group hierarchy is usually established when Ss are approximately 9 weeks old. Schjelderup-Ebbe (1935) has suggested that dominance relations, which form the basis of the peck-order in a flock, are usually stable and relatively permanent once established. A number of factors appear to be involved in attaining social status in a group. Maier & Maier (1970) mention the following: body weight, state of health, age, familiarity with surroundings, and pressure of penmates.

From the literature, it appears that certain experiences in early life have significant influence on later behavior of the organism. Maier & Maier (1970) report that chickens reared in isolation shortly after hatching become restless and show retarded physical growth. Kuo (1960a, b) reports a number of experiments which indicate that isolation compared with group rearing produces Ss that are more aggressive and are better fighters. Guhl (1958) has indicated that the level of agonistic activity is higher among isolated chickens when compared with group-reared chickens.

Since early environment is important in shaping the development of Ss, it should be possible to enhance or diminish certain behavioral characteristics of Ss through manipulation of the early environment. For example, if size is an important factor in achieving dominance, given appropriate environmental conditions, it should be possible to produce Ss that would be heavier and physically larger. Such an approach may reveal the factors involved in the development of dominance and aggression in chickens.

The purpose of this investigation was to examine the effects of early environmental manipulation on dominance hierarchies in later life. The early environment of chickens was manipulated for 14 days posthatch

using three methods: rearing Ss in isolation, imprinting Ss to an artificial model, and rearing Ss in a "normal" group setting. At the age of 9 weeks, the two most dominant and the two most submissive Ss were selected from each group, and paired encounters were staged between Ss. It was expected that the dominant Ss reared in a group setting would dominate Ss from the imprinted group, which in turn would dominate Ss from the isolated group. A similar trend was also predicted for the submissive Ss.

SUBJECTS

A sample of 56 commercially crossbred chickens was removed from an incubator when fluffy-dry, 4-6 h posthatch. The Ss were allocated randomly to three conditions: 21 Ss were isolated, 21 Ss were imprinted, and 14 Ss were kept together in a group. At 4 weeks of age, the chickens were sexed, and only hens were used in the experiment. Except for feeding and routine cleaning, Ss were not disturbed.

APPARATUS

Individual cubicles, 17.5 x 12.5 x 22.5 cm, with wood shaving floors were used to house isolated and imprinted Ss for the first 14 days. A similar cubicle, 55.0 x 62.5 x 22.5 cm, housed the group Ss. Three wire mesh enclosures, 30 x 60 x 135 cm, were used to house Ss from 14 days posthatch. These enclosures consisted of an open area and a wooden shelter.

A plywood enclosure, 270 x 60 x 60 cm, was used for imprinting trials as well as for paired encounters. During the imprinting trials, a partially inflated blue balloon, 15 cm in diam, was rotated around the enclosure by means of a motor to which three pulleys were connected by a belt. The balloon was suspended 5 cm above floor level and traveled at 7.5 cm per sec. The floor was divided into 15-cm square units. An Advance decade timer was used to record the

number of seconds S spent following the balloon within 30 cm.

PROCEDURE

All Ss were weighed when 4-6 h old and then were allocated randomly to the three groups: isolated (IS), imprinted (IM), and group (GP). The experimental design involved three stages.

Stage 1

This stage consisted of a 14-day period during which time the IS Ss were deprived of visual and tactile, but not auditory, stimulation of other chickens. The IM Ss were exposed to a blue balloon on 2 consecutive days. On the first day, an exposure of 20 min duration (two periods of 9 min object moving, 1 min object stationary) was conducted when Ss were 12-19 h old. On the second day, Ss were reexposed for a further 10 min (9 min object moving, 1 min object stationary) when Ss were 24-28 h old. In all other respects, the IM Ss were treated in exactly the same way as the IS Ss. The GP Ss were housed collectively during the first 14 days.

Stage 2

At 2 weeks of age, all Ss were numbered and were transferred to three identical wire mesh enclosures and housed together in groups. At the age of 5 weeks, feed bowls, which had been kept inside the enclosures, were removed and were now placed outside of the enclosures. An opening, 5 cm in diam, was made in the wire mesh which allowed only a single S to obtain feed at any given time. Daily records were taken for 2 weeks of the number of seconds Ss spent feeding at the point source. The Ss that spent the greatest amount of time at the feed point were considered the most dominant. When Ss were 7 weeks old, three additional point sources, 5 cm in diam, were made so as to reduce competition for feed. Daily records were again taken for 2 weeks of Ss that failed to readily obtain feed. The Ss that spent the least amount of time at the point sources were regarded as the most submissive.

Stage 3

On the ninth week, Ss were weighed and the two most dominant as well as the two most submissive Ss were selected from each group. A total of 15 encounters were staged among the dominant Ss from all groups, as well as among the submissive Ss from all groups. An encounter involved a simultaneous release of each S from opposite ends of the neutral enclosure. The maximum time allowed for a paired encounter was 5 min. However, any decisive encounter was terminated immediately. The outcome of the encounters was scored in terms of wins, losses, and no outcomes. To

Table 1
Outcome of Paired Encounters and in Brackets Mean Weight in Grams

	Dominant Ss			Submissive Ss		
	IS	IM	GP	IS	IM	GP
Wins	2 (756)	5 (829)	6 (735)	7 (654)	7 (540)	1 (560)
Losses	6 (794)	3 (868)	4 (833)	3 (667)	3 (560)	9 (528)
No Outcome	2 (784)	2 (896)	0 —	0 —	0 —	0 —

avoid peck-lag effect, Ss were not used in consecutive pairings.

RESULTS

The paired encounter results are set out in Table 1. It can be seen that in the dominant group, IM and GP Ss scored more wins than the IS Ss. However, in the submissive group, IS and IM Ss scored more wins than the GP Ss.

An arc sine transformation of scores was carried out, and two analyses of variance were done on the number of wins. There was no significant difference ($F = 1.94$, $df = 2$, ∞ , $p > .01$) for the dominant Ss between the three groups. However, in the submissive group, the difference was found to be significant ($F = 5.75$, $df = 2$, ∞ , $p < .01$). The IS and IM Ss scored significantly more wins than the GP Ss.

The degree of imprinting was determined during Stage 1. First, on Day 1, all Ss followed the imprinting balloon within 30 cm for at least 50% of the time. Secondly, the mean number of units followed within 30 cm of the balloon increased by 65% from the first 10-min exposure (Day 1) to the last 10-min exposure (Day 2). Both measures indicated an increased attachment to the balloon from Day 1 to Day 2 and satisfied the criterion of imprinting suggested by Jaynes (1957).

At the time when paired encounters were staged (Ss were 9 weeks old), the dominant Ss tended to be heavier than the submissive Ss. However, it can be seen in Table 1 that the heaviest Ss were not always the winners of the paired encounters.

DISCUSSION

The paired encounter results are in partial agreement with the original predictions and on the whole appear to be quite complex. One outcome is clear, however: the same early environmental treatment does not have the same effect on aggression in the dominant and submissive Ss. The dominance-submission factor appears to interact quite differently in the two groups with isolation, imprinting, and group-rearing experience.

There is a marked trend, although not a significant one, for the dominant IM and GP Ss to score more wins than IS Ss, while in the submissive group, IS and IM Ss scored significantly more wins than GP Ss. It can be seen that in

each group, two early environmental treatments produced similar effects; therefore, it is quite likely that a common factor is involved. In the dominant group, both IM and GP Ss had an opportunity to imprint in early life—the former group to a balloon and the latter to other chickens. In the submissive group, IS and IM Ss shared a common experience of isolation. Except for a brief exposure to the balloon on Days 1 and 2, for the remainder of the 14 days, IM Ss were treated the same way as IS Ss. It is thus quite possible that imprinting experience played a significant role in producing more aggressive Ss in the dominant group, while isolation had a similar effect in the submissive group. Such analysis, although based on limited evidence, does offer an explanation for the obtained differences, and it also suggests some guidelines for further research.

Some data obtained in this investigation is in agreement with studies reported in the literature. Kuo (1960a) found that isolation compared with group rearing tended to increase fighting behavior. The submissive group results support this; however, the dominant group results do not. The evidence obtained here shows that while a single factor, e.g., isolation or imprinting, may have important influence in shaping S's aggressive behavior, a combination of factors may have a much greater influence. Kuo (1960a) has shown that isolation and training produced better fighters than either experience alone. In this study, the relative performance in winning paired encounters for IM Ss was about the same in both groups. The imprinting experience can hardly be equated with fighting training in Kuo's experiments; however, the possibility does exist that imprinting and isolation interacted in some way and produced more consistent fighters. There are, of course, other explanations possible. For example, Kuo (1960b) also found that more and better fighting took place in familiar surroundings. It could be argued that IM Ss, which were exposed in the alley during imprinting training on Days 1 and 2, did remember this experience during the 9 weeks and therefore regarded the alley as familiar, showing more consistent fighting in it on reexposure. Furthermore, imprinting

training involved additional handling, and this experience may have contributed also. It is difficult to assess the extent of the contribution each of the above factors may have had in modifying Ss' behavior. However, it does appear that a number of factors may interact. Which factors and at what level such interaction takes place requires further investigation.

Maier & Maier (1970) have indicated that body weight is one of the factors which determines dominance. To some extent, this is supported by the present data, i.e., the dominant Ss tended to be heavier than submissive Ss. Within each group, however, the situation is far more complex. Strobel, Freedman, & Macdonald (1970) have shown that isolation tends to retard physical growth, while imprinting experience and group rearing tends to facilitate it. Wong & Arnsel (1971) have also found that imprinted Ss started eating earlier than isolated Ss. According to these studies, it would be expected that IM and GP Ss would be heavier than IS Ss, and if weight is important, it would follow that IM and GP Ss should win more paired encounters than IS Ss. No such trend was found in this study. In the dominant group, IM Ss were the heaviest, while in the submissive group, IS Ss were the heaviest. There was no direct relationship between weight and winning and losing paired encounters. The weight, as a variable determining aggression, cannot be ruled out, but it does not appear that weight alone is the key factor. The obtained evidence suggests that aggression in chickens is determined by a complex interaction of environmental factors. It is considered that only through carefully controlled studies may it be possible to establish which factors are most important.

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