VISUAL PATTERNS IN THE RECOGNITION OF INDIVIDUALS AMONG CHICKENS

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The establishment of a peck-order in the domestic chicken obviously is based on individual recognition, as the flockmates learn to peck their social inferiors and to avoid those to which they are subordinate. Schjelderup-Ebbe (1923) found that when the loppy comb of a hen was turned and fastened to the other side of the head, she was not recognized by the members of her flock. Guhl (1953) reported that dubbed hens were attacked by their inferiors when returned to the pen; and when several hens were dubbed they developed a peck-order, indicating that the comb was not the sole means of individual recognition. The experiment reported here was an attempt to explore further the visible features which affect individual recognition in chickens.

Thorpe (1951) reviewed evidences of various types of recognition, such as the perception of mates, of eggs, of other species of birds, and of other individuals within the flock. He considered it probable that personal recognition by structural and color characteristics is the exception. Auditory clues appear to be important in some species. Armstrong (1947) in his review concluded that deportment in many species appeared to provide the main clues for individual recognition. Various aspects of recognition also were discussed by Nice (1943). Much of the evidence cited in these reviews was taken from reports of general observations rather than from experimental studies. Techniques have been devised for the study of sex recognition by Noble (1936), and Noble and Vogt (1935); of predator recognition with the use of models by Nice and Ter Pelkwyk (1941), by Kramer and von St. Paul (1951), and by Hartley (1950); of familial recognition by Cushing and Ramsay (1949) and by Ramsay (1951); and of individual recognition by Bennett (1939).

Birds which form a social hierarchy, such as chickens, doves, and pigeons, usually attack a strange bird of the same species or breed that is introduced into the pen or cage. An experimentally modified bird which is attacked upon return to its group has been considered as being unrecognized by its penmates. Bennett (1939) altered appearances of ring doves by dyeing the feathers and by modifying contour with feathers glued to the tips of feathers to produce a ruffled appearance. Feathers were plucked in some areas to change contour. She concluded that differences in color or contour are not factors of considerable importance in recognition of individuals in flocks of ring doves. As these birds exhibit peck-dominance rather than peck-right, Bennett found it difficult to determine precisely whether non-recognition occurred and temporary disturbance of the social order was used as a criterion for loss of recognition.

Chickens were used in the present experiment as these birds readily attack a stranger and form a rather stable peck-order based on peck-right. The attention was focused on the visible features which may play a significant role in individual recognition.

BIRDS USED AND THEIR TREATMENT

Three small flocks of 8, 10, and 12 White Leghorn pullets were used. These were five months old at the beginning of the study and were reared and maintained in a basement laboratory under time-controlled artificial lighting. Unisexual flocks of the same age and raised from chicks in the same groups eliminated probable complications involving sex and marked differences in experience.

Peck-orders were determined and dominance relationships observed throughout the experiment, as shifts in social status following alterations on an individual served as the best indication of a loss of recognition. Pecking relationships are very stable in flocks

of 12 or fewer birds and subordinate individuals habitually give way to their social superiors. Dominant birds in well acquainted flocks may maintain their positions by threatening behavior only. In this report it is assumed that an animal gives evidence of individual recognition of another of the same species when it consistently displays either aggressive or submissive reactions toward it, provided that the individuals of the species usually show a tendency to attack unfamiliar individuals. The term "recognition" here does not necessarily connote an element of consciousness.

From previous experience it was known, and the results given here agree with those observations, that a modified bird will tend to avoid its superiors, as it did by habit previously, and that it will fight readily with any inferior which tries to challenge its dominance. Therefore, it would rarely gain in dominance over its superiors but may lose social status to an inferior. Indeed, if engaged vigorously with several inferiors and pursued by its superiors it may assume a low rank in the peck-order. Fighting with inferiors in a small flocks with a stable social organization is a good criterion for a lack of recognition, and a loss of social status is deemed conclusive.

Alterations were made in contour and/or color. Contour changes were produced by adding features which were taken from other birds and glued to the same areas on the test-bird. Feathers were added to extend such areas as the tail or to enlarge other areas by giving a fluffy appearance when glued with the rachis turned outward (see fig. 1). Contour also was altered by denuding certain areas. The rachises of the feathers were cut above the quill so as to leave all or part of the aftershaft and thereby not changing body color to skin color. The shape of the comb was changed with the use of transparent tape binding the comb in the form of a cone or crown. Dummy combs of red felt or flannel were sewed on the comb to obtain an increase in size. A pattern was made of the largest comb in the flock. Color was added with alcohol solutions of methyl green, gentian violet, picric acid, and mercurochrome; stove polish was used to blacken certain feathers. Simultaneous alterations of contour and color were made by gluing feathers from colored breeds. It is significant to note that these changes were abrupt. Changes in contour which occur normally, such as molting, are very gradual in most birds.

Alterations were made first on posterior areas, then on general body areas, on the entire trunk, the neck, and finally on the features of the head. The results are summarized in brief tables. The altered birds were out of the pen only for the time required to make the changes and to allow the glue or dye to dry. In some cases additional time was required for the pullet to become adjusted to the changes. Before the bird was returned to the flock, the group was given some grain to distract attention from the readmission. The test-bird was quieted and placed gently on the floor just inside the door of the pen. The flock was then observed for two or more consecutive hours. When the test resulted in social disruption and changes in social position, no further tests were made in that flock until the new peck-order became stabilized.

ALTERATIONS OF SPECIFIC BODY AREAS

The results of plumage modifications on such areas as the tail, wings, saddle, back, and breast are given in table 1. Six of these 14 tests involved a change of contour only, namely, addition of white feathers or denudation. Eight included color alterations as well as contour (see fig. 1*a*, *b*, and *c*). In none of these was the altered bird challenged. Reactions followed the patterns of social behavior existing prior to the alteration of plumage. There were, however, reactions to the modifications. The flockmates picked, with an indication of curiosity, at the added feathers. Of particular interest were reactions to tail extensions with red feathers. Upon admission to the pen the pullets avoided the individual with the red tail and the bearer also ran when she caught sight of her

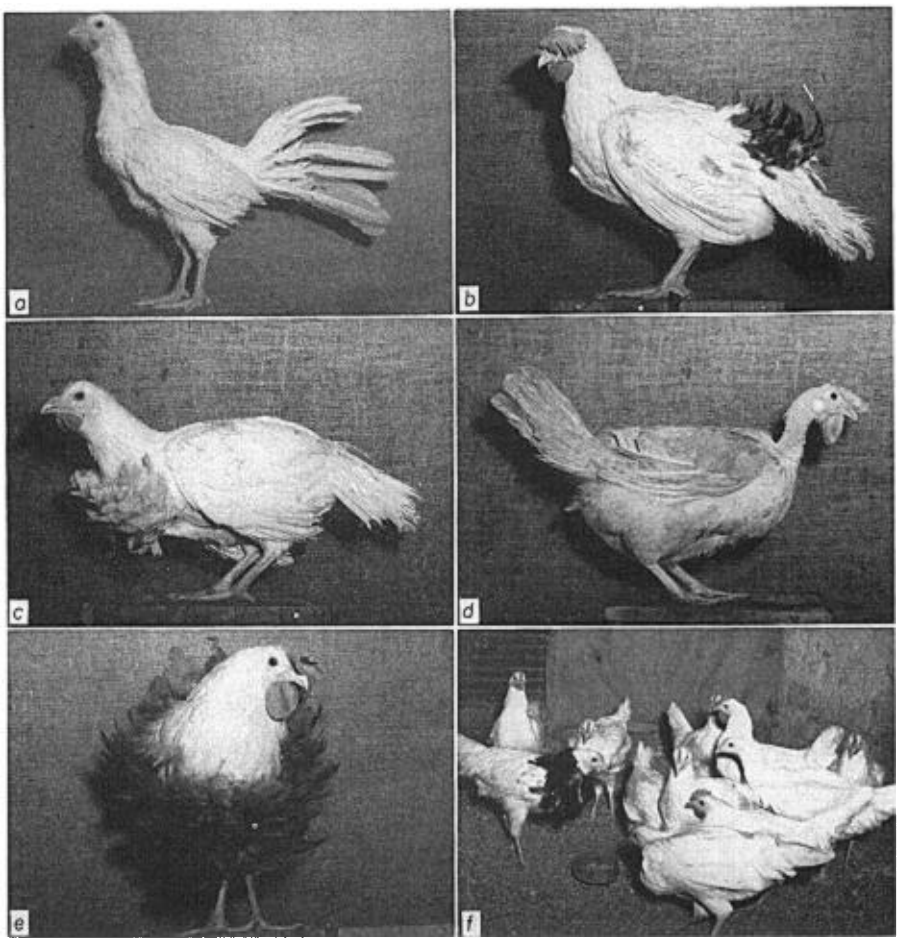

Fig. 1. Alterations made to test for patterns of recognition: (*a*) change in contour by addition of white feathers to tail; (*b*) change in contour and color by addition of red feathers to saddle region; (*c*) contour altered by addition of white feathers to breast; (*d*) denudation of the neck to alter contour; (*e*) trunk modified by addition of red feathers to alter contour and color; (*f*) penmates avoided a pullet after her neck was disguised by addition of red feathers.

new tail feathers. No threatening or aggressive posturing was observed. After several days the innovation was accepted. Some weeks later the red tail feathers were removed and glued to another member of the flock. The pullets showed no particular reaction to either the former bearer nor to the new bearer of the red tail feathers. It was concluded that the earlier reactions were to the tail and not to the individual. The results demonstrate that these birds learn to recognize alterations.

ALTERATIONS OF THE TRUNK

As changes in local areas of the trunk failed to give evidence of a loss of recognition, the next phase of the experiment was to increase the size of the area. Accordingly the whole trunk was altered (fig. 1*e*). The results are summarized in table 2. Five of the 13 tests gave indications of a loss of recognition. One of these tests involved a change

of contour plus a change from white to black plumage. This bird lost social rank in one of its three encounters. Denudation failed to produce a loss of individual recognition. Birds dyed green or black were challenged when returned to the pen. The green and black were intense and produced a marked contrast, whereas the red, violet, and yellow had less intensity or depth of color. One of the birds dyed green lost social position to one of its inferiors, and the other green pullet (in omega rank) won both of her encounters and therefore advanced in the peck-order. Of the two black pullets, one lost its single encounter and the other lost all of its encounters and became the omega individual in the social order.

Table 1

Results of Alterations on Plumage in Various Body Areas

Area	Alteration	Results
Tail	Extended with	
	White feathers	No challenge
	Red feathers	No challenge
	Red feathers	No challenge
	Denuded	No challenge
Wings	Extended with	
	White feathers	No challenge
	Red feathers	No challenge
	Denuded	No challenge
Saddle	Extended with	
	White feathers	No challenge
	Red feathers	No challenge
Back	Extended with	
	White feathers	No challenge
	Red feathers	No challenge
Breast	Extended with	
	White feathers	No challenge
	Red feathers	No challenge
	Denuded	No challenge

Changes in contour only produced no loss of recognition. Marked changes, as with dark green and black dyes, resulted in a loss of recognition. The red feathers added to the trunk were of relatively deep color (see fig. 1*e*), and no satisfactory explanation can be given for a lack of reactions to the two birds altered in this manner. It is prob-

Table 2

Reactions to Alterations of the Trunk

	Alteration	Results
Feathers extended	White	No challenge
	Red	No challenge
	Red	No challenge
	Black	3 encounters with inferiors (11)*
Feathered dyed	Red	No challenge
	Violet	No challenge
	Yellow	No challenge
	Green	2 encounters with inferiors (2)
	Green	2 encounters with superiors (0)
	Black	1 encounter with an inferior (6)
	Black	4 encounters with inferiors (4)
Denuded trunk except wings and tail		No challenge
Denuded trunk and wings and tail		No challenge

* Number of flockmates over which the test-bird was socially dominant previous to the test.

able that there might have been a loss of recognition but that the penmates were not stimulated sufficiently to attack. Past experience has given the impression that hens in small flocks with a stable peck-order attack a stranger less readily than do those in similar flocks which undergo a regular system of rotation in the membership of the flock. Dominance relations may be settled without a fight. Some birds will give way without any aggressive behavior; others will submit readily after receiving a single peck. Whenever these reactions occur, it is impossible to determine whether a peck or a threat by a superior, or submission by an inferior, is an extension of previous habits or a new reaction toward an unfamiliar individual.

ALTERATIONS ON THE NECK

It is not unusual for chickens to lose many of their hackles, sometimes exposing more or less of the skin. This condition is known as a neck-molt and may or may not be accompanied by a reduction of comb size. Modifications on the neck may therefore present some significant information which may be more applicable to normal situations.

Table 3

Reactions to Alterations on the Neck

	Alteration	Results
Denuded	Partially	No challenge
	Completely	1 encounter with inferiors (3)*
	Completely	2 encounters with inferiors (2)
Extended (ruffled)	White feathers	No challenge
Dyed	Dark red	2 encounters with inferiors (5) Driven by 2 of 4 superiors
Added white feathers to cover the red color		1 encounter with an inferior (4) Driven by some superiors
Extended	Red feathers	Avoided by all penmates (4) Became the alpha bird
Removed the red feathers		Lost rank to 4 birds

* Number of birds over which the test-bird was socially dominant previous to the test.

However, the changes which occur normally are produced much more slowly than those made in this experiment. The growth of new feathers also produces a very gradual change in appearance. Such almost imperceptible but cumulative changes permit gradual adjustments by the flockmates.

The reactions to modifications on the neck are summarized in table 3. Complete denudation (fig. 1*d*) resulted in some loss of recognition in each of two tests made, whereas a partial removal of hackles or the addition of white feathers on the neck failed to produce any encounters. The hackles of one pullet were dyed dark red. She had two encounters with inferiors and was driven by two of her superiors. She lost one of the encounters. When the pecking relationships became stabilized the dyed red hackles were covered by additional white feathers. Upon return to the flock she was engaged in a fight with one inferior and was driven again by some of her superiors, indicating a loss of recognition in both instances. A change of contour and color was made on another pullet by gluing red feathers to her hackles (fig. 1*f*). She was avoided by 11 penmates and became the ranking individual in the peck-order. This most striking result may have been caused, in part, from the fact that she simulated a bird with the hackle raised. Such posturing is typical of a threatening individual. However, the addition of white feathers

on the neck of another pullet in this set failed to evoke a challenge or any pronounced avoidance. Furthermore, when the red feathers were removed from the neck of the former pullet she lost rank to four individuals.

Six of the eight tests made on the neck gave evidence of a loss of recognition. Apparently the neck region had a higher valence for recognition than did more posterior regions of the body. The alterations which were effective were very marked, however, and would not normally occur on a chicken.

ALTERATIONS ON THE HEAD

The head of a chicken is indeed small when compared with the trunk, and when compared, by anatomical proportions, with the head of many vertebrates. Alterations of the head proper, areas of the head such as the face or crest, and of head accessories such as the wattles and comb, are not very striking to the human eye. The changes made

Table 4

Reactions to Alterations on the Head

Area	Alteration	Results
Feathers of entire head	Denuded	No challenge
	Dyed green	3 encounters with inferiors (5)*
Face	Added red feathers	No challenge
	Added red feathers	No challenge
	Dyed green	3 encounters with inferiors (6)
Crest	Added white feathers (ruffled)	No challenge
		2 encounters with inferiors (6)
	Added dark red feathers (ruffled)	3 encounters with inferiors (4)
		Driven by superiors
	Dyed green	
Wattles	Painted white	No challenge
	Dummy wattles	No challenge

* Number of birds over which the test-bird was socially dominant previous to the test.

on the head, and the reactions to them are given in table 4. Denudation did not result in a loss of recognition, but when the feathers of the entire head were dyed green there was good evidence of a loss of recognition. The addition of red feathers, which also enlarged the face, failed to evoke a challenge. However, a bird with the facial feathers dyed green had three encounters. As mentioned previously, the intensity of the colors used was not the same. The dark green probably made a greater contrast than did the red feathers. Further studies in recognition probably should give more attention to the qualities of the colors used.

A pullet with white feathers added to those of the crest failed to evoke a reaction. When these were replaced, on the same bird, with dark red feathers, she was challenged by two inferiors. Another pullet with the crest dyed green also met with encounters. Modifications of the wattles, as with white paint or with large dummy wattles (sewed to her wattles), gave no indication of a loss of recognition.

The features of the head, although small in relation to body areas, appeared to play a significant role in recognition. Certainly the anterior parts, including the neck, were more important in individual recognition than were the posterior areas.

ALTERATION OF THE COMB

Several kinds of alterations were made on the comb. Changes in contour and color were made. The simplest disguise was made by shifting the loppy comb to the other side and fastening it in the new position with transparent adhesive tape. In one of two such

tests there was no challenge and in the other there was one encounter (table 5). Two tests were made with combs shaped like a crown; that is, the blade was curved anteriorly and bound in place with tape. There was no evident loss of recognition in one individual, whereas the other pullet had four encounters. The comb of each of three birds was bound in the shape of a cone, similar to the crown except that the points of the comb met at the apex. This change failed to produce an encounter with one bird and each of the other two birds had two encounters. The three individuals which failed to evoke a challenge were all in the same flock, one in which the birds were relatively inactive socially.

A comb painted white resulted in one encounter, and one painted green evoked three encounters.

Table 5

Reactions to Alterations of the Comb

Alteration	Results
Loppy comb turned to other side (2 tests)	No challenge 1 encounter with inferiors (6)*
Comb taped in a crown (2 tests)	No challenge 4 encounters with inferiors (6)
Comb taped in a cone (3 tests)	No challenge 2 encounters with inferiors (4) 2 encounters with inferiors (5) and driven by superiors
Comb painted white	1 encounter with an inferior (3) and avoided by superiors
Comb painted green	3 encounters with inferiors (10)
Dummy comb added (5 tests)	1 encounter with an inferior (4) and driven by superiors 2 encounters with inferiors (7) No challenge; some avoidance Driven by superiors No challenge; some avoidance

* Number of birds over which the test-bird was socially dominant previous to the test.

Dummy combs, about the size and shape of the largest in the flock, were stitched on the comb of each of five pullets. There was evidence of some loss of recognition in all these tests. The altered bird either was challenged or it was avoided.

Alterations of the comb appeared to be somewhat more effective as a disguise than were any of the other alterations. The fact that the three tests which failed to produce any reactions were in an inactive flock suggested that either this group was composed of relatively unaggressive birds or that failure to evoke a challenging attitude was not necessarily an indication of recognition.

DEPORTMENT AS A STIMULUS FOR AGGRESSION

Duplicate disguises of the neck, head, and comb did not always give the same results. In some instances there were no obvious reactions. As the altered bird was familiar with the members of the flock and with the features of the pen, it acted on readmission as previously, and not in the manner of one totally unfamiliar with the pen and its occupants. A test was made to determine whether there may be a difference between the behavior of an altered bird reentering a pen and that of a totally strange individual. It was of particular interest to learn whether a flock would attack a total stranger more readily than it would a disguised penmate.

Past experience has shown that when acquainted birds are moved, as a flock, to new quarters, they usually engage in extensive exploratory behavior. A newcomer in an established group gives evidence of similar reactions. In addition the latter encounters strange individuals. Typically the newcomer is attacked and fights, if aggressive, or it

may avoid encounters if relatively unaggressive. Occasionally a stranger is neither attacked nor does it avoid the members of the host flock.

Initially, in this test, five unmodified but unfamiliar pullets were introduced singly into one of the flocks. In each of these instances the stranger was attacked and submitted without a contest. Subsequently it was driven about the pen by all of the members of the flock.

Two flocks (numbers 2 and 3) in adjacent and similar pens were used in further experimentation. Flock 3 was removed and flock 2 placed into its pen. Four birds (strangers to flock 2) from flock 3 were introduced singly in the pen (their "home" pen). Each of these birds initiated attacks and strutted about the pen until removed, in complete dominance. These results were according to expectation (that is, home pen effect; see Allee, Collias, and Lutherman, 1939). One of the birds of flock 2 was not placed into the strange pen along with its flockmates. She was then disguised by means of a dummy comb and returned to her flock (now in an unfamiliar pen). She was attacked and driven about the pen and lost social position to two of her inferiors. Similar tests were made, with different alterations of the head, which gave somewhat similar results, although less spectacular. It was apparent from these results that a bird in strange surroundings, even when among familiar flockmates, behaved in some manner, detectable by others, which augmented the disguise as a stranger and evoked reactions more readily than when physical alterations only were made.

PSYCHOLOGICAL ASPECTS OF A LARGE COMB DURING INITIAL ENCOUNTERS

The above-mentioned experiments have shown that the comb is an important feature in individual recognition. Comb size is an indicator of androgen concentration in the blood and one of the best single indicators of relative aggressiveness (Allee, Collias, and Lutherman, 1939; Collias, 1943). Hens with the largest combs are usually at highest levels in the dominance order whereas those with the smallest combs are often at the lowest levels, assuming that all are of the same breed and in laying condition. The assumption can be made that large differences in comb size between antagonists, as in initial encounters, might determine psychologically whether a given bird will give an attack or escape reaction.

The application of a dummy comb made it possible to enlarge a comb and not influence the aggressiveness of a hen, as would occur if androgen were used to increase comb size. A series of initial encounters was staged, following the technique used by Collias (1943). Eleven pullets were isolated for two weeks in a laying battery, during which time memory of former penmates was presumed to be lost (Schjelderup-Ebbe, 1923). Each pullet then met each of the others, as pairs, in a small pen, and dominance relationships were established. Three series, or rounds, of initial encounters were staged with an isolation period of two weeks between each round of paired encounters. Of these 165 "control" encounters between 55 pairs of pullets, in 44 pairs (80 per cent) the same individual won the contest in each of the three trials. The indication was that the winner of each paired encounter tended to be the same individual. Comb size was estimated by adding the length from beak to end of blade to the height of the point over the eyes. The coefficient of correlation between comb size and number of contests won was +0.79 and statistically significant at the 1 per cent level.

The three pullets with the smallest combs were selected for comb enlargement with a dummy comb. These birds also won the fewest contests in the control series (none, 7, and 10 out of a possible 30 for each bird). After an appropriate period of isolation each of these three pullets met each of the other eight (unmodified pullets) in a small pen. In five of these 24 paired encounters the altered bird won the contest. It was of particu-

lar interest that the three unaggressive pullets with dummy combs were avoided. Only one of the five changes in dominance resulted from a fight, and that with the most aggressive bird, which gave way readily. The dummy combs were then removed and another series of encounters were staged with the same eight birds, following a period of isolation. All these paired encounters gave results similar to those of the control series. These results with a few birds did not indicate the relative importance of comb size as a psychological factor in establishing dominance, but they suggested that a large comb may have psychological advantage during initial encounters. It may be that past experience with birds having large combs has resulted in some conditioning to them. In these tests it was unlikely that a bird with a large comb was mistaken for a superior penmate, as isolation of 14 days usually eliminates the memory of former penmates.

DISCUSSION AND CONCLUSIONS

A critical evaluation of the data presented in this report must consider certain advantages obtained with the use of chickens and certain limitations in the observations and their interpretation. There can be little question as to the evidence of individual recognition among flockmates which have a stable dominance order. Certainly birds with a peck-right system rather than those with peck-dominance basis (Masure and Allee, 1934) should be more suitable for experimentation, for the latter do not show unidirectional pecking relationships unaltered by perch-rights.

The criterion used for nonrecognition, namely, attacks on strange individuals, was the best one available. However, evidence was given that the threshold for an attack reaction was variable, as some unfamiliar pullets (known to be strangers) were not attacked readily. In the present experiment not all of the encounters between a disguised bird and its flockmates could be observed, as there was a limit to the time available for continuous observation after the introduction of the modified bird. Failure to show any dominance-submissive behavior was not necessarily evidence of recognition nor of nonrecognition. Further evidence of altered thresholds for responses, such as fighting or pecking, was shown by the fact that newcomers were attacked more readily when the flock was in its home pen than when in a similar but strange pen (see also Allee, Collias, and Lutherman, 1939; and Schjelderup-Ebbe, 1935). Well acquainted birds have been found to be combative under certain competitive situations (Guhl and Allee, 1944; and Guhl and Warren, 1946). Stimulus-response mechanisms as related to aggressive behavior have been discussed by Collias (1944).

The 59 tests reported here cannot be considered as an adequate exploration of this field of investigation, but the results do yield information which should be considered in further study of individual recognition.

Alterations of contour appeared to be the least effective, and color changes when intense were the most effective. The use of dummy combs involved changes in contour (and size), probably color intensity, and also texture. These three factors were not made experimentally distinguishable. Bennett (1939) found that contour changes in ring doves were less effective in producing reactions leading to social tension than were color changes. Ramsay (1951), observing parent-offspring recognition in ducks and chickens, noted that color changes resulted in pecking and chasing of the young only when the differences were marked. Shades and tints did not upset recognition. In familial recognition auditory clues seemed to predominate although they were not the only ones.

There is little doubt that the features of the head, and to some extent those of the neck, exerted a dominant influence in individual recognition. Nearly all of the modifications of the comb evoked some reactions indicative of a loss of recognition. James (1873), in writing about game cocks, stated that it was necessary to separate each stage as he

was dubbed; otherwise he was always attacked, his companions not appearing to recognize him. Schjelderup-Ebbe (1923) noted the influence of the comb of hens in recognition. Several of the citations made by Nice (1943) and Thorpe (1951) indicate that head features play an important role in recognition. Armstrong (1947) discussed the relative importance of deportment, features of the head, and voice in individual recognition. Apparently there is much variation among the various species of birds observed.

Deportment or attitudes as factors in recognition were not under investigation in this study. However, a test was made which showed that birds in an unfamiliar pen altered their deportment. The modification which occurred altered the threshold for aggressive reactions. Apparently a bird in strange surroundings is not very prone to attack unfamiliar individuals unless an attack is provoked by the behavior of other individuals.

Except for the alterations of specific areas on the trunk, some of each of the types of disguises evoked an attack by some of the penmates. The indications are that recognition of flockmates is not limited to any particular area or feature. These results are in agreement with those made by Ramsay (1951) who found that recognition seems to involve several factors, variation in any one of which upsets the recognition behavior of adults and young.

The establishment of a peck-order is a learning process in which each individual distinguishes between its penmates, pecking some and avoiding others. Furthermore, memory of flockmates is lost after a separation of at least two weeks (Schjelderup-Ebbe, 1923). Ramsay (1951) concluded that adults and young largely acquire, rather than inherit, the ability to recognize members of the family. Cushing and Ramsay (1949) showed that recognition in heterospecific families were due to non-heritable factors. However, in neither of these two reports was the possibility of imprinting (Lorenz, 1935) considered. Recognition among adults in chickens is not expected to involve imprinting, and peck-orders among chicks do not develop until some weeks after hatching (Guhl, 1953).

No information was obtained in our study which might indicate whether learning to recognize individuals involved steps from the general appearance to the specific features, or from the particular to the general. Potter (1949), working with different breeds of hens, observed that a hen might mistake one member of a breed for another under certain conditions. In our test on the psychological influence of comb size in initial encounters, there may be a suggestion that past experience with hens having large combs is recalled. If this were a valid assumption then certain features such as the comb might exert an early influence in recognition.

Studies of social behavior require some mark of individual identification for the observer. For White Leghorns we have used several colors applied to small body areas. The question has arisen as to whether such markings, or their occasional renewal, influence recognition by the birds. This experiment shows that such complications do not arise if color markings are not applied to the head and neck.

It has been previously emphasized that the disguises used were abrupt changes, whereas the modifications which might occur normally usually show progressive alteration. Birds which become ill or undergo a molt show a decrease in comb size, comb texture and color intensity, and, in the molt, a change in contour with the loss of feathers. Deportment or attitudes also may be altered if the illness is severe or the molt extensive. According to our general observations, birds do not readily lose social status under such conditions in small flocks. These observations along with those of this experiment indicate that individual recognition, once learned, is not readily lost unless the birds are separated for some time. Memory of individuals promotes the stability of the social

order. In large flocks, particularly in spacious quarters, the pair-contacts may be infrequent and memory may then be re-enforced by a higher frequency of aggressive behavior than in small flocks. As memory of individuals is maintained by the frequent meeting of any two individuals, recognition is facilitated by such factors as the length of time the individuals have been together, the number of individuals in the group, and the size of the pen or range. It would be of interest to learn whether the size of flocks of birds in nature shows any relationship to the number of individuals that one bird can recognize and remember. Presumably disruptions may occur in flocks of aggressive species as the limit is approached.

SUMMARY

From experiments on recognition of visual patterns among White Leghorn chickens, the following conclusions may be drawn:

1. Individual birds react to alterations of plumage *per se* and can make adjustments to such changes.
2. Intense color changes on white individuals are more effective in producing a loss of recognition than are shades or tints.
3. Disguised features of the head and neck are more effective in producing a loss of recognition than are those of areas of the trunk.
4. Although some features are more influential in recognition than others, no single feature is the sole means of recognition.
5. Deportment is a factor, or stimulus, which evokes either aggressive or submissive behavior.
6. An individual chicken with a large comb has a psychological advantage in initial encounters.
7. Recognition of individuals and memory promote the stability of the social organization. Modification of features has to be abrupt and quite pronounced to cause a loss of recognition.

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