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FAMILIAL RECOGNITION IN DOMESTIC BIRDS

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INTRODUCTION

THE auditory acuity of birds is well known. In addition, extensive work by Lashley (1916) and by Hamilton and Coleman (1933) has shown that the sensitivity of diurnal birds to color is almost as acute as that of man. Bingham (1922) presented evidence to show that birds are sensitive to size, brightness, and form, in that order. These and related studies were summarized by Maier and Schneirla (1935). However, it is not the purpose of this study to add to the extensive literature on this capacity of birds but rather to demonstrate that familial recognition, based on such cues as the above, may be acquired by both young and adult birds and need not necessarily be a function of inherent specificities alone. The position that recognition is based on a variety of such cues, variation of any one of which upsets the recognition behavior, has been previously assumed by Cushing (1941) in connection with mating preferences and by Davis (1942) as associated with individual recognition in social birds.

In a recent study, Cushing and Ramsay (1949) took the position that the recognition of parent and young need not necessarily depend upon inherent behavior patterns but could involve acquired determinants to a large degree. This is in accord with the theory of Lorenz (1935) who wrote: "In many types of instinctive behavior directed at fellow members of the species, the motor action itself is inborn but not the knowledge of the object of the act."

No anthropomorphic meaning should be attached to such terms as *recognize, avoid, attack* and so on. The word "recognition" is here used in a psychological sense to refer to a phase of memory.

The families of birds used in this study are summarized in Table 1. These families were all reared on 0.5-inch meshwire run-ways elevated three feet above the ground. These runs (2.5 by 1.5 by 6 ft.) were

STODDARD'S YELLOW-THROATED WARBLER, *Dominica d. stoddardi*; TYPE SPECIMEN; SEE PAGE 28.

provided with a shelter at one end and were covered with 0.5-inch mesh-wire cloth.

TABLE 1

FAMILIES OF BIRDS USED IN 1949

Female parent	*Age in years*	*Young*	*Color*	*Number lost in experiment*
	Group I.	*Young hatched June 12–13*		
A_1 White Muscovy duck	5	13 White Rock chicks	yellow	8
B_1 White Muscovy duck	2	6 Muscovy ducklings	yellow	0
C_1 White Rock hen	1	9 White Rock chicks	yellow	0
D_1 White Rock hen	2	6 Muscovy ducklings	yellow	0
	Group II.	*Young adopted June 18*		
A_2 White Muscovy duck	2	6 N. H. Red chicks	red-brown	1
B_2 White Muscovy duck	1	8 turkey poults	sepia	4
C_2 Barred Rock hen	2	15 N. H. Red chicks	red-brown	0
D_2 White Rock hen	1	12 turkey poults	sepia	2
	Group III.			
Female parent	*Age in years*	*Young*	*Hatching date*	*Number lost in experiment*
A_3 White Muscovy duck	2	6 White Rock chicks	Aug. 21	0
B_3 White Muscovy duck	5	7 Muscovy ducklings	Aug. 19	0
C_3 White Rock hen	1	6 Bantam chicks	Aug. 31	2
D_3 White Rock hen	1	6 Mallard ducklings	Aug. 29	0

Aggressive behavior on the part of the adult birds, notably pecking, and the avoiding and seeking reactions of the young were used to obtain quantitative indications of recognition. As preliminary studies showed that hens become more aggressive toward transferred young and Muscovy Ducks, *Cairina moschata*, less so, a 30-minute period was chosen as a fair duration for most of the tests.

I should like to thank Dr. John E. Cushing for his advice and criticism given throughout this study.

LEARNING

By adults.—In many species as the young birds grow older the adults become more active in repelling young of other groups that may approach them. Such behavior is vividly portrayed by Kirkman (1937) for the Black-headed Gull, *Larus ridibundus*. This aversion toward individuals of the species other than those of the immediate family group is regarded by many as one of the foundations of territorial behavior (Nice, 1941). Such behavior was also evident in the domesticated species studied. In these species, however, there was no evidence that the adults mothering them recognized the young individually, or that the species of young reared in one generation

conditioned the adults against rearing the young of another species in the next generation.

Considerable individual variation was evident in the activity of the adults toward transferred young. This was especially noticeable in the parent Muscovy Ducks. Some of these variations could be correlated with age and may be examples of facilitation or the improvement in the performance of an instinctive act by experience, as discussed at length by Nice (1943). This may also explain why Lorenz (1935) could not get a Muscovy to adopt Mallards, *Anas platyrhynchos*. Thus, for example, the first day the young chicks adopted

TABLE 2

LEARNING OF AVOIDANCE BY 16-DAY-OLD CHICKS

	Times attacked	
	First 10 minutes	*Second 20 minutes*
2 chicks from duck A_2 to duck B_2 with poults	28	1
2 chicks from hen C_1 dyed blue to hen C_1	69	20
2 chicks from hen C_1 dyed red to hen C_1	36	17

by duck A_1 were exchanged for the ducklings of duck B_1 (see Table 1), the widely experienced, 5-year-old Muscovy A_1 would not accept ducklings. This duck had previously mothered several broods of Muscovy ducklings, Mallard ducklings, chicks, and a mixed brood of chicks and ducklings. It is also interesting to note that this duck not only pecked at the transferred ducklings but that the call of a Muscovy duckling on one occasion served to release her defense reaction. She treaded rapidly up and down on the duckling beneath her. The heavy mortality of this duck's brood was caused by her great weight, but by the second day her chicks were expert dodgers and would scatter each time she took a step. This same duck later successfully hatched and brooded a group of seven Mallard ducklings. She led them to and from the nest twice on the first day. Young ducklings, removed from her at this time, returned. In contrast to this, a young Muscovy, also mothering Mallards, did not leave her nest until after all her brood but two had left the nest on the second day. If the young had been permitted to stray, it is quite possible that she might have lost them. Similarly, ducks B_1, B_2 and A_2, who also had never mothered young before, made no aggressive moves at all toward young transferred to them on the first day. Later in the course of the experiments, all these ducks became more active in attacking transferred young, yet the older, more experienced duck was more active in each case. Similarly, the older, more experienced hen D_1 was usually more active than the young inexperienced hen C_1. It must also be

noted, however, that the two-year-old hen C_2 pecked at the young transferred to her about twice as frequently as the one-year-old hen D_2 (32 pecks to 13) and that neither of these hens had ever brooded young before.

By young.—There is little doubt, therefore, that the factors determining specific recognition were largely acquired by the individuals concerned and not due to hereditary factors. This is clearly shown by the results given in Table 2. Here the number of attacks by the adult birds on the young have been presented to show that the young birds rapidly learn to avoid the adult that attacks them, even if this be the parent to which they have long been accustomed and which they have learned to recognize individually. This avoidance had been noticed on many occasions before this experiment was made. After such attacks, the young would retreat to the other end of the pen, attempt to hide beneath the other young birds present or seek shelter behind the food tray. Two of the cases presented involved young birds that were dyed in an aqueous solution of aniline dye, dried, and then returned to the parent that had mothered them for 16 days.

REACTIONS OF ADULTS TO YOUNG

Transfers between the members of Group I (hatched June 13) showed that both the parents and the young birds were best able to recognize transferred members when they were unlike members of their own group. This was shown by the aggressive behavior on the part of the adult birds to members of a species different from their own young (Table 3) and by the avoiding reaction on the part of the young when dissimilar parents were used (Table 4). In these latter experi-

TABLE 3

AGGRESSIVE BEHAVIOR OF BOTH REAL AND FOSTER PARENTS TO TRANSFERRED 4-DAY-OLD YOUNG

Young transferred	*from mother*	*to female*	*mothering*	*Times pecked in 30 minutes*	
				transfers	*own*
2 ducklings	duck B_1	duck A_1	chicks	66	4
2 chicks	duck A_1	duck B_1	ducklings	32	1
2 chicks	hen C_1	hen D_1	ducklings	18	1
2 ducklings	hen D_1	hen C_1	chicks	23	0

ments, it was obvious that the avoiding behavior on the part of the young was the controlling factor rather than that the parents became used to the presence of the transferred birds. The young transferred to a parent similar to the adult to which they were accustomed sometimes made an effort to follow this bird; certainly they made no effort

to retreat from her. Young transferred to the adult of a species different from that to which they were accustomed made no effort to follow her and sometimes moved away at her approach. Further, in these exchanges, though transferred members were placed with the strange parent consecutively rather than simultaneously, the order was alternated in the different experiments with no effect on the results tabulated.

Early exchanges between the members of Group II (started June 18) seemed to indicate that one of the first bonds to be formed between parent and young, as might be expected, definitely involved vocal stimuli; this observation was confirmed by later experiments. Here, exchanges were possible on the second day so long as the young birds accepted the strange situation and remained quiet. The young birds were not attacked until they began calling for their parents. Thus, during the first 15 minutes the chicks in with hen D_2 who was mothering young turkeys were quiet, and one chick was brooded by the hen along with her own. Meanwhile the poults pecked at the chicks 13 times. Under these conditions the chicks withdrew to the other end of the pen and began calling. When the chicks called, on three different occasions, the hen left her brood and chased them about the pen pecking at them violently. The poults transferred to hen C_2 withdrew from this group after 10 minutes and were not pecked at by the chicks in this experiment, but the hen left her brood repeatedly and pecked at them 32 times. As a further check as to whether slight differences in color between the chicks and the poults might be an important clue to the adults, some of the young were dyed seal brown (tintex 29) and returned to their parents with no observable results. Note, however, that the experiments summarized in Table 6 show that more extreme deviations in color will also bring about aggressive behavior.

When the members of these families were older, the attacks by the parent birds on the young were more prompt and frequent. Thus hen D_2, mothering poults, chased two chicks from hen C_2 three times and pecked at them 17 times on the second day. Five days later, in the same time interval (the first 30 minutes together) she chased them 17 times and pecked at them 45 times. This indicates that time is involved in the learning of those characteristics used in recognition. This point has previously been made by Davis (1942) in connection with the recognition of the social companion. These results also suggest that the number of characteristics used in recognition also increase with familiarity. This conclusion was confirmed by later experiments.

RECOGNITION OF YOUNG BY SIZE

That the adult birds could distinguish the young by factors associated with differences in age was shown when White Rock chicks from a brooder were transferred to hen C_1 with White Rock chicks and to duck A_1 also mothering White Rock chicks. In these cases the comparative sizes were in the ratio of 1 : 2 in favor of the brooder chicks and 2 : 1 in the other. These results are summarized in Table 5. Note, however, that smaller differences in size bring about no aggressive behavior. In the last two cases presented, the age difference was five days and the ratio in size approximately 4 : 5.

RECOGNITION OF YOUNG BY COLOR

Strong evidence of the ability of the birds to recognize the young by color cues was observed in two series of experiments. First, some of the chicks from Group II were transferred to corresponding members of Group I (for example young from A_2 to A_1), and then some of the young ducks and chicks of Group I were dyed and returned to their parents.

A few of the New Hampshire Red chicks were colored more lightly than the others. In the first of the experiments a dark and a light

TABLE 4

AVOIDING REACTIONS OF 8-DAY OLD YOUNG

Young transferred	*from mother*	*to female*	*mothering*	*Times attacked in 30 minutes*	
				chased	*pecked*
2 chicks	hen C_1	hen D_1	ducklings	4	31
2 chicks	duck A_1	hen D_1	ducklings	5	15
2 ducklings	hen D_1	hen C_1	chicks	1	34
2 ducklings	duck B_1	hen C_1	chicks	2	0
2 chicks	duck A_1	duck B_1	ducklings	0	24
2 chicks	hen C_1	duck B_1	ducklings	0	2

chick were transferred simultaneously from hen C_2 to hen C_1 also mothering chicks. The darker (red-brown) chick was attacked 31 times in 30 minutes. The lighter (buff-colored) was not attacked during this same interval, though on several instances the hen arrested pecking motions toward it. This seemed to show that she recognized the lighter chick as somewhat strange but was willing to accept it. Transfers of dark and light chicks from Muscovy A_2 to Muscovy A_1 yielded similar results. The darker chick was pecked at 16 times in 30 minutes and the lighter chick was accepted. Transfers of chicks from Group I (White Rocks) to Group II (New Hampshire Reds showing considerable variation) yielded no results in the 30 minutes allowed. These differences in results may be attributed to the fact

that the parents in this case were accustomed to a greater variety of color in their broods.

Additional evidence that color is a strong cue in recognition was obtained when some of the chicks were dyed and returned to their parents. In each instance the dyed young were treated as if they were strangers to the group, though the adult birds showed great variability in the intensity of their reactions toward them. Meanwhile the young birds were pecking at the colored ones so constantly that it was impossible to record these observations in tabular form. Similarly, Bennett (1939) found that dyeing the breasts of Ring Doves, *Columba palumbus*, upset their recognition behavior. In this experiment some of the young were also thoroughly washed in water, dried, and returned at the same time as those washed in the dye solution. That these were not attacked suggested the conclusion that odor is not a cue in recognition in birds. This is in accord with the fact that birds are reported to be sensitive only to strong gases (Maier and Schneirla, 1935). Noble, Wurm, and Schmidt (1938) in more extensive studies, found no experimental indication that Night Herons, *Nycticorax nycticorax*, use odor in recognition.

TABLE 5

RECOGNITION OF TRANSFERRED CHICKS BY SIZE

Young transferred	*White Rock chicks*				*Buff-colored chicks*	
Number transferred	2	2	2	2	1	1
Age in days	30	8	30	8	7	7
To female[1]	hen C_1	hen C_1	duck A_1	duck A_1	hen C_1	duck A_1
Age in days of young	16	16	16	16	12	12
Size ratio	2 : 1	1 : 2	2 : 1	1 : 2	4 : 5	4 : 5
Times pecked in 10 minutes	18	26	51	12	0	0

[1] All females mothering White Rock chicks.

The reaction of the adult birds to 18-day-old chicks is shown in Table 6.

After these experiments the dyed birds were separated from the hens as preliminary experiments had shown that these adults become more violent in their attacks. Thus, in one such experiment, a hen mothering two-day-old chicks which were dyed red attacked those which were dyed blue and green immediately, but she did not attack those which were dyed violet until the next day. As the spectrum of the chick (Lashley, 1916) seems to be shortened at the violet end, this may represent recognition by brightness. The use of alcohol soluble dyes and of alcohol as a bath rather than water did not affect the results obtained in this experiment. The young in with the paren

TABLE 6

REACTION OF ADULT BIRDS TO THEIR OWN, BUT DYED, YOUNG

Young	*Female parent*	*Treatment*	*Times pecked in 30 minutes*
2 chicks	hen C_1	dyed methylene blue (Aq)	89
2 chicks	hen C_1	dyed red in eosin (Aq)	53
2 chicks	hen C_1	dyed pink in eosin (Aq)	1
2 chicks	hen C_1	washed in water	0
1 chick	hen C_1	control—no treatment	1
2 chicks	duck A_1	dyed methylene blue (Aq)	97
3 chicks	duck A_1	control—no treatment	2
2 ducklings	hen D_1	dyed methylene blue (Aq)	43
2 ducklings	hen D_1	washed in water	2
2 ducklings	hen D_1	control—no treatment	0
2 ducklings	duck B_1	dyed methylene blue (Aq)	4
2 ducklings	duck B_1	dyed red in eosin (Aq)	5
2 ducklings	duck B_1	control—no treatment	0

Muscovies were left with them as these same preliminary experiments had shown that aggressive action on the part of these adults dissipates itself by the end of the second day.

INDIVIDUAL RECOGNITION OF PARENTS BY VOCAL CUES

The ability of the young to recognize their parents by vocal cues was surprisingly acute. This was determined by an experiment in which the adult birds were confined in wooden nest-boxes 6 feet apart which were all new to all the birds concerned. These boxes (2 by 2 by 2 ft.) were placed on the ground in a pen that was also new to all the birds. The openings of the boxes were placed toward the fence so that the adult birds could be heard but not seen by the young, and a small opening was provided at the front so that the young could squeeze through to join their parents. After the adults were in position the young were transported in a cardboard box and released simultaneously from a point six feet away and equally distant from both nest-boxes.

First, hen C_2 with six 14-day chicks and hen D_1 with six 19-day ducklings were tried. Both hens were calling constantly and the young birds eventually joined their parents. Hen D_2 with three 14-day poults and hen C_1 with three 19-day chicks were then tested. In each instance the poults found their parents in less than an hour and remained with them during the next 30 minutes. The older chicks showed little inclination to join their parent in the time allowed.

In order that these results might be more carefully studied, hen C_3 with her brood of chicks and hen D_3 with her brood of Mallard ducklings were similarly tested on five successive days. On the first of

these tests, the two-day chicks found their parent in less than five minutes and entered the nest-box to join her. The four-day Mallards followed the chicks to this position but none entered the nest-box. In less than five minutes they left this position and went to the box containing their own parent. They remained beside this box during the rest of the hour and one duckling entered to join its parent. During these tests the young birds would move away at the approach of New Hampshire Red hens and Barred Rock hens that were allowed to roam the area unconfined. They did not retreat at the approach of White Rock hens but made no move to follow them. On one subsequent occasion, however, the Mallards followed a White Rock hen for a distance of eight feet. Two of the chicks also followed this same hen for two feet. As all these White Rock hens were brood sisters and, as this same hen was followed by both chicks and ducklings, it is possible that some undetected trait of behavior was the cue in this case. This hen was not calling.

The next day the experiment was repeated. On this occasion, as in all subsequent tests, the positions of the hens in the nest-boxes were reversed. Under these conditions, each group of young birds immediately went to the wrong box (position-response). Both groups reversed their positions, however, in less than 10 minutes and remained with their own foster parents during the rest of the hour. In the three subsequent tests with these groups no significant deviations from this pattern were noticed. Similarly, Nice (1943) found that young Song Sparrows, *Melospiza melodia*, recognize the calls of foster young Cowbirds, *Molothrus ater*, by the seventh day.

TABLE 7

RECOGNITION OF INDIVIDUAL, CONCEALED PARENTS BY AUDITORY CUES

Group of young tested	*Age*	*Parents*	*Number calling*	*Trials*	*Errors*
6 Mallards	2 days	hens	3	3	0
5 Mallards	2 days	hens	4	6	1
1 Mallard	2 days	hens	4	5	1
7 Mallards	5 days	Muscovies	2	3	0
2 Mallards[1]	8 days	Pintail	1	1	0
3 Mallards[2]	5 days	hens	2	5	1
2 Wild Turkeys[2]	5 days	hens	2	5	0.5
2 Wild Turkeys	2 days	hens	4	6	2.5
1 Pintail[3]	4 days	bantam hens	2	7	1
2 Ring-necked Pheasant, *Phasianus torquatus*	2 days	bantam hens	2	7	0

[1] These called in from the pond 50 feet away after several hours. In the meantime tended to join, but not to follow, the male Pintail.

[2] These two groups only conditioned by placing them with the wrong parents on the fourth day for four hours. See text. One poult went to wrong box, did not enter, and then slowly corrected error.

[3] See text.

Later experiments (1950) showed that the young birds could respond to the right parent promptly by the second to fourth day if only one group of young were tested at a time and even if the number of choices was increased to four. Four species (Table 7) of precocial game birds were used in these experiments and these species responded more promptly than did the domestic ones. The position of the similar parent birds was alternated as before and the young of all the parent birds were held near by so that all the adults were calling. Nevertheless, this response seemed to be facilitated by the fact that the parent adult called more loudly as its own young approached it. As before, young seemed to form position responses quickly. This largely explains the errors. Thus a four-day Pintail duckling, *Anas acuta*, twice went into a nest box that had previously contained its own foster parent although it was unoccupied at this time by either hen. These two trials and errors are not included in the table. Other results of this experiment are summarized in Table 7.

RESPONSES OF ADULTS TO BEHAVIOR OF YOUNG

The adults tended to attack any young birds that retreated from them regardless of whether these were their own young or those of another individual. Thus, when in the experiment to be next described, three young Muscovies, that had been removed from their parent duck (B_3) after hatching, were placed in a pen containing parent Muscovies A_3 and B_3, they huddled in a corner by themselves and under these conditions were pecked at by both parents. Duck A_3 attacked them eight times and their own parent 16 times in a 30-minute period. When these ducklings were then placed in a pen with their entire family, parent and siblings, they merged with this group and no further attacks occurred.

Similarly, two four-day game farm Turkeys, *Meleagris gallopavo*, mothered by a New Hampshire Red hen were exchanged for five four-day Mallards also mothered by a New Hampshire Red hen. During this four-hour period, the young birds were chased and pecked by the adults repeatedly. When the two hens were then returned to their own broods, the Turkeys continued to run from the parent hen and their own parent continued to chase them. This hen, however, arrested all pecking motions toward them and, when the pen was darkened after 15 minutes, she called the young to her and brooded them as before.

These experiments suggest automatic responses to behavior rather than recognition by individual traits. Likewise, Davis (1942) found no evidence that behavior patterns are used in recognition.

RECOGNITION CUES REVEALED BY MEMORY TESTS

Three Muscovy ducklings were removed from their parent duck, B_3, at 10 a. m. August 19, 1949, a few hours after hatching. They were carried 0.25 miles away and their ability to recognize the call of their parent was tested every two days in a manner similar to that previously described. These tests lasted one hour. When they were two days old, they responded repeatedly to the call of duck B_3 in preference to that of A_3 from a distance of 25 feet. During this same test period they would run to follow any white bird that approached them closely (Snow Geese, *Chen hyperborea*, Muscovy ducks and drakes, and White Rock hens), but they did not move to follow birds that were not colored white (Canada Geese, *Branta canadensis*, buff-colored hens, and Blue Geese, *Chen caerulescens*). Similar results were obtained on the fourth day, although the distance had to be reduced to 12 feet to bring about a response. By the sixth day they showed no ability to select between the calls of A_3 and B_3 or inclination to respond to the call of either duck, though they would still follow for some distance any white bird that approached them. Somewhat similarly, Noble, Wurm, and Schmidt (1938) found that members of pairs of immature Black-crowned Night Herons could recognize their mates by vocal cues alone after an absence of about four days.

These experiments indicate that in the species studied auditory cues predominate in individual recognition of the parent and that recognition based on such cues is more exact than that based on form, color, or size. This observation is in accord with Huxley's comments (1942) on species recognition factors. Huxley emphasized, for instance, that though the Eastern and Western Flickers, *Colaptes auratus* and *C. cafer*, which differ widely in color and markings, commonly interbreed where their zones have secondarily come to overlap, the Eastern and Western Meadowlarks, *Sturnella magna* and *S. neglecta*, which differ primarily in song pattern, rarely interbreed.

THE INHERENT PATTERN OF THE PARENT COMPANION

Lorenz's studies (1935) indicated that the innate perceptory pattern of the parent companion may, in many cases, be very simple. Conversely, this leaves much to be filled in by learning. Several experiments indicated that such simple elements in the external situation may serve to release the responses of the young. In the first of these experiments, incubator-hatched birds were liberated three feet from pens containing parent females of the species to be mentioned. With few exceptions, these young were hatched in isolation in the incubator. Mallard E (see Table 8) was inadvertently hatched with Muscovy

duckling C. This may possibly explain the aberrant behavior of this Mallard. The young of all the parent birds were removed from them during the experiments so that all the adults were actively calling.

TABLE 8

RESPONSE OF INCUBATOR-HATCHED YOUNG TO ADULTS OF SEVERAL SPECIES

Species	*Age in days*	*Total tests*	*Number of responses to*			
			Hen	♀ *Muscovy*	♀ *Mallard*	*Others*
A Muscovy	1	15	10	4	—	1
B Muscovy	1	18	1	5	—	12 to Human
C Muscovy	2	20	4	9	—	7 to geese
D Mallard	1	20	5	7	—	8 to Human
D Mallard	3	14	4	1	4	5 to Human
E Mallard	2	18	1	17	—	0
E Mallard	3	30	0	30	0	0
F Mallard	1	17	4	1	4	8 to Human
G Mallard	2	11	0	5	3	3 fear response
H Mallard	0.5	20	14	5	1	0
I Chick	1	20	20	0	0	0
I Chick	1	10	—	0	10	0
J Chick	1	21	20	1	0	0
J Chick	1	18	—	0	17	1 to Chukar Partridge
K Chick	0.5	20	20	0	0	0
K Chick	0.5	13	—	2	10	1 to Chukar Partridge

The results of these tests are shown in Table 8. Of all the species studied, only the domestic chick seemed to be able to respond to the correct biological object. Yet it must also be noted that when no parent hen was present, these same chicks later responded almost as consistently to the call of a Mallard Duck. Other responses of these chicks were to the calls of a Chukar Partridge, *Alectoris graeca*, caged much further away. These same chicks made no response to hens that were not calling. Many of the chicks made no response on the first trial until a lapse of five minutes or more. Thereafter, most of the chicks responded rapidly. Younger birds, after a few trials, refused to respond.

These experiments indicate that in all the species studied, except the domestic chicken, the innate perceptory pattern of the parent companion is non-specific or indeterminate. The chicks showed an innate ability to respond to the biologically correct object, but the data summarized in Table 9 indicate that this perceptory inlet is far from completely determinate and that the acquired bond is stronger than the inherent one. The data in this table also indicate that the bond of the young to the parent-object becomes increasingly strong through association and habit formation and would thus seem to indicate that the parent-young bond is not a simple reflex formed at the time of hatching.

TABLE 9

BEHAVIOR OF SIX CHICKS TOWARD BOX AND CLOCK AND TOWARD PARENT HEN*

Age	*Behavior toward box and clock*	*Behavior toward parent hen*
1 day	Hovering. Contented chirping. Would not follow. Froze at any rapid motion of box.	Two went toward parent in 4 minutes. Others in 12. None found hen.
2 days	Followed box for 25 ft. Fled to box rather than to hen when alarmed. Contented chirping. Froze at rapid motion of box.	All went toward hen. Two joined hen for short interval. None remained with hen.
4 days	Followed 17 ft. Froze at rapid motion of box. Four followed box in preference to hen.	One went to hen 7 times and returned. Two followed hen for a total of 15 of 30-minute test period.
6 days	Followed 15 ft. Stayed near box. All followed box in preference to hen.	One went to hen 7 times; another, 3 times. These 2 followed hen for short interval.
8 days	Followed 15 ft. Stayed near box. All followed box and clock rather than hen.	Hen free, 1 chick followed hen for 3 feet only.
10 days		Normal behavior when added to group.
12 days		Two nearly killed by hen.

* Thirty-minute test periods with each. Hen caged three feet away unless otherwise noted.

In this latter experiment an inanimate substitute object was used in place of the parent. The young chicks were hatched in an incubator with a green box (5 by 6 by 8 inches) containing a ticking alarm clock and suspended high enough above the eggs so that the young could form contact with it while hovering. A six-watt bulb incorporated in the incubator gave moderate illumination at hatching. When the young were dry, they were transferred to a larger box (2.5 by 2.5 by 3 feet) and kept beneath the same substitute object. Heat was provided by a 40-watt bulb over this pen, and food and water were kept for them in this same box. The tendency of the young to follow this substitute-object was tested at two-day intervals. The substitute object was attached to a cable stretched between two trees and made to move by a cord attached to it (Plate 2).

The responses of the young of several other species to this same substitute object were tested in a similar manner. In addition, a football was used in other experiments as a substitute object having different characteristics. The results of these experiments are summarized in Table 10.

These experiments would seem to indicate that the innate perceptory pattern of the parent companion in the Muscovy duckling may involve the visual modality alone. Muscovy ducklings, when given a choice of parents of several species, responded at random (Table 8). Many responses were also made by these ducklings to Canada Geese, *Branta canadensis*, which gathered near by during the experiments and which were not calling. Muscovy ducklings responded to the football as a substitute object but not to the box and clock. The innate perceptory pattern of the parent companion in the chick would seem to involve the auditory modality alone. Chicks did not respond to adults that were not calling (Table 8) but responded to the box and clock combination as a substitute object. They did not respond to the football (Table 10).

TABLE 10

RESPONSE OF YOUNG OF SEVERAL SPECIES TO SUBSTITUTE OBJECTS

	Chick	*Mallard*	*Muscovy*	*Canada Goose*
Groups tested with football	2	2	2	1
Response	0	0	2	1
Groups tested with box and clock	3	3	2	1
Response	3	0	0	1

The innate perceptory patterns of the parent companion in the Mallard Duck and the Canada Goose were not determined. Canada Geese responded to both substitute objects. Both of the goslings responded to the call of their parents in preference to the substitute objects at first, but rapidly learned to avoid their family group after having been attacked—the 1949 gosling after one such attack, the 1950 gosling after three such attacks (Plate 2). Both goslings were individually recognized by their parents by the fifteenth day but not appreciably earlier. Neither of the two experimental goslings has yet merged with the other Canada Geese.

These latter experiments were suggested by Dr. David E. Davis. They will be reported on in more detail in a later paper. The accompanying photographs were taken by Mr. Leland A. Graham of the McDonogh School faculty.

SUMMARY

This is a study of domestic birds and their offspring to demonstrate that various factors are used by them in recognition which is understood here as an aspect of memory.

Domestic birds were reared by females of their own and of different species. Twelve families were established—ducks with chicks and poults and ducklings, and hens with similar groupings. Duplicate

groups of those above mentioned were also established. Exchanges of young from one group to another were used to obtain quantitative measures of recognition. Aniline dyes were used to establish the presence of recognition by color, and a multiple-choice technique was devised to demonstrate that the young of different species could find their specifically similar, hidden parents by vocal cues alone.

That the factors determining specific recognition were largely acquired was shown by the avoidance by the young of adults unlike the species to which they were accustomed. The young birds also learned to avoid the adults that attacked them even though these were the parents that had reared them. Such learning was mensurable in a 30-minute test period. Parent birds chased and pecked at young unlike the ones they had adopted, even though the transferred birds belonged to their own species. Transferred young were not attacked on the first day by three inexperienced ducks though one experienced duck attacked young ducklings transferred to her in less than 12 hours after the hatching of her brood of chicks. Hens learned more rapidly.

The parent birds attacked young unlike the ones to which they were accustomed regardless of species. Specific differences in voice were recognized by both the adults and young by the end of the first day. Transferred day-old birds in two cases were not attacked by hens until they began calling for their own parents. Two-day-old young quickly found their own parents, even when they were hidden from them and were forced to choose between other adults of the same species. Comparative studies with four species of precocial game birds gave similar results, even when the number of hens calling was increased to four. Parent birds were correctly identified by vocal cues by the second day and probably sooner. Marked differences in color resulted in pecking and chasing even when the young birds were dyed and returned to their own parents. This discrimination by color also appeared by the second day. Shades and tints did not upset recognition behavior. Marked differences in size were also recognized.

Muscovy ducklings, removed from their parent a few hours after hatching, could recognize their parent by vocal cues four days later. They remembered her color even longer but showed no memory of her size or form.

The response of incubator-hatched young to parent females of several species was tested. Only the domestic chick showed any inherent ability to respond to the biologically correct object. When no parent hen was available to them, these same chicks later responded to Mallard Ducks.

The response of incubator-hatched young of several species to inanimate objects, substituted for their parents, was also determined. Chicks and goslings of the Canada Goose followed a small green box containing an alarm clock. Muscovy ducklings and goslings responded to a football. Mallards responded to neither of these objects.

The above work makes it seem probable that in several species of birds both the adults and the young largely acquire, rather than inherit, the ability to recognize other members of the family to which they belong using color, voice, size and form as cues. Recognition seems to involve several factors, variation in any one of which upsets the recognition behavior of adults and young. In the species studied, auditory cues seem to predominate in recognition, but it is also apparent that these are far from being the only cues involved.

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(*Top*) ACQUIRED RESPONSE OF EXPERIMENTAL 21-DAY GOSLING, MALE PARENT AND SIBLINGS. (*Middle*) HOVERING RESPONSE OF 21-DAY GOSLING TO SUBSTITUTE OBJECT. (*Lower*) FOLLOWING RESPONSE OF 21-DAY GOSLING TO SUBSTITUTE OBJECT.