AFFILIATION AND SOCIAL DISCRIMINATION PRODUCED BY BRIEF EXPOSURE IN DAY-OLD DOMESTIC CHICKS

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Abstract. Discrimination between individual strangers and companions was examined in day-old domestic chicks. In one experiment, pecking rates at companions and strangers were observed in pairwise bouts after 16 hr of cohabitation. The discriminability of strangers and companions was varied by means of pre-hatch colouring. Reliable discriminations between individual strangers and companions emerged as early as the first minute of the encounter. Discriminative cues provided by artificial colouring were found not to be necessary in establishing social discrimination. In a second experiment, undyed chicks were housed in pairs for 1, 4 or 16 hr. Half of the pairs lived in cages that separated companions by a wire screen, and half were housed in undivided cages. Observations of pecking in four-way bouts confirmed previous findings and demonstrated that the opportunity to peck during exposure may be a necessary condition in producing social discrimination. Antecedent conditions that lead to the development of affiliative bonds simultaneously appear to establish social discrimination.

Interaction among members of a given social grouping differs markedly from interaction with outsiders. Group members maintain proximity, agonistic confrontations are infrequent, beneficial responses (e.g. grooming, feeding, playing, etc.) are prevalent, and the exploitation of scarce resources is relatively conflict-free. At the same time 'strangers' are shunned, repelled or attacked. This study is concerned with the early development of social discrimination as it emerges in the context of a communal experience. One-day-old chicks that had been exposed to one another are observed for their ability to discriminate between companions and 'strangers'. Research on the domestic fowl shows that when strange hens are introduced into flocks they immediately become targets of aggression (Schjelderup-Ebbe 1935; Guhl & Allee 1944). However, it is not known at what age domestic chicks begin recognizing companions and distinguishing them from strangers. The emergence of this form of social discrimination is not understood fully, but it is probable that factors that are implicated in the formation of affiliative bonds are also implicated in the development of social discrimination. Hence, procedures that are successful in establishing affiliation (approach behaviour, following and other forms of preference for the given target) should simultaneously establish avoidance and rejection of other objects. In some cases the antecedents of affiliation are remarkably simple. In the imprinting of precocial hatchlings, for example, the

repeated exposure of an object is sufficient for the formation of strong preference for that object (Bateson 1966; Sluckin 1965; Zajonc 1971).

Inferences about social behaviour among adult hens, especially in the areas of affiliation and dominance, are made readily from observations of pecking (Murchison 1935; Ratner 1961). Pecking also serves as an index of ingroup/outgroup discrimination, but quantitative data in this specific area are scarce for adult hens (e.g. Craig, Biswas & Guhl 1969) and are not available for hatchlings. It is not known at present how soon pecking begins to play a significant part in the social life of the hatchling, how soon after hatching mutual social discriminations are made, nor whether they are revealed in pecking interactions. The majority of imprinting research relies on reactions of single individuals to inanimate objects in situations that preclude social interactions. Of the imprinting studies with chicks that are concerned with social choices among conspecifics rather than among inanimate objects, only two measured the effects of social experience for day-old chicks (Kilham, Klopfer & Oelke 1968; Rajecki & Lake 1972). The remaining studies observed these effects on chicks already several days old (Pattie 1936; Smith 1957; Salzen & Cornell 1968) or even several weeks old (Howells & Vine 1940). Without exception, these studies employ confined targets and do not allow, therefore, for inferences about the emergence of social preferences in the context of social interaction.

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The present experiments seek to establish whether the same minimal conditions that are sufficient for the formation of early affiliative bonds, namely brief communal exposures, are also sufficient for the emergence of social discriminations. The main focus is on early exposure and its consequence: the discriminability of individuals. In contrast to imprinting research in which the attainment and maintenance of spatial proximity serve as the primary measure, observations are made of social pecking at companions and at strangers. Generalization of the effects of imprinting to objects not initially exposed is rather limited (Jaynes 1956, 1958; Bateson 1964). We would expect, therefore, that exposure alone should be sufficient in generating social discrimination.

Experiment 1

In the first experiment 1-day-old chicks were observed in a series of pairwise pecking bouts; each chick was matched in some way against its companion and in others against strangers. The role of visual information in establishing and maintaining social discrimination, revealed in differential pecking, was explored by varying supplementary cues in the form of artificially induced pre-hatch colouring. In one condition the colouring of the subjects was designed to facilitate discriminations between 'strangers' and 'companions', in another condition it was irrelevant to this discrimination, and in a third it was designed to have confounding consequences.

Methods

Subjects. All subjects used in experiment 1 and in experiment 2 were of the DeKalb (White Leghorn variety) hybrid stock. In the first experiment 168 chicks were hatched in visual and tactile isolation of each other. Between day 11 and day 13 of incubation the eggs were injected with commercial food colouring (2·5 per cent solution of U.S. certified colour in water and propylene glycol). Half of the embryos were dyed green and half red. The procedure suggested by Evans (1951) and modified by Rajecki & Lake (1972) was followed. The narrow end of the egg was swabbed with alcohol and punctured with a 20-gauge needle, about 1·25 cm from the top. Approximately 0·7 ml of the preparation was injected with a 25-gauge needle. Following injection the puncture was wiped with alcohol and sealed with a small fragment of adhesive tape.

The resulting colouring of the hatched chicks' plumage approximated the 5R 1/12 Munsel red chip and 2·5G 6/8 Munsel green chip. No physiological or behavioural side-effects are known to be associated with the procedure, and none were observed in this experiment.

Apparatus. The subjects were dark-hatched in a Jamesway 252B incubator that maintained a constant temperature of 38°C and 61 per cent relative humidity. After hatching, birds were housed in 22 × 28 × 20-cm cages. The side walls were made of sheet metal. The door and the back wall were made of wire mesh. The back was covered with Lucite. Visual and tactile contact was not possible between birds housed in different cages. The ambient temperature of the housing units was 29° to 32°C and illumination was provided by two 25-W lamps placed directly behind the rear wall of the housing unit, 3 cm behind the Lucite. Behavioural observations were of subjects placed in a 20 × 45 × 25-cm deep box constructed of masonite and lined with absorbent paper that was changed after each test. Two identical boxes were constructed since two pairs of birds were observed at one time.

Procedure. No earlier than 12 hr and not later than 24 hr after hatching, the hatchlings were placed in exposure cages for a period of 16 to 18 hr. Forty-eight green and forty-eight red chicks were housed in pairs of like colouring. Forty-eight chicks, half green and half red, were housed in pairs of unlike colouring. An additional twenty-four hatchlings, also dyed red or green, were housed in isolation for the same period of time.

All testing was carried out in 'tournaments' of tetrads. For each pair of companion chicks one other pair of companion chicks was selected to form a tetrad. In each experimental condition, therefore, there were twelve such tetrads, and in the control condition (chicks housed in isolation) there were six tetrads. Within each tetrad, one pair of companions was always designated A and B, and the other X and Y. Prior to the tournament all chicks were marked with a water-soluble marker to allow identification of individuals.

For each tetrad, the tournament involved observing each individual in several pecking bouts against the remaining three, according to a specified order. These pairwise bouts took place in the masonite boxes described above and lasted 3 min each. The first bout of each tournament would begin with two birds being

placed at opposite ends of the masonite box under opaque cylinders, 14·8 cm in diameter and 31·3-cm high. One minute was allowed to elapse and the opaque cylinders were removed simultaneously. The birds were given 2 min of adaptation, after which all pecks were counted for a period of 3 min, with each minute scored separately. The second and subsequent bouts did not include the 2-min adaptation period.

In each tournament there were four ingroup and four outgroup bouts. Each bird of the tetrad had two bouts with its companion and one bout each with the two strangers. Hence, in each tournament there were the following eight bouts: AB_1, AB_2, AX, AY, BX, BY, XY_1 and XY_2, where subscripts $_1$ and $_2$ stand for the first and second ingroup bout, respectively. At any one time, two of the eight bouts were observed simultaneously, each by a different observer, and in a separate box. While one observer might have observed bout AB_1, the other would be necessarily observing bout XY_1. If, in the subsequent bout the first observer would, according to schedule, observe the AX bout, the second observer would score the BY bout, etc. until all eight bouts were completed.

In each condition there were six different orders of bouts. Birds in different tetrads encountered their companions and strangers in different sequences of bouts. Since two bouts of a given tournament were run at the same time, and since both had to be either ingroup or outgroup encounters, the six orders were IIOO, IOIO, IOOI, OOII, OIOI, OIIO, where I means ingroup and O means outgroup bout.

The starting position of the bird in the observation box and the number of transfers from one box to the other were randomized within each order of bouts. Each of the two ingroup encounters within each tetrad was observed by a different observer. Thus, for example, for the order IOIO, if one observer scored AB_1 as his first ingroup bout, he would score XY_2 as his second ingroup bout. Pecks to all portions of the birds' bodies were counted and tabulated for each minute separately. A reliability check disclosed an acceptable level of agreement (0·98).

Design. Twelve tetrads were of the same colour within pairs and of the same colour between pairs (HOM–HOM); hence all chicks in the given tetrad were either green or red (see Table I). Twelve tetrads were of the same colour within pairs but of unlike colour between pairs (HOM–HET). Twelve pairs composed of one green and one red chick were matched against twelve similar unlike-colour pairs (HET–HOM). The six tetrads of isolates were yoked in colour and order of bouts to six tetrads selected from among the socially reared chicks.

Results

All data were computed from the number of pecks per min per bird. Because the pecking behaviour of one bird within a given tetrad is not independent of the pecking of another, analysis of variance was performed using not individual subjects but instead entire tetrads as data points. Conditions (three levels) and orders (six levels) were between-subject factors, while bouts (four levels) and minutes (three levels) were within-subject factors, with ingroup-outgroup effects (two levels) nested in bouts.

Figure 1 shows pecking rates for each of the thirty-six tetrads as well as the average peck

Table I. Pairing, During Exposure and in Test Bouts

Experimental condition	Cohabitation	Test bouts	
		Ingroup	Outgroup
HOM–HOM	Red with red (24 chicks) or Green with green (24 chicks)	Red vs red or Green vs green	Red vs red or Green vs green
HOM–HET	Red with red (24 chicks) or Green with green (24 chicks)	Red vs red or Green vs green	Red vs green
HET–HOM	Red with green (48 chicks)	Red vs green	Red vs red, Red vs green, and Green vs green

rates for each of the three experimental conditions. It is evident that there is considerably more pecking among 'strangers' than among companions $(F = 178 \cdot 01; df = 1/198; P < 0 \cdot 001)$ There is also a significant discriminability effect, with the HOM–HET condition showing the sharpest differences in peck rates $(F = 19 \cdot 93; df = 2/198; P < 0 \cdot 001)$. The HOM–HET tetrads are those in which the greatest differentiation would, in fact, be expected, since the two pairs are unfamiliar to each other because of lack of common experience, and because in the encounter between strangers their colouring is mutually unfamiliar as well.

While differences in colouring facilitate discrimination (see data for the HOM–HET condition), they are neither necessary nor sufficient for the emergence of differential ingroup/outgroup pecking. That colour differences are not necessary is evident from the contrast between ingroup and outgroup pecking found in the HOM–HOM condition in which the four birds were of the same colouring $(F = 24 \cdot 65 df = 1/198; P < 0 \cdot 001)$. It is not always possible, by means of prehatch dye injections, to produce completely uniform colouring in all hatchlings. Hence, there is some, however limited, possibility that these slight differences in colouring served as discriminable cues in the HOM–HOM condition. However, data from experiment 2 (see below), in which uncoloured chicks were used, will support further the conclusion that

reliable social discrimination can develop without differences in colouring.

That colour differences are not in themselves sufficient is evident from data of the HET–HOM and of the isolate conditions. In the HET–HOM condition the members of the cohabiting pairs are of different colouring. Each bird has one bout with a stranger of the same colouring and one with a stranger of a different colouring than his own. If colour-differences between individual subjects were alone capable of inducing differences in pecking, we would expect (a) that the ingroup peck rate of the HET–HOM condition would be higher than in the other two experimental conditions, (b) that ingroup peck rate of the HET–HOM birds would be higher than their outgroup peck rate, and (c) that they would peck more at the stranger of different colouring than at the stranger of their own colouring. In fact, the opposite is true in each case. The data relevant to (a) and (b) can be seen in Fig. 1. As for (c), the mean peck rate at a like-colour stranger was 4·00 and unlike-colour stranger 3·32. The relatively high peck rate in bouts with a like-colour stranger is due to unfamiliarity of the colouring, because the social experience of the HET–HOM subjects was primarily (and if we exclude experience with self, exclusively) with individuals of colouring different from their own. With respect to the isolates which were all strangers to one another, the sufficiency argument would lead us to expect more pecking in unlike pairs than in like pairs. No difference, however, was found between these two types of pairs among the isolated subjects $(t = 0 \cdot 435; df = 34)$. At the same time, the overall peck rate of the isolates was higher than the highest experimental outgroup peck rate $(8 \cdot 43 \text{ versus } 5 \cdot 74; t = 2 \cdot 81; df = 34; P < 0 \cdot 01)$.

Because of the short time of the tournaments, we may not consider their outcomes as stable social structures (peck orders), but it is possible to examine the tournaments for their consistency. Within each tournament, the outcomes of bouts (i.e. which of the two birds pecks more) can be examined for their transitivity. Therefore, if $A > B$ (meaning 'A beats B') and $B > C$, transitivity exists if $A > C$. There are three such transitivities possible in each tournament, and their presence was assessed by means of coefficients of consistency (Kendall & Smith 1940). The average coefficients of consistency in the HOM–HET, HET–HOM and HOM–HOM groups were respectively 0·96, 0·97 and
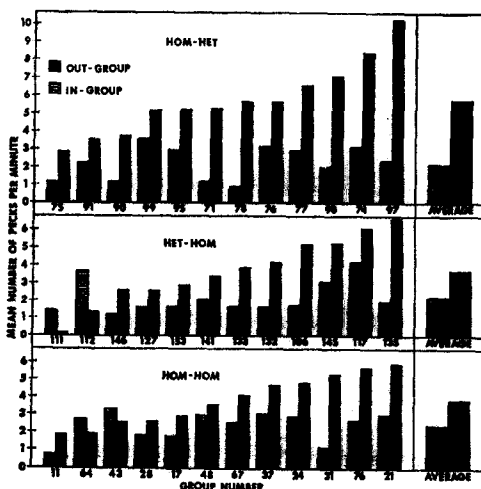

Fig. 1. Ingroup and outgroup pecking for chicks of the same and of different colouring.

0·98, almost complete transitivity in each case. Furthermore, by comparing the peck-orders of birds within tetrads generated by each successive minute of the tournament, we can, within these limits, assess the temporal stability of these social relationships using Kendall's W. The coefficients of concordance (W's) over the 3 min for the HOM–HET, HET–HOM and HOM–HOM conditions were 0·82, 0·65 and 0·65, again quite high (Siegel 1956).

Murchison's (1935) Social Reflex No. 1 (that is, the time and distance traversed by each of two contestants toward each other) was observed in a restricted form. For each bout the observation was made as to which of the two chicks made the first move toward the other. When we compare these figures against the probability of 'winning' the bout, i.e. pecking more than the opponent, it appears that the tendency to 'start' has some power in predicting the outcome. Of those birds that made the first move, 61·3, 61·4 and 58·7 per cent 'won' their bouts in the HOM–HET, HET–HOM and HOM–HOM conditions, respectively. Among isolates the starters had an almost equal chance of winning their bouts (52·0 per cent). This difference between the experimental and isolated birds might be explained by assuming that birds raised socially may have had experience in similar social encounters, and that some of them were reinforced negatively by counter-attacks that followed such 'starts'. This experience would tend to inhibit the tendency to move first. Ratner (1961) has shown that adult White Leghorns are quite capable of learning responses appropriate to subordinate social rank. Since isolates did not have the benefit of experience with conspecifics, probable winners and probable losers were both likely starters.

Behavioural reciprocity can only be evaluated indirectly and was done in the following manner. Separate determination was made for reciprocity among strangers and among companions. (Since each chick has two separate 3-min bouts with two different strangers, we can determine from which of the two strangers it received the greater number of pecks and can inquire whether the pecks delivered vary as a positive or as an inverse function of pecks received.) In each tournament two independent determinations of outgroup reciprocation can be made. Therefore, if $AX > BX$ and $XA > XB$, we have an instance of reciprocity, and if $AX > BX$ and $XA < XB$, we have an instance of complementarity, where AX means all the

pecks delivered by A to X, and XA all the pecks delivered by X to A. If $AX = BX$ or $XA = XB$, no determination can be made. Using this method of assessing reciprocation of pecking, there were fourteen, fourteen and sixteen reciprocations in the HOM–HET, HOM–HOM and HET–HOM conditions respectively. Also respectively, there were six, six and five complementarities, and four four and three indeterminate encounters as far as outgroup pecking is concerned. Across conditions, then, there were forty-four reciprocating, seventeen complementary and eleven indeterminate encounters.

Ingroup pecking, too, can be assessed for reciprocity by comparing the first with the second ingroup bout. Therefore, if $AB_1 > AB_2$ and $BA_1 > BA_2$ (or if $AB_1 < AB_2$ and $BA_1 < BA_2$), there would be reciprocation, for as one bird increases pecking so does the other. If $AB_1 > AB_2$ and $BA_1 < BA_2$, there is again complementarity. If $AB_1 = AB_2$ or $BA_1 = BA_2$, no determination can be made. (According to this procedure, there were eleven, ten and eleven reciprocated encounters in the HOM–HET, HOM–HOM and HET–HOM conditions, five, eight and eight complementary encounters, and eight, six and five indeterminate encounters, for a total of thirty-two reciprocated, twenty-one complementary and nineteen indeterminate encounters.) The large number of indeterminate outcomes among the ingroup triads is due to a preponderance of passive encounters where no pecking at all occurred. Also, it appears that there is less reciprocation in ingroup than in outgroup encounters. Overall, reciprocity occurs about twice as often as complementarity.

Experiment 2

In thirty-two of the thirty-six tetrads of experiment 1 there was clearly more outgroup than ingroup pecking, and in the HOM–HET condition there was nearly three times as much outgroup as ingroup pecking. The maximal differences in ingroup/outgroup pecking were obtained for different-coloured pairs, but there were significant differences in pecking even for those pairs that could not distinguish between companions and strangers on the basis of colour. To approach the minimal conditions necessary for the occurrence of social discrimination, we have tried in experiment 2 to eliminate or to reduce factors that favour differential pecking rates.

Four modifications were introduced to impose these restrictions. (a) Subjects were not coloured. (b) Observations were made of four-way bouts, in which all four birds (previously housed in pairs) were observed for their pecking behaviour. Under these conditions, social discrimination is more difficult to achieve, since each subject must discriminate among three individuals, two of whom are strangers and one its companion. (c) Some pairs were housed, as previously, in cages that afforded visual, auditory and tactile contact, but other birds were housed in cages equipped with wire partitions that prevented social pecking during the exposure phase. (d) Time of exposure was varied, the shortest being 1 hr.

Methods

One hundred and ninety-two undyed chicks were hatched as previously and transferred to exposure cages at ages ranging from 12 to 23 hr.

Exposure was again in pairs, but a third of the chicks were exposed to each other for just 1 hr, a third for 4 hr and a third for 16 hr. Termination of exposure always coincided with the 24th hr of the subject's life. Ninety-six birds were housed as in experiment 1, and ninety-six were housed in similar cages that provided for separation between the two members of the pair by means of a wire partition extending the entire depth and height of the cage.

Testing again was done at the completion of the exposure phase and was carried out in an open field, $45 \times 45 \times 16$-cm high, for a period of 5 min. The bouts were recorded on video tape; all pairwise pecking was tabulated from the tapes.

Results

Entire tetrads, and not individual subjects again served as units of analysis. Data were corrected for the availability of targets. That is, since each bird had the opportunity of pecking at two strangers but at only one companion, for purposes of analysis his peck rate at strangers was divided by two. Figure 2 shows peck rates (pecks per min per subject) for the six experimental groups. The presence of partition during exposure makes a pronounced contribution to the incidence of pecking. Birds housed in partitioned cages peck at each other significantly more than birds housed as in the previous experiment ($F = 5·38$; $df = 1/42$; $P < 0·05$). Moreover, there seems to be no difference between ingroup and outgroup pecking for
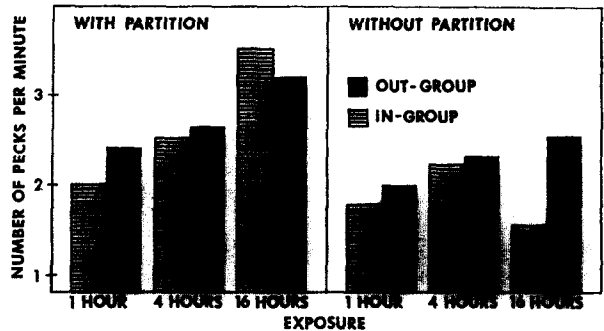

Fig. 2. Ingroup and outgroup pecking as a function of duration of prior exposure for birds housed with and without partition.

birds housed in partitioned cages and hence deprived of an opportunity to peck each other freely. For those birds housed in undivided cages, only the 16-hr group attained signficance. The appropriate interaction term was significant at the 0·05 level, and the difference between ingroup and outgroup peck rates for the non-partitioned 16-hr group was significant at the 0·001 level ($F = 11·81$; $df = 1/42$).

Discussion

The early social life of the chick hatchling appears to be quite sophisticated. Other research has shown that the hatchling exhibits a rich repertoire of social behaviour (Andrew 1966; Evans 1967), and the present studies have demonstrated that it is able to acquire socially significant discriminations very rapidly. Evidence of reliable discrimination between individual strangers and companions was obvious as early as the first minute of the encounter ($F = 46·07$; $df = 1/193$; $P < 0·001$). The two experiments taken together show that pecking is useful in revealing social differentiation that is established by virtue of early exposure.

Interest in pecking behaviour as a form of social interaction has emphasized either its agonistic (Evans 1967) or dominance-related aspects (see, for example, Craig, Biswas & Guhl 1969 or Murchison 1935). While some pecking observed in the present experiments could be categorized as aggressive according to Evans (1967) criteria, for the most part, its character was rather exploratory and not distinct in topography from pecks delivered at the physical segments of the chick's environment, such as the walls or the floors of the enclosures. A number of the present results suggest that pecking is a

vehicle of social exploration. They show that social pecking is highly sensitive to variations in the novelty of the target, which is the primary stimulus for exploratory behaviour. Pecking was consistently elevated whenever the encounter involved a novel element: (a) pecking was greater among strangers than among companions; (b) pecking was greater among strangers of unfamiliar colouring than among strangers of familiar colouring; the HOM–HET condition showed the highest rate of outgroup pecking and in the HET–HOM condition there was more outgroup pecking at the stranger whose colouring was different from the subject's companion than at the stranger whose colouring was the same; (c) chicks raised in isolation and for whom another chick was a totally novel stimulus, exhibited the highest amount of pecking; and (d) in experiment 2, birds housed in partitioned cages manifested more overall pecking than did birds housed without this constraint. In agreement with these observations are those of Craig et al. (1969) who found an increase in social interaction in groups of adult hens containing strangers, and of Guiton & Sluckin (1969) and Dimond (1970) who observed more overall social pecking among dark-reared than among light-reared chicks.

Even though the directly observable quality of early pecking among chick hatchlings is exploratory, it nevertheless seems to have pronounced social consequences. Under some circumstances it may familiarize specific individuals with one another, laying ground for affiliation and attachment. Possibly through repeated pecking contact the reciprocal reactions of two particular individuals assume predictable and recognizable patterns. For instance, the approach and the exploratory posture of each individual may be in some measure unique and identifiable, and so may be the reactions of those to whom it is addressed. The fact that birds housed in partitioned cages did not show discrimination between strangers and companions suggests that pecking might contribute to and facilitate the identification of particular individuals.

Under other circumstances, and perhaps entirely accidentally, exploratory social pecking develops into a chain of agonistic reactions. For example, a given exploratory peck is directed accidentally at a vulnerable or an injured part of the target's body: if it produces pain, the target might avoid the explorer in future encounters. Or, retaliatory pecking may be elicited, escalating into a higher level of aggression.

Little fear (freezing, jumping, etc.) was observed in encounters between birds, including those without any prior social experience. If fear manifested itself in ways that were not readily detectable, it did not seem to depress pecking. This seems to be in contrast with the observation that novel stimuli and novel environments depress food pecking: a phenomenon explained by invoking the inhibitory effects of fear of novel environment (Hogan 1965; Wilson 1968). It is possible that in these studies food pecking was reduced because other targets, being novel, elicited exploratory pecking that competed successfully with pecking for food. However, our findings are consistent with results showing that fear responses do not emerge until chicks are somewhat older than 24 hr.

Because the behaviour observed in the present experiments involved reciprocation and mutuality, certain aspects of social phenomena were revealed with greater clarity than is usually the case in imprinting experiments. Interindividual pecking, never used previously in the study of early avian social behaviour and imprinting, seems to be an efficient and reliable measure. Above all, it is very easy to quantify. Because a large sample of pecking can be obtained within relatively short observations, unlike choice behaviour, for example, it attains high levels of reliability that are determined readily. The high level of reliability of social pecking is quite apparent in the high coefficients of consistency and of concordance reported above. Pecking seems to be less vulnerable to extraneous fluctuations than, for instance, first choice, the latency of choice or maintenance of proximity.

Future research should determine the permanence of social bonds established by means of early exposures and contact, and whether social discrimination is maintained through interindividual pecking once the hatchlings begin to feed. The vulnerability of social bonds to subsequent separations and isolation should also be explored.

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