Control of aggressive behavior by an imprinted stimulus

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Ducklings raised in isolation but imprinted to a moving stimulus were paired with ducklings that had been previously exposed to other ducklings but had not seen the imprinting stimulus before. The imprinted ducklings attacked the socialized birds when the imprinting stimulus was present, but not in its absence.

Ramsay & Hess (1954) have reported that imprinting was facilitated when naive ducklings were exposed to an imprinting stimulus in the presence of a second, previously imprinted bird. In the process of conducting a pilot experiment to examine this facilitation, an unanticipated effect was discovered—that of an interaction between imprinting and aggressive behavior in 5-day-old ducklings, a phenomenon which deserves reporting in its own right. Aggression toward novel moving stimuli has been observed in young chicks by Evans (1967), who emphasized the significance of nonfamiliarity and strangeness in eliciting aggressive responses. A similar phenomenon was observed in the present study, with the additional finding that, for imprinted ducklings, occurrence of aggressive behavior was determined by the presence of the imprinted stimulus. When the stimulus was present, an imprinted duckling would display aggression toward a second, unfamiliar bird; in the absence of the stimulus, however, such aggression did not occur. Although it has previously been found that an imprinted stimulus can control many aspects of a duckling's behavior, e.g., distress calls (Hoffman, 1968), operant responses (Hoffman et al, 1966), and feeding behavior (Hoffman et al, 1969), there has been no evidence that an imprinted stimulus might also influence the tendency to engage in aggressive acts. The present experiment was designed to document the details of this effect.

SUBJECTS

Eight Khaki Campbell duck eggs, obtained from George F. Shaw, Inc., West Chester, Pa., were hatched in isolation and subsequently transferred to specially arranged housing units. These consisted of 15-gal translucent plastic containers, lined with disposable heavy-duty polyethylene bags that had an absorbent material

(San-i-cel) on the floor. When in its unit, a given duckling could hear other ducklings but its visual stimulation was restricted to that provided by the interior of the container.

APPARATUS

The imprinting apparatus was located in a sound-treated room. (For an illustration of the apparatus, see Hoffman, Eiserer, & Singer, 1972.) It consisted of a plywood box (183 x 76 x 76 cm), divided lengthwise into two equal-sized compartments by a stainless steel mesh screen. The S compartment was lit by two continuously illuminated 75-W incandescent lamps mounted above the screen; the stimulus compartment was kept dark so that ducklings could not see into that compartment until stimulus presentation occurred. For this event, two 75-W bulbs were illuminated in the stimulus compartment, thereby giving the Ss visual access to the imprinting stimulus, a rectangular white foam rubber covering (30 x 10 x 10 cm) over a model train engine that moved mechanically back and forth along HO-ga track at a speed of approximately 30 cm/sec. Stimulus withdrawal was accomplished by extinguishing the lamps in the stimulus compartment and terminating movement of the stimulus.

A specially constructed voice key, sensitive only to frequencies in the range in which the ducklings' distress vocalizations normally fall (3,000-4,000 Hz), was used to detect distress calls. Distress calls and stimulus presentations were recorded automatically on an Esterline Angus operations recorder. A closed-circuit television system provided continuous opportunity for observation.

PROCEDURE

For the first 4 days posthatch, four of the ducklings were housed individually. Each of these birds was exposed to the moving imprinting stimulus for 1 h a day until 5 days posthatch. The other four ducklings, the socialized birds, were housed in pairs and were not exposed to the imprinting stimulus. At 5 days posthatch, the socialized birds were

separated from their rearing companions and moved to individual containers. This arrangement provided us with eight Ss: four that were well socialized but not imprinted to the moving stimulus and four that were well imprinted but not socialized to other birds.

Testing began when the ducklings were 5 days old. Each of the socialized birds was placed in the apparatus with one of the imprinted birds, while the moving imprinting stimulus was continuously visible. After 25 min in this condition, the imprinting stimulus was withdrawn for 2 min. The members of each pair were then separately administered a second test in which a given duckling was exposed to 10 alternate presentations and withdrawals of the stimulus (20 sec present, 20 sec absent). All ducklings received the entire test sequence on each of 2 test days. During the first test day, the birds were observed via the closed-circuit television system and written records were made of the behavioral events that transpired in each of the several conditions. The intent here was to train the Os and to develop criteria for subsequent documentation of aggressive behavior. On the second test day, all Ss were again exposed to the sequence of tests and quantitative recordings of distress vocalization and aggressive attacks were obtained. In recording aggressive attacks, an experienced O watched a given pair via the closed-circuit television and activated a hand-held switch (connected to one channel of the operations recorder) when and only when a given bird's pecks at its partner were of sufficient intensity to initiate flight on the part of the latter. Although this was a relatively stringent criterion for aggression, especially when compared to others reported in the literature (Evans, 1967), the aggressive attacks generated in the present circumstances were so dramatic and easily discerned that the use of a rigid criterion seemed justified.

RESULTS

The conditions of this experiment yielded a consistent behavioral pattern that did not differ from pair to pair. In every case, throughout the 25 min of stimulus presentation, the imprinted birds either followed the stimulus or stood close to the screen in the middle of the compartment observing it. The socialized birds, on the other hand, directed their attention toward the imprinted birds and frequently attempted to approach them. Each attempt, however, incited an aggressive attack by the imprinted bird, who would turn from the stimulus and peck vigorously at the socialized bird. The socialized birds were never

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observed to retaliate; instead, they would flee to the side of the apparatus farthest from the stimulus, often pursued by the imprinted birds. The imprinted birds would then return to following and/or watching the stimulus. Often, in the intervals between aggressive encounters, the socialized birds would pace back and forth along the distant wall of the compartment as if they were following the imprinted birds at a distance. Very few distress calls were heard from either group of birds when the imprinting stimulus was present.

When the imprinting stimulus was withdrawn, the behavior of the imprinted birds exhibited a dramatic change. They began to emit distress vocalizations and moved about the apparatus as if searching for the stimulus. The socialized birds, however, continued to remain relatively silent and to direct their attention to the imprinted birds. Occasionally a socialized bird would approach the imprinted bird while the imprinting stimulus was withdrawn. When this occurred, rather than engaging in an aggressive attack, the imprinted bird invariably ran from the socialized bird. Under these circumstances, the socialized bird would follow the imprinted bird (as when the stimulus was present), but in no instance did the socialized bird exhibit aggressive pecking or any other behavior that resembled attack.

The recordings obtained on the second test day provide a quantitative index of the magnitude of these effects. For each S (or pair of Ss), the records were analyzed to determine the rate of distress vocalization expressed in seconds of distress calling per minute and of aggressive attacks expressed in attacks per minute. During the 25 min of stimulus presence, very few distress calls, a mean of 0.2 sec/min, were recorded from both birds; when the stimulus was withdrawn for 2 min, however, this rate increased to 15.0 sec/min. This difference is statistically significant ($t = 4.78$, $df = 3$, $p < .05$).

The aggression rates revealed an antithetical effect; during the presence of the imprinting stimulus, the imprinted birds made an average of 2.8 attacks/min (or about 70 attacks over the 25-min period), but during stimulus withdrawal, the attack rate was reduced dramatically to zero in all pairs. Again, this difference is statistically significant ($t = 4.41$, $df = 3$, $p < .05$).

To make certain that these changes in distress vocalization and aggressive attacks were not due to a simple time factor, data from the final 2 min of

the 25-min stimulus-exposure period were separately tabulated. When these rates were compared to the rates obtained during the entire 25-min exposure period, no significant differences were found for either distress calls or aggressive attacks (0.2 sec/min vs 0 sec/min for distress calls and 2.8 attacks/min vs 2.0 attacks/min for aggressive encounters). The other comparisons were, however, statistically significant: the change in the rate of distress calls in the final 2 min of stimulus presence as compared to the rate during the 2 min of stimulus absence that immediately followed ($t = 4.85$, $df = 3$, $p < .05$), and the change in rate of aggressive attacks from the final 2 min of stimulus presence compared to the 2 min of stimulus absence that followed ($t = 4.90$, $df = 3$, $p < .05$).

In the final phase of the test sequence, the pairs of birds were separated and each S was individually exposed to alternating presentations and withdrawals of the imprinting stimulus. The recordings on the second test day revealed that, like their performance when paired with another bird, the imprinted bird's distress vocalization was completely controlled by the presence or absence of the imprinted stimulus. During stimulus absence, an average of 28.8 sec/min of distress calls were emitted, whereas during stimulus presence, no distress calls occurred. This difference is statistically significant ($t = 3.23$, $df = 3$, $p < .05$).

It will be recalled that, when paired with an imprinted bird, the socialized birds were observed to be emitting very few distress calls either during stimulus presence or absence. When tested individually, on the other hand, these birds emitted many distress calls, and the rate was unaffected by the presence or absence of the imprinting stimulus. In its presence, distress calls were emitted at a rate of 20.2 sec/min, whereas in its absence, the rate was 21.0 sec/min. The difference is not statistically significant.

DISCUSSION

In addition to providing a quantitative index of the young ducklings' surprisingly high potentiality for aggressive behavior, these findings indicate circumstances that are sufficient for its occurrence. In the present study, aggressive attacks were observed only in the presence of the imprinting stimulus and then only by the imprinted ducklings. There are several factors which probably contributed to this configuration of results. For the imprinted ducklings that were raised in isolation, the socialized birds were unfamiliar

stimuli. As Evans (1967) has shown, unfamiliar stimuli can elicit aggression in immature precocial birds. The socialized birds, on the other hand, had been raised with a companion, and, consequently, the imprinted birds were familiar stimuli. Furthermore, from the finding that socialized birds emitted distress calls only in the absence of the imprinted birds, one may surmise that the imprinted birds were also objects of social attachment for the socialized birds. This would account for the socialized birds' repeated attempts to approach the imprinted birds, and it is consistent with the lack of retaliation when these attempts were thwarted by an aggressive attack.

Of special interest here is the finding that, in the absence of the imprinting stimulus, imprinted birds emitted distress calls and fled rather than attacking the approaching socialized birds. More data than are provided here would be needed to specify fully the factors responsible for this abrupt change in the imprinted birds' behavior. One possibility is that the presence of the imprinting stimulus somehow enhanced the imprinted birds' tendency to behave aggressively and that, with stimulus withdrawal, this tendency returned to an otherwise low baseline level. Another possibility is that stimulus absence somehow interfered with and thus precluded an otherwise strong tendency to emit aggressive behavior. While the present experiment does not include sufficient variations in living and testing conditions to differentiate between these possibilities, it is clear that such factors could be studied in future work. In the meantime, it seems important to note that these procedures can produce data that are indicative of a powerful and readily discerned interaction between imprinting and aggression.

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