

# Effects of environmental novelty on distress vocalizations of ducklings following withdrawal of an imprinting object

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Imprinted ducklings typically pause several seconds before initiating distress vocalizations following withdrawal of an imprinting object. In the present research, this pause was found to be shorter in the presence of a novel, presumably fear-inducing stimulus. This in turn implies that environmental novelty added to withdrawal of the imprinting object in determining the affective state of the ducklings. Although opponent process theory has no trouble with such additive effects, the very occurrence of the poststimulus pause presents problems for the theory.

In many animals, including certain species of ungulates, birds, primates, rodents, and canines, the infants emit loud, high-pitched vocalizations (distress calls) when separated from objects of social attachment (Collias, 1962; Hoffman, 1968; Mason, Hill, & Thompsen, 1971; Petti-john, 1979). Ducklings, for example, emit few distress calls in the presence of an imprinting stimulus but generate high rates of calling when the stimulus is withdrawn. When the stimulus is again presented, rates of calling decline (Hoffman, 1968).

As noted by Hoffman (1968), the decline in distress calls that occurs upon presentation of an imprinting stimulus is quite abrupt, almost immediate. In contrast, distress calling does not ordinarily begin until several seconds after the stimulus has been withdrawn (see Hoffman, Schiff, Adams, & Searle, 1966, for graphical representation of this effect). Although the control of distress vocalization by attachment objects has been intensively studied from a wide range of empirical perspectives, the poststimulus pause has not itself been systematically examined. Yet as a component of the temporal dynamics characterizing infant reaction to social separation, the pause may have potentially important theoretical implications.

One theory of relevance is *opponent process theory* (Hoffman & Solomon, 1974; Starr, 1978). According to this theory, a primary affective State A (caused by an underlying a-process) is generated immediately with presentation of an affect-arousing stimulus (like an imprinting stimulus) and then decays quickly with stimulus termination. The opponent b-process is more slowly recruited with stimulus presentation and also decays slowly after stimulus termination. State B (the product of the b-process) is only evident upon stimulus termination, when the a-process has vanished and some b-process still re-

mains. In their application of this theory to imprinting, Hoffman and Solomon (1974) and Starr (1978) assumed that suppression of distress calls during stimulus presence reflected an affectively pleasurable State A, and that distress calls following stimulus withdrawal reflected an affectively aversive State B. Those authors did not, however, specifically consider poststimulus pause in their application of the theory to imprinting phenomena.

The present study was designed to examine the effect of environmental novelty on the length of the poststimulus pause in distress calling that follows withdrawal of an imprinting object. Environmental novelty is commonly assumed to induce fear, or at least an aversive affective state, in precocial birds that are several days old (Sluckin, 1967). Thus, the present work was done to examine the possible interaction of two aversive affective states, one induced by withdrawal of an imprinting object, and the other induced by environmental novelty.

## METHOD

### Subjects

Eleven Khaki Campbell ducklings (*Anas platyrhynchos domesticus*) were hatched in visual isolation from eggs obtained from George F. Shaw, Inc., West Chester, PA. Except for periods spent in the experimental apparatus, each duckling was maintained in an individual housing unit consisting of a 15-gal, white translucent container, which was lined with a clear polyethylene bag and partially filled with bedding material. Under these circumstances, the ducklings could hear each other, but their visual environment was restricted to that provided by the inside of their individual housing units. While in these units, the ducklings had continuous access to food and water.

### Apparatus

The experimental apparatus consisted of a plywood box (122 × 76 × 76 cm) divided lengthwise by a fine mesh stainless steel screen into approximately equal compartments, one for the ducklings and the other for the imprinting stimulus. Lighting in the subject compartment was provided by two continuously illuminated 75-W incandescent lamps mounted above the screen. These lamps were positioned so that unless the stimulus compartment was also illuminated, the light that reflected from the screen prevented the subject from seeing into the stimulus compartment.

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The imprinting stimulus consisted of a yellow rectangular foam-rubber covering ( $22 \times 10 \times 10$  cm) mounted over a model train engine that ran the length of the stimulus compartment on HO-gauge track. Presentations of the imprinting stimulus were produced by illuminating two overhead 75-W incandescent lamps in the stimulus compartment and moving the object back and forth along its track at approximately 30 cm/sec. Stimulus absence was accomplished by extinguishing the overhead lamps and stopping movement of the stimulus.

Along the outer side of the subject compartment, opposite the side bordered by the stimulus compartment, a small platform supported an amber-colored lamp (21 cm high) of the sort used on the top of many emergency vehicles. Since the screen separating this lamp from the subject compartment was not fine mesh, the lamp's superstructure was always visible to the ducklings. Utilized in the present work as a novel stimulus, this lamp was presented by concurrently illuminating its bulb and rotating its lens system. Withdrawal of the lamp entailed extinguishing the bulb and terminating rotation.

Distress calls were monitored with a specially constructed voice key, which, through selective filtering, was sensitive only to sounds falling in the frequency range characteristic of distress calls (approximately 3000–4000 Hz). An operations recorder documented distress calls and stimulus events; in addition, the ducklings were observed through a closed-circuit television system.

### Procedure

After hatching, each duckling remained in the incubator for 8–12 h. Each subject was then transferred to the experimental apparatus for its first exposure session with the imprinting stimulus. During this 20-min session of continuous exposure to the imprinting stimulus, the amber lamp was visible on its platform but was not presented. Each duckling received two such sessions on each of the first 3 days posthatch.

On Day 4 posthatch, the ducklings were tested to assess effects of both the imprinting stimulus and the novel stimulus on baseline distress vocalization. In this test, 15-sec presentations of the imprinting stimulus were alternated with 15-sec presentations of the novel stimulus, with each stimulus presentation being preceded by a 15-sec period of complete stimulus absence. The sequence of "imprinting stimulus/absence/novel stimulus/absence" was presented 10 times.

On Days 5–7 posthatch, each subject received one daily session that involved brief presentations of the imprinting stimulus when the novel stimulus was either concurrently presented or withdrawn. More specifically, two types of trials were involved: On novel stimulus trials, the amber lamp was presented alone for 15 sec, after which the imprinting stimulus was also presented so that both stimuli were in view for 15 sec; the imprinting stimulus was then withdrawn and the novel stimulus remained in view for an additional 15 sec. On control trials, the imprinting stimulus was simply presented alone for 15 sec. Each session consisted of six trials of each type occurring in random order. The intertrial interval was approximately 60 sec.

## RESULTS

Observations by the experimenter on Day 4 revealed that most ducklings reacted to initial presentations of the rotating lamp with either immediate crouching and partial suppression of distress calls, or else equally immediate flight to a corner of the subject compartment, where they emitted distress calls more or less continuously. With more and more presentations of the lamp, crouching became less frequent until almost all ducklings were quickly withdrawing from the area of the lamp while simultaneously giving distress calls. Presentations of the imprinting stimulus, on the other hand, invariably elicited approach as well as nearly complete cessation of distress vocalization. During stimulus absence, the ducklings wandered about the subject compartment while giving high rates of distress vocalization.

These observations were supported by statistical analysis. After an analysis of variance for repeated measures had revealed significant differences across the three stimulus conditions [ $F(2,20) = 9.23, p < .05$ ], the Newman-Keuls test indicated that distress vocalization during presentation of the imprinting object differed from distress vocalization during both presentation of the novel stimulus and the baseline condition of stimulus absence ( $p < .05$  in both cases). The latter two conditions did not differ ( $p > .05$ ). Overall means for the three conditions were 27.1 distress calls per minute for the baseline condition, 29.3 during presentation of the novel stimulus, and 0.8 during presentation of the imprinting stimulus.

In assessing results of the test given on Days 5–7, post-stimulus pause was defined as the latency (in seconds) of the first distress call after withdrawal of the imprinting stimulus. The pause was shorter during the concurrent presence of the novel stimulus (a mean of 2.3 sec) than during its absence (a mean of 4.1 sec), an effect that was statistically reliable [ $t(10) = 3.89, p < .05$ ].

## DISCUSSION

The tendency of ducklings to initially crouch silently in response to the novel stimulus, but to later flee the stimulus while giving high rates of distress calls, is consistent with previous research in suggesting that distress vocalizations are not linearly related to environmental novelty (Ginsburg, Braud, & Taylor, 1974; Hodges & Prestrude, 1978). Rather, the relationship appears to be curvilinear, with high novelty inhibiting distress calls while the birds crouch, moderate novelty inducing high calling and flight responses, and low novelty (i.e., familiarity) again inhibiting distress calls while the birds approach.

The pause that occurs in distress calling following withdrawal of an imprinting object is probably not simply the result of an inherently long response latency in the vocal behavior of ducklings; no doubt, ducklings are physically able to begin distress calling about as quickly as they cease calling with stimulus onset (i.e., virtually instantly). Some other, less mechanical, process must be responsible.

One possibility is that the pause reflects the time needed for a duckling's level of aversive affect to reach some threshold for calling, after having been reduced to subthreshold levels by the presence of the imprinting object. In terms of opponent process theory, the present findings (i.e., that poststimulus pause is shorter during the concurrent presence of a novel stimulus) represent an additive effect between the aversive State A produced by novelty and the aversive State B that follows withdrawal of the imprinting stimulus. The threshold for distress calling, in other words, was reached sooner, and thus the poststimulus pause was shorter.

Berns and Bell (1979) also reported what could be interpreted as an additive effect on the affective state of precocial birds in the context of imprinting. These authors, examining the effects of withdrawing an imprinting stimulus on the duration of an induced tonic immobility reaction in chicks, found that tonic immobility was lengthened by stimulus withdrawal. In terms of opponent process theory, the aversive State B following withdrawal of the imprinting stimulus added to the aversive State A that presumably mediates tonic immobility.

Although opponent process theory has no trouble accounting for such additive effects, the very occurrence of the poststimulus pause presents problems for the theory. The pause would seem to imply that the a-process does not decay instantly with stimulus withdrawal, but instead takes numerous seconds. Thus the present data offer a new detail in the mechanics of the theory, which heretofore has only maintained that the a-process (or State A) "rapidly drops to zero when the stimulus input is terminated" (Hoffman & Solomon, 1974). Indeed, while the theory specifically alludes to the decay time of B (called "tau"), a decay time for A has not yet been extensively considered. The present results sug-

gest that some elaboration of opponent process theory is in this respect warranted, and future research on parameters of the poststimulus pause may better indicate the exact configuration this elaboration should take.

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