THE RESPONSIVITY OF NEONATAL CHICKS TO CONSPECIFIC DISTRESS AND CONTENTMENT VOCALIZATIONS

by

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Neonatal precocial birds interact with their siblings, as well as, their mother in natural settings (Lorenz, 1937; Bermant, 1963). Communication among precocial bird siblings may involve the utilization of tactile, visual, and/or auditory information. Since ducklings and chicks are capable of emitting recognizable call notes prior to hatching (Gottlieb & Vandenbergh, 1968), it is likely that auditory communication may occupy a fundamental position in the regulation of young-young and mother-young relationships. While the auditory characteristics mediating and facilitating development of the mother-young/imprinting relationship have been extensively examined (e.g., Ramsay, 1951; Fischer, 1966, 1972; Fischer & Gilman, 1969; Smith & Bird, 1963, 1964; Gottlieb & Simner, 1969), the nature of acoustically mediated young-young relationships has not been clearly specified. In particular, the potential role played by neonatal chick distress and contentment vocalizations in the mediation of sibling social behavior is largely unknown. The major objective of the present series of studies is to determine the nature of the response topographies associated with the reception of conspecific distress and contentment vocalizations in the neonatal domestic chick. Manipulations of post-hatch auditory experience, rearing and testing environments, and age at testing will be performed in an attempt to elucidate the behavioral significance of distress and contentment vocalizations.

Vocalizations of the Neonatal Chick

In a descriptive discussion of the physical and behavioral characteristics of the vocalizations of the young domestic chick it is important to note the difficulties inherent in this type of task.

Bremond (1963) has indicated that there is no completely satisfactory method for describing the acoustical signals of birds. He reported that calls may be described as notes on a musical scale, as they compare to other sounds, employing onamatapeia, with a spectrograph or oscillograph, in relation to the state of the donor during emission, and/or in relation to its action on the receptor. He has suggested that sounds can best be described based upon objective records (e.g., sonagrams) and in relation to the action of the signal on the receptor. While sonagrams of chick vocalizations are readily available (Collias & Joos, 1953; Andrew, 1964, 1975), only scanty information is available concerning the action of vocalizations on a chick receiver.

This difficulty in relation to the chick vocalization literature is partly manifested in the variety of names which have been attached to each of the chick vocalizations. For example, Lorenz (1937) refers to an abandonment call; Collias (1952, 1963) refers to distress vocalizations, distress peeps, distress notes, or cheeps; Andrew (1964, 1975) refers to peeps, and shrieks; and Hogan (1965) refers to shrill vocalizations. Spectrographic evidence relating these calls is present concerning the nomenclature employed by Collias and Andrew, however, the physical nature and communicative significance of the other presumably related, if not identical, vocalizations is not available. Similarly, Collins refers to twitterings, pleasure, or contentment vocalizations, Andrew refers to twitters, and Hogan refers to trills.

Collias (1968) has suggested that distress and contentment calls are not only uttered in opposite kinds of situations, but that they are structural opposites. In addition he contends that they are associated with different postures (head up - distress vocalizations, head down - contentment vocalizations) and opposite tendencies to react can be observed in the presence of each call. Collias (1952) reported that approach responses are likely to accompany contentment vocalizations and avoidance responses are likely to accompany distress vocalizations. He further postulated two antithetical neural systems to account for the production of distress and contentment vocalizations.

In contrast, Andrew (1964) feels that the twitter and peep vocalizations are only extreme variants of a continuous series of patterns. That is, he suggested that the calls of the chick form a single response system in which increases in the intensity of "stimulus contrast" are shown by increases in the length, pitch, and number of trilling cycles. He indicates that persistent and relatively intense contrast is necessary to evoke calls toward the peep end of the "twitter-peep series" and that very intense contrast is necessary to elicit shrieks. Also in opposition to the traditional Collias interpretation, Andrew reports that the association between twitters and approach responses and peeps and avoidance responses can be better explained by assuming that approach may be elicited by moderate stimulus contrast and avoidance by intense contrast (after Schneirla, 1965).

With regard to other chick vocalizations, the situation becomes more complicated since distinctions or relationships between the brooding-call (Gottlieb, 1966; Gottlieb & Vandenbergh, 1968), the fear note or fear trill (Collias & Joos, 1953), the chevron call, the circumflex call, the short peep, and the warble (Andrew, 1964; 1975) have seldom been specified in meaningful behavior contexts.

Collias (1952) reported that many of the categories used in the analytical description of the central nervous system may also be applied to the neonatal chick vocalization system. For example, latency is observed in this vocalization system since several seconds or minutes may transpire before distress calls are heard when a chick is isolated from sibs. Rhythmicity also characterizes this system since it has been observed that distress calls are given repeatedly at fairly regular intervals, revealing some predisposition to recur in groups. The existence of fluctuating threshold may be documented, in that, alternating periods of distress and contentment calls may be recorded when a chick is isolated from a cage-mate for an hour or more. Afterdischarge may be observed in chicks that continue to emit contentment calls after stroking them has been discontinued and they are abruptly isolated. Inhibition is a characteristic of the chick vocalization system since distress and contentment calls are essentially incompatible and that a situation which stimulates one call will inhibit the other calls. Refractoriness was discussed by Collias and illustrated by the observation that some chicks, after prolonged exposure to an imprinting model, will cease emitting contentment calls and begin emitting distress calls.

Gottlieb and Vandenbergh (1968) have extensively examined the ontogenesis of chick and duckling vocalization. Vocalization begins as early as 3 days prior to hatching in chicks and 5 1/2 days before hatching in ducklings. By 24 h before hatching all chick embryos and by 3 1/2 days before hatching all duck embryos were vocalizing. They report that the vocalizations heard prior to hatching resemble those heard after hatching and can be categorized as distress vocalizations, contentment vocalizations, and brooding-like calls. They further determined that the basic source of sound production in chicks and ducklings was the constriction and vibration of the tympaniform membrane during exhalation. Apparently, the syrinx, trachea, and syringeal muscles are important in modifying the sounds produced by the tympaniform membrane. Simner (1966) further determined that the likelihood of vocal activity in newly hatched chicks is increased when ongoing heart rate decreases toward the pre-hatch cardiac rate. As is the case with chicks, the distress and contentment calls of ducklings differ in duration, intensity, pitch, change in pitch over time, and rate of emission (Rajecki & Eichenbaum, 1975).

The observation that chick vocalizations may be brought under operant control (Lane, 1960a, b) added a valuable technique to the investigation of chicken vocalizations. For example, Lane (1960a) determined that the rate of "chirping" in hungry chicks could be controlled by the schedule of presentation of food. He reported that in Bantam chicks a fixed ratio schedule of reinforcement established a readily obtainable high rate of vocalization. Lane (1960b) also determined that while pecking and vocalizing both produced similar cumulative records during acquisition, pecking decreased rapidly and vocalizing decreased gradually and cyclically during extinction. He found that during the conditioning of pecking a low rate of chirping was maintained and that during extinction of pecking the unreinforced chirping also declined. It is important to note that while the frequency of emission of chick vocalizations may be altered by learning, it is generally recognized that for domestic fowl learning plays little if any role in the development of the vocal repertoire (Konishi, 1963). Bremond (1963) has stated that vocal signals of female chicks are entirely innate, whereas those of the male are partially so. Lanyon (1960) has indicated that non-passerine vocalizations are all of the simple call note variety and are highly stereotypic.

Distress Vocalizations

Distress vocalizations have been more closely examined than any of the other neonatal chick vocalizations. The occurrence of distress vocalizations has been used as an index of attachment to an imprinting model, attachment to a particular rearing environment, attachment to conspecifies, emotionality, and as a predictor of tonic immobility response duration. Distress calls have also been broadcast in farm areas and around air fields in an attempt to produce active avoidance responses in a variety of avian species.

Collias (1952, 1968) and Collias and Joos (1953) described the chick distress vocalization as loud, "insistent" peeps which are usually given repeatedly and can carry over a relatively large distance. They noted that the distress vocalization is composed entirely of descending frequencies. Hess (1959a) described distress notes as a series of high intensity, medium-pitch tones with a duration of approximately 1/4 sec. He additionally observed that distress calls tended to occur in bursts of five to ten signals, and are characterized by little frequency modulation. In an investigation of the vocalizations of the Peking duckling, Rajecki and Eichenbaum (1975) determined that duckling distress calls have a duration of approximately 125 msec. and an intensity of 70-85 db.

Distress calls are likely to be emitted in response to a loss of contact with the egg shell and the cooling of moist down during hatching, and when a chick is isolated from its parent or the rest of the brood (Collias, 1952; Bermant, 1963). Collias (1952) further observed an increase in the frequency of distress vocalizations when a chick was hungry, in pain, under restraint, or when it was approached by a large object. Rajecki, Eichenbaum, and Heilweil (1973) have simply suggested that more distress calls can be measured when a chick is "uncomfortable". Andrew (1969) reported that intracranial stimulation at hypothalamic sites produced high rates of peeping both during and after the stimulation. He further indicated that peep vocalizations were likely to accompany "attention scanning", "recognition processes", and fleeing. Interestingly, Andrew (1972, 1975) reported that the administration of testosterone to male chicks of the Warren sex link strain results in a replacement of peeps with silence and greater persistence of search behaviors. Changes in the syrinx were not noted as a result of this hormone manipulation.

McGrath, Shalter, Schleidt, and Sarvella (1972) have analyzed the distress calls of chicken x pheasant hybrids and have concluded that the frequency and duration of distress calls seems to be genetically controlled in different ways. They tested males and females from each of the parental species and hybrids from the two size strains (small hybrids - females, large hybrids - males) in an anechoic chamber. No differences between the male and female chicken distress calls were noted, however, no male pheasant emitted distress calls while four out of five female pheasants emitted distress calls. The principal attributes of both sized hybrids' distress calls were intermediate to the parent species, in that, the duration of the calls was similar to that exhibited by female pheasants, while the 50-80 Hz frequency modulation of the calls was similar to that recorded in the chicken subjects.

Distress calls in young precocial birds have been observed to produce a dramatic effect on subsequent parental behavior. For example, Bremond (1963) reported that a Mallard hen will approach every duckling emitting distress calls and after chasing away any aggressors will subsequently kill the duckling if it is not her own. Domestic hens are also known to react to the distress calls of strange young, but the incidence of the subsequent killing of young is not known. Bermant (1963) has similarly indicated that chick distress vocalizations produce "strong" behavior in the hen directed toward the sound even if the chick is out of sight. He subsequently indicated that increases in the rate and intensity of distress calls also increases the likelihood of a protective response by a hen.

Attachment to an imprinting stimulus. Hess (1959b) noted that distress notes are emitted when a young chick falls appreciably behind an imprinting model. Conversely, a reduction or elimination of distress calls has been taken as a measure of the beginning of the establishment of imprinting (e.g., Collias & Joos, 1953; Hess & Schaefer, 1959; Salzen & Tomlin, 1963).

Hoffman, Schiff, Adams, and Searle (1966) performed a study to determine how the Peking ducklings' tendency to emit distress calls is influenced by the return, after an absence, of an imprinting model. Their apparatus was programmed such that the imprinting stimulus would appear each time a duckling emitted distress calls. One of two possible outcomes may be predicted; either the constant availability of the imprinting stimulus through distress vocalizations should minimize emotionality and thereby reduce distress calls, or the return of the imprinting stimulus may tend to strengthen the response which preceded it and therefore the rate of distress calling should increase. They found that high rates of distress calling occurred following the removal of the imprinted stimulus and continued until the stimulus was again presented. They concluded that when ducklings have been imprinted the tendency to emit distress calls is determined by the proximity of the imprinted stimulus.

Hoffman, Searle, Toffey, and Kozma (1966) replicated these findings and extended them to include the observation that when a duckling has constant access to an imprinting stimulus via an operant key peck response, the pecking responses tend to occur in bursts and few distress calls are emitted even during extended periods of time between bursts. However, if key pecks fail to produce the imprinted stimulus, the duckling will initially peck more rapidly and begin to emit distress calls. They also found that various objects in the experimental chamber, in addition to the imprinting stimulus, can acquire control over a duckling's behavior by virtue of the observation that distress vocalizations or key pecking responses are decreased in the presence of these objects and increased when the objects are removed.

Hoffman (1968) performed a study which further refined the nature of the relationship between the emission of distress calls and attachment to an imprinting object. He placed Peking ducklings in four conditions: (a) a standard individual imprinting situation, (b) an apparatus familiarization procedure in which the stimulus compartment of the apparatus was illuminated but remained empty, (c) an imprinting situation in which the subject's movement was restricted by exposing the duckling to the imprinting stimulus while it remained in its home cage, and (d) a group imprinting condition. More distress calls were recorded during stimulus withdrawal than during stimulus presentation in the standard imprinting situation and in the restricted movement situation. These findings were reversed for the familiarization condition group and only weak following and few distress calls were recorded for the group imprinting condition. It was also observed that with paired ducklings (initially imprinted in a four bird group) few distress calls were noted; however, if the same subjects were then tested individually many distress peeps were emitted especially in the absence of the imprinted stimulus. It was concluded that the nature of a duckling's social experience and the familiarity of the imprinting stimulus configuration contribute to the determination of the bird's vocal response to the presence and absence of the imprinted object. Hoffman further concluded that visual, rather than auditory, stimuli make major contributions to the control of distress vocalizations exerted by an imprinted stimulus. On the other hand, Bermant (1963) has convincingly determined in naturally incubated and reared Black sex link strain chicks that sound and the combination of sight and sound of a hen are very effective in controlling both the rate and intensity of distress calling.

Observations indicating that duckling distress calls are enhanced during a reduction in body temperature, during threat from a predator, during painful stimulation and during separation from an imprinting model prompted Hoffman, Stratton, Newby, and Barrett (1970) to investigate the relationship between distress call emission and changes in duckling arousal levels. It was once again determined that reliably more distress calls were emitted in the absence of the imprinting stimulus than in its presence. They further demonstrated that imprinting stimulus presentation did not reliably influence the 17 h old duckling's tendency to emit distress calls when the stimulus did not move. It was therefore concluded that the absence of distress calls in the presence of a moving imprinting stimulus represents a reduction in duckling arousal. Since acceptable physiological measures of arousal were not taken this conclusion seems tenuous as well as circular.

A classical conditioning paradigm was employed by Hoffman, Barrett, Ratner, and Singer (1972) in an attempt to determine if a neutral stimulus (lights) could acquire the capacity to suppress distress vocalizations as an imprinted stimulus does. The stimulus light gradually developed control of distress calling and the nature of this control was largely determined by the temporal relationship between when the light and imprinting stimulus were presented. By the fifth trial involving forward pairing of the lights and the imprinting stimulus, distress calls were completely suppressed. They further investigated the suppression of distress vocalizations utilizing a differential conditioning paradigm, in which one stimulus light could be associated with the imprinting stimulus, while another stimulus light was never associated with the imprinting stimulus. It generally took longer for the control of distress calls to emerge under these conditions in Khaki Campbell ducklings.

Hoffman, Ratner, and Eiserer (1972) investigated further the suppression of distress vocalizations by visual imprinting stimuli in Khaki Campbell ducklings. They found that prior to imprinting, both a moving stimulus and a revolving light could control distress vocalizations, however, after imprinting the control exerted by the imprinting stimulus increased while the control exerted by the nonimprinted stimulus decreased. In a second investigation, ducklings were assigned to one of four conditions: (a) single imprinting stimulus group, (b) two imprinting stimuli presented simultaneously, (c) two imprinting stimuli presented alternately, and (d) no imprinting stimulus. They found a high positive correlation between the distress call suppression ratio value and the amount of time spent before an imprinting stimulus. Further, as the number of enforced exposures proceeded, the imprinting stimulus exhibited increasing tendencies to suppress distress calls. It was concluded that the development of a social alliance with one stimulus can under certain situations facilitate the development of a subsequent alliance with another stimulus.

Moreover, Eiserer and Hoffman (1970) indicated that the presentation of an imprinted stimulus reliably facilitated the subsequent emission of distress calls (during separation from the imprinted stimulus), and that more distress calls were produced following presentation of an imprinted stimulus than following presentation of a novel stimulus. They observed that most ducklings responded in one of two ways to the initial presentations of a novel stimulus; subjects either engaged in immediate crouching behaviors in which case few distress calls were heard, or subjects engaged in an immediate flight reaction away from the stimulus and a large number of distress calls were emitted. Bateson (1964) has similarly demonstrated that the rate of peep calling decreased once active avoidance responses ceased.

In the Lane (1960a, b) tradition, Hoffman, Newby, and Stratton (1973) investigated the similarities of pecking and distress vocalizing as operant responses. Ducklings were trained using a successive approximations technique to either emit a pole-pecking response or a distress call with the presentation of an imprinting stimulus used as a reinforcer. Birds reinforced for distress calls emitted an average of 20.7 distress calls/h, while birds reinforced for pole-pecking emitted only 2.3 distress calls/h (rates averaged over a 10 h observation period). In a second experiment neither the pole-pecks nor the distress calls were reinforced. The group which had been reinforced for emitting distress calls exhibited a gradual decline in time spent distress calling (from 14 sec to 7 sec/20 sec stimulus presentation-stimulus withdrawal cycle). The group which had been reinforced for pole-pecks also showed a decline in tendency to emit distress calls across cycles (2 sec/20 sec cycle). It was indicated that the reinforced distress calls did not differ acoustically from distress calls emitted in stressful situations. However, Hoffman _et_ _al_. (1973) suggest that reinforced distress calls may not reflect the same kind of underlying emotional reactions as distress calls evoked in a stressful situation.

Hoffman, Eiserer, Ratner, and Pickering (1974) attempted to specify the factors responsible for the distress vocalizations that occur when an imprinted stimulus is withdrawn from ducklings. Two groups of Khaki Campbell ducklings were employed in this study. One group was reared in the imprinting apparatus to ensure that the birds would be familiar with it and also to ensure that the ducklings would not be emitting distress calls at the time of stimulus onset. The second group of ducklings were reared individually in standard housing units and tested in the imprinting apparatus. In the apparatus-reared birds the amount of distress calling increased during the stimulus withdrawal phase after the initial stimulus presentation. In the cage-reared ducklings distress calls were high prior to stimulus presentation, ceased during presentation of the imprinting stimulus, and were thereafter confined to periods of stimulus withdrawal. These findings are in agreement with those presented by Hoffman and Ratner (1973) in which it was determined that single 10 min presentation of an imprinting stimulus was sufficient to generate substantial amounts of distress calling in 17 h old ducklings which had been reared in the imprinting apparatus and had never emitted a distress call prior to the initial stimulus presentation. Hoffman _et_ _al_. (1974) suggest that these results may be interpreted by employing the opponent-process theory of motivation (after Solomon & Corbit, 1973). That is, they suggest that motivational aftereffects (distress vocalizations) are produced which are opposite to the affective state generated by imprinting stimulus presentation.

Rajecki, Eichenbaum, and Heilweil (1973) investigated the relationship between the emission of distress vocalizations in White Leghorn chicks and approach to an imprinting stimulus. As has been repeatedly demonstrated by Hoffman and his associates, Rajecki _et_ _al_. (1973) found that distress calling was reduced in the presence of an imprinting stimulus (bank of miniature flashing lights). More distress calls were also emitted later in exposure sessions than earlier and more distress calls occurred in chicks which had been pre-exposed to temperatures which were lower than the incubating temperature. In summary, they found that chicks whose distress call rates were most affected by exposure to the imprinting target were also the best followers of the target. Similarly, Zajonc, Markus, and Wilson (1974) indicated that a greater reduction in distress calls is noted as the familiarity of an object increases. In addition, Zajonc *et al*. (1974) suggest that the emission rate of distress calls is a fairly sensitive measure of repeated exposure effects since it is relatively uncontaminated by curiosity and exploratory motives.

Snapp (1969) performed a most interesting study on the recognition of maternal feeding and distress calls in parentally naive Burmese Red Junglefowl chicks. It was found that the maternal distress call produced sustained distress vocalizations and increased movement in chicks. The most commonly observed response to the feeding call was silence. The lack of specific orientation to the source of the maternal distress call was interpreted to mean that this call is primarily an arousal and agitative call, the emission of which results in varying orientational stances. Snapp further discusses the biological appropriateness of increased movements and vocalization in the presence of maternal distress calls. It was speculated that increased movement could serve to bring the chick in contact with either its parent or concealing vegetative coverage. Further, the increased vocalization was construed to function by maintaining vocal contact with a parent while under concealment. Although it is easy to speculate upon the biological inappropriateness of such responses, one may also defend freezing or remaining motionless and silent in the presence of maternal distress vocalizations in a nondomesticated population.

Attachment to a specific rearing environment or to conspecifics. Collias (1952) has suggested that the presence of distress calling in the experimental situation is largely due to the isolation of the chick from its companions. Guiton (1959) has carefully presented the temporal sequence in which isolation and vocalization effects proceed. For example, six Brown Leghorn chicks were reared socially from the ages of 20-54 h until they were placed around the perimeter of a circular runway. The chicks were separated by approximately 50 cm and they were observed for 30 min. Through the sixth minute all birds crouched quietly. On the seventh minute, however, one chick started emitting distress calls (softly and hesitantly at first) which became louder as the subject began to walk around. By the eighth minute, all chicks had one-by-one participated in this pattern. After this period of time the young chicks soon began to meet up with one another and distress calls were observed to cease 5 sec after a chick "joined up" with its sibs. By the thirteenth minute all chicks had come together and distress calls had been completely replaced by contentment calls.

Guiton (1959) has also described the sequence of events which transpire when a naive socially reared chick is placed into runway approximately 140 cm from a group of other chicks. Again, the chick's first response was crouching and no vocalizations were detected. Next, distress calls were emitted which increased in volume as the chick stood up and began to locomote around the apparatus. Then, after a further interval of emitting contentment calls and approaching the group of six chicks, the subject hesitated about 30 cms away from the group and emitted more distress calls. Finally, the chick joined the group of chicks.

Kaufman and Hinde (1961) investigated the emission of distress calls in relation to environmental temperature and social experience in White Leghorn and Rhode Island Red chicks. They found that: (a) the number of distress calls increases as temperature decreases, (b) in high (over 100° F) and intermediate (81-100° F) temperatures an increase in distress calling occurs with increasing age, (c) the number of distress calls increases with increasing age in socially reared birds which are tested individually in the presence of high temperatures, and (d) the number of distress calls decreased in socially reared birds exposed to a mirror, but increased in isolate reared birds in the presence of a mirror. Kaufman and Hinde conclude that separation from social companions becomes an effective causal factor for the emission of distress vocalizations. They further suggest that distress calls are fear responses. In this context, Hess (1959b) has suggested that fear develops in White Rock chicks around 33-36 h post-hatch based upon an increase in distress calling which was noted at this time.

The relationship between the emission of distress calls and group size in ducklings has recently been investigated by Gaioni, Hoffman, Klein, and Depaulo (1977). A number of casual observations prompted this inquiry. For example, they noted that newly hatched ducklings which were reared in pairs seldom emitted distress calls unless disturbed. However, if the ducklings were separated, both birds emitted large amounts of distress calls. They had also noticed that when a few ducklings were removed from a larger group of birds, the remaining birds quickly began to emit distress calls until their companions were returned. Following more controlled investigation they determined that: (a) as birds are individually removed from groups of three, six, or ten birds the number of distress calls emitted increased progressively as more subjects were withdrawn, (b) a given number of birds remaining from a large group emitted more distress calls than the same number of birds remaining from a smaller group, (c) a dramatic increase in group size (from two to twelve birds) has no readily apparent effect on distress calls, and (d) interchanging birds between two equal-sized groups also had no effect on distress calling. It can be safely concluded, therefore, that distress calling induced by reduction in group size was not produced solely by environmental/stimulus change.

Lampros (1976) has similarly determined that the peep call of socially reared domestic chicks is highly persistent and related to separation from rearing mates until at least 29 days of age. Age-related monotonic decreases in the amount of peep calling were also noted. It was found that a live conspecific could reduce the peeping of others. Features of the chick which facilitated this reduction included: both visual and auditory characteristics of the chick which combined additively, both upper and lower body regions of the chick, and movement of the chick. Similarly, Sigman, Lovern, and Schulman (in press) have suggested that the preference for socially reared targets in a V-maze exhibited by both socially and individually reared subjects may be explained by the vocalizations of the target animals, the movements of the target animals, and/or the auditory and visual stimuli resulting from pecking in target animals.

Fullerton, Berryman, and Sluckin (1970) have investigated the affect of environmental and social change on the distress vocalizations of Cobb chicks. A first experiment was performed to determine what extent certain disturbances of the physical environment have on distress vocalizations. Subjects were reared in groups of four chicks and tested at 1 or 4 days of age. Distress calls were recorded from individual chicks either following removal of the chick from its rearing box and placing it in another identical empty box (handled) or following removal of three rearing-mates from the box (not handled). No differences were discernable between the two groups, birds in both situations were described as highly "distressed". The purpose of their second experiment was to determine, in the absence of social bonds, whether slight degrees of "stimulus contrast" (Andrew, 1964) could produce differences in peeping. Three min recordings of vocalizations were made on isolate reared birds that were tested at 1 or 4 days of age under one of the following conditions: (a) chick remained in rearing box and a single tap was made on the side of the box, (b) the chick was gently lifted up out of the rearing box and replaced immediately in the box, (c) the chick was removed from its rearing box and placed in a new, but identical box, and (d) the chick was removed from its home box and placed in an open field. The number of distress calls recorded increased with increasing environmental change, however, no age-related differences in the amount of peeping were noted. The absence of age-related peeping increases is in conflict with the data presented by Lampros (1976) and Kaufman and Hinde (1961). Fullerton _et al_. (1970) expressed some surprise at these results suggesting that if peeping is regarded as a measure of distress at separation, then one would expect the amount of distress calling exhibited to be proportional to the degree of attachment.

Emotionality. The most commonly employed technique to assess emotionality in animals is the open field test. Dependent measures which are commonly taken when chicks are subjects in open field tests include: the frequency of defecation, duration of freezing responses (alternately, latency to first movement), number of squares entered or lines crossed, and frequency of distress calling. Candland, Nagy, and Conklyn (1963) were among the first investigators to provide information concerning age-related changes in the behavior of the domestic chick in an open field situation. White Leghorn chicks were housed individually and tested at 1, 8, 15, 28, 44, 64, and 90 days of age. They noted that distress calling was prevalent through 15 days of age and reached a peak at 8 days of age (70 percent of chicks distress called). Interestingly, while only 20 percent of the chicks engaged in freezing responses on Day 8, 50 percent of chicks on Days 15, 28, and 44 exhibited freezing responses. No relationship was found between distress calling and defecation measures, however, freezing and elimination measures were very highly correlated. Candland and Nagy (1969) suggest that ontogenetically, it seems emotional behavior in the chick produces an increase in defecation and a decrease in distress calls from 1-15 days of age. Faure and Folmer (1975) determined that two types of extreme behavior may be observed and selected for in young chicks tested in an open field. The chicks they studied typically fell into either an active group (much movement and exploratory behavior, frequent defecation, and emission of distress calls) or an inactive group (low amounts of activity, few distress calls, etc.). They demonstrated that emotionality in chicks is a heritable characteristic. Faure (1975) further found that emotionality has an inhibitory effect on behavior as evidenced by decreases in activity, number of jumps, number of distress calls and frequency of defecation. It has also been determined that chicks characterized by medium levels of emotionality are more dominant when compared to low-emotivity and high-emotivity chicks (Faure, 1977a). Interestingly, highly emotional hens (inactive) were found to have better growth rates (heavier weights and more rapid growth of long bones) than less emotional hens (Faure, 1977b). While selection for high weights in young birds led to an increase in activity in an open-field, selection for high adult weights had an effect only on exploratory activity (Faure & Richard, 1977).

Hogan (1965) has investigated the nature of young chicks' responses to mealworms and found that fear of the environment and fear of mealworms are additive in their effects on distress (shrill) calling. He further observed that most distress calling was noted in moderately unfamiliar surroundings. The progression of behaviors exhibited with increasing unfamiliarity is: (a) moving, pecking, preening, drinking, and ground scratching occurs less frequently,

(b) shrill calling, "escape", and defecation first increase, then decrease in frequency, and (c) sleeping and sitting occur first with decreasing, then increasing frequency.

The response of White Plymouth Rock chicks to an electric door bell and a hand thrust were investigated by Phillips and Siegel (1966). These chicks were reared either individually or in groups of three and tested at 6, 12, 18, 24, 48, 72, 96, 120, 144, and 168 h post-hatch. Loud peeps (distress calls) were first emitted at 18 h and reached a peak at 24 h. Socially reared birds emitted more peeps at 72 h than individually reared and tested birds and by 120 h post-hatch less peeping was heard in all chicks. Peeping was generally observed to accompany locomotor activity. Phillips and Siegel suggest that observations of young chicks during and after distress peeping reveals the possibility that distress vocalizations are not always a sign of fear (after Salzen, 1962) but could at first represent a reflexive response which may be triggered later by some of the same stimuli that elicit fear (after Andrew, 1964).

Harless and Collins (1971) also studied the behavior of chicks in an open field. They used New Hampshire Red chicks which were housed socially and tested individually or as trios at 8-9 and 22-23 days of age. While no activity differences were obtained between groups, older chicks run individually peeped more than socially run birds. This finding is not surprising in light of the data presented by Kaufman and Hinde (1961); Gaioni, Hoffman, Klein, and Depaulo (1977); and Lampros (1976). It was, however, concluded that none of the chicks appeared to be particularly distressed in the open field situation.

The development of the neonatal chick's response to a novel environment, with or without the presence of a companion bird, and subsequent modifications of these reactions have recently been examined (Khan, 1973). It was observed that neither active avoidance responses nor social reactions developed instantaneously. Khan found that complete immobilization (presumably due to high levels of arousal) was the first reaction of a young chick to a novel environment. A second, transitory stage followed in which a high rate of distress calling and much activity were observed. Finally, the relevant response pattern emerged with the onset of social reactions occurring before the onset of avoidance reactions.

Montevecchi, Gallup, and Dunlap (1973) have performed a series of studies in an attempt to determine the relationship between distress calling and fear in 15 day old chicks, they refer to as Production Reds. One of their most consistent findings was the demonstration of a negative correlation between peeping and activity latency measures, in the presence of presumably arousal elevating manipulations. Chicks apparently vocalize less frequently when they are inactive. Also, chicks which were tested in the presence of a mirror peeped less and had longer activity latencies than chicks which were tested without a mirror. Exposure to a loud noise reduced peeping in chicks tested with or without a mirror, whereas pre-test shock only produced peeping decrements in chicks tested without a mirror. Moreover, peeping did not show significant decrements following the ingestion of metoserpate hydrochloride (a tranquilzer). They conclude that peeping is probably not a response to fear or arousal, but rather peeping is a response to the absence of or a change in an accustomed stimulus configuration (after Andrew, 1964, 1969). Therefore, according to Salzen (1962) any sufficient and persistent changes in familiar homeostatic levels of temperature, hunger, thirst, etc. could reliably elicit peep responses.

Ginsburg, Braud, and Taylor (1974) have also suggested that there is not a monotonic relationship between the degree of fear or arousal and the emission of distress calls in young chicks. In their investigation, the handled group of White Rock chicks emitted more distress calls than the nonhandled group. The nonhandled group, however, had longer immobility durations, exhibited longer periods of freezing, and had lower activity scores. In this context, Gallup, Nash, and Wagner (1971) suggested that the emission of distress vocalizations just prior to the termination of a tonic immobility response could be viewed as evidence for waning fear, leading eventually to the self-paced termination of the response.

Responses of birds to distress calls. A variety of gregarious bird species form large aggregations in locations which may be economically disadvantageous to man. One technique which has been employed is the broadcasting of biologically meaningful acoustic stimuli (e.g., distress or alarm calls) to repel these birds (Frings, Frings, Cox, & Peissner, 1955).

Bremond (1963) has presented information concerning the nature of the interspecific effect on fleeing of some species distress calls. For example, the distress call of the jackdaw (_Corvus monedula_) stimulates an escape reaction from the rook (_Corvus frugilegus_), the carrion crow (_Corvus corone_), and the magpie (_Pica pica_). The jackdaw distress call has, however, only a slight effect on the jay (Garrulus glandarius), while the distress call of the jay produces attraction, then escape in all the species mentioned above. Similarly, Bremond, Gramet, Brough, and Wright (1968) determined that mixed flocks of gulls in North Wales responded equally well to a recorded distress call of a French herring gull (Larus argentatus) as to one of their own species. They found no indication of differences in dialect affecting the birds' behavior. Bremond et al. (1968) suggest that variability of distress calls within a species may explain these results. It has also been suggested that the interspecific value of distress calls may be a result of the convergence of the characteristics of the signal for mixed flocks of jackdaws and other corvids residing in coastal areas (Morgan & Howse, 1973).

Morgan and Howse (1973, 1974) have investigated via operant techniques the active avoidance of distress calls in jackdaws. The calls tested by Morgan and Howse in order of their effectiveness in producing escape behavior were: (a) high fidelity calls, (b) high-pass jackdaw calls, (c) herring gull distress calls, (d) distress calls minus transients, (e) low fidelity jackdaw distress calls, and (f) 1 kHz tones. Apparently, there are redundant elements of information in the calls since considerable distortion can occur without destruction of the information content. It has been noted, however, that distress calls may not be effective negative reinforcers for all individuals. Three out of nine jackdaws did not learn to avoid the distress calls in the Morgan and Howse (1973) study, while two out of six birds required some shaping in the Morgan and Howse (1974) investigation.

Contentment Vocalizations

The contentment vocalization of the neonatal chick has not been extensively examined. The relative paucity of information on this call may in part stem from the difficulties experienced in providing stimuli which reliably elicit sustained contentment vocalizations. Also, Collias and Joos (1953) have indicated that sound spectrograms of contentment calls reveal considerable variability in the call, particularly in reference to the relative proportion of each note that is composed of ascending vs. descending frequencies.

Hess (1959a) has characterized contentment calls as a series of low intensity, high-pitched notes. The calls are emitted in bursts of three to eight notes and considerable pitch modulation occurs during emission. Hess estimated the duration of contentment notes to average about 1/12 sec.

Bateson (1964) described contentment calls in Rhode Island Red x Light Sussex chicks as tending to be softer vocalizations which rise in pitch and are emitted at a rate of slightly more than four/sec. Additionally, Collias (1952) determined that contentment calls do not carry a great distance. Rajecki and Eichenbaum (1975) measured contentment calls in ducklings following the reintroduction of water after 16 h of deprivation and noted that the duration of the call was approximately 40 msec, while its intensity was 60-70 db.

Collias (1952) has noted that contentment vocalizations are likely to be emitted when a pipped egg is held in the hand and its position changed, or if traction is placed on the extraembryonic membranes surrounding the chick as it is hatching. Bermant (1963) reported that contentment calls were likely to be emitted when a chick was returned from an aversive situation to its mother or home cage, or simply when the chick was in a suitable environment.

Andrew (1964) found that contentment calls (twitters) could be evoked by a very wide range of stimuli in a variety of sensory modalities as long as the stimulus contrasted markedly with general background noise. For example, visual stimuli which produced contentment calls or intermediate calls included a sudden change in illumination, a moving object, and a sheet of paper attached to a moving pendulum bob. Effective tactile stimuli were an unexpected light touch, a slight squeeze, a pinprick, and, in light deprived (hood-reared) chicks in a harness, mild electric shock will sometimes produce twitters. Andrew also reports that any sudden change in acoustic stimulation is likely to evoke twitters. He further indicated that naive chicks twitter while pecking at any type of small particle, whereas experienced chicks emit twitters during pecks at food when hungry. He cites operant evidence demonstrating that chicks trained to peck a lever for food (water) gave the highest frequency of twitters coincident with the time they perceived cues announcing the arrival of food (water). He therefore concluded that twitters are evoked when stimulation is received which "tends to make the chick repeat the response which prevoked the stimulation" (1969, p. 636).

Andrew (1975) has examined the relationship between intracranial self-stimulation in the chick and the elicitation of various vocalizations. While twittering falls off or ceases during stimulation of the tractus septo-mesencephalicus, rapid twitter vocalizations are noted immediately before and after such stimulation. Twitters were observed to reach a peak during stimulation of neostriatal areas.

Additionally, Guiton (1959) has reported that there is higher incidence of contentment calls in large moving groups of chicks than in small immobile groups. It has also been determined that more contentment vocalizations are emitted in the presence of a 75 db auditory imprinting stimulus than in the presence of a 62 db auditory imprinting stimulus (Robinson-Guy & Schulman, 1976).

Brown (1975) has performed an investigation to determine the potential attractiveness of neonatal chick contentment (twitter) vocalizations. She investigated first, whether hen cackles and chick twitters, when matched for intensity (75-85 db), would produce differential initial responsiveness; and second, whether experience during rearing with one variety of auditory stimulation would selectively facilitate responsivity to that sound. White Leghorn x Black Orpington chicks were housed individually and tested at 16, 32, or 48 h post-hatch. Both kinds of auditory stimuli were found to be more effective than a silent model in eliciting approach and following responses. She further noted that there was no difference in the effectiveness of the two auditory stimuli and that the auditory stimulus the chicks were reared with tended to be the one they preferred during subsequent testing. It was observed that improvement in following the chick noise in comparison with the silent stimulus was significantly greater at 48 h than at 16 h post-hatch. This finding agrees with an observation made by Gray (1961) that 2 day old Leghorn chicks prefer an agemate to a hen. Along this line, Scaneirla (1952) discussed the possibility that auditory self- and inter-stimulation might play a role in fostering chicks' initial approach responses to other chicks.

Other Chick Vocalizations

The possibility that the vocalizations emitted by hatchlings may serve as a "training" stimulus which facilitates species identification has been investigated by Gottlieb (1966, 1971). He suggested that by virtue of stimulus generalization the call of the parent may derive its attractive qualities from its similarity to the perinatal vocalizations of the neonate. Gottlieb (1966) derived two predictions from this hypothesis: (a) the neonatal call should be capable of evoking the neonatal following response more strongly than the maternal call and (b) in simultaneous discrimination tests the neonate should prefer a model emitting its own call in preference to a similar model emitting the maternal call of its species. In a first experiment, 40 isolate reared White Rock chicks were exposed to a replica of a White Rock hen which emitted a prerecorded chick call (63-64 db, single burst 6 notes, 1.5 sec, 4 notes/sec) and 57 isolate reared Peking ducklings were similarly exposed to a stuffed Peking duck from which duckling sounds (62-64 db, single burst 8 notes, 1.8 sec, 4.4 notes/sec) emanated. The incidence, latency, and duration of following measures collected in this study were compared with previously collected data in which a young chick or duckling was exposed to an appropriate parental model and an adult exodus call (chicken hen 7 notes, 2.8 sec, 2.5 notes/sec; Mallard hen 9 notes, 2.2 sec, 4.1 notes/sec). The chick and duckling calls were determined to be significantly less effective in instigating and maintaining following responses than were the appropriate maternal calls.

In a second experiment, 40 Peking ducklings were simultaneously exposed to two stuffed Peking ducks. From one of the ducks a prerecorded exodus call emanated and from the other, a duckling brooding call emanated. The ducklings were divided into two groups, one of which received no prior auditory experience other than hearing themselves and their sibs, while the other group received the brooding-like call of the Peking duckling (70-72 db) before testing. The ducklings chose the maternal call of their species in preference to the duckling call. In fact, pre-exposure to the brooding call enhanced the percentage of ducklings which responded to the maternal call.

In a third and final experiment, Gottlieb investigated the possibility that the duckling brooding call might serve an enhancing function for the ducklings' responsiveness to the maternal call of its species. Ducklings were again tested in a simultaneous discrimination situation; one model emitting the exodus call of the wood duck (*Aix sponsa*, single burst, 13 notes, 1.75 sec, 7.4 notes/sec), while the other model emitted the brooding-like call of the Peking duckling. Again, the ducklings were exposed prior to testing with either the brooding call of ducklings or no special auditory stimulation. As evidenced by both approach and following measures, the ducklings preferred the model emitting their own call in preference to one emitting the Wood duck maternal call. From this series of experiments, Gottlieb (1966, 1971) concluded that the brooding-like call of the Peking duckling functions to generally enhance the duckling's responsiveness to calls of its own species. A higher frequency of responses might, however, have been directed to duckling (and chick) brooding calls had an appropriate model (i.e., a duckling or chick) been used. It is possible that the duckling brooding calls may have been more attractive if they had been paired with the naturally occurring emitter of the call. There may have been too much incongruity between the model and the nature of the call to produce reliable approach responses.

Farrell (1969) has investigated the development and maintenance of operant responding under the control of species-produced auditory stimuli. The subjects were eight chicks which were reared in auditory isolation from conspecifics, however, they could hear their own vocalizations. It was determined that key-pecking responses increased in frequency with the presentation of the auditory stimulus (unquantified colony room sounds of a group of young chicks). Further, after an increase in the rate of responding, a decrease in rate of responding with continuous auditory stimulus exposure usually occurred within or between sessions. Therefore, it was concluded that the sounds of young chicks can function as primary reinforcers in young domestic fowl, in the sense of original stimuli to which subjects responded without prior post-hatch experience.

Stern and Hoemes (1970) performed an interesting study employing the visual cliff apparatus and two strains of domestic chicks. Forty Dekalb (no. 131) and forty Ghostley chicks were tested for four consecutive days on a visual cliff apparatus. Recordings of colony room "cheeping" were played to attract chicks to the deep side of the visual cliff. The Dekalb chicks clearly surpassed the number of deep responses made by the Ghostley chicks. This finding suggests that genetic differences may exist in the responsivity of neonatal chicks to conspecific auditory stimulation. The influence of selective breeding (domestication) may have differentially influenced chick responsivity to conspecific neonatal vocalizations.

Chick vocalizations and their possible fear attenuating characteristics have been investigated by Hogan and Abel (1971). The purpose of their experiment was to determine the effect of auditory experience on fear reactions by observing visually isolated Burmese Red Junglefowl chicks in an unfamiliar environment in the presence of sounds of other chicks. The behavior of three groups of chicks was recorded: (a) chicks tested in isolation, (b) chicks tested with a stimulus group of five chicks of the same age, and (c) chicks tested in isolation, with a group of five chicks located behind a cardboard barrier adjacent to the testing chamber. The results obtained for the chicks tested in isolation were virtually identical. However, for the group tested in the company of other chicks a number of responses were markedly different from those obtained for the individually tested subjects. Socially tested chicks were observed to engage in more pecking and moving responses. Frequency of distress (shrill) peeping did not vary among any of the groups tested. These results indicate that sounds made by chicks (pecking, scratching, and vocalizing) are not the stimuli that attenuate fear reactions in chicks tested with social companions.

It is quite clear that vocalizations form an integral part of the behavioral repertoires of young domestic chicks in a variety of diverse situations. The inter-sibling or age-mate communicative significance of distress and contentment vocalizations is still largely unknown, however. The purpose of the current study is to ascertain what responses a young chick or group of chicks will emit in the presence of age-mate distress and/or contentment vocalizations. Specifically, approach latencies, distress calling, contentment calling, pecking, and orientation away responses will all be monitored in an attempt to determine the impact of chick vocalizations on the behavior of young chicks. It is deemed inappropriate to formulate predictions concerning expected chick behavior under these conditions since the existing information in this area is contradictory or simply nonexistent. The data will, however, be discussed in light of the fear, arousal, and stimulus contrast hypotheses which have been presented in an effort to explain behavior in related situations.

General Method

Subjects

Eggs were obtained from matings of the Cornell Randombred population of White Leghorns or from matings of Athens Canadian Randombred population males x Cornell Randombred females maintained at the Virginia Polytechnic Institute and State University Poultry Research Center. The eggs were incubated in a forced air incubator (Humidaire, model number 50, serial number 7345) at 32.5° and 93-98 percent relative humidity for 18 days. The eggs were then transferred to a hatcher (Leahy Manufacturing Company, model number 416) and maintained at 75-80 percent relative humidity (Sears humidity control, model number 387 93082).

Shortly after hatching, chicks were housed either individually or socially in wire and stainless steel cages (single cage - 17 cm x 17 cm x 24 cm; double cage - 41.3 cm x 17 cm x 24 cm). The floors of the cages were lined with pieces of 0.6 cm^2 hardware cloth to permit subjects to locomote easily within the cage. Individually housed chicks were maintained in visual isolation from conspecifics and experimenters, while socially housed chicks were not permitted to view experimenters. No attempt was made to control the auditory input experienced by the chicks. Two layers of beige polyethylene were affixed to the front of each cage to prevent chicks from viewing one another (isolates) and experimenters. The chicks were housed under conditions of 24 h illumination. Illumination within each single cage was approximately 16.15 luxes and within each double cage was approximately 10.8 luxes (General Electric dual range light meter, model number 126). The colony room temperature was maintained at 32.5 - 37.5° C. Purina chick starter feed or A-No-1 starter and grower mash and water were available *ad libitum* following Day 2 post-hatch. Three hundred forty-eight chicks were run at 24, 48, 72, 96, and/or 120 h post-hatch (all ages ± 6 h). In the first three experiments a group was composed of 12 chicks, no more than one half of which came from the same hatch. In the fourth experiment a group was composed of 30 chicks, no more than one third which came from the same hatch.

Apparatus

The apparatus for Experiments 1, 2, and 3 consisted of a straight runway, cassette tape player (Panasonic, model number RG 224S), two stop clocks (Lafayette Instruments Company, model number 58007, 1/100 sec), two photo cells, a photo relay panel (Hunter, model number 3355), a six channel event recorder (Campden Instruments, Ltd. model number 650) and a stop watch (Marcel & Cie. 1/10 sec). The apparatus for Experiment 4 will be discussed in detail in the Method section for Experiment 4.

The runway, 117 cm (L) x 21 cm (W) x 36 cm (H) was constructed of 2 cm thick plywood painted flat white. Hardware cloth (0.6 cm^2) formed the floor of the runway. The runway was divided into three compartments; a start area, an alley area, and a goal area. The start area was separated structurally from the rest of the runway by a guillotine door and functionally by one of the photo cells. The start area photo cell was located 6 cm from the floor of the runway and 25 cm from the rear wall of the start area. Raising the guillotine door closed a microswitch which started the first stop clock. When a chick interrupted the first photo beam, by walking through it, the first stop clock stopped (start time) and the second stop clock was simultaneously activated. The alley and goal areas were functionally separated by the second photo cell which was located 6 cm from the floor and 101 cm from the rear wall of the start box. When a chick broke the second photo beam, the second clock stopped (run time).

Two auditory stimuli were employed in each study. Both the contentment and distress call stimuli were collected using the same 2 day old chick in a sound studio and recorded on 60 sec endless loop tape cassettes. Regular emission of the distress call was facilitated by dangling the chick upside down by one foot (for sonagram see Appendix A). Regular emission of contentment twitters was facilitated by first imprinting the chick to the experimenter's hand and then allowing the chick to follow and crawl under the experimenter's hand (for sonagram see Appendix B). The distress and contentment sonagrams were similar to those presented by Collias and Joos (1953) and Andrew (1964). The distress vocalization was played at 70 db and the contentment vocalization was played at 68 db as measured from the start box of the runway with the guillotine door open (Realistic sound level meter, model number 33 1028). These auditory stimulus intensities were employed because they represent the intensity of each call as measured at a distance of 30 cm from a young chick emitting each call. Distress call auditory stimulus intensities and corresponding runway locations were: start area - 70 db, center of alley area - 72 db, and goal area - 74 db. Runway locations and corresponding contentment call auditory stimulus intensities were: start area - 68 db, alley area - 70 db, and goal area - 71db. The auditory stimuli emanated from a speaker (Zenith, 1 watt, 3.2 ohms) which was mounted in the rear wall of the goal area 22 cm from the floor of the runway. The speaker was covered with several layers of cheesecloth to eliminate marked visual contrast effects with the rest of the apparatus. The tape head was cleaned and the auditory stimulus intensities were recalibrated frequently.

A stationary taxidermic model of a 2 day old chick was placed in the goal box of the runway. A plexiglas barrier separated the taxidermic model from the chick subjects. The taxidermic model was positioned facing the left side wall of the apparatus thus enabling chick subjects to view one half of the model from beak to tail feathers. The taxidermic model was placed on a platform approximately 5 cm from the floor of the apparatus. The model measured: 10 cm from beak to tail feathers, 6.3 cm from the platform floor to mid-back, 7.6 cm from the platform floor to the top of its head, and 7.7 cm from breast to tail.

The laboratory was illuminated by a 40 W incandescent light bulb located inside the goal area of the runway. Ambient laboratory light intensity was 21.53 luxes. Runway locations and associated light intensities are: start area - 10.8 luxes, alley area - 26.9 luxes, and goal area - 193.8 luxes. Ambient laboratory temperature was 24-26° C. The temperature within the goal area was 26.5-27.5°C. A wide angle mirror was mounted above the runway permitting observation of each chick anywhere in the runway. Ambient noise level in the laboratory was 60 db. Birds were transferred from their home cages to the apparatus in a small closed cardboard box. The six channel event recorder was used to measure the occurrence of discrete behavioral responses including; distress vocalizations, contentment vocalizations, pecking, and orientation away from the goal area. The stopwatch was used to measure intertrial interval (ITI) and goal area exposure time.

Procedure

The general procedure for Experiment 1, 2, and 3 consisted of placing an individual chick into the start area with the guillotine door closed; after 30 sec the tape player was turned on and the guillotine door was raised. Each chick was then allowed a maximum of 2 min in both the start and alley areas. When a subject failed to leave either area within 2 min it was gently placed by hand into the next area of the runway approaching the goal area. The guillotine door was closed after placing chicks from the start area into the alley area. Chicks were given 30 sec in the goal area with the auditory stimulus present. At the end of this period the tape was turned off and the chick was returned to the start box for an ITI of 30 sec. Start and run times (latencies) were recorded for each trial.

Additionally, the occurrence and frequency between trials of distress vocalizations, contentment vocalizations, pecking, and orientation away from the goal area were recorded. Distress and contentment notes were differentiated according to the criteria outlined by Collias and Joos (1953). Peeps of medium frequency which were loud and emitted at a slow rate were designated distress calls. In contrast, peeps of high frequency which occurred at a rapid rate and sounded like twittering were designated contentment calls. Pecking was recorded when chicks pecked the walls and floor of the apparatus and conspecifics (when possible). Orientation to the goal area was characterized by the front of the chick's head and breast appearing in a plane perpendicular to the rear wall of the goal area. Orientation away from the auditory stimulus was recorded when the bird was in any position relative to the goal area wall, other than the position indicated above.

The general location in the apparatus (start area, alley area, goal area) where each behavior pattern occurred was recorded on a trial by trial basis daily. Between trial frequencies, rather than within trial frequencies, of the additional behaviors were recorded so as not to artificially inflate certain behavioral values for chicks spending relatively more time in any certain area of the apparatus. Scoring of the behavior checklist items consisted of arbitrarily assigning a value of 1 if the behavior occurred in the start area, 3 if the behavior occurred in the alley area, and/or 5 if the behavior occurred in the goal area. Scores were weighted in this fashion to accentuate proximity to the source of auditory stimulation.

Statistical Techniques

Correlation coefficients were obtained for all dependent variables in relation to each other in order to eliminate redundant analyses of variance. It was arbitrarily decided that correlation coefficients approaching a value of $\underline{r} = .70$ (approximately 50 percent of the variance accounted for) would indicate possible redundancy in analyzing those variables separately. In no case, however, did any of the correlation coefficients approach this value. Separate univariate analyses of variance are therefore presented for each dependent measure. The nature and the degree of association among the dependent variables will be discussed for Experiments 1, 2, and 3.

All mean median start and run (approach) data were analyzed with a parametric analysis of variance (Experiments 1, 2, and 3). Medians were used as a measure of central tendency since approach response data are typically skewed. The Neuman-Keuls sequential range test was employed to determine the nature of multiple contrasts in the analysis of variance.

The distress vocalization, contentment vocalization, pecking and orientation away data were also subjected to parametric analysis of variance (Experiments 1, 2, and 3). The Newman-Keuls sequential range test was employed to determine the nature of multiple contrasts in the analysis of variance.

The activity, proximity, and vocalization score data for Experiment 4 were analyzed via a parametric analysis of variance and, again, the Neuman-Keuls sequential range test was applied to the data to determine the direction of differences in the analysis of variance. Source tables for each analysis of variance are presented in the Appendix section in the order in which they are discussed.

The subjects variable was treated as a random variable, while all other independent variables were treated as fixed variables in the statistical model. Analysis of variance $\underline{F}$ ratios approaching statistical significance ($\underline{p} \leq 0.06 - 0.10$) are reported, though firm conclusions are not based upon effects which may best be regarded as trends.

Experiment 1

The purpose of this experiment was to determine the characteristics of the neonatal approach response and its behavioral accompaniments over days to distress or contentment calling.

Method

Experiment 1 was a longitudinal mixed design study. Twenty-four Athens Canadian x Cornell Randombred chicks were given five trials per day for four consecutive days with the same auditory stimulus (either distress vocalizations or contentment vocalizations). The chicks were housed individually in single cages and had access to Purina chick starter feed *ad lib*. When necessary, subject placements were performed from start and alley areas. The additional behavioral measures were also taken. A methodological replication of this study was also performed 2 months after the collection of the original data. The additional behaviors were not systematically recorded for the replication of Experiment 1.

Results

Approach data. Differential approach latencies were not obtained to the two vocalization recordings (Figure 1-I). A repeated measures analysis of variance on the start data did not reveal a main effect for vocalization, F (1, 22) = 0.68, $p > 0.05$. However, a main effect for days was obtained, F (3, 66) = 3.64, $p \leq 0.01$. Simple effects analysis indicated that Day 1 birds were significantly slower to leave the start area than Day 2 birds ($p \leq 0.05$). It is interesting to note that start latencies did not, however, improve over all four of the test days. The Vocalization x Days interaction was not significant, F (3, 66) = 1.20, $p > 0.05$.

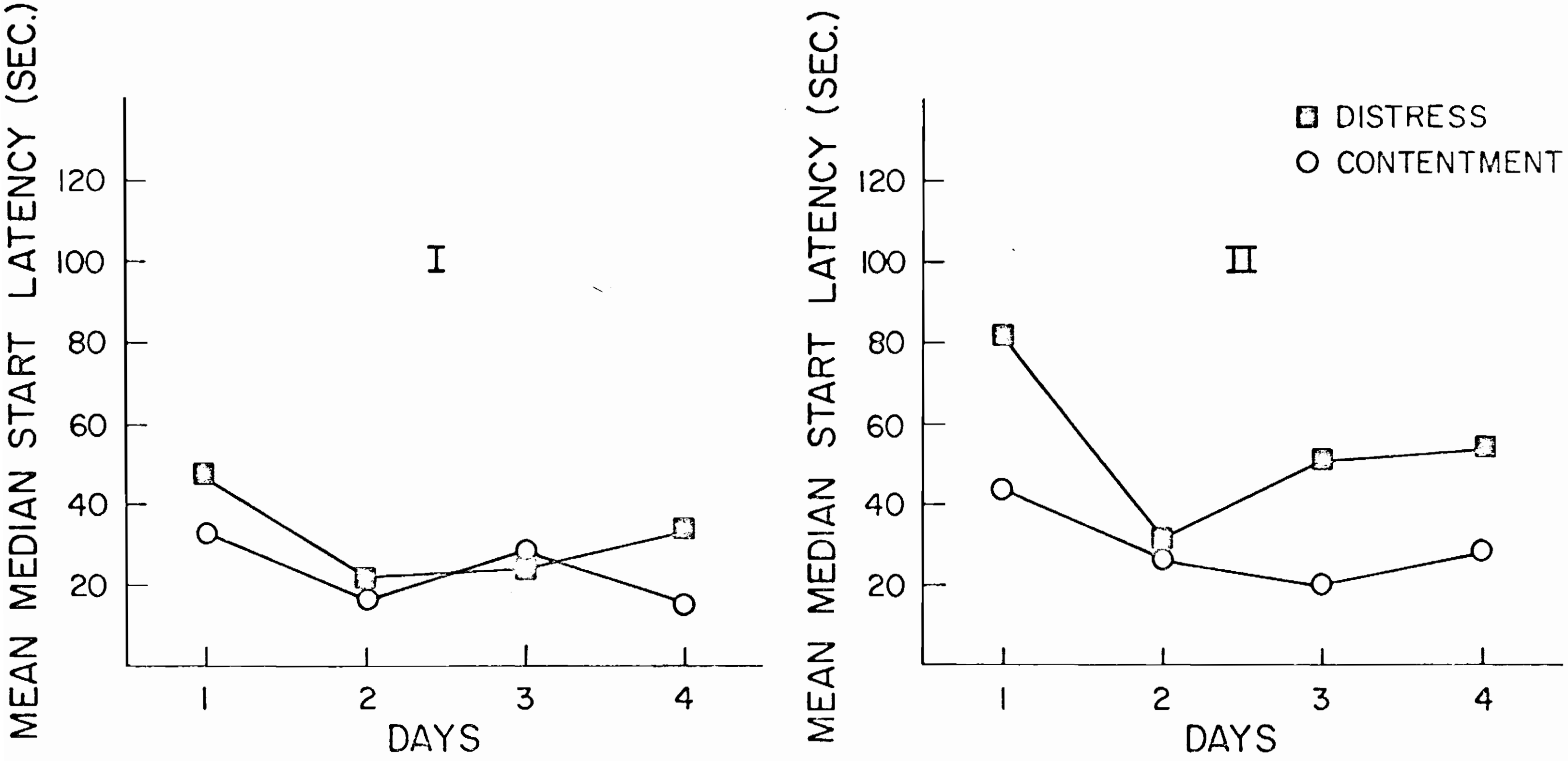

Figure 1. Mean median start latencies to distress or contentment vocalizations over the first four days of post-hatch life. I - Original data; II - Replication.

Analysis of variance performed on the mean median start latency data for the replication of Experiment 1 did, however, reveal a significant vocalization main effect, F (1, 22) = 4.68, $p \leq 0.05$. In this study, chicks were observed to leave the start area more rapidly in the presence of contentment vocalizations, than in the presence of distress vocalizations (Figure 1-II). As was the case with the original data, a days main effect was obtained, F (3, 66) = 5.40, $p \leq 0.01$. Simple effects analysis demonstrated that the latency to leave the start area was significantly greater for Day 1 birds than Day 2, Day 3, and Day 4 birds ($p \leq 0.01$). Note again that improvement in responding with regard to shorter start latencies did not occur over all experimental days. That is, performance on Day 4 did not statistically differ from the performance of Day 2 and Day 3 birds. The Vocalization x Days interaction was not significant.

Analysis of variance of start latency data from Experiment 1 and the replication of Experiment 1 did not yield a significant replication main effect, F (1, 44) = 3.67, $p > 0.05$. Further, the Replication x Vocalization, the Replication x Days and the Replication x Vocalization x Days interactions were all not significant ($p > 0.05$) indicating that the combined data reflect responses from the same population. Analysis of variance on the combined data from Experiment 1 and its replication, eliminating the experiment variable, revealed a significant vocalization main effect F (1, 46) = 4.41, $p \leq 0.05$. Start latencies were significantly longer in those birds exposed to distress vocalizations than in those birds exposed to contentment vocalizations. Further, there was a highly significant days main effect, F (3, 138) = 9.01, $p \leq 0.01$.

Simple effects indicated that birds on Day 1 were significantly slower to approach either auditory stimulus than birds on Day 2, Day 3, and Day 4 ($p \leq 0.01$). Thus, start latencies are reliably lower on Day 2 to either auditory stimulus condition. The Vocalization x Days interaction was not significant, F (3, 138) = 1.60, $p > 0.05$.

A repeated measures analysis of variance was performed on the mean median run latency data. A vocalization main effect which approached statistical significance was revealed for these data F (1, 22) = 3.88, $p = 0.06$ suggesting a preference for contentment vocalizations as evidenced by shorter run latencies to this variety of auditory stimulation (Figure 2-I). A significant main effect for days was obtained, F (3, 66) = 3.43, $p \leq 0.05$. Simple effects analysis revealed that chicks on Days 3 and 4 had longer run latencies to approach the vocalizations than those on Day 2 ($p \leq 0.05$). As with the start data, no improvement (i.e., reduction in latency) was observed coincident with increasing age. The Vocalization x Days interaction was not significant, F (3, 66) = 0.44, $p > 0.05$.

With regard to the run data obtained in the replication of Experiment 1, a vocalization main effect approaching statistical significance, F (1, 22) = 3.00, $p = 0.09$, was similarly obtained. Again these data suggest that run latencies are shorter in the presence of contentment vocalizations than in the presence of distress vocalizations (Figure 2-II). The days effect, F (3, 66) = 0.65, $p > 0.05$, and the Vocalization x Days interaction, F (3, 66) = 1.08, $p > 0.05$, were not significant.

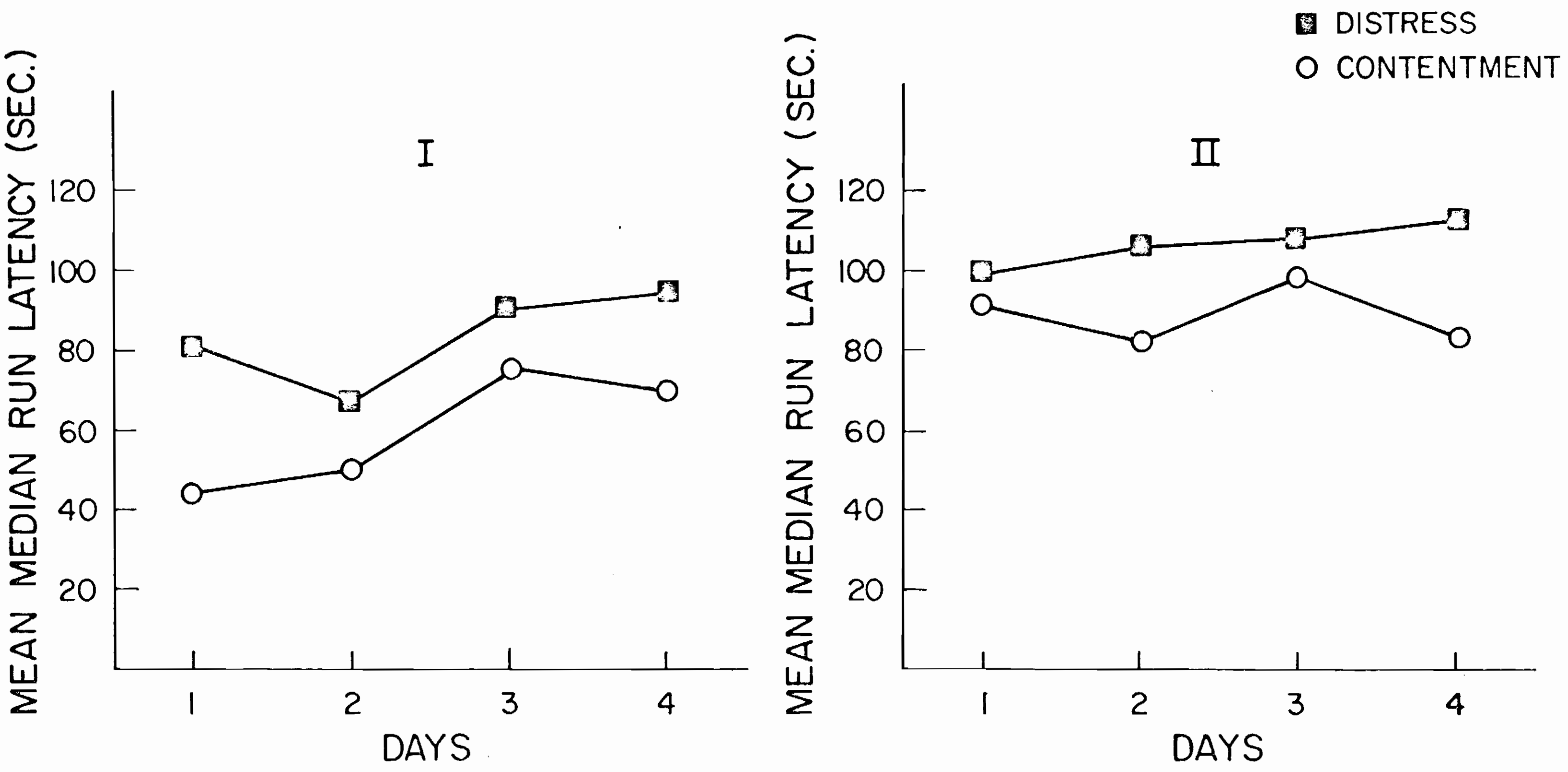

Figure 2. Mean median run latencies to distress or contentment vocalizations over the first four days of post-hatch life. I - Original data; II - Replication.

The analysis of variance performed on the combination of run latency data from Experiment 1 and its replication yielded a significant replication effect, F (1, 44) = 10.88, $p \leq 0.01$. Run latencies obtained in the replication of Experiment 1 were significantly greater than the run latencies collected for Experiment 1. The Replication x Vocalization interaction, the Replication x Days interaction, and the Replication x Vocalization x Days interaction were not significant ($p > 0.05$). Since the replication did not significantly interact with any of the other variables, the other significant main effects for the combined data will be presented. A significant vocalization effect was obtained, F (1, 44) = 7.14, $p \leq 0.01$. As was the case with the start latency data, the contentment vocalization condition was approached more rapidly than the distress vocalization condition. A significant days effect was also obtained for these combined data, F (3, 132) = 3.76, $p \leq 0.01$. Simple effects analysis indicated that Day 3 and 4 chicks were slower to approach either auditory stimulus, than Day 1 and 2 chicks.

Additional behavioral measures. A repeated measures analysis of variance performed on the distress vocalization data revealed a significant vocalization effect, F (1, 22) = 5.49, $p \leq 0.05$ (Figure 3). More distress calling was recorded in the presence of the distress vocalization condition than in the contentment vocalization condition. The days effect was also significant, F (3, 66) = 8.42, $p \leq 0.01$, with more distress peeps emitted on Day 1, than on Days 2, 3, and 4 ($p \leq 0.01$). Further, the Vocalization x Days interaction approached statistical significance, F (3, 66) = 2.29, $p = 0.08$. This trend suggests that

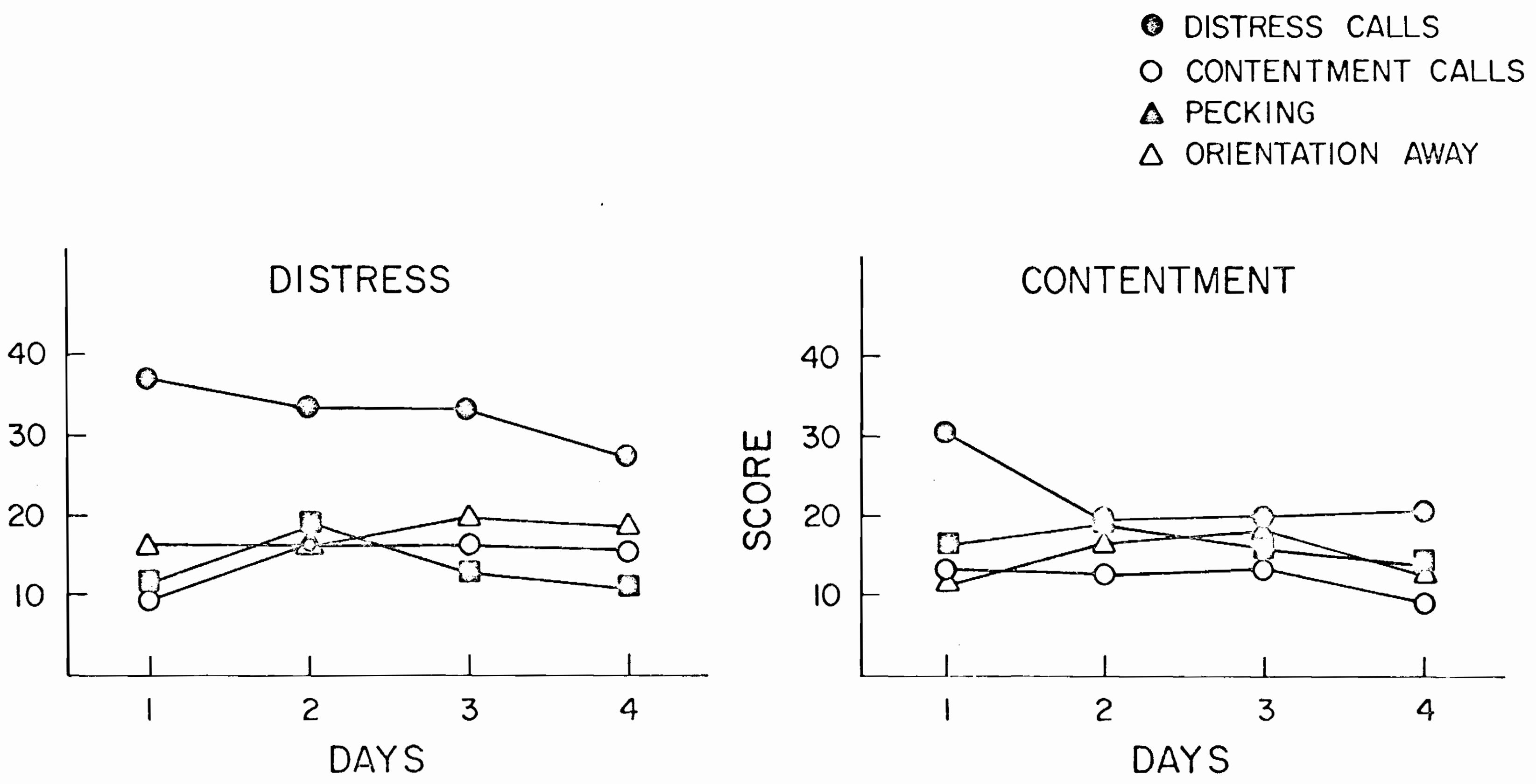

Figure 3. Behavior checklist scores for chicks exposed to either distress or contentment vocalizations over the first four days of post-hatch life.

Day 2 birds in the contentment condition emitted fewer distress calls than subjects in other conditions. Thus, the distress score measure seems to vary reliably with the vocalization and age parameters investigated in this study.

The analysis of variance performed on the contentment vocalization score data indicated that neither the vocalization effect nor the days effect were significant. Further, the Vocalization x Days interaction was also not significant. The emission of contentment vocalizations therefore does not appear to vary reliably with the presentation of either distress or contentment vocalization recordings over days. As can be noted in Figure 3, the contentment vocalization score remained at relatively low levels in the presence of both auditory stimulus conditions over days.

Although the vocalization effect was not significant for the pecking score data, the days effect approached statistical significance, $\underline{F}$ (3, 66) = 2.30, $\underline{p}$ = 0.08. The birds tended to engage in slightly more pecking on Day 2 than on Day 4 (Figure 3). The Vocalization x Days interaction was not significant.

As was the case with the contentment score data, the orientation away from the goal area data do not appear to vary systematically with either the vocalization or days conditions (Figure 3). Neither vocalization nor days effects approached significance. Similarly, the Vocalization x Day interaction was also not significant.

The associations among the six dependent variables in Experiment 1 are recorded in Table 1. Clearly, a large number of these variables seem to be correlated significantly with at least one other variable.

Table 1

Correlation Coefficients for the Six

Dependent Measures in Experiment 1

Dependent Measure	Contentment Vocalization Score	Pecking Score	Orientation Away Score	Start Latency	Run Latency
Distress Vocalization Score	-0.27**	-0.26**	0.10	0.19	0.12
Contentment Vocalization Score		0.33**	0.30**	0.20*	0.31**
Pecking Score			0.28**	0.22*	-0.20*
Orientation Away Score				0.08	0.38**
Start Latency					0.31**

*$\underline{p} \leq 0.05$
**$\underline{p} \leq 0.01$

The distress vocalization score is negatively correlated with both the contentment vocalization score ($\underline{p} \leq 0.01$) and pecking score ($\underline{p} \leq 0.01$). It is intuitively appealing that distress and contentment vocalizations are negatively correlated since these calls are typically viewed as reflecting quite different emotional states in young chicks (e.g., Collias, 1952). Pecking scores are negatively correlated with distress calling, but positively correlated with contentment calling ($\underline{p} \leq 0.01$), further substantiating the dichotomous nature of distress and contentment vocalization stimulation. The contentment vocalization score data are positively correlated with all of the remaining variables, namely orientation away score ($\underline{p} \leq 0.01$), start latency ($\underline{p} \leq 0.05$), and run latency ($\underline{p} \leq 0.01$). It may be that the presence of contentment vocalization is a good predictor of low levels of general activity since it is negatively correlated with both start ($\underline{p} \leq 0.05$) and run latencies ($\underline{p} \leq 0.05$), while positively correlated with the orientation away score ($\underline{p} \leq 0.01$). Clearly, the orientation away score may or may not reflect a high level of ongoing activity since it is highly correlated with run latency ($\underline{p} \leq 0.01$), but is not correlated with start latency. Finally, it is not surprising that run latency is correlated with start latency ($\underline{p} \leq 0.01$) since both responses have such similar topographies. Evidently, stimulation capable of initiating approach responses is frequently capable of maintaining approach responses.

Discussion

Clearly, one of the most interesting findings in this study was the observation that contentment calls were generally approached more rapidly than distress vocalizations. This finding is consistent with predictions which may be derived from Scheneirla's (1965) biphasic approach/withdrawal theory. That is, contentment calls may have been approached more rapidly because they were played at a lower intensity (68-71 db) than were the distress vocalizations (70-74 db). This possibility seems unlikely, however, for three reasons. Firstly, the intensity differences between the recorded calls in this study are quite small, thus minimizing the possibility of discrimination based upon this feature alone. Secondly, active avoidance or withdrawal responses were never observed in chicks during exposure to the distress vocalization condition. And thirdly, Robinson-Guy and Schulman (1976) have presented data which indicate that auditory imprinting stimuli played at 75 db produce rapid approach responses, rather than withdrawal responses.

A number of other possibilities may be offered to account for these differential approach rates. It is possible that contentment vocalization atimulation is more attractive to young chicks by virtue of the information content of this call. Additionally, contentment vocalizations possess two of the three characteristics of sound that attract chicks (Collias & Joos, 1953). Namely, contentment calls are characterized by repetitiveness and brief duration of component notes. In contrast, distress calls are characterized by relatively long durations of component notes. Finally, it is possible that contentment calls exerted their effect on approach behavior by simply increasing the chicks' general level of activity, thereby increasing the probability that the chick would come into contact with the source of the stimulation. The emission of contentment vocalizations by the chicks, however, was correlated with both start and run latency measures. This suggests that while the reception of contentment calls might increase activity, the emission of contentment calls is probably associated with lower levels of locomotor activity. The observation that pecking is positively correlated with contentment calling suggests that stationary activities may be associated with this type of stimulation.

Assessment of the effects of distress calls on activity is more difficult since it has been repeatedly documented that the emission of distress calls is associated with movement, at least on the part of the emitter of the call (e.g., Andrew, 1975; Khan, 1973; Phillips & Siegel, 1966). From the observation that more distress calls were emitted in the distress vocalization condition it would seem to follow that chicks in this treatment group would maintain a certain relatively high level of activity. It may be that while contentment vocalization stimulation produces stimulus-oriented movement, distress vocalization stimulation produces non-stimulus-oriented movement or generalized movement.

The age-related effects revealed in this study are interesting, in that, Day 1 birds have consistently higher start latencies than birds on the other days, while Day 3 and 4 birds have consistently higher run latencies than the other birds. Apparently, factors controlling the initiation (start responses) and maintenance (run responses) of approach behavior in the presence of distress and contentment vocalizations are quite different. It is easy to understand the higher start latencies of Day 1 birds due to the possible deficits in locomotor and perceptual skills of younger birds and the novelty of the experimental apparatus. More distress peeps were also recorded for Day 1 chicks, though. On the other hand, it is rather difficult to explain the higher run latencies recorded for Day 3 and Day 4 birds. Increased fear (after Hess, 1959b) might explain higher run latencies in older birds (birds over 36 h old), but higher start latencies would also be expected if fear was sufficient enough to compete with one phase of approach behavior. It might also be possible to argue that the stimulus complex (stationary taxidermic chick and prerecorded vocalization tape) no longer met the stimulative requirements of the older chicks.

Experiment 2

The purpose of this experiment was to determine in a successive choice situation if a preference for either distress or contentment vocalizations is present in the young chick.

Method

This experiment was also a longitudinal, mixed design study. Twenty-four Athens Canadian x Cornell Randombred chicks received both auditory stimuli (distress and contentment vocalizations) for three trials on four consecutive days. Twelve of the chicks always received auditory stimulation in the presence of intermittent goal box light (1.5 flashes/sec), whereas the other 12 subjects always received auditory stimulation in the presence of constant goal box light. Simner (1978) has determined that flashing lights within the frequency range of 1.5-4 flashes/sec are attractive to young chicks. The intermittent light condition was included in this investigation to determine if the rather slow approach latencies obtained in Experiment 1 might reflect localization difficulties encountered by the chicks. The chicks were housed individually in single cages and had access to A-No-1 chick starter and grower mash *ad lib*. The order of auditory stimulus presentation was counterbalanced over the four experimental days and within the two light presentation groups. Start and run latencies were recorced for six trials/day. If necessary, subject placements were performed in all stimulus conditions. The additional behaviors were also recorded.

Results

Approach data. The mean median start latency data are presented in Figure 4. The presence of constant or intermittent light did not exert a statistically significant effect on start latencies. Analysis of variance did, however, reveal a significant days effect, $\underline{F}$ (3, 66) = 9.64, $\underline{p} \leq 0.01$. Simple effects analysis indicated that birds on Day 1 had significantly greater start latencies than birds on Day 2, Day 3, or Day 4 ($\underline{p} \leq 0.01$). Neither the vocalization effect, nor any of the interactions involving main effects were significant.

The mean median run data are presented in Figure 5. Analysis of variance indicated a vocalization effect which approached statistical significance $\underline{F}$ (1, 22) = 3.15, $\underline{p} = 0.09$. This trend suggests that birds when exposed to distress vocalizations tend to have longer run latencies than when they are exposed to contentment vocalizations. The Light x Vocalization interaction also approached significance, $\underline{F}$ (1, 22) = 3.35, $\underline{p} = 0.08$. Simple effects analysis suggested that birds in the intermittent light and contentment conditions had shorter approach latencies than the birds in the other conditions. None of the other main effects or interactions approached statistical significance.

Additional behavioral measures. The data for the various behavior categories investigated in this study are presented in Figure 6. Analysis of variance on the distress vocalization data revealed a days effect which approached statistical significance, $\underline{F}$ (3, 66) = 2.38, $\underline{p} = 0.08$. Higher distress scores were recorded on Day 2 than on the other days. The repeated measures analysis of variance further indicated that the Light x Vocalization interaction was significant, $\underline{F}$ (1, 22) = 4.34, $\underline{p} \leq 0.05$. Simple effects analysis revealed that birds in the constant light condition in the presence of contentment

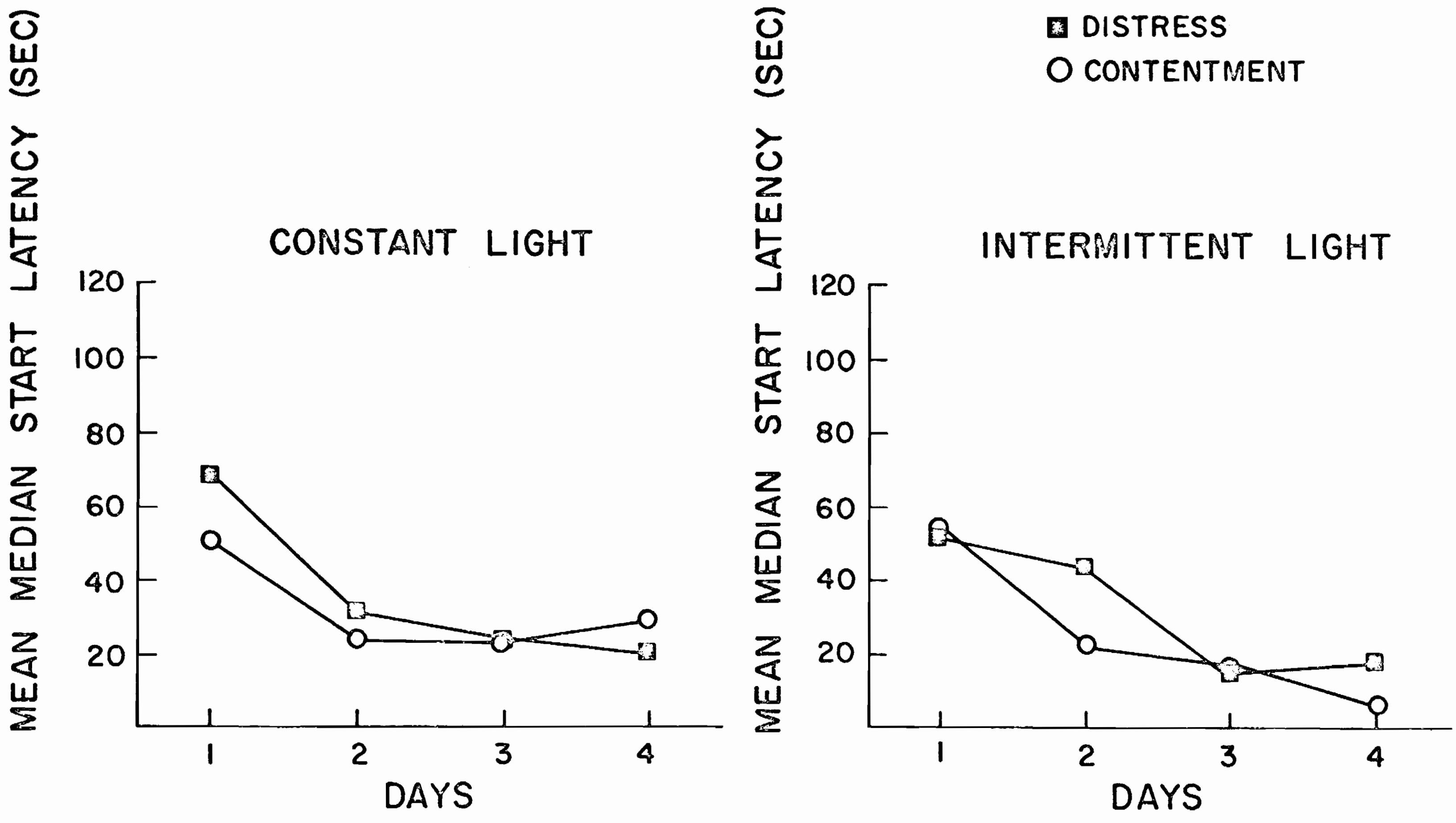

Figure 4. Mean median start latencies to distress and contentment vocalizations in the presence of either constant or intermittent light over the first four days of post-hatch life.

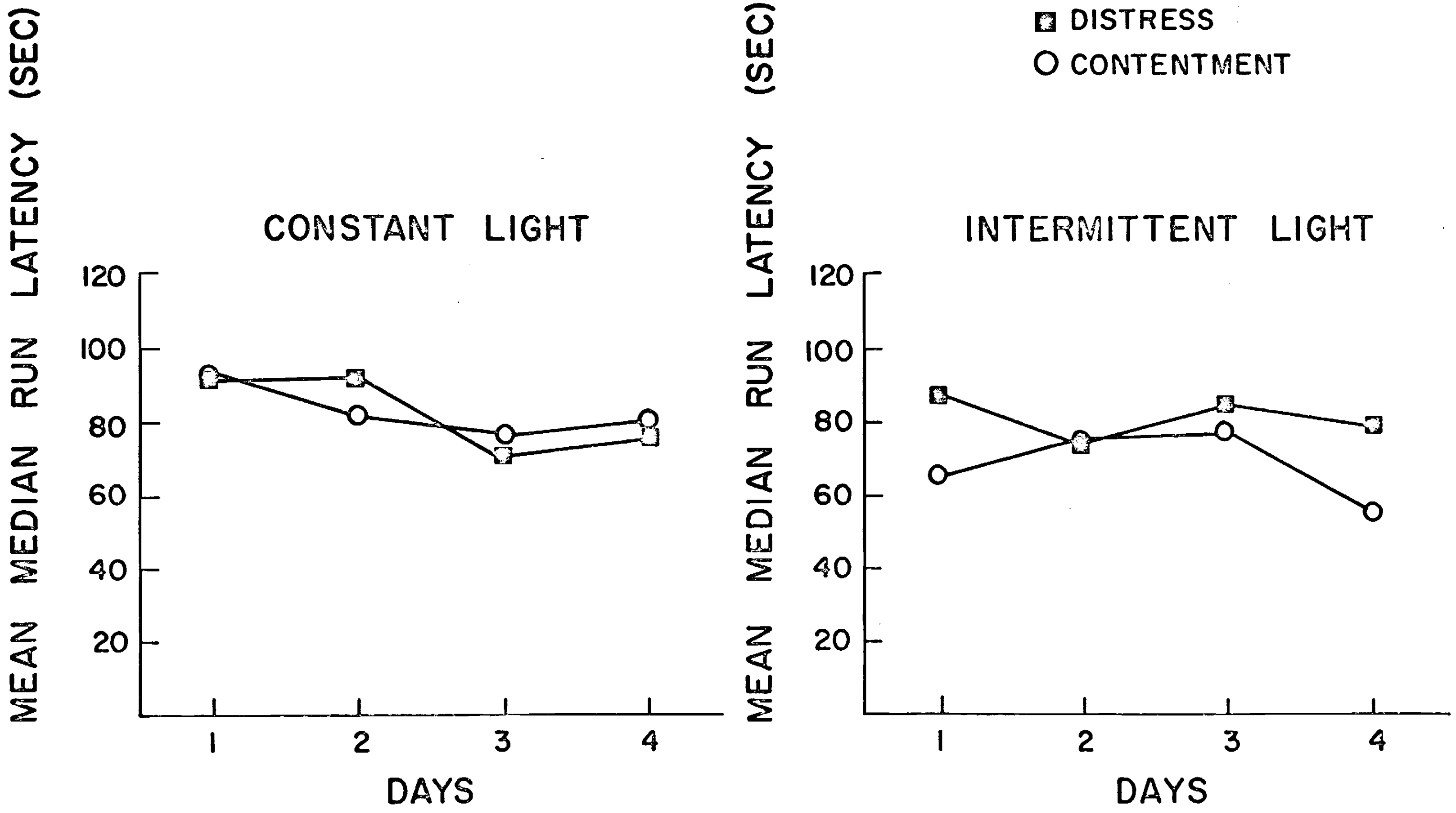

Figure 5. Mean median run latencies to distress and contentment vocalizations in the presence of either constant or intermittent light over the first four days of post-hatch life.

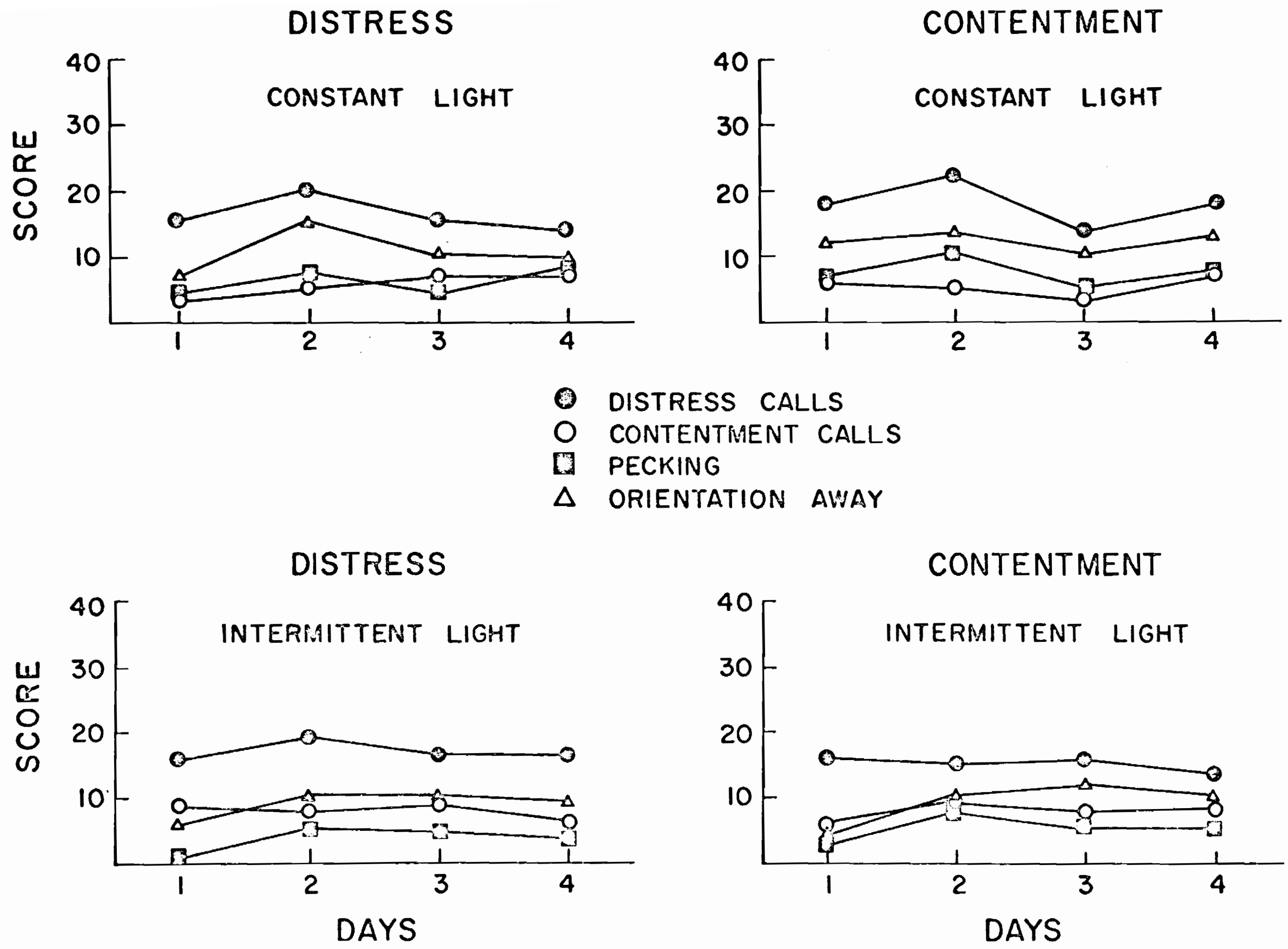

Figure 6. Behavior checklist scores for chicks exposed to distress and contentment vocalizations in either the presence of constant or intermittent light over the first four days of post-hatch life.

vocalizations emitted more distress calls than chicks in the intermittent light condition in the presence of contentment vocalizations. None of the remaining main effects or interactions approached significance.

With regard to the contentment vocalization score data, analysis of variance revealed a light main effect approaching statistical significance, $\underline{F}$ (1, 22) = 3.15, $\underline{p}$ = 0.09. This trend suggests that chicks in the intermittent light condition emitted more contentment notes than birds in the constant light condition. The Light x Vocalization x Days interaction also approached significance, $\underline{F}$ (3, 55) = 2.34, $\underline{p}$ = 0.08. Thus, the contentment score seems to be dependent upon the age and experience of the subjects. While Day 4 chicks tend to have similar contentment vocalization scores regardless of vocalization or light conditions, deviations below this score may be seen on Day 3 in the contentment condition in the presence of both constant and intermittent light and on Day 1 in the constant light distress condition. None of the other main effects or interactions were signficant.

Analysis of variance on the pecking score data revealed a significant days main effect, $\underline{F}$ (3, 66) = 4.13, $\underline{p} \leq 0.01$. Simple effects analysis suggested that more pecking was observed on Day 2 than on all other days. A vocalization main effect which approached statistical significance, $\underline{F}$ (1, 22) = 3.33, $\underline{p}$ = 0.08, was also found. These data suggest that more pecking occurs in the presence of contentment vocalizations than in the presence of distress vocalizations. Other main effects and interactions did not approach significance.

A days effect was also obtained for the orientation away data, $\underline{F}$ (3, 66) = 5.04, $\underline{p} \leq 0.01$ with more orientation away from the goal area was noted on Day 2 than on Day 1 ($p \leq 0.05$). A vocalization effect which approached significance was also revealed, F (1, 22) = 3.35, $p = 0.08$. This trend may be reflected in the observations which suggest that more orientation away occurred in the presence of contentment vocalizations than in the presence of distress vocalizations. Finally, the three-way interaction, Light x Vocalization x Days also approached statistical significance. This interaction suggests that the display of orientation away responses is affected by the age and experience of the bird. In short, more orientation away responses were noted on Day 2 in the constant light condition in the presence of both contentment and distress, than in the intermittent light condition. Also, more orientation away responses were observed on Day 2 in the constant light condition in the presence of distress vocalizations than were observed in any of the other conditions.

The associations among the six dependent variables are presented in Table 2. Again, all of the measures are correlated with at least one other measure. The distress vocalization score is positively correlated ($p \leq 0.01$) with the orientation away score. Interestingly, the contentment vocalization score is also positively correlated ($p \leq 0.05$) with the orientation away score. The distress vocalization score is also negatively correlated ($p \leq 0.05$) with start latency which suggests that higher distress scores are associated with shorter start latencies. Similarly, higher contentment vocalization scores are apparently associated with short start latencies ($p \leq 0.05$). Pecking scores are associated with contentment vocalization scores ($p \leq 0.05$) and with orientation away scores ($p \leq 0.01$). As has been suggested

Table 2

Correlation Coefficients for the Six

Dependent Measures in Experiment 2

Dependent Measure	Contentment Vocalization Score	Pecking Score	Orientation Away Score	Start Latency	Run Latency
Distress Vocalization Score	-0.11	0.07	0.21**	-0.14*	-0.13
Contentment Vocalization Score		0.16*	0.14*	-0.17*	0.08
Pecking Score			0.23**	-0.13	-0.03
Orientation Away Score				-0.11	0.26**
Start Latency					0.34**

*$\underline{p} \leq 0.05$
**$\underline{p} \leq 0.01$

before (Robinson-Guy & Schulman, 1976), the physical act of pecking often necessarily involves orientation away from the goal area due simply to the mechanics of the response. Further, high orientation away scores are associated with long run latencies ($\underline{p} \leq 0.01$). When long run latencies are obtained it may be argued that the goal box stimulation does not meet the stimulative requirements of the chick or that these stimuli do not possess sufficient attention-getting or attention-directing properties. If this is the case then it is quite logical to presume that chicks would not maintain prolonged orienting responses to the source of stimulation. As was the case in Experiment 1 start latency is correlated with run latency ($\underline{p} \leq 0.01$).

Discussion

In Experiment 2, while a number of the dependent measures suggest that young chicks behave differently in the presence of distress and contentment vocalization stimulation, none of the vocalization main effects reached acceptable levels of statistical significance. Each of the vocalization trends are, however, in a direction which supports the hypothesis that the reception of contentment vocalization stimulation is associated with increased activity levels in young chicks. That is, the chicks approached the contentment vocalizations more rapidly than the distress vocalizations, and pecked more and oriented away more in the presence of contentment vocalization stimulation. Further, the emission of contentment vocalizations was positively correlated with the pecking score and the orientation away score (as in Experiment 1). The emission of contentment calls was negatively correlated with start latency times (unlike in Experiment 1) which suggests that more rapid approach responses were associated with the emission of more contentment calls. However, the emission of distress calls is also positively correlated with the orientation away measure and negatively correlated with the start latency measure. Therefore, the observations that approach responses accompany contentment vocalizations and that avoidance responses accompany distress vocalizations were not supported by these data (Collias, 1952).

The general lack of statistically significant differences in behavior which were observed in this study may be partially accounted for by the nature of the vocalization stimulation presentation procedure. That is, the chicks were only given three daily trials with each auditory stimulus in a successive choice situation. Possibly the temporal separation of the two vocalization stimulus presentations obviated the development or prevented the appearance of sensory discrimination between the two stimuli. Or, perhaps stimulus generalization occurred in which the responses acquired to one of the vocalizations simply generalized and were expressed in the presence of both kinds of auditory stimulation. Experiments in which the two auditory stimuli are presented simultaneously should help to clarify this issue.

Age-related changes in chick behavior were readily apparent in Experiment 2. That is, birds on Day 1 had greater start latency times than all other birds (as in Experiment 1), Day 2 birds pecked more than all other birds, and Day 2 birds oriented away from the source of the audiovisual stimulation more than Day 1 birds. It is probable that Day 1 birds oriented away less, simply because they tended to engage in less locomotor activity than older subjects. By the same token, Day 2 birds seem to be more active than other age birds, since they engaged in more pecking and orientation away responses and tended to emit more distress calls than other birds. It may be that the Day 2 birds were capable of more coordinated kinds of behavior than the Day 1 chicks. The Day 2 birds were clearly more familiar with the experimental apparatus and procedures. While Day 2 birds may have engaged in more exploratory and locomotor activity, these possibilities cannot be documented by differential run latency times based on age.

The relative absence of differences in behavior observed in the presence of intermittent vs. constant light is somewhat surprising. However, it should be remembered that the flash frequency of the intermittent light used in this study was approximately 1.5 flashes/sec. This flash frequency represents the lower end of the range of flash frequencies which reliably influence chick approach responses to intermittent light (Simner, 1978). Furthermore, Simner has demonstrated that individual differences exist in young chicks' attraction to intermittent light and has raised the possibility that these differences may be genetic in origin.

The finding that more distress calls were emitted in the presence of constant light in the contentment vocalization condition, than in the presence of intermittent light in the contentment vocalization condition is interesting. This finding represents the only statistically reliable indication that intermittent light: (a) exerts an effect on chick behavior under these stimulation procedures, and (b) may be preferred to constant light stimulation, at least in the presence of contentment vocalizations. It is possible that, in the presence of intermittent light, the taxidermic chick model may have appeared to be in motion. Since it would appear that one effect of the reception of contentment vocalization stimulation on chick behavior is to increase activity, often stimulus-oriented activity (or at least activity is not inhibited), the perception of a moving conspecific emitting contentment calls was probably readily localizable, attractive, and/or exerted a calming influence on the chick and thereby functioned to reduce distress vocalizations. The observation that distress calls were not reduced in the presence of intermittent light and distress vocalization stimulation suggests the possibility that the reception of distress vocalization stimulation in the presence of intermittent light, though readily localizable, may not be attractive and/or soothing to the chick.

The nature of the relationship between activity and the reception and/or emission of neonatal chick vocalizations is still unresolved. That is, it is unclear whether the reception of contentment vocalizations functions to increase a receivers' level of activity or whether the receivers' activity level is basically unaltered, relative to the effects of distress vocalization stimulation on activity. Moreover, the effects of emission of distress or contentment calls on the emitters' subsequent level of activity are unclear. The following experiments should help to resolve the nature of the relationships between these variables.

Experiment 3

The purpose of this study was to determine the influence of social experience on the responsibity of young chicks exposed to distress and contentment vocalizations.

Method

This experiment was a cross-sectional, between groups study. One hundred ninety-two Cornell Randombred White Leghorn chicks received one auditory stimulus (either distress or contentment calls) for five trials for one day only. Chicks were also assigned to one of two rearing conditions. Subjects were either housed individually in single cages or socially (groups of five, only four of which actually participated in data generation) in double cages. Chicks were further assigned to one of two training conditions. The chicks were run either individually or in pairs. Furthermore, chicks were either run at 24 h or 72 h of age. The chicks in this study had access to Purina chick starter feed. As in the other experiments approach data and the additional behavioral measures were taken. Subjects were also given runway placements when necessary.

Results

Approach data. The mean median start latency data for Experiment 3 are presented in Figure 7. Analysis of variance of these data showed a highly significant rearing main effect, F (1, 176) = 36.40, $p \leq 0.01$. Where socially reared chicks took significantly longer to leave the start area than those individually reared. None of the other main effects or interactions were significant.

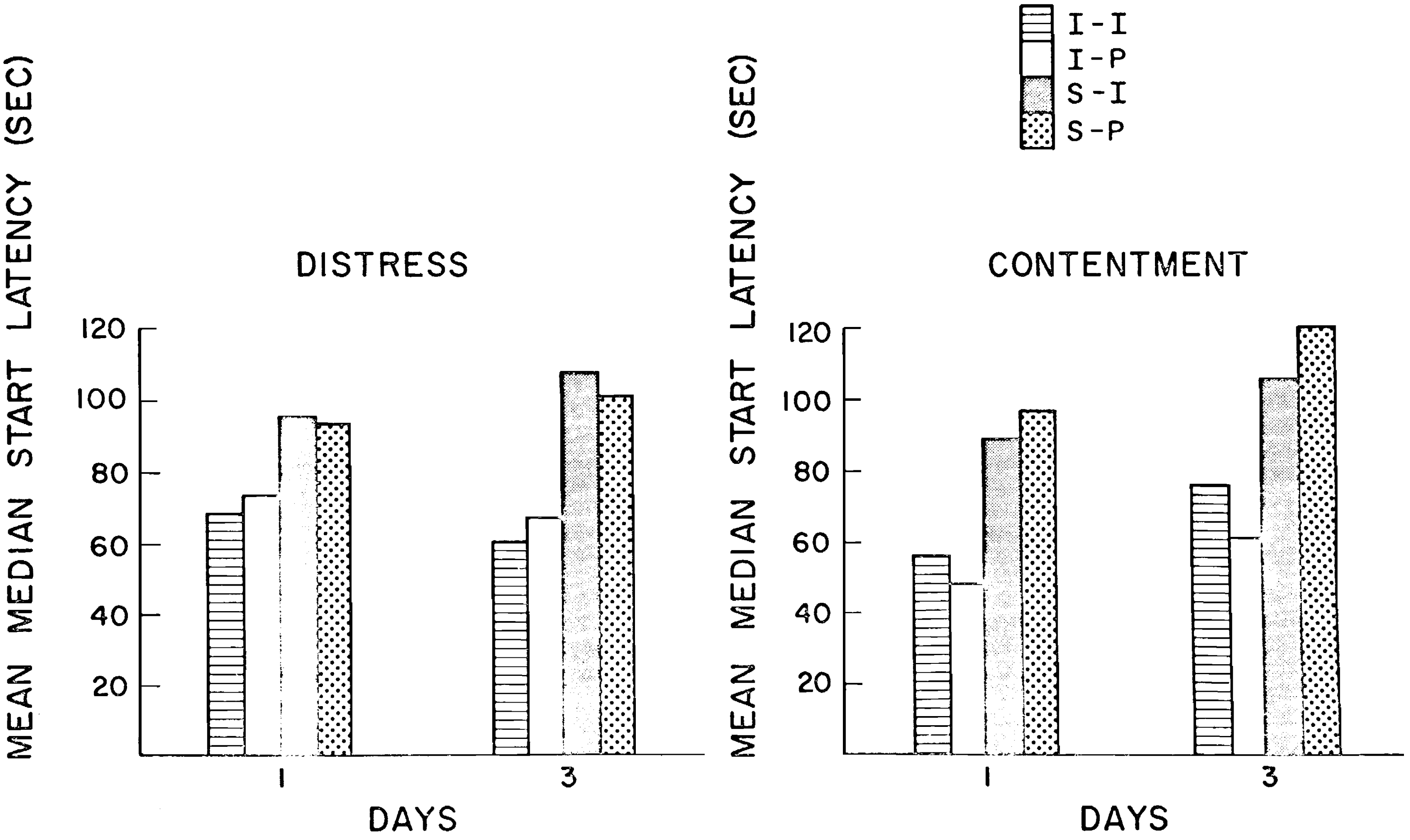

Figure 7. Mean median start latencies for chicks exposed to distress or contentment vocalizations on either Day 1 or Day 3 of post-hatch life. Legend: letters on left represent rearing condition (I - individual, S - social), letters on right represent running condition (I - individual, P - pair).

The mean median run latency data are presented in Figure 8. Analysis of variance showed a highly significant rearing effect, $\underline{F}$ (1, 176) = 10.00, $\underline{p} \leq 0.01$. Similarly, the socially reared subjects took longer to traverse the alley area than their individually reared counterparts. Analysis of variance also revealed a significant Running x Days interaction, $\underline{F}$ (1, 176) = 4.99, $\underline{p} \leq 0.05$. Simple effects analysis demonstrated that Day 3 birds run in pairs took significantly longer to traverse the alley area than the birds run in pairs on Day 1 and birds run individually on Day 1 and 3. In addition, the Vocalization x Rearing x Running interaction approached significance, $\underline{F}$ (1, 176) = 2.87, $\underline{p} = 0.09$. Birds exposed to distress vocalizations and reared and run individually and birds exposed to contentment vocalizations and reared individually and run in pairs appear to have shorter run latencies than chicks in other conditions.

Additional behavioral measures. The data for the various additional behaviors of chicks exposed to distress and contentment vocalizations are presented in Figures 9 and 10, respectively. Analysis of variance performed on the distress vocalization score data indicated a highly significant running effect, $\underline{F}$ (1, 176) = 41.76, $\underline{p} \leq 0.01$. Birds run individually reliably emitted more distress notes than birds run in pairs. None of the other main effects or interactions reached statistical significance.

Analysis of variance on the contentment vocalization score data revealed a significant rearing effect, $\underline{F}$ (1, 176) = 27.39, $\underline{p} \leq 0.01$. Individually reared birds had contentment vocalization scores twice the value of the socially reared birds. A highly significant days effect

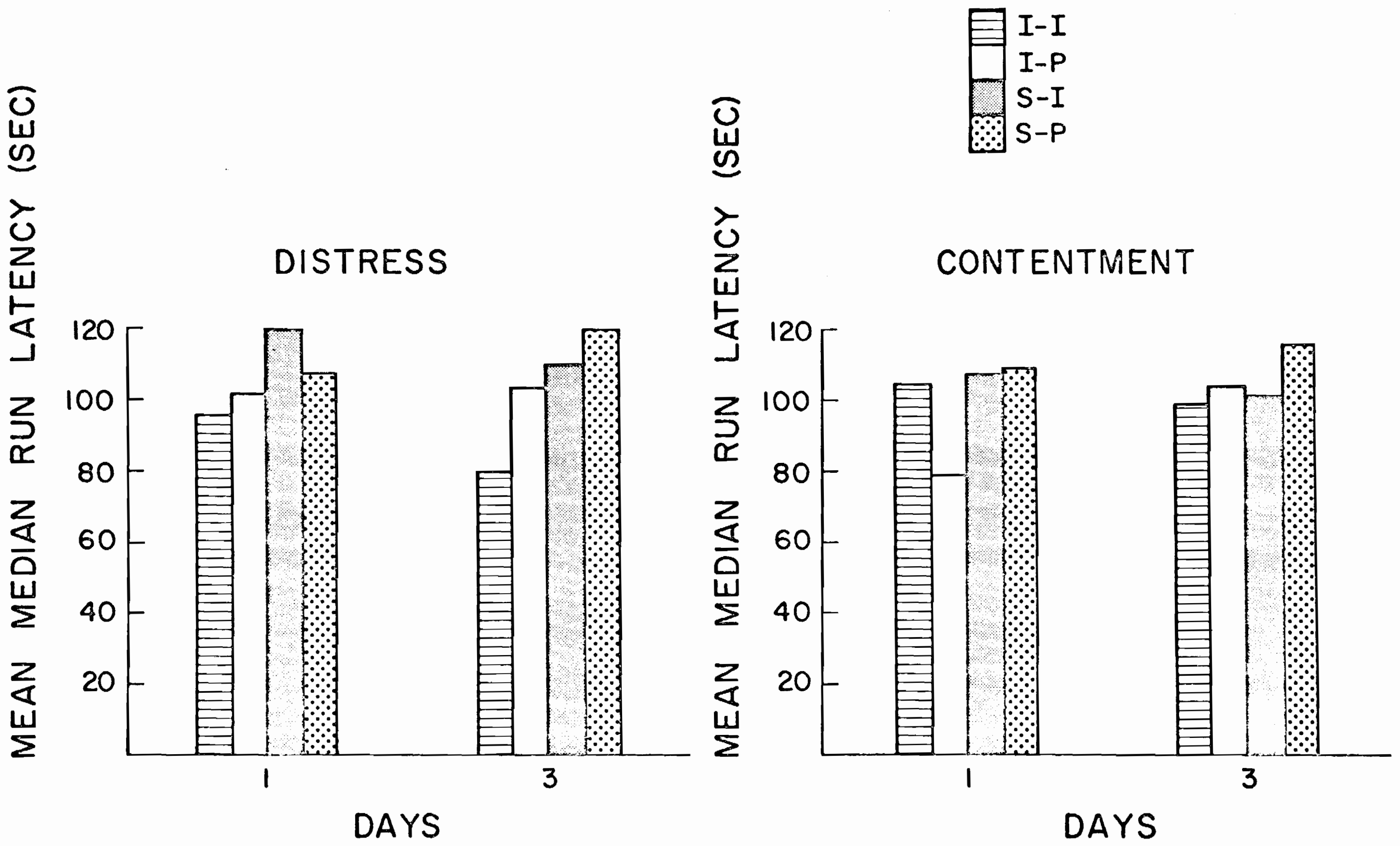

Figure 8. Median run latencies for chicks exposed to distress or contentment vocalizations on either Day 1 or Day 3 of post-hatch life. Legend: letters on left represent rearing condition (I - individual, S - social), letters on right represent running condition (I - individual, P - pair).

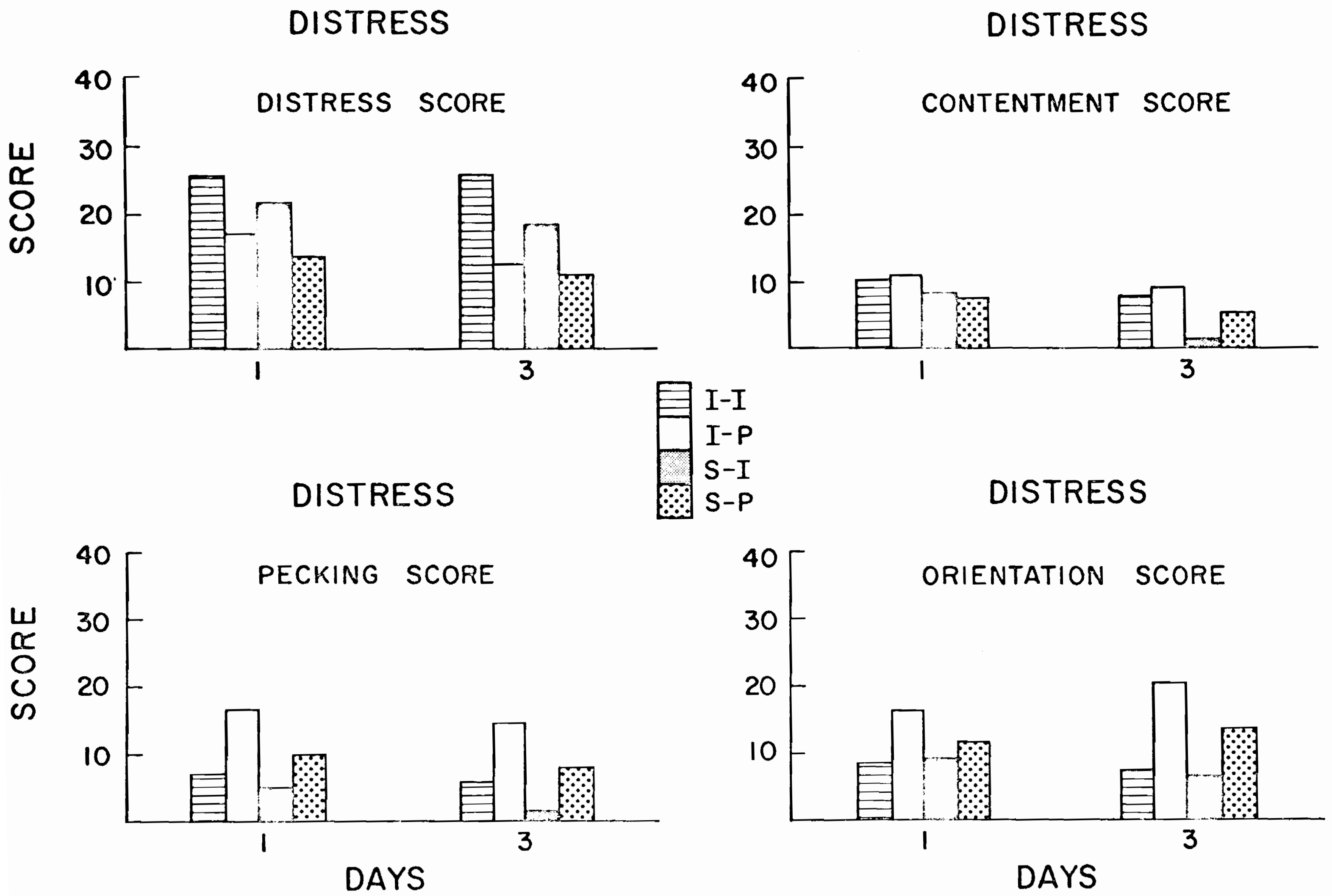

Figure 9. Behavior checklist scores for chicks exposed to distress vocalizations on either Day 1 or Day 3 of post-hatch life. Legend: letters on left represent rearing condition (I - individual, S - social), letters on right represent running condition (I - individual, P - pair).

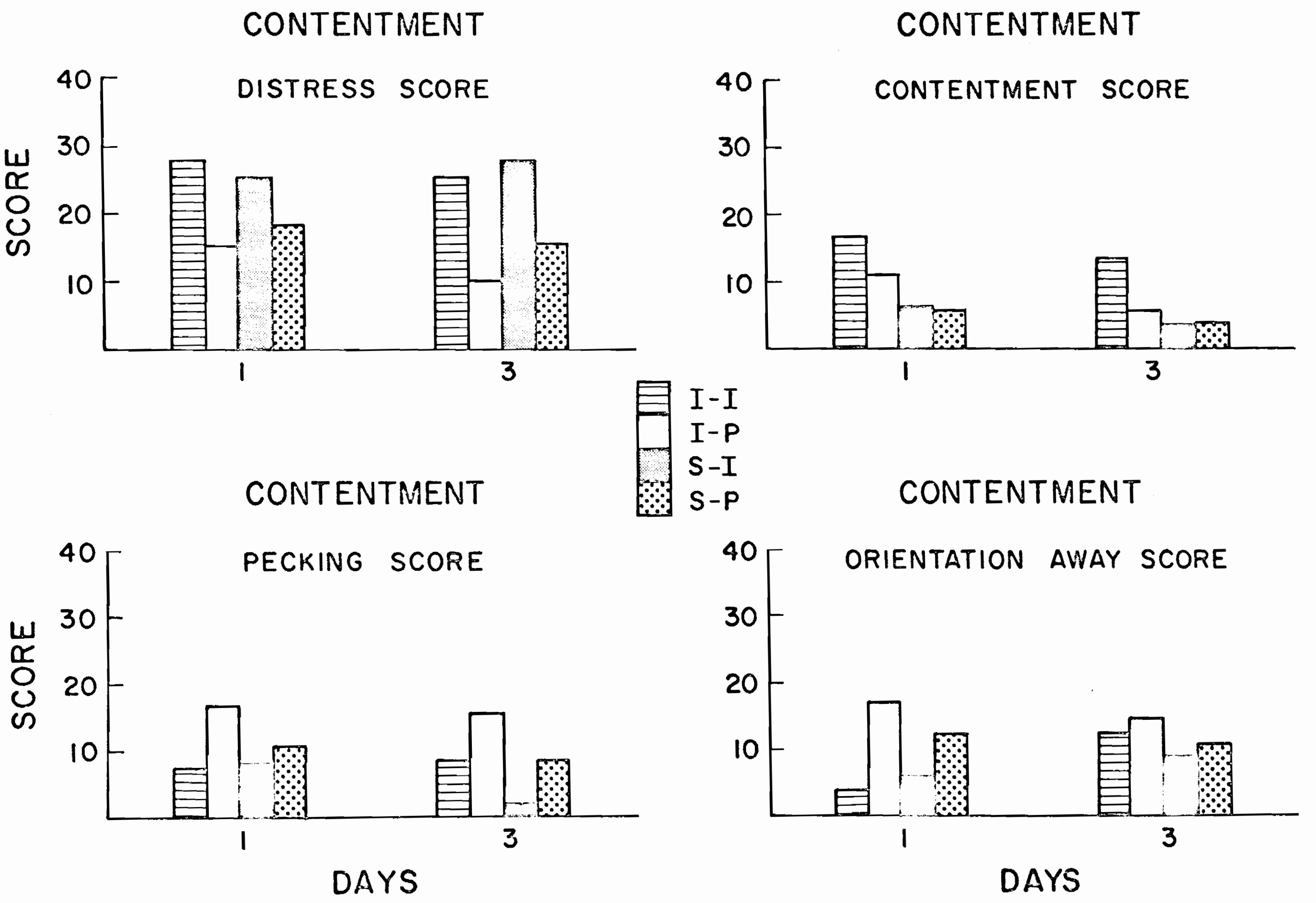

Figure 10. Behavior checklist scores for chicks exposed to contentment vocalizations on either Day 1 or Day 3 of post-hatch life. Legend: letters on left represent rearing condition (I - individual, S - social), letters on right represent running condition (I - individual, P - pair).

was also obtained, F (1, 176) = 10.90, $p \leq 0.01$. In this case, Day 1 birds emitted more contentment calls than Day 3 birds. Further, a significant Vocalization x Running interaction was noted, F (1, 176) = 5.45, $p \leq 0.05$. Chicks run individually in the presence of contentment vocalizations emitted more contentment notes than birds run individually in the presence of distress vocalizations. Also, chicks run individually in the presence of contentment vocalizations emitted more contentment calls than those run in pairs in the presence of contentment vocalizations. Finally, a Rearing x Running interaction was obtained, F (1, 176) = 3.97, $p \leq 0.05$. In this case, individually reared and run birds emitted more contentment twitters than socially reared and individually run birds and socially reared and pair-run birds. Thus, the contentment vocalization score measure would appear to be a good discriminator of chick responsivity in cross-sectional studies.

Pecking was also observed to systematically vary with a number of independent variables in Experiment 3. Analysis of variance on the pecking score data revealed a significant rearing effect, F (1, 176) = 30.62, $p \leq 0.01$. Individually reared birds pecked more than socially reared birds. A highly significant running effect was also obtained, F (1, 176) = 57.43, $p \leq 0.01$. Birds run in pairs pecked more than individually run birds. This effect may largely be due to the observation that young chicks engage in a great deal of sib pecking. Obviously, individually run birds did not have access to this variety of highly appealing pecking target. Further, analysis of variance indicated a significant days main effect, F (1, 176) = 5.45, $p \leq 0.05$. Day 1 birds pecked more than Day 3 birds. This effect is interesting in light of the fact that birds 24 h of age do not require the ingestion of external sources of food since they are still gaining sustenance from the yolk sac, whereas older, e.g., 72 h birds might be expected to peck more in search of external food sources. Alternately, it would appear biologically inappropriate for 24 h chicks to engage in high levels of aggression-related pecking. A significant Rearing x Running interaction was also found, F (1, 176) = 3.65, $p \leq 0.05$. Chicks reared individually and run in pairs engaged in more pecking than chicks in all other rearing and running conditions.

The orientation away score data were also observed to vary systematically with a number of the experimental manipulations in Experiment 3. Analysis of variance indicated a significant rearing effect, F (1, 176) = 6.26, $p \leq 0.01$. Isolate reared birds oriented away from the source of the vocalizations more than socially reared birds. This effect complements the direction of the other rearing main effects observed and may reflect a general reduction in activity in socially housed chicks. In addition, a highly significant running main was obtained, F (1, 176) = 39.97, $p \leq 0.01$. Birds run in pairs oriented away from the goal area more than individually run subjects. Clearly, a stationary taxidermic chick model and recorded vocalizations did not command as much of the chicks' attention as did a live (moving and vocalizing) chick. A Rearing x Running interaction was also obtained, F (1, 176) = 3.76, $p \leq 0.05$. Individually reared birds run in pairs oriented away more than birds in all other comparison groups. Finally, a Vocalization x Running x Day interaction was noted, F (1, 176) = 8.69, $p \leq 0.01$. Birds exposed to distress vocalizations and run individually on Days 1 and 3 differ from subjects which were exposed to contentment vocalizations and run in pairs on Day 1. The former groups oriented away more than the latter group. In the contentment condition, chicks run individually on Day 1 exhibited fewer orientation away responses than subjects in the distress condition which were run in pairs on Day 1 and 3.

The associations among the six dependent measures in Experiment 3 are presented in Table 3. As was observed in Experiment 1, the distress vocalization score was negatively correlated with the pecking score ($p \leq 0.01$), whereas the contentment vocalization score was positively correlated with the pecking score ($p \leq 0.01$). Pecking frequency would seem to be a good predictor for chick responsivity to distress and contentment vocalizations. As was observed in the other two experiments, contentment vocalization score is positively associated with the orientation away score ($p \leq 0.01$). Another consistent finding includes the significant correlation between pecking and orientation away scores. The pecking score data were negatively correlated with both start and run latency data ($p \leq 0.01$), suggesting that the pecking measure may further be a good indicator of general activity levels. The observation that both start and run latencies are negatively correlated with the pecking score data is a good indicator that longer times spent in the runway per trial did not artificially inflate the pecking score data. Finally, as was noted in the two previous experiments, start latency was significantly correlated with run latency ($p \leq 0.01$).

Discussion

While the emission of distress and contentment vocalizations systematically varied with a number of experimental manipulations, the

Table 3

Correlation Coefficients for the Six

Dependent Measures in Experiment 3

Dependent Measure	Contentment Vocalization Score	Pecking Score	Orientation Away Score	Start Latency	Run Latency
Distress Vocalization Score	0.10	-0.21**	0.08	-0.05	-0.09
Contentment Vocalization Score		0.37**	0.26**	-0.12	-0.06
Pecking Score			0.44**	-0.24**	-0.19
Orientation Away Score				-0.05	0.11
Start Latency					0.45**

$^{**}p \leq 0.01$

reception of distress and contentment vocalization stimulation had little systematic impact on the behavior of the chicks in this study. This paucity of vocalization effects may in part be attributed to the limited exposure of each bird (5 trials for one day only) to the auditory stimulation. The following relationships were detected, however. It appears that the presence of contentment stimulation facilitated contentment calling in isolate run chicks and that orientation away responses were lower in the presence of contentment stimulation for birds in both running conditions on Day 1. The lack of differential approach latencies to the vocalization stimulation may be partially accounted for by two possibilities. Firstly, socially reared subjects may simply have been sensitive to the artificiality of the experimental condition (e.g., no movement on the part of the target chick, the prolonged nature of the vocalization stimulation, etc.) and secondly, socially run birds may have experienced difficulties in localizing the source of auditory stimulation due to the vocalizations emitted by their running mates.

Few age-related changed in behavior were also documented in this study. However, Day 1 birds were observed to emit more contentment vocalizations and pecking responses than the Day 3 birds. It may be speculated that Day 1 birds emitted more contentment peeps than the older subjects because the degree of "stimulus contrast" (after Andrew, 1964) encountered between rearing and testing environments for the younger birds was moderate enough to facilitate the emission of contentment notes, while older subjects perceived a large amount of stimulus contrast between rearing and testing environments and the emission of contentment notes was no longer facilitated. The weakness of this interpretation lies in the failure of distress calls to increase on Day 3 as Andrew's stimulus contrast hypothesis would predict. It also seems unlikely that a fear or arousal interpretation could account for this finding since approach latencies do not significantly increase in the older birds. The higher frequency of pecking which was noted in younger birds is hard to explain. This pecking may best be regarded as exploratory, since 24 h old chicks do not need to seek external food sources.

Clearly, the outstanding feature of the data for Experiment 3 is the preponderance of rearing effects which may be noted. Isolate reared subjects had lower start and run latencies, emitted more contentment peeps, pecked more, and oriented away from the goal area more than socially reared birds. These findings are in accordance with data reported by Kennan (1972) in which it was determined that isolate reared subjects obtained greater imprinting scores and exhibited less fear than socially reared chicks. Similarly, Schaller and Emlen (1962) determined that socially reared precocial birds exhibited a higher number of avoidance responses to novel stimulation than isolate reared birds. The greater incidence of pecking in individually reared, pair run birds is in agreement with the rearing effects on pecking discussed by Zajonc, Wilson, and Rajecki (1975). One possible explanation for the differential effects of rearing is that socially reared birds have become imprinted on one another (after Guiton, 1959) and the stimulation provided in the goal area of the runway can thereby no longer meet the stimulative requirements of the chicks.

The differential effects of social experience were also evident when running effects were considered. Pair run birds pecked more and oriented away more than individually run chicks. These effects are perhaps best attributed to the observation that pair run subjects pecked at each other very frequently. As has been previously mentioned the execution of pecking responses almost always necessitates orienting away from the goal area. Interestingly, more orientation away responses were noted in individually reared, pair run chicks than in all other comparison groups. Since individually run birds did not have another chick present to peck at, their pecking and orientation away scores were much lower than the scores obtained for their socially run counterparts. All individually run birds emitted more distress calls than socially run birds. This observation is consistent with date presented by e.g., Kaufman and Hinde (1961), Harless and Collins (1971) and Lampros (1976).

Experiment 4

The purpose of the present study is to elucidate the spatio-temporal characteristics of responses of young chicks to distress and contentment vocalizations in an open field.

Method

Subjects. Experiment 4 was a longitudinal, mixed design study. Sixty Athens Canadian x Cornell Randombred chicks were exposed to three auditory stimulus conditions (distress vocalizations, contentment vocalizations, and no auditory stimulus). One half of the subjects were housed individually in single cages, while the other 30 chicks were reared socially (groups of three) in double cages. All subjects were run as trios. Trios were composed of birds which did not live together, however, the trios retained the same membership over days. This practice was initiated to more effectively separate the effects of rearing and training on the chicks' behavior.

Apparatus. The apparatus for Experiment 4 consisted of an open field, a cassette tape player, two speakers, a hen model, a styrofoam block, and a 1/10 sec stopwatch. The open field, 91.5 cm^2 x 30.5 cm (H), was constructed of 1.6 cm plywood painted flat white. The floor of the open field was divided into 36 equal squares (15.24 cm^2). Square boundaries were marked with 1.6 cm black electrical tape. Sheets of clear polyethylene were placed over the grid to facilitate washing the surface of the open field. The surface of the open field was washed with water after each trio of subjects was run.

One speaker (Archer, .2 W, 8 ohms) was located on each of two (opposite) sides of the open field. Several layers of cheesecloth were applied over the speakers to minimize contrast value with the rest of the apparatus. Each speaker was mounted in the middle of one side of the apparatus 17.8 cm from the floor.

The auditory stimuli were played on a tape player (Lafayette, model number 99-16024) at 70 db for the distress calls and 68 db for contentment vocalizations, as measured 30.5 cm from each speaker. Systematic investigation with a sound level meter revealed that there were no measurable differences in the intensity of the auditory stimulation in any area of the open field.

The hen model was a lawn ornament hen which was painted flat white, with a red comb and wattles and a yellow beak. The hen model had no feet or legs. Relevant measurements of the hen include: 30.5 cm from breast to tail feathers, 33 cms from top of comb to the floor, 33 cms from beak to tail feathers, 25 cm from top of tail feathers to the floor and 15 cm breast width. The hen was not positioned in a broody posture. When the hen was not in the open field a white styrofoam block (26.7 cm x 17 cm x 8.3 cm) occupied the hen's location. Ambient light intensity and temperature were the same as in Experiments 1, 2, and 3.

All chicks were marked with a non-toxic felt tip marker in two coding systems: one to identify the chicks' rearing group and the other to indicate the chicks' running group.

Procedure. The procedure consisted of placing a trio of chicks into the center of the open field for 30 sec. The subjects were confined to an area of 15 cm^2 by placing a cardboard box over them. After 30 sec elapsed, the cardboard box was raised and the positions of each chick in the trio were recorded every 10 sec. The chicks received a total of 4 min with each of the three auditory stimulus conditions. One half of the time a hen model was present, while the other half of the time the styrofoam block was present in the apparatus. Thirty sec separated the hen present-hen absent conditions during which time the chicks were again placed in the center of the open field under the cardboard box. The type of auditory stimulus and direction from which it came was counterbalanced over hen present-hen absent conditions, over rearing conditions, and over days. Three behavioral measures were taken: an activity score, a hen proximity score, and an auditory stimulus localization score. The activity data represent the number of squares entered by each chick per 10 sec observation period. Scoring of the proximity data consisted of assigning a value of 10 to observation periods when chicks were located within an area approximately 0-15 cm from the hen or styrofoam block, 5 to observation periods when the birds were located approximately 15-45 cm from the hen model or styrofoam block, and 1 to observation periods when chicks were located within an area 45-75 cm from the hen model or styrofoam block. The localization data was coded in much the same fashion. A value of 10 was assigned observation periods when chicks were located within an area 0-30 cm from the speaker from which the auditory stimuli emanated, a value of 5 was assigned when chicks occupied an area with a 30-60 cm range from the speaker and a value of 1 was assigned when chicks were located 60-90 cm from the speaker. Birds loosely associated with either the hen model/styrofoam block (45-75 cm) or the speakers (60-90 cm) were assigned values of 1 to eliminate zero values from the analysis.

The chicks were run at 24, 48, 72, and 144 hours of age.

Results

Activity score data. The activity score data for Experiment 4 are presented in Figure 11. Analysis of variance revealed a highly significant rearing effect, F (1, 58) = 11.28, $p \leq 0.01$. Isolate reared birds entered significantly more squares than socially reared birds. A significant days effect was also obtained, F (3, 174) = 7.65, $p \leq 0.01$. Simple effects analysis revealed that birds on Days 2 and 3 entered significantly more squares than birds on Days 1 and 6. Analysis of variance also indicated a significant vocalization main effect, F (2, 116) = 18.81, $p \leq 0.01$. Simple effects analysis revealed that more squares were entered in the presence of the vocalization auditory stimulation than in the presence of no auditory stimulation ($p \leq 0.01$). It was also determined that chicks exposed to contentment vocalizations entered more squares than chicks exposed to distress vocalizations ($p \leq 0.05$). A Rearing x Day interaction was also obtained for these data, F (3, 174) = 2.55, $p \leq 0.05$. Simple effects analysis indicated that individually reared birds on Days 2 and 3 entered significantly more squares than all other subjects. Further, chicks which were socially reared entered fewer squares on Day 6, than Day 6 individually reared birds, Day 1 individually reared birds and Day 2 socially reared birds. The Hen x Day interaction was also significant, F (3, 174) = 3.85, $p \leq 0.01$. In this case, hen model Day 2 and Day 3 birds and no hen model Day 3 birds entered significantly more squares than hen model Day 6 birds, no hen model Day 1 and Day 6 birds. Also, hen model Day 1 and 3 chicks entered more squares than hen model Day 6 birds and no hen model Day 1 birds. In addition, a significant Day x Vocalization

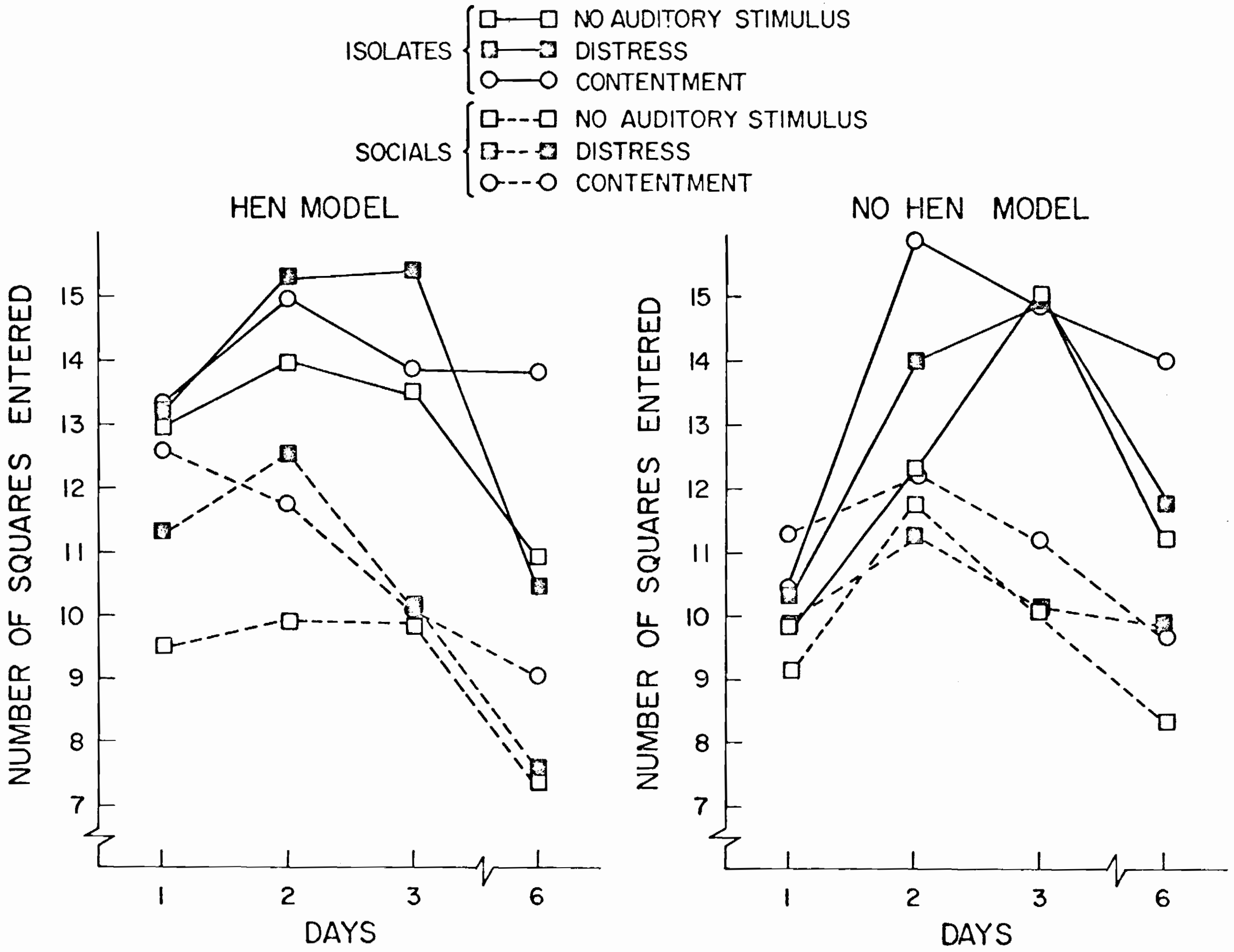

Figure 11. Activity score data for chicks exposed to distress vocalizations contentment vocalizations, and no auditory stimulus over Days 1, 2, 3, and 6 of post-hatch life.

interaction was found, *F* (6,348) = 26.50, $p \leq 0.05$. Simple effects analysis revealed a rather complex relationship between activity scores and vocalization exposure over days. Birds exposed to contentment vocalizations on Day 2 entered more squares than all other groups, except birds exposed to distress vocalizations on Day 2. The Day 2 distress vocalization birds entered more squares than all groups except the Day 3 subjects exposed to distress and contentment vocalizations. The Day 3 distress and contentment birds entered more squares than the Day 1 birds exposed to distress vocalization, Day 1 birds exposed to no auditory stimulus, and Day 6 birds exposed to no auditory stimulus, and Day 6 birds exposed to distress vocalizations. Chicks exposed to no auditory stimulus on Days 2 and 3 and chicks exposed to contentment vocalizations on Days 1 and 6 entered more squares than the Day 1 and 6 birds exposed to no auditory stimulus and Day 6 birds exposed to distress vocalizations. Finally, Day 1 chicks exposed to distress vocalizations entered more squares than Day 6 birds which had been exposed to either no auditory stimulus or to distress vocalizations.

The three-way Rearing x Days x Vocalization interaction was also significant, *F* (6, 348) = 31.15, $p \leq 0.01$. There appears to be one major contributor to this interaction. That is, while isolate reared birds exposed to contentment vocalizations over all days and distress vocalization exposed birds on Days 2 and 3 generally tend to enter more squares than birds in the other conditions, some socially reared birds exposed to contentment vocalizations on Days 1 and 2 and distress on Day 2 tend to enter more squares than Day 6 individually reared birds exposed to all auditory stimulus conditions.

Proximity score data. The proximity score data are presented in Figures 12 and 13. Analysis of variance performed on these data indicated a significant rearing effect, F (1, 58) = 7.68, $p \leq 0.01$. That is, socially reared subjects had higher proximity scores (stayed closer to both the hen model and styrofoam block) than individually reared subjects. A hen main effect was also obtained, F (1, 58) = 5.79, $p \leq 0.01$. Chicks had higher proximity scores in the presence of the hen model, than in the presence of the styrofoam block. A highly significant day effect was found, F (3, 174) = 11.71, $p \leq 0.01$. Simple effects analysis indicated that Day 6 birds had significantly lower proximity scores than Day 1, 2, and 3 birds. The vocalization effect was also determined to be significant, F (2, 116) = 9.49, $p \leq 0.01$. Simple effects analysis indicated that proximity scores were significantly lower in birds exposed to no auditory stimulus than in birds exposed to either distress or contentment vocalizations.

A number of significant interactions were also found, suggesting that direct interpretation of all main effects is not warranted. The Rearing x Hen interaction was significant, F (1, 58) = 13.02, $p \leq 0.01$. It was determined that individually reared birds exposed to the styrofoam block had significantly lower proximity scores than chicks in all other groups. The Rearing x Day interaction was also significant, F (3, 174) = 6.64, $p \leq 0.01$. Simple effects analysis indicated that socially reared birds on Day 1 had higher proximity scores than all other birds, except Day 2 and Day 3 socially reared birds. Day 2 and 3 socially reared birds had higher proximity scores than socially reared Day 6 birds and isolate reared Day 1, Day 3, and Day 6 birds. Also,

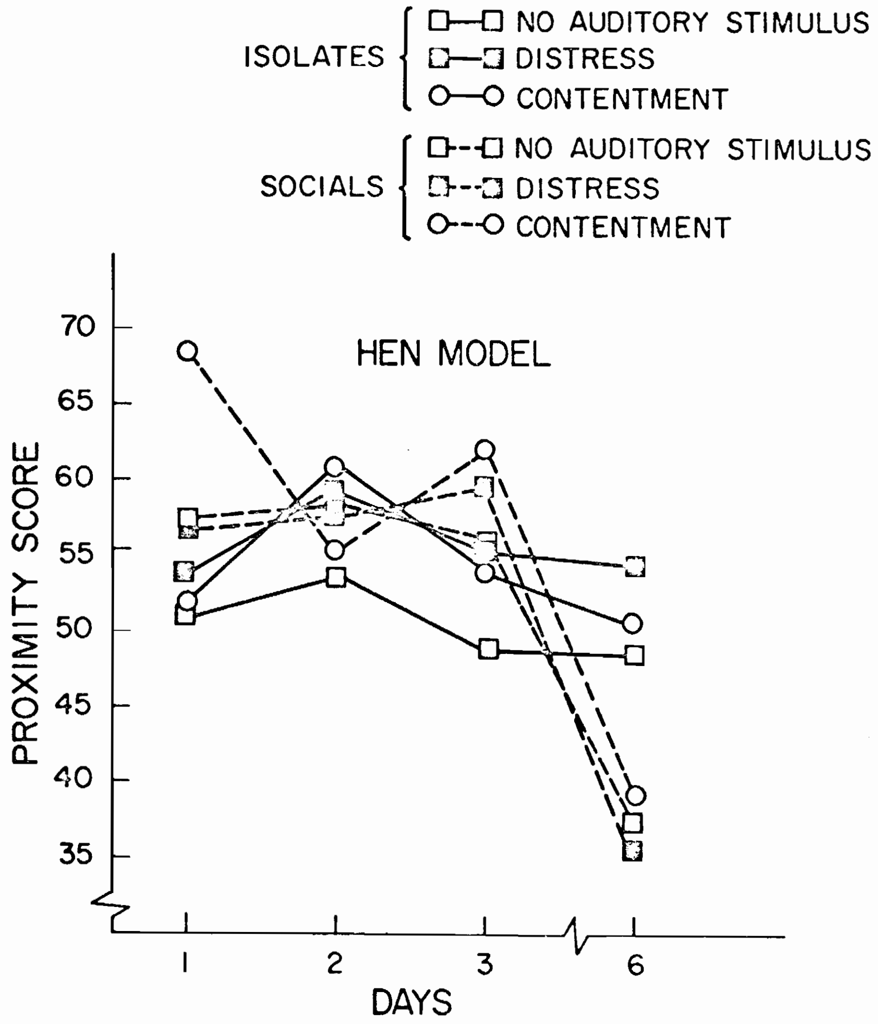

Figure 12. Proximity score data for chicks exposed to distress vocalizations, contentment vocalizations, and no auditory stimulus in the presence of the hen model over Days 1, 2, 3, and 6 of post-hatch life.

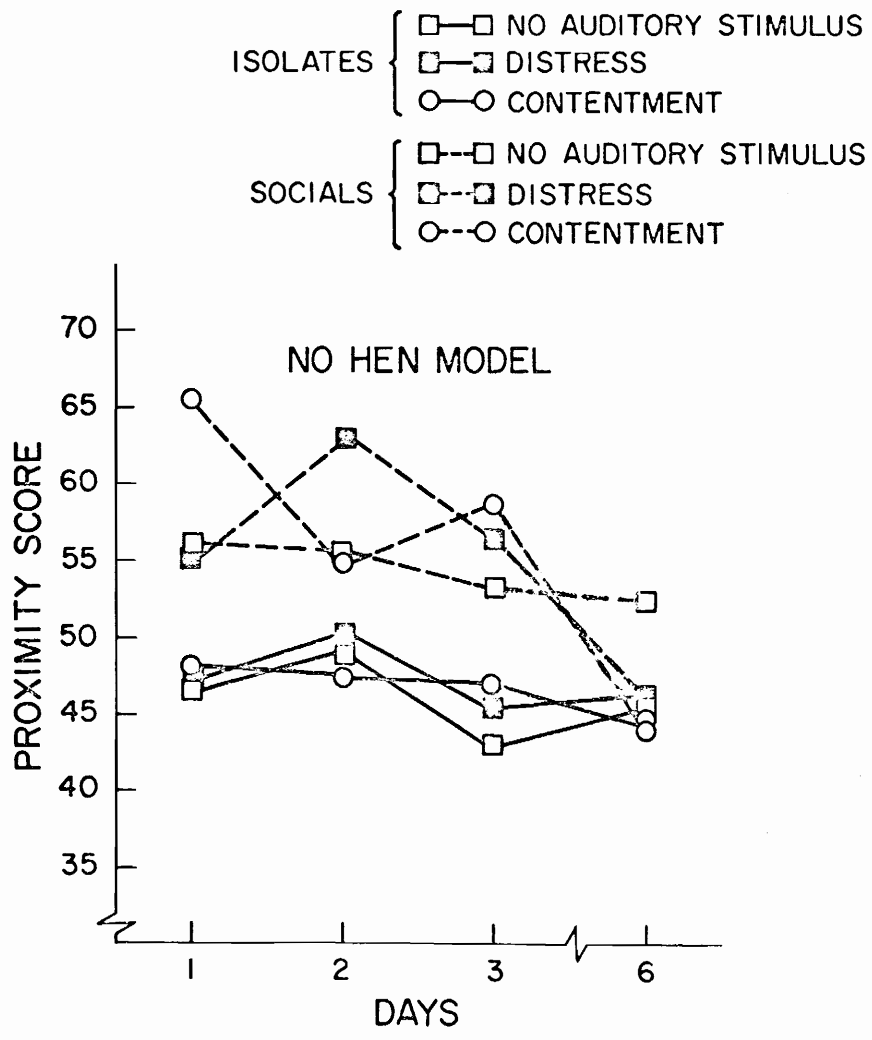

Figure 13. Proximity score data for chicks exposed to distress vocalizations, contentment vocalizations, and no auditory stimulus in the presence of the styrofoam block over Days 1, 2, 3, and 6 of post-hatch life.

individually reared chicks on Day 2 had higher proximity scores than Day 6 socially reared chicks.

The Rearing x Vocalization interaction approached statistical significance, F (2, 116) = 2.75, $p = 0.07$. Simple effects analysis suggested that socially reared birds exposed to contentment calls may have had higher proximity scores than the isolate reared birds exposed to distress calls, contentment calls, and no auditory stimulus. Further, socially reared birds exposed to distress vocalizations and no auditory stimulation tended to have higher proximity scores than individually reared birds exposed to no auditory stimulation. A second interaction which approached statistical significance was the Hen x Vocalization interaction, F (2, 116) = 2.64, $p = 0.07$. These data suggest that birds exposed to distress and contentment vocalizations in the presence of a hen model have higher proximity scores than birds in all other groups.

The Day x Vocalization was highly significant, F (6, 348) = 4.32, $p \leq 0.01$. Simple effects analysis indicated that Day 6 birds exposed to each of the three auditory stimuli had lower proximity scores than Day 1, 2, and 3 birds exposed to distress and contentment vocalizations. Further, Day 2 birds exposed to no auditory stimulation had higher proximity scores than Day 6 birds exposed to no auditory stimulus and to contentment vocalizations. Finally, Day 1 birds exposed to no auditory stimulation had higher proximity scores than Day 6 birds exposed to contentment vocalizations.

The Rearing x Day x Vocalization interaction was highly significant, F (6, 348) = 3.47, $p \leq 0.01$. Simple effects analysis indicated that socially reared birds on Day 1 in the presence of contentment vocalizations had the highest proximity score. This score was significantly larger than all other group scores ($\underline{p} \leq 0.05$). Socially reared Day 6 subjects exposed to all three auditory stimulus conditions had the lowest proximity scores and differed from all groups except individually reared Day 1 and 3 birds which were exposed to no auditory stimulus and Day 6 birds which were exposed to contentment vocalizations.

Localization score data. The localization data are presented in Figures 14 and 15. A repeated measures analysis of variance indicated that the rearing main effect approached statistical significance, $\underline{F}\ (1, 58) = 3.30$, $\underline{p} = 0.07$. This trend suggested that isolate reared subjects have higher localization scores (i.e., assumed positions close to the source of auditory stimulation) than socially reared subjects. The day effect was highly significant, $\underline{F}\ (3, 174) = 7.72$, $\underline{p} \leq 0.01$. Simple effects analysis revealed that Day 1 birds had significantly higher localization scores than Day 2, 3, and 6 birds.

Analysis of variance also indicated a significant Rearing x Hen interaction, $\underline{F}\ (1, 58) = 7.72$, $\underline{p} \leq 0.01$. Individually reared birds in the presence of the hen had higher localization scores than socially reared birds in the presence of the hen. Further, the Rearing x Day interaction was highly significant, $\underline{F}\ (3, 174) = 7.03$, $\underline{p} \leq 0.01$. Simple effects analysis revealed that individually reared birds on Day 1 had higher localization scores than individually reared birds on Days 2 and 3, and socially reared birds on Days 1, 3, and 6. In addition, Day 2 socially reared subjects and Day 6 individually reared birds had higher localization scores than individually reared birds on Day 2.

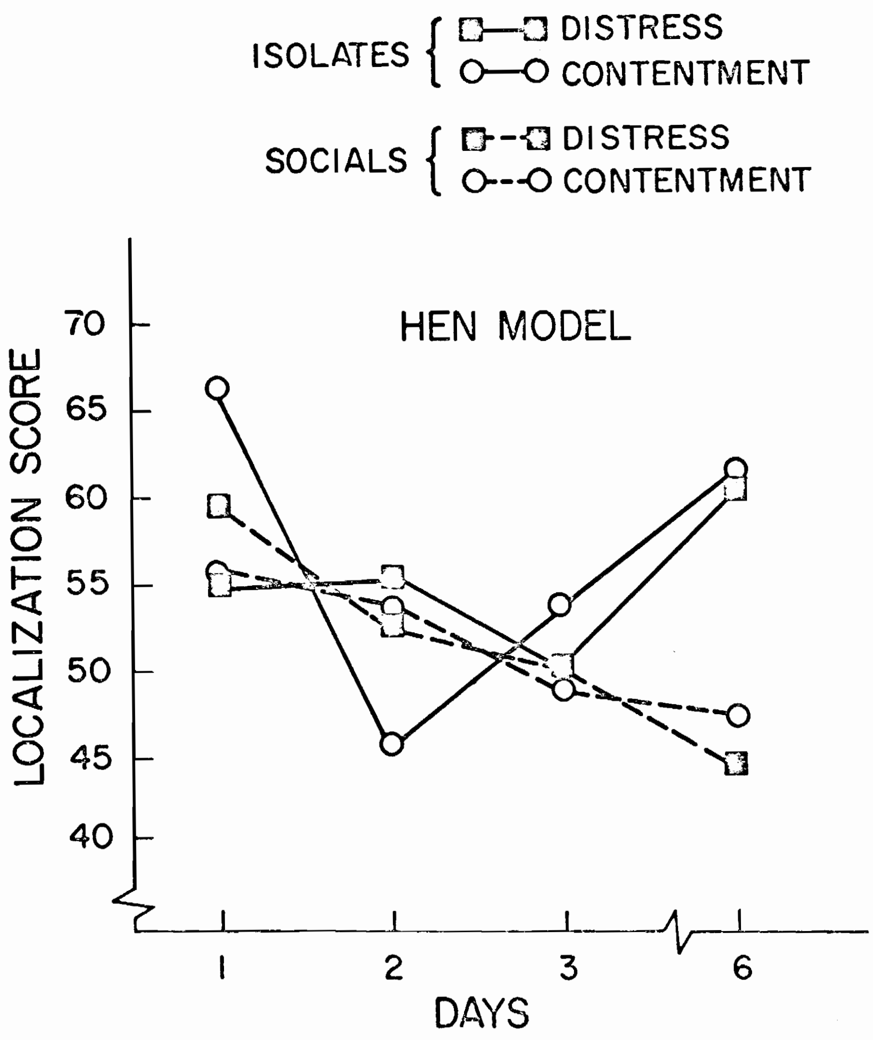

Figure 14. Localization score data for chicks in the distress and contentment vocalization conditions in the presence of the hen model over Days 1, 2, 3, and 6 of post-hatch life.

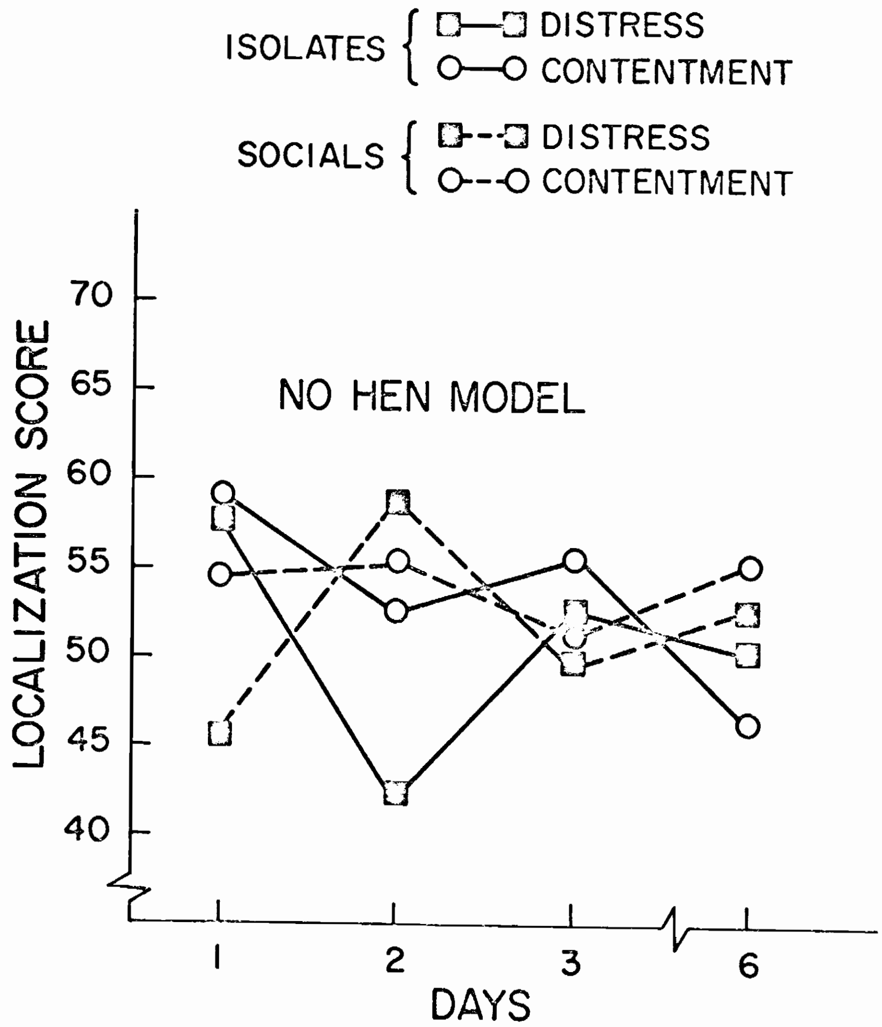

Figure 15. Localization score data for chicks in the distress and contentment vocalization conditions in the presence of the styrofoam block over Days 1, 2, 3, and 6 of post-hatch life.

The three-way, Rearing x Hen x Day interaction was significant, *F* (3, 58) = 6.63, $p \leq 0.01$. Individually reared birds with the hen model on Days 1 and 6 had significantly higher localization scores than individually reared birds with a hen model on Days 2 and 3, individually reared birds without the hen model on Days 2 and 6, socially reared birds with the hen model on Day 3 and 6, and socially reared birds without the hen model on Day 1 and 3. Further, socially reared birds with the hen model on Day 6 and individually reared birds without the hen on Day 2 had significantly lower localization scores than individually reared birds without the hen model on Day 1, socially reared subjects with the hen model on Day 1 and socially reared subjects without the hen model on Day 2.

Finally, the Rearing x Hen x Day x Vocalization interaction was highly significant, *F* (3, 174) = 6.39, $p \leq 0.01$ and precludes analysis.

Discussion

The finding that young chicks had higher activity scores in the presence of contentment vocalization stimulation than in the presence of distress vocalization stimulation and no auditory stimulation is consistent with the suppositions put forth to explain the vocalization effects noted in Experiments 1 and 2. Also, the observation that activity scores were higher for chicks in the presence of auditory stimulation than in its absence, suggests that the neonatal vocalizations selected for investigation in this series of studies do influence chick behavior relative to the absence of vocalizations. On Day 2, chicks entered more squares when in the presence of distress and contentment vocalizations than chicks in all other comparison groups. It may be speculated that contentment vocalizations signal "safety" in a given situation which produces a higher frequency and variety of exploratory activities than is noted in the presence of distress vocalization stimulation.

Interestingly, chicks in the presence of both distress and contentment vocalization stimulation spent more time in close proximity to the hen model or styrofoam block than when they were exposed to no auditory stimulation. This finding underscores the mother-young communicative potential of neonatal chick vocalizations. The adoption of proximity responses to the styrofoam block is curious but may be partially explained by stimulus generalization, since the block resembled the hen in size and color.

Since the chicks did not closely associate themselves with the source of the distress and contentment vocalization stimulation (an admittedly difficult task without the aid of differential intensity gradients) it is suggested that either these vocalizations are not attractive, or that the information content of the calls is such that close proximity to the emitter of the call is not actively sought. The latter suggestion is consistent with the rather long run latencies which were obtained to both vocalizations in the runway apparatus.

Several age-related changes in responsivity were noted in Experiment 4. For example, the activity scores were higher for Day 2 and 3 birds than for Day 1 and 6 birds. It seems probable that Day 1 birds did not move around the apparatus as much as the older subjects, due to locomotor and perceptual deficits and the novelty of the situation. Additionally, it may be presumed that Day 6 birds had lower activity scores since they had not been tested for 48 h and the experimental situation was again perceived as novel. Perhaps fear and arousal interpretations best explain this decrease in responding. The observation that Day 6 birds also had lower proximity scores than the younger subjects is probably understandable in terms of their low activity scores. The Day 6 birds simply did not move around the apparatus enough to come into contact with the hen model or styrofoam block. The finding that Day 1 birds had higher localization scores than all older chicks is surprising and difficult to explain. This observation clearly calls into question the suggestion that Day 1 birds are characterized by locomotor deficiencies in relation to older subjects.

As was similarly noted in Experiment 3, rearing environment conditions exerted a profound effect on the results obtained in Experiment 4. As might be expected, based upon the findings in Experiment 3, the isolate reared chicks had higher activity scores than the socially reared subjects. The isolate reared birds may have found the presence of other chicks in the testing situation energizing or anxiety reducing (after Thompson & McElroy, 1962). This suggestion is consistent with the Rearing x Running interactions noted for contentment calling, pecking and orientation away responses in Experiment 3. However, it should be recalled that significant Rearing x Running interactions were not obtained for the approach latency measures in Experiment 3.

Socially reared birds did, however, have higher proximity scores than their individually reared counterparts. This may be due to the general lack of movement observed in these birds, and/or by virtue of their social experience they were more likely to engage in further social responses. Analysis of the localization score data revealed a trend which suggested that isolate reared birds had higher localization scores than socially reared birds. The maintenance of localization responses clearly necessitated more locomotor activity than the maintenance of proximity responses.

Finally, the proximity scores revealed that the hen model was more closely associated with than the styrofoam block. The lowest proximity scores were obtained for individually reared birds in the presence of the styrofoam block. This suggests that even without prior social experience, the young chicks could discriminate between a hen model and styrofoam block and preferentially associate with the biologically more appropriate model. Also, individually reared birds in the presence of the hen had higher localization scores than socially reared subjects with or without the hen. This observation is in agreement with observations collected by Thompson and McElroy (1962). They demonstrated that maternal presence in rats seemed to reduce anxiety in mildly stressful situations.

General Discussion

The major purpose of the present studies was to determine the nature of the responses emitted by a young chick or groups of chicks in the presence of age-mate distress and/or contentment vocalizations. To this end, an effort was made to determine and analyse the frequency of distress vocalizations, contentment vocalizations, pecking, and orientation away responses, in addition to, collecting start and run latency data on chicks in a straight runway. The activity level, proximity to a hen model, and localization of the sound source were also determined for birds observed in an open field in the presence of conspecific vocalizations. The present findings clearly demonstrate that young chicks do respond differentially to age-mate, conspecific distress and contentment vocalizations. The experimental designs employed partially influenced the trend of the responses to the vocalizations. By varying exposure duration and qualitative stimulus experience, a variety of vocalization effects, age effects, and rearing effects were revealed.

Vocalization Effects

Clearly, the presence of conspecific vocalizations differentially influenced the behavior of neonatal chicks. It was determined that young chicks approach contentment vocalizations more readily than distress vocalizations (Experiment 1) and that more locomotor activity is observed in the presence of contentment vocalization stimulation, relative to distress vocalization stimulation and no auditory stimulation (Experiment 4). Similarly, a trend suggesting that neonatal chicks approach contentment vocalizations more rapidly than distress vocalizations was revealed in a successive choice situation (Experiment 2). The absence of a vocalization effect in Experiment 3 may largely be attributed to the brief duration of exposure to the vocalization stimulation in this cross-sectional analysis.

Contentment calls appear to influence chick behavior by generally increasing exploratory activity. This effect may be partially accounted for by: (a) the acoustically attractive characteristics of contentment vocalizations (after Collias & Joos, 1953) and/or (b) the information content (signal value) of contentment vocalizations. It is suggested that the presence of same-age conspecific contentment vocalizations in a novel situation may produce a reduction in fear or emotionality in young chicks. That is, by virtue of the presence of contentment vocalizations, relative "safety" may be perceived in an unfamiliar environment and exploratory behaviors may ensue. Partial confirmation of this suggestion may be found in the trend revealed in Experiment 2 which suggested that more orientation away responses occurred in the presence of contentment vocalizations than in the presence of distress vocalizations. It is considered unlikely that a young chick would not orient to the source of information of potentially threatening stimuli.

The reception of conspecific distress calls, on the other hand, appears to produce exploratory locomotor activity deficits relative to contentment vocalization stimulation. Similarly, it is speculated that: (a) the relative lack of acoustically attractive features of distress calls and/or (b) the information content of distress vocalizations produces decrements in general activity in young chicks. It is suggested that the presence of distress vocalizations in a novel environment produces a sufficient level of arousal in young chicks which may be observed in the form of "cautionary" exploratory behaviors. An arousal interpretation of the responses of chicks to distress vocalizations must be cautiously employed, however, since appropriate physiological correlates of arousal were not monitored in these investigations. In this context, it is important to note that active avoidance responses were never noted in the presence of distress vocalizations.

More distress calls were emitted in the presence of distress vocalization stimulation than in the presence of contentment vocalizations in Experiment 1. This is interesting in light of the observation that contentment vocalizations were not noted to reliably increase in the presence of either variety of auditory stimulation. In natural situations, chorusing of distress vocalizations may minimize the chances that any particular individual will be localized by a predator. The weakness in this interpretation, however, lies in the possibility that appropriate parental figures may also experience difficulty in localizing "distressed" individuals. The evolution and maintenance of contentment vocalizations in young chicks is generally difficult to explain. The emission of contentment vocalizations may have only a self communicative function rather than a conspecific communicative function. That is, the emission of contentment vocalizations may simply function to increase the probability of performance of a response which produced the stimulation which, in turn, facilitated the occurrence of the contentment vocalizations (after Andrew, 1969). Alternatively, it is quite possible that contentment vocalizations are effective in the regulation of the behavior of parental figures.

Finally, with regard to the vocalization effects obtained in the runway studies it is important to note: (a) that rapid approach responses (i.e., combined start and run latency values $\leq$ 30 sec) to either variety of auditory stimulation were never obtained, and (b) the execution of all behaviors occurred against a backdrop of fairly high levels of distress calling. The lack of rapid approach responses may be attributed to the lack of movement of the stimulus bird (after Hoffman, Stratton, Newby, & Barrett, 1970; Lampros, 1976; Sigman, Lovern, & Schulman, in press).

Age Effects

Approach responses did not become faster and activity scores did not become higher over the first several days of post-hatch life. Rather peaks in most forms of activity were noted on Day 2, and in some cases Day 1. For example, responses which peaked on Day 2 include: distress calling, pecking, orientation away responses, and run times (Experiment 2), activity scores in the presence of distress and contentment vocalizations (Experiment 4), and a trend in pecking (Experiment 1). Responses which peaked on Day 1 include: distress calling (Experiment 1), contentment calling and pecking (Experiment 3), and localization score (Experiment 4). The high frequencies of emission of some of these behavioral responses clearly indicates that young domestic chicks are capable of a fairly high degree of coordinated activity within one day of hatching. Perhaps, much of the activity which was noted in the Day 1 and 2 birds was exploratory in nature and declined with increasing familiarity of the experimental apparatus and procedures. Casual observation suggests that the relative decline in overall activity which was noted in older birds cannot be attributed to an increase in freezing responses. Further Candland and Nagy (1969) have suggested that while high levels of activity or exploration are generally considered to reflect low levels of emotionality, it can be inappropriate to conclude that age-related decreases in activity with repeated testing reflects an increase in emotionality.

Rearing Effects

One of the most striking features of Experiment 3 and 4 is the finding that isolate reared birds are generally more responsive to environmental stimuli than socially reared birds. Birds reared in social isolation: (a) exhibited lower start and run latencies and emitted more distress vocalizations, more contentment vocalizations, more pecking responses, and more orientation away responses (Experiment 3) and (b) had higher activity scores and a trend toward higher localization scores (Experiment 4). These findings are in agreement with previously reported data concerning the effects of isolate vs. social rearing conditions (e.g., Zajonc, Wilson, & Rajecki, 1975; Keenan, 1972). Explanations offered earlier in this paper probably contribute to some degree to this phenomenon. That is, socially reared birds were probably imprinted on one another (after Guiton, 1959) and/or were perhaps more sensitive to the artificiality of the experimental conditions. Isolate reared birds were, however, more responsive to the experimental stimuli by virtue of their lack of experience with appropriate social stimulation.

Summary and Conclusions

The present series of studies investigated the responses of young domestic chicks to same-age, conspecific vocalizations. Chicks were exposed to distress and/or contentment vocalizations over the first several days of post-hatch life in either a straight runway (dependent measures - start and run latencies, distress calls, contentment calls, orientation away responses, and pecking responses) or an open field (dependent measures - activity scores, proximity to a hen model score, and localization of the source of auditory stimulation score). It was concluded that:

1. Neonatal chicks are capable of emitting differential approach responses to conspecific distress and contentment vocalizations. Similarly, differential activity scores were obtained for birds exposed to distress vocalizations, contentment vocalizations, and no auditory stimulation.

2. Neither approach responses, additional behavioral measures, nor activity measures varied monotonically with the age of the birds at testing.

3. Rearing conditions (isolate vs. social) exert a profound effect on neonatal chick responsivity patterns to conspecific distress and contentment vocalizations. Isolate reared birds generally engaged in a much higher level of activity than socially reared birds.

4. The four experimental designs employed in this investigation definitely influenced the trend of responsiveness to the auditory stimulation. Generally contentment vocalizations were approached more rapidly or were associated with higher activity levels than distress vocalizations, however.

5. Contentment vocalizations may influence chick behavior by virtue of the information content of the call and the acoustic characteristics of the call. It was speculated that the reception of contentment vocalization stimulation may indicate relative "safety" in a given environment.

6. Distress vocalizations may, on the other hand, signal moderate arousal and produce "cautionary" behavior patterns in young chicks receiving this variety of auditory stimulation.

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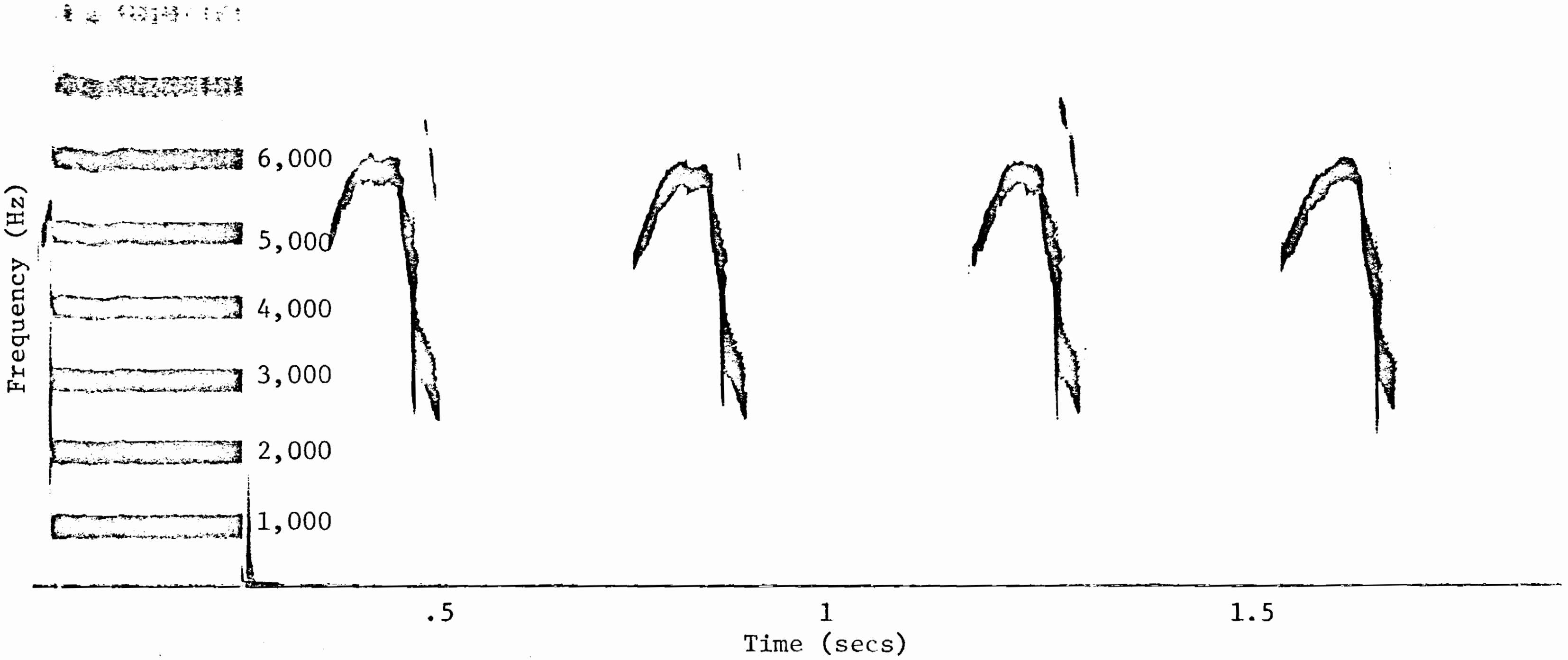
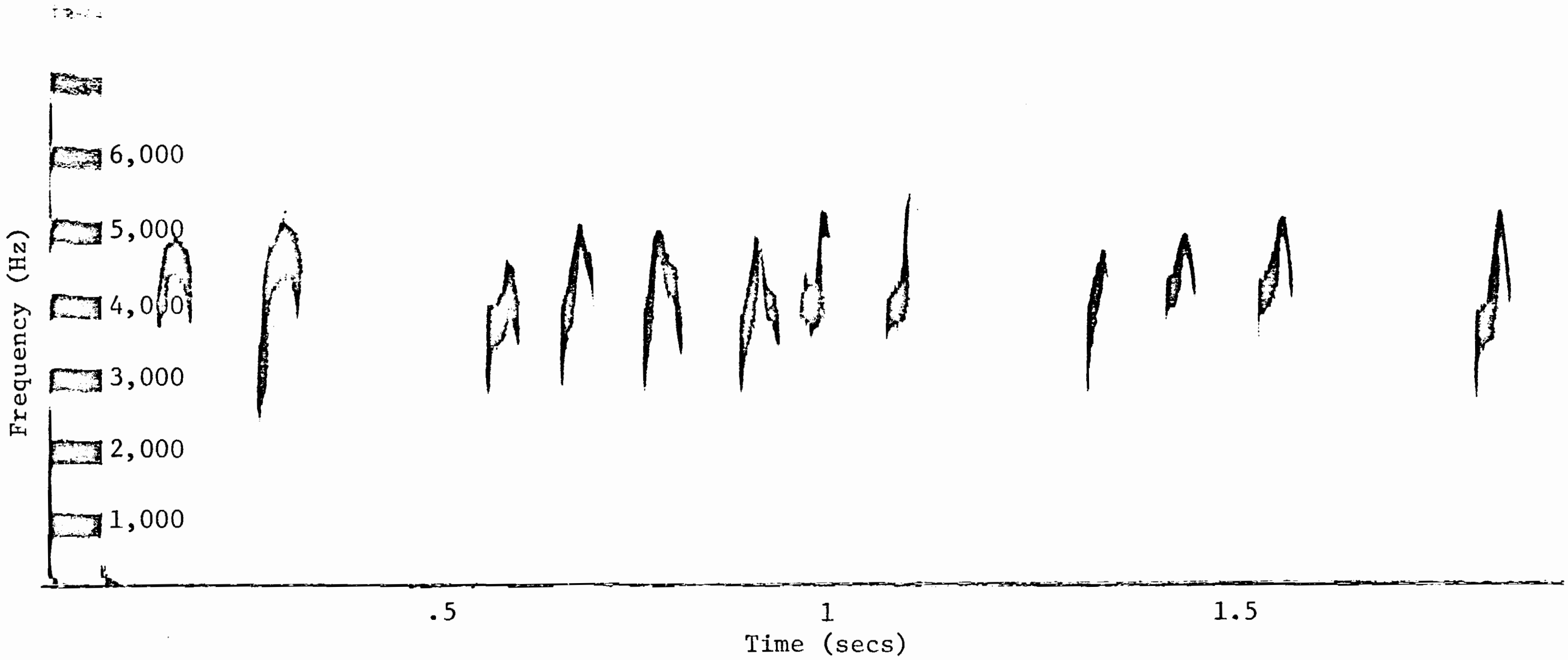
APPENDICES



APPENDIX A: Sonagram of the Distress Vocalization.



APPENDIX B: Sonagram of the Contentment Vocalization

APPENDIX C

Analysis of Variance on Mean Median Start Latency Data for Experiment 1

Source	df	SS	MS	F
Vocalization	1	1671.50	1671.50	0.68
S (Vocalization)(Error)	22	53954.00	2452.45	
Days	3	6099.28	2033.09	3.64**
Vocalization x Days	3	2003.53	667.84	1.20
Days x S (Vocalization)(Error)	66	36828.70	558.01	
Total	95	100557.00	1058.49	

**$p \leq 0.01$

APPENDIX D

Analysis of Variance on Mean Median Start Latency Data for the Replication of Experiment 1

Source	df	SS	MS	F
Vocalization	1	14464.37	14464.37	4.68*
S (Vocalization)(Error)	22	68064.15	3093.83	
Days	3	14968.70	4989.56	5.40**
Vocalization x Days	3	3759.17	1253.05	1.36
Days x S (Vocalization)(Error)	66	60970.19	923.79	
Total	95	16226.60	1707.65	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX E

Analysis of Variance on Mean Median Start Latency Data for Experiment 1 and the Replication of Experiment 1

Source	df	SS	MS	F
Replication	1	10182.97	10182.97	3.67+
Vocalization	1	12984.97	12984.97	4.68*
S (Replication x Vocalization) (Error)	44	122018.14	2273.14	
Days	3	19827.66	19827.66	8.29**
Replication x Vocalization	1	3150.90	3150.90	1.14
Replication x Days	3	1240.33	413.44	0.56
Vocalization x Days	3	3523.27	1174.42	1.59
Replication x Vocalization x Days	3	2239.43	746.90	1.01
Days x S (Replication x Vocalization) (Error)	132	97798.89	740.90	
Total	191	272966.57	1429.14	

+$p \leq 0.10$
*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX F

Analysis of Variance on Mean Median Start Latency Data for the Combination of Experiment 1 and its Replication

Source	*df*	SS	MS	*F*
Vocalization	1	12984.97	12984.97	4.41*
S (Vocalization)(Error)	46	135352.02	2942.43	
Days	3	19827.66	6609.22	9.01**
Vocalization x Days	3	3523.27	1174.42	1.60
Days x *S* (Vocalization)(Error)	138	101278.65	733.90	
Total	191	272966.57	1429.14	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX G

Analysis of Variance on Mean Median Run Latency Data for Experiment 1

Source	*df*	SS	MS	*F*
Vocalization	1	13258.23	13258.23	3.88+
S (Vocalization)(Error)	22	75229.64	3419.53	
Days	3	12386.17	4128.72	3.43*
Days x *S* (Vocalization)(Error)	66	79355.15	1202.35	
Total	95	181821.92	1913.91	

*$p \leq 0.05$
+$p \leq 0.10$

APPENDIX H

Analysis of Variance on Mean Median Run Latency Data for the Replication of Experiment 1

Source	*df*	SS	MS	*F*
Vocalization	1	8016.15	8016.15	3.00+
S (Vocalization)(Error)	22	58843.84	2674.72	
Days	3	1248.28	416.09	0.65
Vocalization x Days	3	2069.37	689.79	1.08
Days x *S* (Vocalization)(Error)	66	42103.90	637.94	
Total	95	112281.53	1181.91	

+$p \leq 0.10$

APPENDIX I

Analysis of Variance on Mean Median Run Latency Data for the Combination of Experiment 1 and the Replication of Experiment 1

Source	*df*	SS	MS	*F*
Replication	1	33202.17	33202.17	10.88**
Vocalization	1	21790.33	21790.17	7.14**
S (Replication x Vocalization) (Error)	44	134302.36	3052.32	
Days	3	10530.45	3510.15	3.76**
Replication x Vocalization	1	440.86	440.86	0.14
Replication x Days	3	4211.52	1403.84	1.50
Vocalization x Days	3	1180.71	393.57	0.42
Replication x Vocalization x Days	3	2281.99	760.66	0.82
Days x *S* (Replication x Vocalization)(Error)	132	123130.25	932.80	
Total	191	331070.64	1733.35	

**$p \leq 0.01$

APPENDIX J

Analysis of Variance on the Distress Vocalization Score Data for Experiment 1

Source	df	SS	MS	F
Vocalization	1	3060.04	3060.04	5.49*
S (Vocalization)(Error)	22	12256.42	557.11	
Days	3	1539.87	513.29	8.42**
Vocalization x Days	3	418.87	139.62	2.29+
Days x S (Vocalization)(Error)	66	4025.75	60.99	
Total	95	21300.96	224.22	

+$p \leq 0.10$
*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX K

Analysis of Variance on the Contentment Vocalization Score Data for Experiment 1

Source	df	SS	MS	F
Vocalization	1	137.76	137.76	0.69
S (Vocalization)(Error)	22	4364.23	198.37	
Days	3	172.19	57.39	0.95
Vocalization x Days	3	298.03	99.34	1.65
Days x S (Vocalization)(Error)	66	3971.52	60.17	
Total	95	8943.74	94.14	

APPENDIX L

Analysis of Variance on the Pecking Score Data for Experiment 1

Source	*df*	SS	MS	*F*
Vocalization	1	155.04	155.04	0.97
S (Vocalization)(Error)	22	3506.42	159.38	
Days	3	444.46	148.15	2.30+
Vocalization x Days	3	92.13	30.71	0.48
Days x *S* (Vocalization)(Error)	66	4259.92	64.54	
Total	95	8497.96	89.03	

+$p \leq 0.10$

APPENDIX M

Analysis of Variance on the Orientation Away Score Data for Experiment 1

Source	_df_	SS	MS	_F_
Vocalization	1	70.04	70.04	0.38
_S_ (Vocalization)(Error)	22	4058.96	184.49	
Days	3	190.58	63.53	1.24
Vocalization x Days	3	118.21	39.40	0.77
Days x _S_ (Vocalization)(Error)	66	3372.21	51.09	
Total	95	7810.00	82.21	

APPENDIX N

Analysis of Variance on Mean Median Start Latency Data for Experiment 2

Source	df	SS	MS	F
Light	1	1501.19	1501.19	0.50
S (Light)(Error)	22	65816.81	2991.67	
Vocalization	1	1526.24	1526.24	1.71
Light x Vocalization	1	83.70	83.70	0.09
Vocalization x S (Light)(Error)	22	19683.13	298.23	
Days	3	42219.04	14073.01	9.64**
Light x Days	3	2315.11	771.70	0.53
Days x S (Light)(Error)	66	96324.17	4378.37	
Vocalization x Days	3	1544.83	514.94	0.67
Light x Vocalization x Days	3	3308.32	1102.77	1.43
Vocalization x Days x S (Light)(Error)	66	51075.42	773.87	
Total	191	285397.97	1494.23	

$^{**}p \leq 0.01$

APPENDIX O

Analysis of Variance on Mean Median Run Latency Data for Experiment 2

Source	*df*	SS	MS	*F*
Light	1	2842.38	2842.38	0.34
S (Light)(Error)	22	185107.69	8413.99	
Vocalization	1	2254.06	2254.06	3.15+
Light x Vocalization	1	2385.30	2385.30	3.33+
Vocalization x *S* (Light)(Error)	22	15750.01	715.91	
Days	3	3556.41	1185.47	0.57
Light x Days	3	3831.44	1277.15	0.61
Days x *S* (light)(Error)	66	137799.42	2087.87	
Vocalization x Days	3	806.64	268.88	0.34
Light x Vocalization x Days	3	2454.81	818.27	1.05
Vocalization x Days X *S* (Light)(Error)	66	51465.55	779.71	
Total	191	408253.71	2137.45	

+$p \leq 0.10$

APPENDIX P

Analysis of Variance on Mean Distress Vocalization Scores for Experiment 2

Source	df	SS	MS	F
Light	1	52.08	52.08	0.22
S (Light)(Error)	22	5239.65	238.17	
Vocalization	1	0.75	0.75	0.03
Light x Vocalization	1	111.02	111.02	4.34*
Vocalization x S (Light)(Error)	22	562.98	25.59	
Days	3	392.85	130.95	2.38+
Light x Days	3	223.13	74.38	1.35
Days x S (Light)(Error)	66	3630.27	55.00	
Vocalization x Days	3	56.79	18.93	0.91
Light x Vocalization x Days	3	105.35	35.12	1.70
Vocalization x Days x S (Light)(Error)	66	1366.10	20.70	
Total	191	11740.98	61.47	

$^*p \leq 0.05$
$^+p \leq 0.10$

APPENDIX Q

Analysis of Variance on Mean Contentment Vocalization Scores for Experiment 2

Source	*df*	SS	MS	*F*
Light	1	336.02	336.02	3.15+
S (Light)(Error)	22	2348.15	106.73	
Vocalization	1	3.00	3.00	0.12
Light x Vocalization	1	6.02	6.02	0.23
Vocalization x *S* (Light)(Error)	22	573.73	26.08	
Days	3	23.71	7.90	0.24
Light x Days	3	77.94	25.98	0.79
Days x *S* (Light)(Error)	66	2163.10	32.77	
Vocalization x Days	3	58.04	19.35	0.88
Light x Vocalization x Days	3	153.85	51.28	2.34+
Vocalization x Days x *S* (Light)(Error)	66	1448.35	21.94	
Total	191	7191.92	37.65	

+$p \leq 0.10$

APPENDIX R

Analysis of Variance on Mean Pecking Scores for Experiment 2

Source	*df*	SS	MS	*F*
Light	1	112.55	112.55	1.60
S (Light)(Error)	22	1543.10	70.14	
Vocalization	1	131.67	131.67	3.33+
Light x Vocalization	1	1.17	1.17	0.03
Vocalization x *S* (Light)(Error)	22	870.78	39.58	
Days	3	421.43	140.48	4.13**
Light x Days	3	122.81	40.94	1.20
Days x *S* (Light)(Error)	66	2245.14	34.02	
Vocalization x Days	3	28.10	9.37	0.81
Light x Vocalization x Days	3	36.02	12.00	1.04
Vocalization x Days x *S* (Light)(Error	66	758.76	11.50	
Total	191	6271.50	32.84	

+$p \leq 0.10$
**$p \leq 0.01$

APPENDIX S

Analysis of Variance on Mean Orientation Away Scores for Experiment 2

Source	*df*	SS	MS	*F*
Light	1	290.08	290.08	2.06
S (Light)(Error)	22	3105.15	141.15	
Vocalization	1	72.52	72.52	3.35+
Light x Vocalization	1	8.33	8.33	0.39
Vocalization x *S* (Light)(Error)	22	476.15	21.64	
Days	3	482.73	160.91	5.04**
Light x Days	3	118.83	39.61	1.24
Days x *S* (Light)(Error)	66	2106.44	31.92	
Vocalization x Days	3	59.39	19.79	0.79
Light x Vocalization x Days	3	169.08	56.36	2.24
Vocalization x Days x *S* (Light)(Error)	66	1659.52	25.14	
Total	191	8548.31	44.75	

+$p \leq 0.10$
**$p \leq 0.01$

APPENDIX T

Analysis of Variance on Mean Median Start Latency Data for Experiment 3

Source	*df*	SS	MS	*F*
Vocalization	1	143.27	143.27	0.08
Rearing	1	68373.56	68373.56	36.40**
Running	1	1.26	1.26	0.00
Days	1	4502.17	4502.17	2.40
Vocalization x Rearing	1	1196.40	1196.40	0.64
Vocalization x Running	1	12.79	12.79	0.01
Vocalization x Days	1	3431.38	3431.38	1.83
Rearing x Running	1	481.21	481.21	0.26
Rearing x Days	1	1228.77	1228.77	0.65
Running x Days	1	16.31	16.31	0.01
Vocalization x Rearing x Running	1	3442.38	3442.38	1.83
Vocalization x Rearing x Days	1	493.25	493.25	0.26
Rearing x Running x Days	1	18.53	18.53	0.01
Vocalization x Running x Days	1	0.11	0.11	0.00
Vocalization x Rearing x Running x Days	1	257.33	257.33	0.14
Error	176	330625.38	1878.55	
Total	191	414224.13	2168.71	

**$p \leq 0.01$

APPENDIX U

Analysis of Variance on Mean Median Run Latency Data for Experiment 3

Source	df	SS	MS	F
Vocalization	1	72.49	72.49	0.07
Rearing	1	10754.75	10754.75	10.00**
Running	1	283.63	283.63	0.26
Days	1	76.73	76.73	0.07
Vocalization x Rearing	1	558.42	558.42	0.52
Vocalization x Running	1	608.40	608.40	0.57
Vocalization x Days	1	812.30	812.30	0.76
Rearing x Running	1	19.39	19.39	0.02
Rearing x Days	1	3.58	3.58	0.00
Running x Days	1	5368.50	5368.50	4.99*
Vocalization x Rearing x Running	1	3082.89	3082.89	2.87+
Vocalization x Running x Days	1	11.62	11.62	0.01
Rearing x Running x Days	1	173.58	173.58	0.16
Vocalization x Rearing x Days	1	927.96	927.96	0.86
Vocalization x Rearing x Running x Days	1	438.93	438.93	0.41
Error	176	189253.04	1075.30	
Total	191	212446.24	1112.28	

+$p \leq 0.10$
*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX V

Analysis of Variance on Distress Vocalization Score Data for Experiment 3

Source	*df*	SS	MS	*F*
Vocalization	1	302.51	302.51	2.31
Rearing	1	59.63	59.63	0.46
Running	1	5472.01	5472.01	41.76**
Days	1	210.42	210.42	1.61
Vocalization x Rearing	1	447.13	447.13	3.41+
Vocalization x Running	1	86.67	86.67	0.66
Vocalization x Days	1	1.88	1.88	0.01
Rearing x Running	1	159.51	159.51	1.22
Rearing x Days	1	26.26	26.26	0.20
Running x Days	1	131.67	131.67	1.00
Vocalization x Rearing x Running	1	18.13	18.13	0.14
Vocalization x Rearing x Days	1	47.01	47.01	0.36
Vocalization x Running x Days	1	15.75	15.75	0.12
Rearing x Running x Days	1	5.67	5.67	0.04
Vocalization x Rearing x Running x Days	1	51.05	51.05	0.39
Error	176	23062.42	131.04	
Total	191	30097.70	157.58	

$^{+}p \leq 0.10$
$^{**}p \leq 0.01$

APPENDIX W

Analysis of Variance on Contentment Vocalization Score Data for Experiment 3

Source	df	SS	MS	F
Vocalization	1	9.19	9.19	0.18
Rearing	1	1408.33	1408.33	27.39**
Running	1	36.75	36.75	0.71
Days	1	560.33	560.33	10.90**
Vocalization x Rearing	1	75.00	75.00	1.46
Vocalization x Running	1	280.33	280.33	5.45*
Vocalization x Days	1	3.00	3.00	0.06
Rearing x Running	1	204.19	204.19	3.97*
Rearing x Days	1	3.52	3.52	0.07
Running x Days	1	17.52	17.52	0.34
Vocalization x Rearing x Running	1	111.42	111.42	2.16
Vocalization x Running x Days	1	42.19	42.19	0.82
Vocalization x Rearing x Days	1	72.52	72.52	1.41
Rearing x Running x Days	1	30.08	30.08	0.59
Vocalization x Rearing x Running x Days	1	0.33	0.33	0.01
Error	176	9049.16	51.42	
Total	191	11903.48	247.99	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX X

Analysis of Variance on the Pecking Score

Data for Experiment 3

Source	df	SS	MS	F
Vocalization	1	111.02	111.02	2.63
Rearing	1	1291.69	1291.69	30.62**
Running	1	2422.52	2422.52	57.43**
Days	1	229.68	229.68	5.45*
Vocalization x Rearing	1	5.33	5.33	0.13
Vocalization x Running	1	16.33	16.33	0.39
Vocalization x Days	1	0.97	0.97	0.00
Rearing x Running	1	154.08	154.08	3.65*
Rearing x Days	1	75.00	75.00	1.78
Running x Days	1	6.75	6.75	0.16
Vocalization x Rearing x Running	1	1.02	1.02	0.02
Vocalization x Rearing x Days	1	28.52	28.52	0.68
Vocalization x Running x Days	1	1.02	1.02	0.02
Rearing x Running x Days	1	46.02	46.02	1.09
Vocalization x Rearing x Running x Days	1	14.08	14.08	0.33
Error	176	7424.16	42.18	
Total	191	11827.25	61.92	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX Y

Analysis of Variance on Orientation Away Score Data for Experiment 3

Source	df	SS	MS	F
Vocalization	1	33.34	33.34	0.60
Rearing	1	346.69	346.69	6.26**
Running	1	2214.08	2214.08	39.97**
Days	1	44.08	44.08	0.80
Vocalization x Rearing	1	3.00	3.00	0.05
Vocalization x Running	1	35.02	35.02	0.63
Vocalization x Days	1	6.02	6.02	0.11
Rearing x Running	1	208.33	208.33	3.76*
Rearing x Days	1	44.08	44.08	0.80
Running x Days	1	20.02	20.02	0.36
Vocalization x Rearing x Running	1	13.02	13.02	0.24
Vocalization x Rearing x Days	1	2.52	2.52	0.05
Vocalization x Running x Days	1	481.33	481.33	8.69**
Rearing x Running x Days	1	38.52	38.52	0.70
Vocalization x Rearing x Running x Days	1	36.75	36.75	0.66
Error	176	9750.16	55.39	
Total	191	13276.98	69.51	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX Z

Analysis of Variance on the Activity Score Data for Experiment 4

Source	df	SS	MS	F
Rearing	1	3007.33	3007.33	11.28**
S (Rearing)(Error)	58	15460.42	266.55	
Hen	1	6.27	6.27	0.13
Rearing x Hen	1	64.60	64.60	1.35
Hen x S (Rearing)(Error)	58	2779.34	47.92	
Day	3	1568.37	522.79	7.65**
Rearing x Day	3	523.51	174.50	2.55*
Day x S (Rearing)(Error)	174	11885.41	68.31	
Vocalization	2	527.42	263.71	18.81**
Rearing x Vocalization	2	1.90	0.95	0.07
Vocalization x S (Rearing) (Error)	116	1626.59	14.02	
Hen x Day	3	449.67	149.89	3.85**
Rearing x Hen x Day	3	50.54	16.85	0.43
Hen x Day x S (Rearing)(Error)	174	6776.07	38.94	
Hen x Vocalization	2	17.48	8.74	0.76
Rearing x Hen x Vocalization	2	14.07	7.03	0.61
Hen x Vocalization x S (Rearing)(Error)	116	1338.86	11.54	
Day x Vocalization	6	159.02	26.50	2.27*
Rearing x Day x Vocalization	6	113.89	18.98	1.56
Day x Vocalization x S (Rearing)(Error)	348	4056.18	11.65	
Hen x Day x Vocalization	6	113.89	18.98	1.56
Rearing x Hen x Day x Vocalization	6	74.41	12.40	1.02
Hen x Day x Vocalization x S (Rearing)(Error)	348	4223.27	12.13	
Total	1439	54911.55	38.16	

*$p \leq 0.05$
**$p \leq 0.01$

APPENDIX AA

Analysis of Variance on the Proximity Score Data for Experiment 4

Source	*df*	SS	MS	*F*
Rearing	1	7649.83	7649.83	7.68**
S (Rearing)(Error)	58	57743.11	995.57	
Hen	1	2730.75	2730.75	5.79**
Rearing x Hen	1	6138.00	6138.00	13.02**
Hen x *S* (Rearing)(Error)	58	27342.94	471.43	
Day	3	22904.68	7634.89	11.71**
Rearing x Day	3	12979.21	4326.40	6.64**
Day x *S* (Rearing)(Error)	174	113422.06	651.85	
Vocalization	2	1968.67	984.33	9.49**
Rearing x Vocalization	2	571.48	285.74	2.75+
Vocalization x *S* (Rearing) (Error)	116	12031.51	103.72	
Hen x Day	3	2826.44	942.15	1.72
Rearing x Hen x Day	3	2187.79	729.26	1.33
Hen x Day x *S* (Rearing) (Error)	174	95189.56	547.06	
Hen x Vocalization	2	433.75	216.87	2.64+
Rearing x Hen x Vocalization	2	273.80	136.90	1.67
Hen x Vocalization x *S* (Rearing)(Error)	116	9533.11	82.18	
Day x Vocalization	6	2916.38	486.06	4.32**
Rearing x Day x Vocalization	6	2345.15	390.85	3.47**
Day x Vocalization x *S* (Rearing)(Error)	348	39154.13	112.51	
Hen x Day x Vocalization	6	979.82	163.30	1.40
Rearing x Hen x Day x Vocalization	6	502.57	83.76	0.72
Hen x Day x Vocalization x *S* (Rearing)(Error)	348	40724.94	117.02	
Total	1439	462549.73	321.44	

+$p \leq 0.10$
**$p \leq 0.01$

THE RESPONSIVITY OF NEONATAL CHICKS TO CONSPECIFIC DISTRESS AND CONTENTMENT VOCALIZATIONS

by

Elizabeth D. Robinson-Guy

(ABSTRACT)

Four experiments were performed to investigate the responses of neonatal chicks in either a straight runway or an open-field to same-age, conspecific distress and contentment vocalizations over the first several days of post-hatch life. Three hundred forty-eight White Leghorn chicks from either a sample of the Cornell Randombred or Athens Canadian x Cornell Randombred population were tested at 24, 48, 72, 96, and/or 144 hours of age. The effects of intermittent light (Experiment 2) and rearing conditions (Experiments 3 and 4) on chick responsivity to conspecific vocalizations were also examined. The results indicated that contentment vocalization stimulation produced lower approach latencies and higher activity levels than distress vocalization stimulation. Moreover, many of the behavioral responses varied with the age of the birds, however, these relationships were seldom monotonic. In addition, individually reared chicks engaged in much higher levels of activity (lower approach latencies, more contentment peeping, more pecking and more orientation away responses) than socially reared birds. Patterns of behavior associated with the reception of conspecific vocalization stimulation were different from the patterns of behavior associated with the emission of these calls. Speculations concerning the communicative significance of domestic chick distress and contentment vocalizations were discussed.