

THE EFFECTS OF SOCIAL EXPERIENCE ON IMPRINTING
IN DIFFERENTIALLY HOUSED DOMESTIC CHICKS,
A MULTI-MEASURE APPROACH

by

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INTRODUCTION

One of the earliest anecdotes concerning the phenomenon of imprinting is that told by Pliny the Elder (27 A.D.), who writes in volume ten of his Naturalis Historia:

[Geese] may possibly be thought also to possess the power of understanding wisdom: thus there is a story that a goose attached itself continually as a companion to the philosopher Lacydes, never leaving his side by night or by day, either in public or at the baths.

Though it has yet to be documented that geese possess the ability to understand philosophical wisdom, there is certainly evidence that very young geese, or nidifugous birds in general, can form social attachments to individuals (humans included) not of their species. The first scientific investigation concerning this attachment process can properly be ascribed to Spalding (1954) who in his republished, 1873 article noted that newly hatched, domestic chicks will follow any moving object as soon as they are able to locomote. Spalding showed that if a chick is allowed to follow a human during its first few days, it will continue to do so for several weeks. Furthermore, the chick at this latter point can no longer be successfully returned to the hen.

Heinroth (1910), as cited by Lorenz (1935), showed that newly hatched goslings can indeed become attached to humans. The study of the social attachment process in young nidifugous birds expanded and became popularized as a result of the work of Lorenz. Lorenz (1935) referred to this attachment process as "imprinting." Based on his work with goslings and ducklings, Lorenz theorized that these birds "know" only a few characteristics of the "parent companion" at the time

of hatching. The imprinting process allows the young bird to rapidly learn additional characteristics of the parent companion which, besides resulting in attachment behavior to the parent companion, determines the species (which normally is the correct one) that the bird will later direct its sexual behavior toward.

The formation of the attachment supposedly necessitates exposure to the object during a restricted period of time, beginning at hatching and ending within two or three days. Lorenz referred to this period as the critical period. Subsequent research, however, has shown that the period during which such attachments may form can extend beyond a week (Fabricius, 1964; Sluckin, 1973). The term, sensitive period, being more neutral in connotation and less restrictive with regard to period duration has thus found favor in the general literature. Although, as Fabricius (1964) has pointed out, the term, critical period, can be used to refer to the period of "maximum imprintability" in nidifugous birds; the sensitive period, being the more inclusive term, can refer to that period where imprinting is at least possible.

It is somewhat surprising that though imprinting is by its nature a social phenomenon, the social environment that typifies the natural occurrence of imprinting has generally been ignored as a factor in a good portion of the literature. In such studies as Bateson (1964), Bateson and Jaekel (1974), Goodwin and Hess (1969), Graves and Siegel (1974), Kovach (1971), or Salzen and Meyer (1967), subjects are housed individually and are exposed individually to the stimulus or object of attachment. This is, of course, in direct contrast to what occurs in nature;

that is, the birds are naturally group reared and are exposed to each other and to the hen as a group.

Studies which have considered social factors in imprinting have utilized a variety of experimental designs and, not surprisingly, have yielded a rather heterogeneous array of results. Gottlieb and Klopfer (1962) reported that isolation housed ducklings show a preference for auditory stimulation during the first half of the sensitive period and a preference for visual stimulation during the latter half of the sensitive period. However, no such developmental pattern was evident for ducklings which were socially housed.

Polt and Hess (1964) found that when given two hours of social experience prior to being exposed to a vocalizing blue ball, isolation reared chicks show better following to the ball than do isolation reared chicks not given the social experience. The enhanced following was evident at 16 and 36 hours post-hatch. However, when tested a day later, the effect disappeared. Polt and Hess (1966) replicated the facilitative effect of the two-hour social experience on following behavior. Hess (1964) nonetheless felt that socialization lowers imprinting strength and that any enhancement in responding due to social experience is transient. Interestingly enough, Saegert and Rajecki (1973) found a similar, facilitative effect on approach to a novel object due to prior exposure to an artificial, animate object.

Klopfer (1959) found that ducklings already imprinted onto an experimenter could induce following in groups of untrained ducklings which otherwise would not follow the experimenter. Fabricius (1964) reported other similar instances of social facilitation. Fabricius also reported

instances of "social inhibition." In these cases, socialization with siblings supposedly led to an earlier loss of the following or approach response to novel stimuli. Like Hess, Fabricius shared the view that socialization has a negative effect on imprinting to novel objects. In fact, Fabricius postulated that socially reared, nidifigous birds imprint onto each other and that this sibling imprinting actually prevents further attachments to novel objects.

Hoffman (1968), using distress calling during stimulus withdrawals as a measure of imprinting, found that ducklings which were group trained during the imprinting experience did not differ from ducklings which were trained individually. All ducklings were isolation housed and tested individually. Hess and Hess (1969), utilizing approach behavior as a measure of imprinting, also found that ducklings which were group trained evidenced the same level of imprinting strength as did ducklings trained individually. Again, all ducklings were housed in isolation and tested individually.

Various studies using domestic chicks as their subjects have been concerned with two general classes of social manipulation. One, as in the aforementioned duckling studies, is that of introducing one or more conspecifics during the actual imprinting experience, which can be classified as a training manipulation. The other category is that of housing manipulations. Typically, the performance of isolation housed chicks is compared with that of socially housed chicks, where social housing refers to housing by groups of at least two.

In interpreting the following studies it is important to make the distinction between the training phase and the actual test of imprinting.

The training phase refers to that time period wherein the actual attachment process has presumedly taken place. It typically is within or at least overlaps with the critical period, and by definition is within the sensitive period. A problem that can occur is that of temporary approach or following behavior, or transient enhancement of such behavior (as in Polt and Hess, 1964), during the critical period. This period of maximal responsivity to novel objects (and also of maximal imprintability) is not well defined for the domestic chick. Although Jaynes (1957), as cited by Hess (1973), and Hess (1973) indicate that its upper limit is somewhere under three days post-hatch. It is apparent then that in order to demonstrate an imprinted attachment, it is necessary to test for it after the critical period, when such responding is likely to be more reliable.

This criterion for a test of imprinting has been emphasized by Fabricius (1964) and Sluckin (1973). Hess (1964) has also argued that responding during the critical period cannot be used as an index of imprinting strength.

It is not surprising then that Bateson and Jaekel (1974) found chicks' activity during training to be only weakly correlated with the strength of the tested preference for the familiar object. Zajonc, Markus, and Wilson (1974) have shown that imprinting is more gradual a process than once thought, and that repeated exposures to the object can affect, i.e., increase, the strength of the attachment. Taking these two studies together with the previous discussion, one has to be very careful in interpreting data derived from a one-shot exposure test during the first few days post-hatch.

James (1960), using a flickering light as the imprinting stimulus, found that isolation housed chicks imprinted more strongly than did socially housed chicks. All chicks were run individually during training and testing. These results are complicated, however, by the fact that for the first 48 hours post-hatch, all chicks were identically housed in a hatchery.

Graves and Siegel (1968) reported that at 24 hours post-hatch, isolation housed chicks exhibit shorter approach latencies than do socially housed chicks, during a brief exposure to an audio-visual stimulus. Bateson and Reese (1969), using an operant conditioning paradigm and a flashing light as the stimulus-reinforcer, found that isolation housed chicks reach criterion before socially housed chicks at 48 hours post-hatch. Neither of these two studies, however, due to reasons discussed above, can be taken as evidence that isolation housed chicks imprint more strongly than do socially housed chicks.

Guiton (1959) found that imprinted, socially housed chicks are less responsive to a model, which differs from the model they were trained with, than are isolation housed chicks. Chicks in the social group were not housed socially until after training. All chicks were trained and tested individually. Guiton concluded that socialization increases selectivity. Guiton also found that isolation housed chicks which were given 4-1/2 hours of social housing, in lieu of training with an imprinting model, later showed better following to a model than non-trained, isolation housed chicks not given any such experience.

Guiton (1961), using an audio-visual stimulus, found that isolation housed chicks showed the same level of imprinting strength as did socially

housed chicks, when chicks from both groups were trained and tested individually. However, social housing did not commence until 40 hours post-hatch which was after the first day of training. Guiton also trained some chicks in groups of five (though tested individually). Chicks trained alone evidenced stronger imprinting than chicks trained in groups. Guiton concluded that social interactions interfere with the imprinting process. He suggested that the relative ineffectiveness of the communal training was partly due to the chicks responding to each other and perhaps even imprinting onto each other. He also suggested that the ineffectiveness was partly due to the "low level of fear" in the chicks when assembled as a group; the assumption being that the level of fear would affect imprinting.

Using a rotating, black and white disc as the imprinting stimulus, Smith and Bird (1963a) found that isolation housed chicks which were trained in groups approach just as well as isolation housed chicks trained individually. On the other hand, socially housed chicks which were trained alone approached better than socially housed chicks trained in groups. Group trained chicks were not tested alone. Smith and Bird also found that isolation housed chicks develop a stronger approach response to the stimulus than do socially housed chicks. Smith and Bird concluded that socialization reduces responsiveness of chicks to a novel stimulus. This view was also shared by Salzen (1962) who proposed that socially reared chicks fear novel moving objects, and that this is so because of the discrepancy between their familiar moving objects, i.e., cagemates, and the novel moving object.

Many studies concerned with imprinting phenomena have paid attention only to the visual dimension (i.e., Bateson, 1964; Bateson and Jaeckel, 1974; Bateson and Reese, 1969; James, 1960; Saegert and Rajecki, 1973; Salzen and Meyer, 1967; Smith and Bird, 1963a). However, auditory stimuli play an important role in eliciting initial approach responses or in imprinting itself (Gottlieb, 1963; Gottlieb and Klopfer, 1962; Sigman and Schulman, 1976; Griesemer, Jankowitz, and Sigman, Note 1). Gottlieb (1965) has even shown that there is a strong preference for the parental call of the ducklings' or chick's own species. Furthermore, Hess (1973), in reference to studies by Porter and Stettner (1968), points out that vocalizing model is more effective than a silent model in eliciting attachment behavior in quail chicks. Smith and Bird (1963b, 1964) have shown that an audio-visual stimulus is more effective than either component alone in eliciting and sustaining approach behavior in domestic chicks.

Smith and Bird (1964) hypothesized that the inferior responding of socially housed chicks, as compared to isolation housed chicks, in Smith and Bird (1963a) might be improved with a more attractive imprinting stimulus, i.e., an audio-visual stimulus. They also suggested that a more attractive stimulus would overcome the releasing stimulation produced among groups of socially housed chicks. Smith and Bird (1964) did indeed find that, when using an audio-visual stimulus, socially housed chicks do not show lowered responsivity as compared to isolation housed chicks. However, Smith and Bird also found that the greater the number of chicks trained together, the lower the responsiveness of the individuals in the group to the stimulus.

The results of Guiton (1961) and Smith and Bird (1964) indicate that observed superiority in responding of isolation housed chicks over socially housed chicks can, in many cases, be attributed to an inadequate imprinting stimulus, i.e., a visual-only stimulus. This indeed could easily account for the previously discussed results of James (1960), Smith and Bird (1963a), and Bateson and Reese (1969).

More recently, Schulman, Rimpau, and Lythgoe (in press) have examined the effects of social experience on imprinting using two measures of imprinting strength: approach latencies during acquisition and approach latencies during extinction. The terms "acquisition" and "extinction," as used in the study, are similar to their learning analogs in that they refer to conditions of stimulus presence and stimulus absence, respectively, where the imprinting stimulus is seen as a reinforcer of the instrumental, approach response. Using a vocalizing, bobbing-bird model, Schulman et al. found that isolation housed chicks, which were trained and tested individually, did not differ during acquisition from socially housed chicks, which were trained in pairs and tested individually. However, the social chicks displayed stronger resistance to extinction than did the isolate chicks; that is, social chicks were more persistent in approaching the empty goal box than were isolate chicks. Schulman et al. concluded that social experience with siblings strengthens imprinting.

In an attempt to further define the results of Schulman et al., Rimpau (Note 2), in an extended replication, added two more groups to the experimental design: isolate chicks trained in pairs and social chicks trained individually. Thus two crossed factors were defined: housing and training. Rimpau found that isolates approached more quickly

than social chicks during the training phase. However, at the time of testing, when all chicks were run individually, there were no differences between groups on run speeds. During stimulus absence, isolates which were trained alone displayed greater resistance to extinction than isolates trained in pairs. On the other hand, social chicks which were trained in pairs displayed slightly greater resistance to extinction than social chicks trained alone. Most important, however, was the replicated finding that socially housed chicks display stronger resistance to extinction than chicks housed in social isolation (where resistance to extinction is defined in terms of approach latencies).

It appears then that when using an audio-visual stimulus, socially housed chicks perform just as well as isolation housed chicks during a test for imprinting, when the stimulus-object is present. When the audio-visual stimulus is then removed, socially housed chicks appear to show greater appetitive behavior than isolation housed chicks.

One of the purposes of the present study is to incorporate three measures of imprinting into the same study. As was previously discussed, a test for strength of attachment comes after a training phase, and it should occur after the third day post-hatch. One measure of imprinting strength utilized in the present study is that of approach latency, with the stimulus-object present, on Day 5 post-hatch. This is, of course, a traditional measure of imprinting strength. A second measure utilized in the present study is that of approach latency, where the stimulus has been removed, on Day 6 post-hatch. Thus stimulus conditions differ for the first two measures of strength of attachment.

Hinde (1961) pointed out that imprinted birds display search behavior and distress calling when the object of attachment is removed, whereas non-imprinted birds do not. Search behavior could operationally be defined as approach to an empty goal box, which had contained an object on previous trials. Approach behavior, under the condition of stimulus removal, has been shown to be rather sensitive to differences not found during stimulus presence, as evidenced by Schulman et al. and Rimpau, and also by Schulman and Roehling (1974); thus, its inclusion in the present study.

Hinde was not alone in noting that imprinted birds distress call, when the object of attachment is withdrawn or missing. Bermant (1963) housed domestic chicks with actual hens. He noted that the chick's distress calling increased when they could hear but not see the hen. They distress called at an even higher level when they could neither see nor hear the hen. In observing feral, domestic chicks in their natural environment, McBride, Parer, and Foenander (1969) noted that chicks emitted loud distress calls when accidentally separated from their brood and the hen. In the previously discussed study by Schulman et al., acute distress calling during extinction was observed. Hoffman (1968) used distress calling during stimulus removal as an index of imprinting strength for ducklings. Zajonc, Markus, and Wilson (1974) used distress calling as an index of imprinting strength for domestic chicks and strongly recommended its usage. Distress calling is thus included as the third measure of imprinted attachment in the present. It should be noted that distress calling provides a measure of imprinted attachment which is independent of the two approach measures.

Another purpose of the present study is to covary housing and training conditions and to determine their effects on imprinting, where the object of attachment contains both auditory and visual components. The few investigators who compared isolate and social chicks, trained in pairs or groups, trained their isolates with other isolates and social chicks with other social chicks. Pairs or groups are treated as subject-units during training, although chicks are typically run individually during testing. There is a confound inherent in such designs. Isolates and social chicks do not have the same social training experience. This confound is eliminated in the present study. The subject at all times is the individual chick and, independent of its housing condition, is trained either alone, with an isolation housed conspecific, or with a socially housed conspecific. It cannot be overemphasized that training with an isolate conspecific might be very different from training with a social conspecific. Sigman, Lovern, and Schulman (1978) have shown that both isolation and socially housed chicks can discriminate between other isolation and socially housed chicks, and both will approach a socially housed, target chick significantly more than an isolation housed, target chick in a two-choice task.

The present study, therefore, asks these four questions:

- (1) Given that an audio-visual stimulus is used, do socially housed chicks imprint at least as well as isolation housed chicks?
- (2) Do chicks trained with an isolation housed conspecific differ from chicks trained alone in terms of imprinting strength?

- (3) Do chicks trained with a socially housed conspecific differ from chicks trained alone?
- (4) Do chicks trained with a socially housed conspecific differ from chicks trained with an isolation housed conspecific?

METHODS

Subjects

Non-incubated, Canadian Athens random-bred chicken eggs were obtained on a weekly basis from the Department of Poultry Science at Virginia Polytechnic Institute and State University. The eggs were incubated in the Department of Psychology in a Humidaire forced-air incubator (model #50). The temperature was kept at 37.5°C and wet-bulb hygrometer readings varied between 28 and 31°C. Three days before hatching eggs were transferred to a Favorite forced-air incubator (model #416) which was used as a hatcher. The temperature was kept at 37.5°C and relative humidity varied between 60 and 65%. Shortly after hatching, while the chicks were still wet, they were quickly transported to the cages in which they were housed throughout the duration of the experiment. For any given hatch, the chicks selected were ones which hatched within four hours of each other, so that they would all be of comparable developmental age.

In the initial placement of chicks into their cages, they were randomly assigned to one of two conditions. They were either housed socially in pairs or they were housed in social isolation. Social isolation consisted of visual but not auditory isolation. The cages were stainless steel and measured 18 x 24 x 18 cm. The front of each cage was covered with a sheet of translucent plastic in order to minimize extra-experimental visual experience. Illumination within a cage was at 16.15 luxes. Outside, constant illumination in the room was provided by overhead fluorescent lights. The temperature in the room varied between 32

and 37°C. Food and water were provided ad libitum, except for the first 24 hours post-hatch during which only water was available to insure that chicks would drink.

Seventy-two chicks were used as subjects in the study. Additional chicks served as cagemates or as training companions. No attempt was made to sex any of the chicks. However, Graves and Siegel (1974) and Bateson and Jaekel (1974) report no sex differences in the approach behavior of domestic chicks.

In specifying the age of the subjects, the following notation is used. Day N post-hatch is equivalent to 24 x N hours post-hatch. Thus a chick on Day 3 would be at 72 hours post-hatch. As a final note, isolation housed chicks henceforward will be referred to as isolates and socially housed chicks will be referred to as 'socialates' for economy of identification.

Apparatus

The apparatus contained a straight runway, though trapezoidal in shape as seen from above. The larger of the two parallel sides was 49 cm in length and is designated as the goal-box end of the apparatus. The shorter parallel side was 24 cm in length and is designated as the start-box end. The sides of the apparatus were non-parallel, diverging toward the goal-box end, and each was 128 cm in length. The walls of the apparatus were 35.5 cm in height and were made of plywood, 1.6 cm in thickness, except for the end wall of the goal box which was 1.9 cm in thickness. The entire apparatus was painted flat white, except for the

inner walls of the goal box which were painted flat black. The floor consisted of wire mesh. The apparatus was open from above.

The start box was completely separated from the runway by a wooden, guillotine door, 0.6 cm in thickness. The shortest distance from the starting wall to the start-box door was 20.5 cm. Two photobeams transected the runway. The shortest distance from the start box to the first photobeam was 4.4 cm. The distance from the first photobeam to the second photobeam was 62 cm. The second photobeam marked the beginning of the goal area. A sheet of plexiglass, 0.6 cm in thickness, separated the goal area from the goal box. The distance from the second photobeam to the plexiglass was 14 cm.

Two Standard electric, automatic timers were used to record approach latencies for chicks run individually. Opening of the start-box door started the first timer. Breaking the first photobeam stopped the first timer which recorded the start latency, and started the second timer. Breaking the second photobeam stopped the second timer which recorded the run latency. The photocells were controlled by a Hunter amplifier relay (model #335S). When subjects with training companions were run, the automatic timers could not be used, as only the subject's (and not the quickest of the pair's) latencies were to be recorded. The same timing criteria were utilized for subjects with training companions; however, instead of the automatic timers, two hand-operated stopwatches were used. The photobeams were kept on for all subjects, so that their potential as distractors would not be available to just chicks run individually.

The audio-visual stimulus was a 'vocalizing' model hen and was located in the goal box, behind the plexiglass divider. The hen was

painted flat white, except for the beak which was yellow, the eyes which were black, and the comb and wattles which were reddish orange. It should be noted that domestic chicks show an innate preference for red or orange (Bateson and Jaeckel, 1974; Bateson and Reese, 1969; Goodwin and Hess, 1969; Salzen, Lily, and McKeown, 1971). The dimensions of the hen were as follows: the distance from the tip of the beak to the end of the tail feathers was 33 cm; the distance from the breast to the tail feathers was 30.5 cm; from the head to the ground was 33 cm; from the tail feathers to the ground was 25.5 cm; and the breast width was 15 cm. By way of a system of pulleys and string (painted black so as to not stand out against the black background) attached to a motor underneath the apparatus, the hen was set in vertical motion. It was lifted 7.5 cm and lowered down again once every five seconds.

Behind the hen, hidden in the wall, was a speaker which emitted the auditory component (which was on tape). It consisted of an intermittent 500 Hz tone which pulsed 4 times per second, with the duration of each pulse being 50 msec. These tone characteristics have been found to be optimal in eliciting approach behavior in domestic chicks (Fischer, 1972). The intensity of the tone in the start box was at 69 db. This intensity level is within the optimal range for eliciting approach behavior (Fischer and Gilman, 1969; Robinson-Guy, Note 3).

Also located in the goal box was a 40 watt, incandescent, light bulb which supplied the only source of light for the apparatus. Suspended over the apparatus was a mirror, 12 cm in diameter, which was utilized by the experimenter in observing the chick's behavior.

Distress calling was recorded by way of a Campden Instruments, Six Pen Event Recorder (model #650). Each time a distress call was heard, the experimenter depressed a button which activated one of the recording pens.

Procedure

The 72 subjects were randomly assigned to one of three training conditions. They were either trained alone, trained with an isolate or trained with an unfamiliar socialate. As was indicated before, chicks were also randomly assigned to one of two housing conditions: isolation or social (pair) housing. The resultant 2 x 3 factorial yields the basic design which was used in the study.

The experimental procedure consisted of three phases: training, testing with stimulus present, and testing with stimulus absent. Training consisted of five trials per day for three consecutive days. It began on Day 2 post-hatch and conformed to the following schedule:

Depending on the training condition, the subject was placed either alone or with a training companion into the start box. The visual component of the stimulus, the model hen, was present in the goal box and in motion; but the start-box door prevented the chick(s) from seeing her. After 30 seconds the start-box door was raised, as the auditory component was added to the stimulus, and trial 1 began. The subject was allowed a maximum of 120 seconds to cross the first photobeam. This constituted the start latency. If the subject failed to interrupt the beam, it was given a score of 120 seconds and was gently pushed (along with its

companion if had one) past the first photobeam and on to a point approximately one third the distance of the runway.

After crossing the first photobeam (or after being pushed past), the subject was then allowed a maximum of 120 seconds to cross the second photobeam, which placed the chick in the goal area. This constituted the run latency. The subject was then allowed an additional 30 seconds of exposure to the audio-visual stimulus before it was returned to the start box (along with its training companion if it had one), thus ending trial 1. When the chick was returned to the start box, the auditory component was turned off and the start-box door was lowered. If the subject failed to cross the second photobeam in the allotted time, it was gently pushed (along with its training companion if it had one) past the second photobeam and into the goal area. It was also allowed an additional 30 seconds of exposure before being returned to the start box.

The chick(s) remained in the start box for an intertrial interval of 30 seconds. Then trial 2 began and so on until all 5 trials were completed. The chicks were then returned to their respective cages. The second day of training occurred on Day 3 post-hatch and the third day on Day 4. Each chick in a social training condition had its own training companion which was used for all three days of training. Distinguishing the subject from the companion was facilitated by painting a blue dot on the subject's head. This was done for all subjects, regardless of training condition, on Day 1 post-hatch.

In addition to measuring start and run latencies, distress calls emitted by the subject were counted during trials. The distress call is distinctive from other vocalizations in terms of its duration,

amplitude, pitch, pattern, and rate (Zajonc, Markus, and Wilson, 1974). It typically is loud and occurs in repetitive, discrete units and is easily detectable (Kaufman and Hinde, 1961; Rajecki, Suomi, Scott, and Campbell, 1977; Zajonc, Markus, and Wilson, 1974). Following Rajecki et al. (1977), the distress call in the present study was only classified as such, and thus counted, if there was in addition an obvious opening of the mandibles. This criterion was especially useful for subjects run with training companions.

On Day 5 post-hatch all subjects were tested with the audio-visual stimulus still present in the apparatus. The procedure was identical to that used in training, except that each subject was run individually, regardless of its previous training condition. This was done so that social interactions would not interfere with the test for strength of attachment to the audio-visual stimulus. This was also done to simulate running conditions during the stimulus absence phase. Strength of attachment or imprinting is defined here in terms of approach latencies; thus the shorter the latency the stronger the attachment. As in training, 5 trials were given and distress calls were counted.

On Day 6 post-hatch all subjects were individually tested in the apparatus with the audio-visual stimulus absent. A few additional changes were implemented during this test. If the subject did not cross the first photobeam in 120 seconds, the trial ended, and the subject was given a score of 120 seconds for its start latency and also for its run latency. Only if the subject crossed both photobeams did it receive the additional 30 seconds in the runway. Ten trials were used instead of five.

Strength of attachment, or imprinting, during this test is defined in terms of approach latencies as in the test on Day 5 post-hatch; but now, it is also defined in terms of distress calling. By definition, the greater the amount of distress calling, the stronger the imprinting. Using approach behavior, under the condition of stimulus absence, as an index of attachment presupposes that imprinted chicks display a substantial amount of search behavior. Search behavior here is defined as approach toward the empty goal box.

In addition to the quantitative measures that were taken, observations were made throughout the experiment on behavior in general. In particular, during training, observations were made on aggressive behavior in social training conditions. Aggressive pecking is defined here as pecking directed toward the head or body of another chick, excluding the feet.

Planned Comparisons and General Statistical Analyses

For each dependent measure, separate 3-way or 2-way analyses of variance were utilized for the three phases: training, testing with stimulus present, and testing with stimulus absent. Housing and training condition constitute the two independent variables in the 2-way analyses of variance which were used for the two testing phases. Three-way analyses of variance were used for the training phase, where the third variable is the repeated factor, days. In all cases, the subject's mean latency across trials for a given day was used as the subject's raw score in each analysis. Individual trials were ignored as the present study is only concerned with average responding for a given session.

T-tests (for paired observations) were used to determine if there were any changes in approach behavior from Day 4, the last day of training, to Day 5, testing with stimulus present (when subjects were run individually).

There were no planned comparisons involving the distress measure. However, for the training factor, there was a set of three two-tailed comparisons which were performed on the two latency measures for each of the three experimental phases. The comparisons were as follows: trained alone vs. trained with an isolate, trained alone vs. trained with a socialate, and trained with an isolate vs. trained with a socialate. Under the condition of heterogeneity of variances, a separate variance estimate was utilized in evaluating planned comparisons.

The housing comparison, socialate vs. isolate, was inherent in the main effect analysis, as there are but two levels of housing. All other comparisons were treated as post hoc, and were evaluated using Tukey's honestly significant difference or the Scheffé test (depending on whether pairs of means or combinations of means were compared, respectively).

Due to the nature of the output obtained from the event recorder, individual distress calls could not be resolved. Thus a distress index was developed, based on the obtained output, which roughly corresponded to the proportion of time a subject spent distress calling during a day's training or testing. The distress index is on an integer scale from 1 to 7, with 1 representing zero or little distress calling and 7 representing continuous distress calling. Inter-rater reliability for this measure was excellent with $r = 0.94$, based on a sample of 70 pairs of ratings. Thus it is this measure that the corresponding analyses are performed on.

RESULTS

Training

Figure 1 shows the mean start and run latencies for each group on each day of training. The isolation housed groups, trained alone, trained with an isolate, and trained with a socialate, are designated as I-A, I-I, and I-S, respectively. Likewise, the analogous, socially housed groups are designated as S-A, S-I, and S-S, accordingly. An analysis of variance performed on the start latencies revealed a significant main effect for training condition, $F(2,66) = 8.15$, $p < .001$. Subjects trained alone displayed shorter start latencies than subjects trained with a socialate companion, $t(37) = 3.36$, $p < .005$. Subjects trained with an isolate also displayed shorter latencies than subjects trained with a socialate, $t(37) = 3.03$, $p < .005$. Subjects trained alone did not differ from subjects trained with an isolate companion, $t(46) = 0.45$. There was a significant main effect for days, $F(2,132) = 86.76$, $p < .001$, with start latencies decreasing across days. There was also a significant housing \times days interaction, $F(2,132) = 6.62$, $p < .005$. A simple main effects analysis revealed that isolates exhibited shorter start latencies than socialates on the first day of training, $F(1,70) = 7.19$, $p < .01$; however, the two housing levels did not differ on the second day, $F(1,70) = .01$, nor on the third day, $F(1,70) = .08$. No other effects were significant based on the start latencies.

An analysis of variance performed on the run latencies revealed a significant main effect for training condition, $F(2,66) = 8.52$, $p < .001$. Subjects trained alone exhibited shorter run latencies than

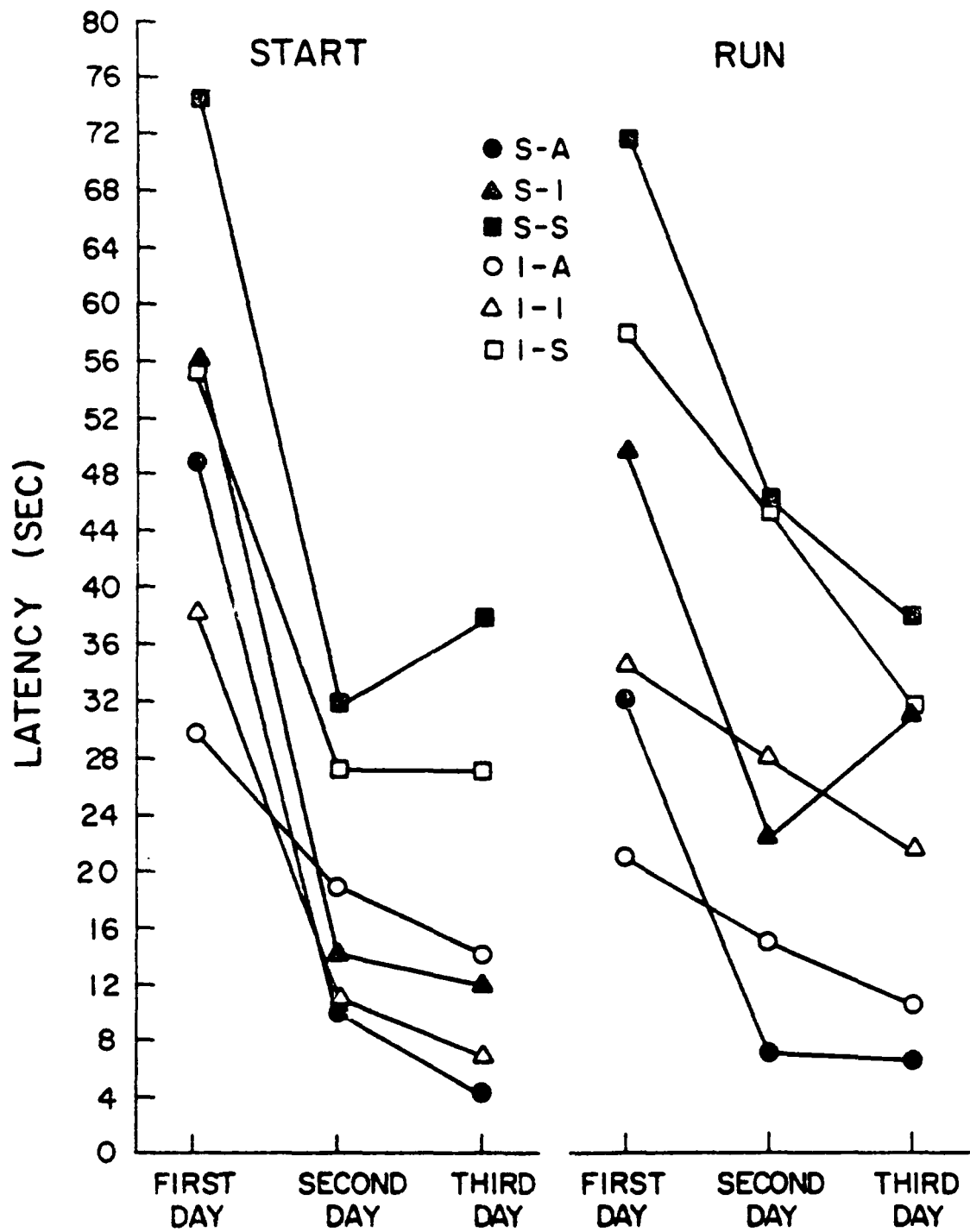


Figure 1. Mean start and run latencies for each group on each day of training. (See text for group identification.)

subjects trained with a socialate companion, $t(29) = 4.15$, $p < .001$, and than subjects trained with an isolate companion, $t(34) = 2.57$, $p = .01$. Subjects trained with an isolate displayed somewhat shorter latencies than subjects trained with a socialate, though this difference only approached significance, $t(42) = 1.87$, $p < .07$. The analysis also revealed a significant main effect for days, $F(2,132) = 17.39$, $p < .001$, with run latencies decreasing across days. No other effects were significant in the analysis.

Figure 2 shows the mean distress index for each group on each day of training. An analysis of variance performed on the distress index revealed a significant main effect for training condition, $F(2,66) = 14.46$, $p < .001$. Subjects trained alone exhibited a higher level of distress calling than subjects trained socially (Scheffé test, $\alpha = .05$). The main effect for housing approached significance, $F(1,66) = 3.42$, $p < .07$, with socialates exhibiting slightly greater distress calling than isolates. However, socialates trained alone did exhibit a significantly higher level of distress calling than isolates trained alone (Tukey test, $\alpha = .05$). Although, as can be seen from Figure 2, this difference is non-existent on the second day of training. The analysis of variance also revealed a significant main effect for days, $F(2,132) = 5.01$, $p < .01$, with distress calling decreasing after the first day of training. No other effects in the analysis were significant.

Testing: Stimulus Present

T-tests for paired observations, where $df = 11$, indicated that each group (or 2 x 3 cell) did not differ, in start or run latencies, in going from the last day of training to the testing phase with stimulus present.

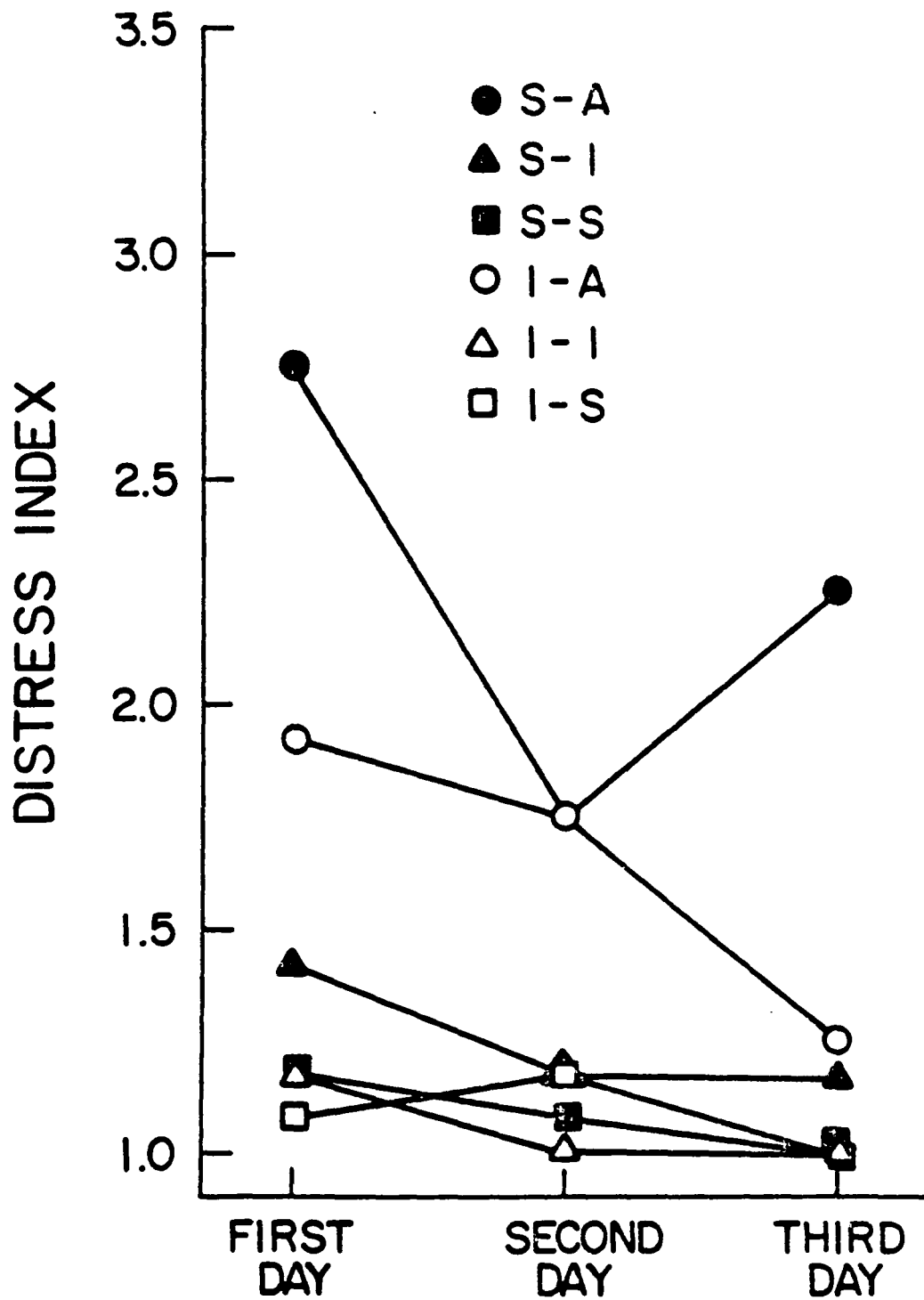


Figure 2. Mean distress index for each group on each day of training.

Therefore, socially trained subjects do not exhibit performance changes when tested individually.

Figure 3 shows the mean start and run latencies for each group during testing with stimulus present. The two housing conditions, isolation and social housing, receive the labels, I and S, accordingly. The three training conditions, trained alone, trained with an isolate, and trained with a socialate, are designated as ALONE, W/I, and W/S, respectively. An analysis of variance performed on the start latencies revealed a significant main effect for training condition, $F(2,66) = 9.65$, $p < .001$. As in the training phase, subjects trained alone displayed shorter start latencies than subjects trained with a socialate, $t(26) = 3.70$, $p = .001$, but did not differ from subjects trained with an isolate, $t(34) = .84$. Again, subjects trained with an isolate exhibited shorter start latencies than subjects trained with a socialate, $t(34) = 2.98$, $p = .005$. The housing and housing \times training condition effects were non-significant.

An analysis of variance performed on the run latencies revealed a significant main effect for training condition, $F(2,66) = 9.01$, $p < .001$. As during the training phase, subjects trained alone exhibited shorter run latencies than subjects trained with a socialate, $t(24) = 3.96$, $p = .001$, and also than subjects trained with an isolate, $t(26) = 2.21$, $p < .05$. Subjects trained with an isolate displayed shorter run latencies than subjects trained with a socialate, $t(36) = 2.35$, $p < .05$. No other effects in the analysis were significant.

Figure 4 shows the mean distress index for each group during testing with stimulus present. An analysis of variance performed on the distress index revealed a significant main effect for housing, $F(1,66) = 19.97$,

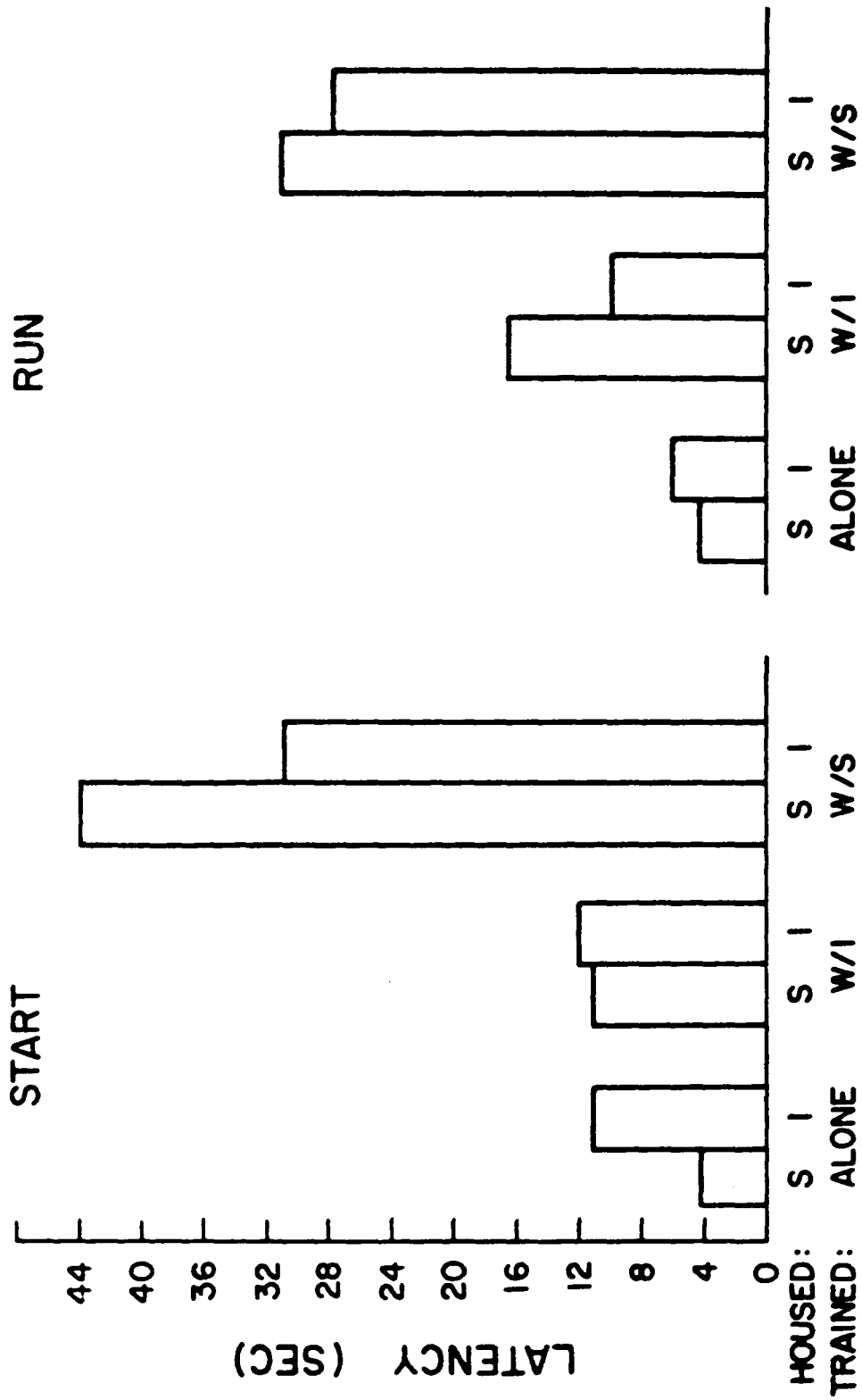


Figure 3. Mean start and run latencies for each group during testing with stimulus present.

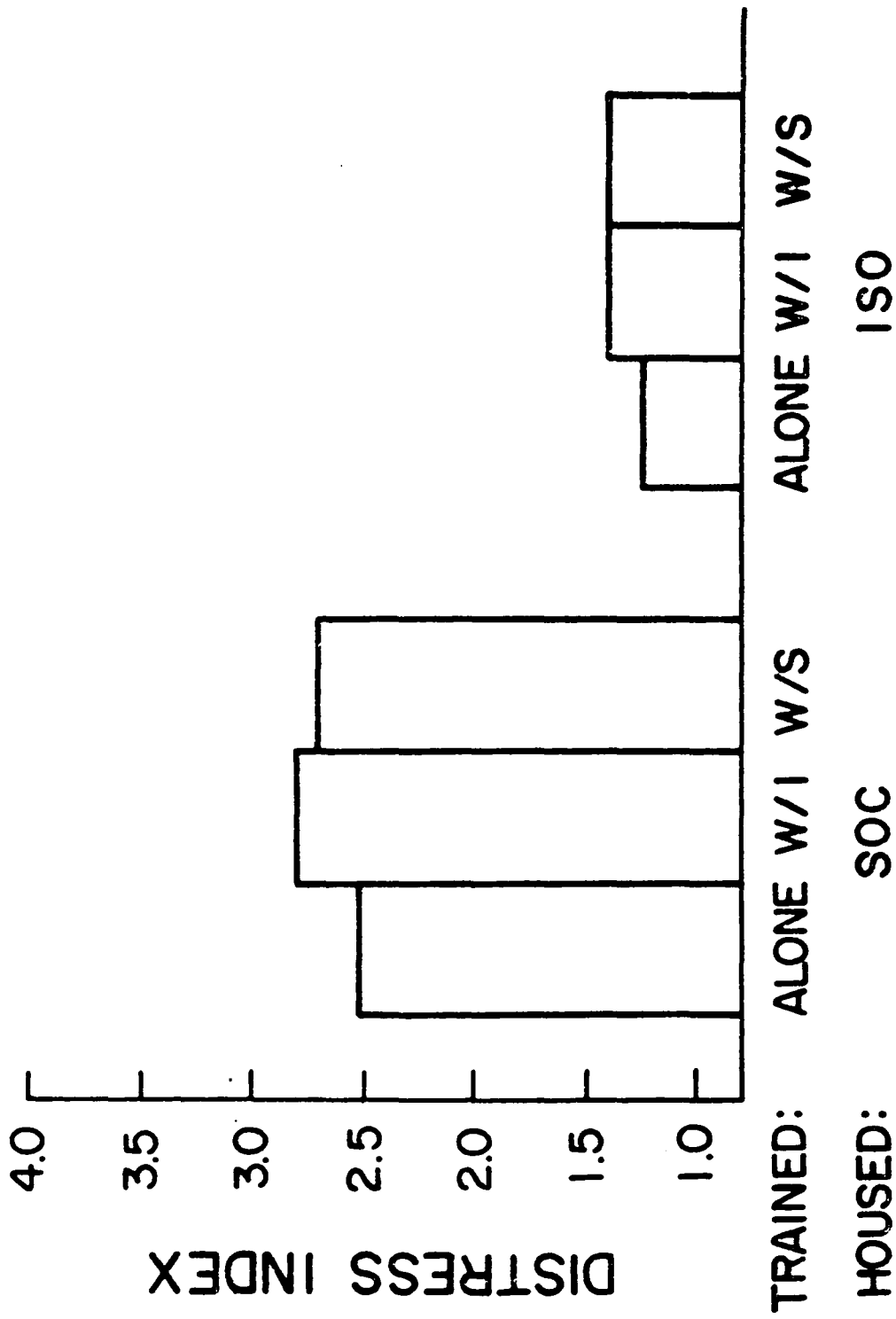


Figure 4. Mean distress index for each group during testing with stimulus present.

$p < .001$. Socialates displayed a greater level of distress calling than isolates. No other effects in the analysis were significant.

Testing: Stimulus Absent

Figure 5 shows the mean start latencies for each group during testing with stimulus absent. An analysis of variance performed on the start latencies revealed a significant main effect for training, $F(2,66) = 4.10$, $p < .05$. Again, subjects trained alone exhibited shorter start latencies than subjects trained with a socialate, $t(69) = 2.63$, $p = .01$, but did not differ from subjects trained with an isolate, $t(69) = 0.39$. Subjects trained with an isolate displayed shorter latencies than subjects trained with a socialate, $t(69) = 2.24$, $p < .05$. In Figure 5 it appears that socialates trained with a socialate companion exhibit shorter start latencies than isolates trained with a socialate companion. However, this difference is not significant (Tukey test, $\alpha = .05$).

An analysis of variance performed on the run latencies did not reveal any significant effects. Mean run latencies were generally quite long for all groups, and there were a large number of non-approaches (that is, failures in crossing the second photobeam). An attempt was made to see if there were any group differences based on the number of approaches, or complete runs, exhibited by each subject. An analysis of variance performed on the number of approaches did not reveal any significant effects.

Figure 6 shows the mean distress index for each group during testing with stimulus absent. An analysis of variance revealed a significant main effect for housing, $F(1,66) = 13.16$, $p = .001$. Socialates spent

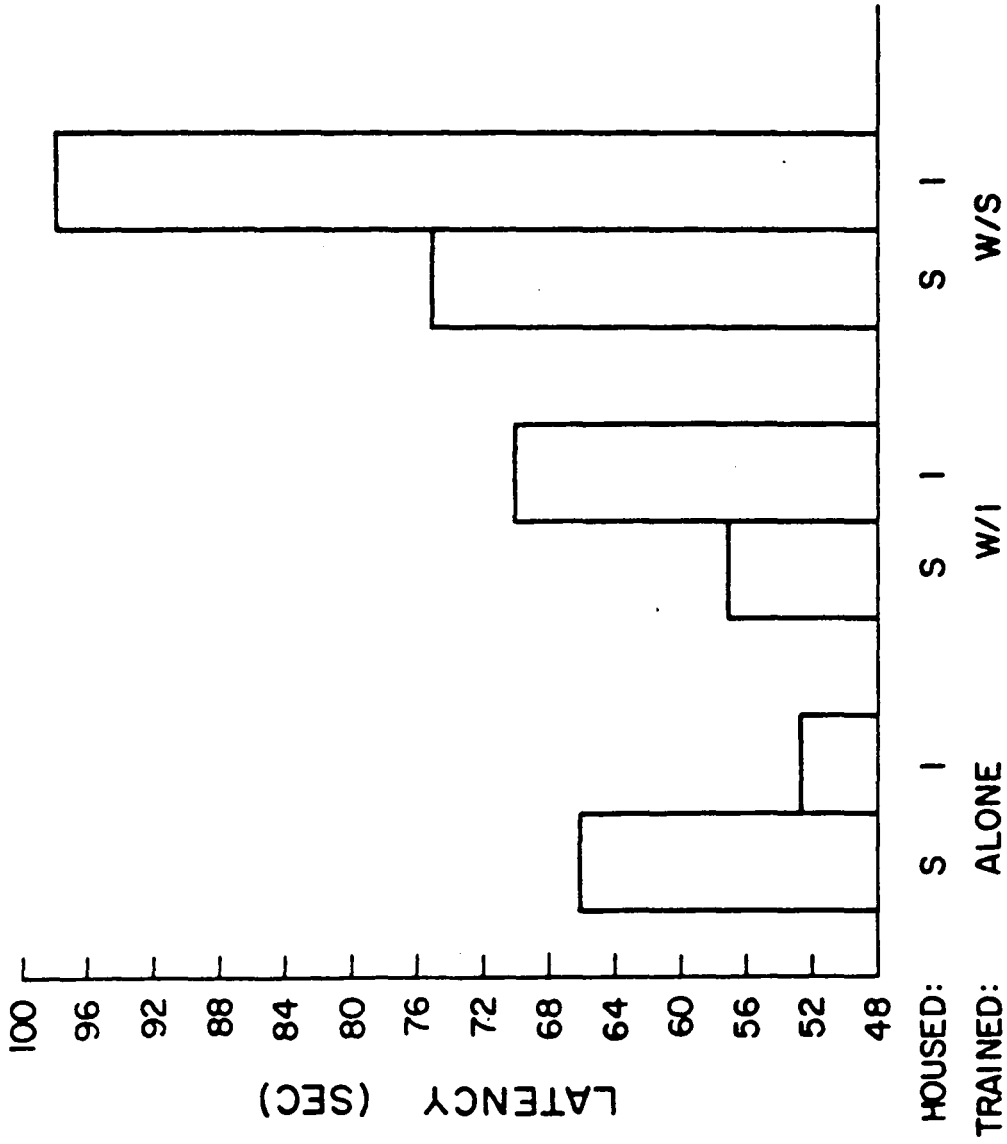


Figure 5. Mean start latencies for each group during testing with stimulus absent.

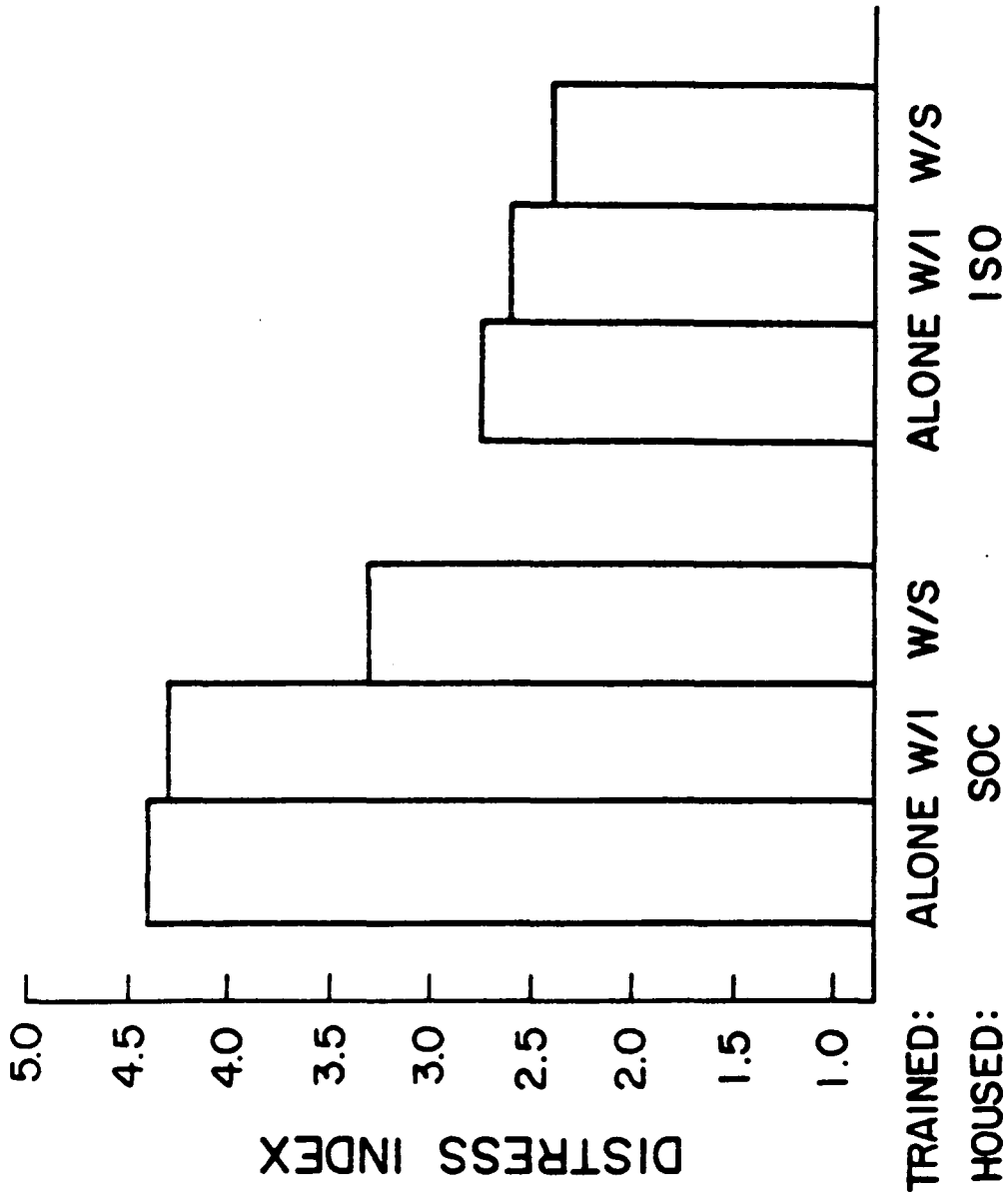


Figure 6. Unadjusted mean distress index for each group during testing with stimulus absent.

a greater, proportionate amount of time distress calling than isolates. No other effects in the analysis were significant.

It was quickly realized that the distress index, during testing with stimulus absent, could not offer a 'clean' measure of strength of attachment. Some chicks, particularly socialates, were distress calling in part due to being alone in the apparatus, as evidenced by the significant housing effect during testing with stimulus present. Thus variance in the distress scores on Day 6 post-hatch (testing with stimulus absent), which could be accounted for by variance in the distress scores on Day 5 post-hatch (testing with stimulus present), had to be removed before a meaningful analysis could be done (with regard to the measurement of strength of attachment to the goal object).

The critical assumption of homogeneity of the regression coefficients was met, and an analysis of covariance was performed on Day 6 distress scores, with the covariate being distress scores on Day 5. The analysis still revealed a main effect for housing, with socialates exhibiting higher distress scores than isolates, although this time, significance was marginal, $F(1,65) = 3.84$, $p = .05$.

Analysis of variance (or covariance) summary tables for all experimental phases and dependent measures are in Appendices A-K.

Additional Observations

Aggressive pecking was observed in all four socially trained groups. The group S-S exhibited the least amount of aggressive pecking. On occasion, high levels of ground-pecking were observed for this group. The group I-I exhibited a substantial amount of aggressive pecking

throughout training. The eyes, and head in general, were a frequent target for this group. In the groups S-I and I-S, aggressive pecking was also common. In these groups pecking was most initiated and most persistently maintained by the isolate chick. Some socialates turned away from the isolate's 'attacks,' while others reciprocated.

It should be noted that aggressive pecking among the socially trained groups did not necessarily interfere with approach behavior. In some cases, the two chicks would quickly traverse the runway, then commence pecking at one another, while in the goal area. On the other hand, it was sometimes observed that an isolate would turn around, after making some progress or even after entering the goal area, and run back to attack its training companion, if it was lagging behind. In a similar vein, it was sometimes observed that the isolate, in groups I-S or S-I, would interfere with the socialate's entering the goal area, if it had lagged behind.

During testing with the stimulus absent, in addition to distress calling it was not uncommon for chicks to attempt to jump or fly out of the apparatus; although, the height of the apparatus walls apparently prevented success at their age. This behavior occurred mostly in the start box but also was observed in the runway.

DISCUSSION

Training

During the training phase, socialates performed just as well as isolates in terms of run latencies. The same generally held true for the start latencies, except for the first day of training, where isolates exhibited quicker start latencies than socialates. This housing difference on the first day is consistent with Graves and Siegel (1968) and Bateson and Reese (1969), who both found isolates to outperform socialates during initial experience with an imprinting stimulus. Although, in the present study, this difference is rather transient and trivial in that no such difference manifested itself in the run latencies. This is at odds with Rimpau (Note 2) who found isolates to exhibit both quicker start and run speeds than socialates throughout the training period, but is consonant with Schulman, Rimpau, and Lythgoe (in press), who also found a general lack of housing differences during training.

In noting differences in terms of housing or training effects between the earlier described Rimpau study and the present study, it is important to first examine the methodology of the two studies in somewhat closer detail. Both studies are similar with regard to the measurement of start and run latencies; although, Rimpau designated each pair of chicks (in the social training conditions) as the subject-unit being measured, where the quicker of the two chicks determined the start or run latency. In the present study, only one member of a pair (in the

social training conditions) is designated as the subject, and it is that subject's behavior which is measured.

Both studies used repeated trials over days during the training phase, although the specific values for both of these differ between studies. However, the crucial difference between the two studies lies in the experimental design itself. The original study which spawned both Rimpau's and the present study was that of the previously described Schulman, Rimpau, and Lythgoe (in press). In Schulman et al., no attempt was made to separate the effect of housing from that of training, as that was not the concern of the study. Rimpau, in separating these two effects, defined training in terms of two levels: trained alone or trained in pairs, where isolates were paired with isolates and socialates were paired with socialates.

The present study redefines the training and housing factors used in Rimpau's study. Whereas in Rimpau's experiment, the difference between his pair-trained isolates and pair-trained socialates is defined as a housing difference, in the present study, the analogous two groups, I-I and S-S, are defined as differing in training level as well as in housing level. Thus housing and training effects in the two studies are not really interchangeable. Differences in results between the two studies should not be too unexpected, and similarities, though certainly of interest, should be treated with some caution so that application of the preceding logic be symmetrical.

In the present study, it was also found, during the training phase, that chicks trained alone displayed shorter approach latencies than chicks trained with a socialate. Chicks trained alone did not differ

from chicks trained with an isolate on the start latencies, but the run latencies did reveal quicker approach for chicks trained alone. Thus social training had an inhibitory effect on approach latencies during the training phase. Within the two social training conditions, chicks trained with an isolate approached more quickly than chicks trained with a socialate (though this difference appeared to be somewhat more of a function of the start latency than of the run latency).

During the training phase, chicks trained alone showed greater distress calling than chicks trained socially. Within the trained alone condition, socialates distressed called more than isolates. The finding that socialates distress call more than isolates when alone is not surprising and will be discussed at a later point.

Testing: Stimulus Present

A not unexpected finding was that socially trained chicks do not alter their performance, in terms of approach latencies, in going from the last day of training to testing, when all chicks are then run individually. This was also found by Smith and Bird (1964), Schulman, Rimpau, and Lythgoe, and by Rimpau.

An important finding was that with the stimulus present, socialates do not differ from isolates on the basis of their test scores, that is, their approach latencies. This replicates the similar findings of Guiton (1961); Smith and Bird (1964); Schulman, Rimpau, and Lythgoe; and Rimpau.

The training effect which obtained during testing was basically a continuation of the pattern during training. Social training had a negative effect on test scores. Within the social training conditions,

chicks trained with an isolate had better scores than chicks trained with a socialate. That social training had a negative effect on the behavioral index for strength of attachment replicates similar findings by Guiton (1961) and by Smith and Bird (1964).

During testing with stimulus present, socialates distress called quite a bit more than isolates. Socialate chicks distress call in response to social separation (among other things), i.e., being placed alone into an apparatus, as evidenced by previous studies (Gallup, Montevicchi, and Swanson, 1972; James, 1960; Kaufman and Hinde, 1961). Thus when tested individually, it is not surprising to find elevated distress calling in socialates relative to isolates.

Testing: Stimulus Absent

Chicks trained with socialates once again exhibited longer start latencies than either chicks trained with isolates or chicks trained alone. However, with the stimulus absent, there were no differences between groups based on run latencies or numbers of complete approaches. Basically, there was general non-responsivity in all groups. Thus the start latency differences become trivial in meaning. This lack of approach behavior during stimulus absence is at variance with Schulman et al. and Rimpau. This will be discussed further at a later point.

The distress data, however, indicate that the socialates imprinted somewhat more than the isolates did to the audio-visual stimulus. This finding is consistent with Schulman et al. and with Rimpau. Thus, the condition of stimulus absence is sensitive to differences in imprinting strength between differentially housed chicks.

Aggressive Behavior

During training, it was observed (for the social training conditions) that isolates exhibit more aggressive pecking than socialates. Isolation induced, or enhanced, aggression in domestic chicks has been previously reported by Hess (1973); Petri and Mills (1977); Rajecki, Ivins, and Rein (1976); Rajecki, Nerenz, Barnes, Ivins, and Rein (1977); and by Rajecki, Suomi, Scott, and Campbell (1977). The observation of Rajecki et al. (1976) and Rajecki, Nerenz, Barnes, Ivins, and Rein (1977) that isolates tend to aim their pecks at the other chick's head is congruent with what was observed in this study. Also, both teams of investigators found that socialates cage-peck more than isolates. Similar observations were made in the present study for ground-pecking. Petri and Mills noted that isolates were just as likely to peck at socialates as at other isolates. Again, this was observed in the present study. Petri and Mills also noted that socialates remain non-aggressive even when attacked. This was observed for only some of the cases in the present study. Some socialates did reciprocate.

General Discussion

It has been noted that during testing with stimulus present, chicks trained alone obtain better imprinting scores than chicks trained socially. Guiton (1961) also noted that social interactions interfere with the imprinting process. However, Guiton recognized that this situation might be somewhat artificial:

If the present results are valid, they show that the interactions in effect inhibit imprinting in birds which would become

[more strongly] imprinted if left alone with the stimulus-object. The argument cannot, of course, simply be applied to a group of wild chicks with their own dam since in that situation the imprinting value of a fellow chick may be far below that of the parent, whereas in the experiments described the chicks were in competition with a highly artificial model which there is no reason to suppose constitutes an optimal stimulus (p. 175).

Though the training effect in the present study might indeed be atypical with regard to what occurs in nature, it is an effect which is in need of explanation. The effect can be divided into two parts. For one thing, social training has an inhibitory effect on imprinting scores. Guiton believed that chicks in a social training condition might be imprinting onto each other, thus detracting from the imprinting experience with the stimulus-object. Though it is not critical to postulate that the chicks are imprinting onto each other, it can be suggested that in attending and actively responding to the conspecific, enough attention is directed away from the stimulus-object to interfere with imprinting to that object.

The second part of the training effect is in reference to the finding that chicks trained with an isolate obtain better imprinting scores than chicks trained with a socialate. Carrying the attentional hypothesis one step further, it can be hypothesized that chicks attend more to a socialate conspecific than to an isolate conspecific; thus the inhibitory effect is more pronounced in training with a socialate. This explanation is somewhat speculative in that no behavioral measures were taken which could support or not support it. However, Sigman, Lovern, and Schulman (1978) have shown that chicks, independent of their own housing condition, are more likely to approach a socialate than an

isolate in a two-choice situation. This could be taken as indirect support for chicks attending more to a socialate than to an isolate.

If chicks are more attentive to a socialate conspecific, then it might be predicted that socially trained, socialate subjects should exhibit lower imprinting scores than socially trained, isolate subjects. The prediction is based on the expectation that socialate subjects attend more to their training companions than do isolate subjects; the underlying assumption being that the differential attentiveness would be a function of the training companion attending more to a socialate subject than to an isolate subject. Unfortunately, this predicted housing x training condition interaction did not obtain in the present study.

There is an alternative explanation for chicks trained with an isolate doing better than chicks trained with a socialate. Hess (1964) has shown that mild electric shock has a facilitative effect on following (which includes an approach component) behavior during the critical period. It has been noted that the isolates in the present study frequently displayed persistent aggressive pecking toward other chicks. Now, if being pecked at happens to have the same general excitatory effect as mild electric shock, then chicks trained with an isolate should do better than chicks trained with a socialate. However, something akin to the attentional hypothesis is still needed to explain the superior performance of chicks trained alone over chicks trained with an isolate. There is one further problem for the alternative explanation; the facilitative effect of mild electric shock, in Hess (1964), was age dependent and disappeared at 32 hours post-hatch. Training in the present study did not start until 48 hours post-hatch.

The finding that chicks trained with an isolate obtain better imprinting scores than chicks trained with a socialate has some serious implications for research in this area, if these results prove to be reliable. Isolates trained with isolates can no longer be considered as a comparable training level to socialates trained with socialates. Thus any study which includes these two groups under the same level of training (in a factorial design), i.e., social training, is incorporating a confound into its design.

There was one rather disappointing and, at a glance, confusing result in this study. The three measures of imprinting did not converge very well in their detection or non-detection of group differences. However, approach during stimulus absence can and should be thrown out as a measure of imprinting for this particular study. This is so, because it was previously mentioned that this particular measure is dependent on chicks displaying "a substantial amount of search behavior." Previous research had shown chicks to be highly responsive during stimulus absence (Schulman and Roehling, 1974; Schulman, Rimpau, and Lythgoe, in press; Rimpau, Note 2). This did not happen here. The relatively high frequency of maximum latencies across groups, in the present study, automatically biases that measure against detecting any real group differences.

If the remaining two measures used are to be both taken as indices of imprinting strength, then the following argument has to be formulated. The approach latency measure, under the condition of testing with stimulus present, is apparently more sensitive to training effects and less sensitive to housing effects than is the distress index, under the condition of testing with stimulus absent. This need not solely be

a reiteration of the obtained results. The training effect, which is based on approach behavior, describes differences in instrumental behavior and presumably differences in imprinting strength. It is possible that the training effect is reflective of substantial differences in instrumental performance related to only small or trivial differences in actual attachment. Furthermore, the relationship between approach behavior (or any instrumental behavior for that matter) and strength of attachment need only be monotonic in nature (if even that much of a relationship exists). In fact there is no reason to assume anything more than monotonicity, especially since criteria for approach are experimenter-imposed, and therefore arbitrary, and are somewhat unnaturalistic. According to the observations of McBride, Parer, and Foenander (1969) on feral, domestic chicks, chicks typically move about at a distance from the hen that is considerably greater than the distance used in the present study in defining the goal area. Thus, the requirement that the chicks must enter the goal area to complete the run latency is a rather unnaturally stringent one.

If the training effect does indeed represent trivial differences in actual strength of attachment, then the effect should disappear or become, at most, marginally significant when a measure such as the distress index is used. This is so because the distress index presumably reflects the emotional state of the subject and does not contain an artificial criterion of instrumental responding imposed by the experimenter. It is therefore interesting to note that in Figure 6, which shows the unadjusted, mean distress scores during stimulus absence, the rank ordering of the training conditions corresponds to the training

effect (based on approach latency) found during testing with stimulus present. It should also be noted that this particular rank order did not manifest itself in the mean distress scores during testing with stimulus present, where the distress index for this condition does not indicate strength of attachment to the stimulus-object.

The aforementioned, two measures of imprinted attachment apparently show weak convergence with regard to the training effect. Unfortunately, the housing effect, based on the distress index, did not manifest itself in any way in the approach latencies during testing with stimulus present. However, one must keep in mind that the approach measure and the distress measure are probably related to some 'true' scale of imprinting strength via two distinct monotone transformations. Given that the magnitude of a true difference in imprinting strength will be differentially distorted in the transformation to the behavioral measures, it is quite possible for one measure to yield a statistically significant difference whereas the other measure does not. Furthermore, depending on the extent of sampling and measurement error, the other measure may or may not yield the proper rank ordering representing the true difference.

As was previously mentioned, the lack of responsivity, that is, the lack of experimenter-required responsivity, found during stimulus absence is at variance with Schulman et al. and Rimpau. However, there are distinctive features concerning the apparatus used in the present study which might account for this variance. For one thing, the audio-visual stimulus used in the present study is larger than the bobbing-bird model used in Schulman et al. and in Rimpau. The possibility therefore exists that with a larger stimulus absent from the goal box, the more visible

is its absence as viewed from the start box, which might reduce the probability of approach behavior.

However, if chicks approach an empty goal box regardless of how obvious the object's absence is, then there is still another apparatus difference which could account for the lack of approach behavior. The apparatus in the present study is considerably wider than the apparatus used in the other two studies. Furthermore, the apparatus, being trapezoidal in shape (unlike the rectangular shapes used in the other two studies), widens in the direction of the goal box. It is then, perhaps, a bit optimistic to think that chicks would readily cross an open 'field,' such as the one in the apparatus used in this study, with the goal object not in view.

In the naturalistic case, it is rather disadvantageous for very young chicks to freely traverse wide open areas, as they would be more obvious to predators of the land or sky. In fact, if a potential predator approaches, the broody hen will quickly attempt to hide her chicks before proceeding to meet the intruder; and if she misses a chick, the chick does not race across the open field to find her. The chick stays where it is and distress calls until the hen returns and hides the chick, if still necessary (McBride, Parer, and Foenander, 1969).

The point here is that the apparatus in the present study might be responsible for the lack of search or approach behavior during stimulus absence. Another possibility exists in that fewer training days were used in the present study than in either Rimpau or in Schulman et al. It is therefore possible that imprinting was not strong enough to cause chicks to cross the open field, or runway, during stimulus absence.

Distress calling during stimulus absence might be a fairly direct indicator of degree of attachment, provided distress calling due to other reasons is first taken into account and its variance removed. (This was done in the present study via analysis of covariance.) Hoffman and Solomon (1974), in an extension of the opponent process theory of motivation of Solomon and Corbit (1974), also express the belief that distress calling in young nidifugous birds is directly in touch with the imprinting process, under the condition of stimulus-object removal. Basically, Hoffman and Solomon feel that the stimulus-present condition, by way of some process 'a,' activates some positive emotional state, or A-state. At the same time, an opponent process, or b-process, is activated which manifests itself if the conditions which maintain the A-state are disrupted. The resultant B-state, in this case, is a negative emotional state and is caused by the removal of the stimulus-object. Distress calling during stimulus absence is presumed to indicate the intensity of the B-state which is a direct function of the b-process, which in turn is a function of the a-process.

Regardless of the theoretical paradigm, the distress measure should indicate, at least in an ordinal sense, the degree of imprinting. In the present study it indicated that socialates imprint slightly better than isolates to an audio-visual stimulus. This replicates the previously mentioned similar findings of Schulman, Rimpau, and Lythgoe and Rimpau (to the extent that the between study design differences allow such comparison). It is apparent then that testing with the imprinting stimulus removed is very sensitive in yielding housing differences, as is evidenced by the above two studies and the present study.

SUMMARY AND CONCLUSIONS

Domestic chicks were housed either individually or socially upon hatching. They were imprinted to a 'vocalizing' model hen, in a trapezoidal shaped runway, during daily training sessions over Days 2-4 post-hatch. Chicks were trained either alone, with an isolate conspecific, or with a socialate conspecific. On Day 5 post-hatch, all subjects were tested individually with the stimulus-object still present in the apparatus. All subjects were again tested individually on Day 6 post-hatch with the stimulus-object absent from the apparatus. Approach latencies on Days 5 and 6 and degree of distress calling on Day 6 served as indices of imprinting strength. It was found that:

- (1) Socialates did not differ in approach latencies from isolates during the training phase, except for the first day of training, when isolates exhibited shorter start latencies but not run latencies.
- (2) Social training had an inhibitory effect on approach behavior during the training phase. Within the social training conditions, chicks trained with an isolate exhibited significantly shorter start latencies than chicks trained with a socialate. A similar, near-significant trend held for the run latencies.
- (3) Socialates did not differ in imprinting scores from isolates during testing with stimulus present.
- (4) With the stimulus present, chicks trained alone exhibited the highest imprinting scores; chicks trained with an

isolate exhibited the next highest; and chicks trained with a socialate exhibited the lowest.

- (5) During testing with stimulus absent, all groups exhibited very poor approach behavior with no differences resulting in the run latencies or in number of approaches.
- (6) During testing with stimulus absent, socialates exhibited higher imprinting scores than isolates based on the distress index. The training effect, which obtained during testing with stimulus present, manifested itself ordinally in the distress scores, though not significantly.

It was postulated that:

- (1) In attending and actively responding to the training companion, enough attention is directed away from the stimulus-object to interfere with imprinting in the social training conditions.
- (2) Chicks attend more to a socialate than to an isolate training companion, which results in slightly poorer imprinting to the stimulus-object for the former.
- (3) Distress calling, during stimulus absence, is a more direct measure of imprinting strength than approach to the goal area due to the lack of any experimenter-imposed, artificial criterion of instrumental responding.
- (4) The training effect, which obtained during testing with stimulus present, is related to only small or trivial differences in actual strength of attachment as evidenced by the distress index during testing with stimulus absent.

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APPENDICES A-K

ANALYSIS OF VARIANCE AND COVARIANCE

SUMMARY TABLES

Appendix A. Summary of analysis of variance performed on the start latencies during training.

| Source | SS | df | MS | F |
|--|-----------|-----|----------|---------|
| H ¹ | 2384.03 | 1 | 2384.03 | 1.96 |
| T | 19805.01 | 2 | 9902.51 | 8.15** |
| HxT | 1240.62 | 2 | 620.31 | 0.51 |
| S/HT (Error term for above effects) | 80192.70 | 66 | 1215.04 | |
| D | 51192.78 | 2 | 25596.39 | 86.76** |
| DxH | 3908.67 | 2 | 1954.33 | 6.62 |
| DxT | 1175.71 | 4 | 293.93 | 1.00 |
| DxHxT | 743.48 | 4 | 185.87 | 0.63 |
| DxS/HT (Error term for above effects) | 38942.48 | 132 | 295.02 | |
| Total | 199585.47 | 215 | 928.30 | |

1. In all Appendices housing condition is designated as H, training condition as T, and subjects as S. In Appendices A-C days is designated as D.

*p < .005

**p < .001

Appendix B. Summary of analysis of variance performed on the run latencies during training.

| Source | SS | df | MS | F |
|--|-----------|-----|----------|--------|
| H | 1041.92 | 1 | 1041.92 | 0.45 |
| T | 39648.61 | 2 | 19824.30 | 8.52* |
| HxT | 637.65 | 2 | 318.83 | 0.14 |
| S/HT (Error term for above effects) | 153625.86 | 66 | 2327.67 | |
| D | 18283.68 | 2 | 9141.84 | 17.39* |
| DxH | 2668.46 | 2 | 1334.23 | 2.54 |
| DxT | 1610.63 | 4 | 402.66 | 0.77 |
| DxHxT | 316.51 | 4 | 79.13 | 0.15 |
| DxS/HT (Error term for above effects) | 69388.36 | 132 | 525.67 | |
| Total | 287221.67 | 215 | 1335.91 | |

*p < .001

Appendix C. Summary of analysis of variance performed on the distress index during training.

| Source | SS | df | MS | F |
|--|--------|-----|-------|---------|
| H | 3.89 | 1 | 3.89 | 3.42 |
| T | 32.95 | 2 | 16.48 | 14.46** |
| HxT | 3.51 | 2 | 1.76 | 1.54 |
| S/HT (Error term for above effects) | 75.19 | 66 | 1.14 | |
| D | 3.95 | 2 | 1.98 | 5.01* |
| DxH | 1.56 | 2 | 0.78 | 1.98 |
| DxT | 2.44 | 4 | 0.61 | 1.54 |
| DxHxT | 1.99 | 4 | 0.50 | 1.26 |
| DxS/HT (Error term for above effects) | 52.06 | 132 | 0.39 | |
| Total | 177.55 | 215 | 0.83 | |

*p < .01

**p < .001

Appendix D. Summary of analysis of variance performed on the start latencies during testing with stimulus present.

| Source | SS | df | MS | F |
|--------|----------|----|---------|-------|
| H | 43.56 | 1 | 43.56 | 0.07 |
| T | 12476.46 | 2 | 6238.23 | 9.65* |
| HxT | 1257.49 | 2 | 628.74 | 0.97 |
| S/HT | 42647.91 | 66 | 646.18 | |
| Total | 56425.41 | 71 | 794.72 | |

*p < .001

Appendix E. Summary of analysis of variance performed on the run latencies during testing with stimulus present.

| Source | SS | df | MS | F |
|--------|----------|----|---------|-------|
| H | 121.17 | 1 | 121.17 | 0.29 |
| T | 7592.82 | 2 | 3796.41 | 9.01* |
| HxT | 210.45 | 2 | 105.23 | 0.25 |
| S/HT | 27823.09 | 66 | 421.56 | |
| Total | 35747.53 | 71 | 503.49 | |

*p < .001

Appendix F. Summary of analysis of variance performed on the distress index during testing with stimulus present.

| Source | SS | df | MS | F |
|--------|--------|----|-------|--------|
| H | 30.68 | 1 | 30.68 | 19.97* |
| T | 0.78 | 2 | 0.39 | 0.25 |
| HxT | 0.11 | 2 | 0.06 | 0.04 |
| S/HT | 101.42 | 66 | 1.54 | |
| Total | 132.99 | 71 | 1.87 | |

*p < .001

Appendix G. Summary of analysis of variance performed on the start latencies during testing with stimulus absent.

| Source | SS | df | MS | F |
|--------|----------|----|---------|-------|
| H | 1050.31 | 1 | 1050.31 | 0.86 |
| T | 10055.20 | 2 | 5027.60 | 4.10* |
| HxT | 4170.40 | 2 | 2085.20 | 1.70 |
| S/HT | 80984.63 | 66 | 1227.04 | |
| Total | 96260.56 | 71 | 1355.78 | |

*p < .05

Appendix H. Summary of analysis of variance performed on the run latencies during testing with stimulus absent.

| Source | SS | df | MS | F |
|--------|----------|----|---------|------|
| H | 877.09 | 1 | 877.09 | 1.01 |
| T | 3430.63 | 2 | 1715.32 | 1.97 |
| HxT | 744.37 | 2 | 372.18 | 0.43 |
| S/HT | 57411.57 | 66 | 869.87 | |
| Total | 62463.66 | 71 | 879.77 | |

Appendix I. Summary of analysis of variance performed on the number of approaches during testing with stimulus absent.

| Source | SS | df | MS | F |
|--------|--------|----|-------|------|
| H | 10.13 | 1 | 10.13 | 1.02 |
| T | 42.25 | 2 | 21.13 | 2.13 |
| HxT | 6.25 | 2 | 3.13 | 0.32 |
| S/HT | 654.24 | 66 | 9.91 | |
| Total | 712.87 | 71 | 10.04 | |

Appendix J. Summary of analysis of variance performed on the distress index during testing with stimulus absent.

| Source | SS | df | MS | F |
|--------|--------|----|-------|--------|
| H | 37.56 | 1 | 37.56 | 13.16* |
| T | 6.86 | 2 | 3.43 | 1.20 |
| HxT | 2.53 | 2 | 1.26 | 0.44 |
| S/HT | 188.33 | 66 | 2.85 | |
| Total | 235.28 | 71 | 3.31 | |

*p = .001

Appendix K. Summary of analysis of covariance performed on the distress index during testing with stimulus absent.

| Source | SS | df | MS | F |
|------------------------------------|--------|----|-------|---------|
| Dist-5 ¹ (Covariate) | 47.76 | 1 | 47.76 | 18.56** |
| H | 9.89 | 1 | 9.89 | 3.84* |
| T | 7.75 | 2 | 3.88 | 1.51 |
| HxT | 2.27 | 2 | 1.14 | 0.44 |
| S/HT | 167.24 | 65 | 2.57 | |
| Total | 235.28 | 71 | 3.31 | |

1. Dist-5 refers to the distress index on Day 5 post-hatch.

*p = .05
**p < .001

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THE EFFECTS OF SOCIAL EXPERIENCE ON IMPRINTING
IN DIFFERENTIALLY HOUSED DOMESTIC CHICKS:

A MULTI-MEASURE APPROACH

by

Jeffrey Michael Jankowitz

(ABSTRACT)

The purpose of the present study was to covary housing and training conditions and to determine their effects on imprinting to a 'vocalizing' model hen. Domestic chicks were housed either individually or in pairs. They were run over Days 2-4 post-hatch under one of the following conditions: alone, in the presence of an isolate conspecific, or in the presence of an unfamiliar 'socialate' conspecific. All chicks were then tested individually on Day 5 post-hatch with the stimulus-object present in the apparatus. They were again tested on Day 6 post-hatch with the stimulus-object absent from the apparatus. Approach latencies on Days 5 and 6 and degree of distress calling on Day 6 served as indices of imprinting strength. Based on the approach measure, in testing with the stimulus-object present, chicks trained alone obtained the highest imprinting scores; chicks trained with an isolate, the second highest; and chicks trained with a socialate, the lowest. Apparently, during training chicks are more attentive to a socialate than to an isolate conspecific, which is reflected in their lower imprinting scores obtained during testing. Based on the distress index, in testing with the stimulus-object absent, socially housed chicks obtained higher imprinting scores than chicks housed individually. The differential detection of housing

and training effects for the approach and distress measures is discussed in terms of the nature of the probable underlying relationship between strength of imprinted attachment and the behavioral measures.