THE EFFECTS OF SOCIAL EXPERIENCE AND INDUCTIVE PROCEDURE ON TONIC IMMOBILITY IN DOMESTIC CHICKS

by

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In recent years there has been an upsurge of interest in the phenomenon of tonic immobility. This is attributable to a number of factors. One of these being that it has been proposed as an animal model for the study of both human hypnosis (Volgyesi, 1963) and human catatonic schizophrenia (Gallup and Maser, 1974). Another reason is that immobility is being used in the examination of a variety of drug effects (e.g. Maser, Gallup, Hicks and Edson, 1974). From the ethological viewpoint it is of interest because it is so widespread phylogenetically, having been induced in species ranging from the cephalopods up to and possibly including humans. Additionally it is being interpreted as a fear response possibly involved in the predator-prey relationship.

Tonic immobility has acquired numerous names over the years: death feigning, mesmerism, catalepsy, immobilization reflex and animal hypnosis to name a few (Ratner, 1967). Regardless of what it is termed however the response is characterized by a state of pronounced but reversible immobility accompanied by an apparent unresponsibeness to external stimulation. In chickens and other fowl, manifestations of the state may include distress vocalization, defecation, tonic and clonic tremor and eye closure. In the laboratory tonic immobility is usually induced through some form of restraint.

A review of the literature on animal hypnosis suggests that inductive procedure and rearing conditions may affect susceptibility to tonic immobility but there are little experimental data to substantiate this.

It has been demonstrated that other procedural variables have pronounced effects on immobility. For example, Gallup, Nash and Wagner (1971) demonstrated that both pretest experience and the duration of restraint during induction could affect the duration of immobility. A restraint period of 15 sec was found to yield the highest durations followed in effectiveness by 30 sec, 60 sec, and 5 sec restraint periods. Chicks that were carried in the hand of the experimenter to the testing area had significantly lower durations than those carried in a cardboard box. In another study Gallup, Cummings and Nash (1972) discovered that the duration of the response was exaggerated by close proximity of the experimenter to the subject and the maintenance of eye contact with the subject.

The purpose of this experiment then was the parametric evaluation of three inductive methods and three social rearing conditions. The subsequent effects on tonic immobility durations in White Leghorn chicks were tested during the first fourteen days posthatch. Theoretical considerations will be presented in addition to the empirical results.

REVIEW OF THE LITERATURE

The earliest recorded experimental induction of tonic immobility was performed in 1646 by the Jesuit priest, Kircher, and was termed the "experimentum mirabile imaginatione gallinae." The state was induced by tying the feet of a chicken together and then laying the chicken down such that the ventral surface contacted the ground. A chalk line was then rapidly drawn away from the beak of the bird. When at that point the feet were untied the bird remained immobile in the position it had been placed (cited in Chertok, 1968). It was later found that the chalk line was not necessary to induce the state. The restraint involved in the tying of the feet was apparently sufficient to induce immobility. This was an early version of what is now called the ventral placement technique.

Three centuries later Gilman, Marcuse and Moore (1950) examined the effect of repeated inductions within days and across days on the susceptibility to immobility and the subsequent duration of the state. There was no reduction in the response across trials when all testing was performed within the course of one day. However when nine month old White Leghorn chickens were tested for tonic immobility twice daily over a twenty-one day period there was a marked change in the response. Both the susceptibility and the

duration of the response declined with repeated inductions. This was attributed to habituation and explained in terms of a fear hypothesis. Gilman, et al. theorized that there was a close relationship between fear and the appearance of immobility. Repeated handling involved with the induction of immobility led to a reduction of this fear. The taming effect thus led to a reduction of immobility.

Ratner and Thompson (1960) reported the results of two experiments on the development of the immobility response in fowl. In a comparison of a repeated testing group with several single testing groups across a nine week period they also reported habituation of the response in the repeated testing group. The results of the second experiment suggested that there is a maturational period for the appearance of the response in young fowl. Chicks were placed in either a repeated test group or one of several single test groups, as in the first experiment, and tonic immobility was tested for on Days 2 through 12 posthatch. The chicks showed a very low susceptibility to immobility in the first week posthatch. However there was a very rapid increase in susceptibility in the second week posthatch such that by Day 10 90% of the subjects demonstrated the response. The repeated test group showed lower durations during this period than the single test groups.

This latter finding was substantiated by Salzen (1963). Reliable immobility could not be induced before Day 7 posthatch. He also concluded that social experience was a necessary prerequisite

for the appearance of reliable immobility in fowl. Group reared birds (housed in groups of about six) had a significantly higher percentage of immobility when tested in isolation than did birds reared in isolation, who rarely showed the response. This he explained in terms of an incongruity hypothesis. For socially reared birds, being tested in isolation was a novel situation and therefore arousing. Such arousal potentiated the susceptibility of the birds to tonic immobility. Being tested in isolation for isolation reared birds was not a novel experience and therefore did not lead to such exaggerated levels of arousal.

Prestrude (in press) also found evidence of a developmental period for the appearance of the response as suggested by the findings of Salzen (1963) and Ratner and Thompson (1960). However, he found that birds initially tested prior to Day 5 posthatch demonstrated the longest durations of immobility on Day 5 and those initially tested after Day 5 gave the maximum durations on the first day of testing. This time was somewhat earlier than the Day 7 to Day 10 period suggested by the earlier studies. Prestrude (in press) also showed that the decrease in susceptibility to tonic immobility with repeated inductions across days was due to prior experience and not the result of some further maturational process. He found that the decline took place over an eight day period with chicks that were immobilized ten times daily showing a faster decline than chicks immobilized three times daily. The group tested ten times daily also demonstrated increased percent responding across trials within days. It was

suggested that prolonged handling and short intertrial intervals may have a potentiating effect on tonic immobility.

These four studies illustrate the diversity of inductive procedures being used. The study by Salzen (1963) used dorsal placements while Ratner and Thompson (1960) and Prestrude (in press) used the lateral method with alternations between right and left sides. Finally the study by Gilman, et al. (1950) utilized all three of the common inductive procedures--dorsal, lateral, and ventral. However, it is apparent from these early studies that no quantitative comparison of the three inductive methods was attempted.

Other recent studies have emerged however questioning the inability to induce immobility in the first week posthatch. Braud and Ginsberg (1973) noted in the course of an imprinting experiment that it was possible to immobilize very young chicks when immobilization was performed in the palm of the hand. They suggested that it was the curvature of the palm that was responsible for the appearance of the response at such an early age. In an attempt to quantify this idea an experimental group of White Leghorn chicks were tested for immobility in a cloth trough formed by folding a white laboratory coat, while a control group were tested on a hard flat surface. The dorsal inductive procedure was used and testing continued across the first fourteen days posthatch.

The chicks immobilized in the cloth trough showed pronounced immobility as early as Day 1 posthatch with a continuing increase in

the duration of the response through Day 5. After Day 5 there began the decline in durations associated with the habituation of the response. The immobility obtained with the use of the cloth trough appeared to be quantitatively similar to that obtained by other experimenters testing on flat surfaces. The habituation curves were similar to those reported before and there were similar behavioral characteristics reported. In addition the induction method was the same as that used in previous studies.

It seemed that the cloth trough was responsible for the earlier appearance of the immobility response. Braud and Ginsberg (1973) suggested as possible explanations that the trough prevented the subject from rolling over and thus terminating the response or that the snugness of the trough caused an elevation of fear in the chick. They summarized however that (pg. 107), "Regardless of its exact mechanism of action, the cloth trough is merely a facilitator, and not an unconditional producer of the immobility reaction; i.e., the presence of the cloth trough is a necessary but not sufficient condition for immobility in very young birds." Apparently the induction of immobility in young birds was a matter of proper testing conditions. This idea was supported by two other studies.

Rovee and Luciano (1973) and Rovee and Kleinman (1974) were able to induce reliable immobility in very young chicks through the use of the ventral inductive procedure. This particular technique had fallen into disuse following the appearance of a footnote in the

paper of Gilman, et al. (1950) questioning its effectiveness. Rovee and Luciano (1973) noted that ventral placements were used because pilot testing with the dorsal and lateral methods did not produce immobility in young birds. The success of this method in inducing immobility was attributed by the authors to the fact that this posture is compatible with the righting reflexes the chicks attempts shortly after hatching. It is similar in fact to the crouching posture young chicks assume under the mother hen.

Rovee and Luciano (1973) confirmed Salzen's 1963 finding in that their birds reared in groups of four demonstrated significantly higher durations than those chicks reared in isolation. Those chicks reared socially in a high density situation showed the highest durations of any group. It was suggested that the frequency of social contact and the amount of tactile stimulation are important factors in the appearance of the immobility response.

The development of the immobility response induced by ventral placement over the first ten days posthatch was investigated by Rovee and Kleinman (1974). They used ten groups of subjects; each tested on one of the ten days. The overall results indicated an increasing duration of immobility across days; that is, with increasing age. This trend asymptoted between Days 7 and 10 posthatch. It was noted that this was the period of time at which Salzen (1963) and Ratner and Thompson (1963) first obtained immobility using dorsal and lateral placements respectively.

These recent studies point out that reliable immobility can be obtained in very young chicks. They do however seem to support the idea that there is a maturational period involved in the appearance of maximum durations of immobility. The end of this maturational period would appear to be around Day 5 as first suggested by Prestrude (in press).

Three methods of induction are commonly used in testing for immobility in chickens; these being dorsal, ventral, and lateral placements. The present experiment systematically manipulated these methods, utilizing the cloth trough suggested by Braud and Ginsberg (1973). Within this context the author sought to replicate the findings of Salzen (1963) and Rovee and Luciano (1973) that social experience was necessary for the appearance of reliable immobility. To this end, the subjects were housed in either isolation or in groups of six. In addition an intermediate value of three chicks reared together was examined to see if the number of chicks housed socially affects tonic immobility. The dependent variable examined was duration of the response, a commonly used measure in research on tonic immobility.

The literature does not allow real predictions to be made concerning the comparison of the three induction techniques. A prediction is possible regarding the other manipulated variable, that of rearing condition. Based on the findings of Salzen (1963) and Rovee and Luciano (1973) the immobility durations demonstrated for the two social conditions should be significantly higher than those of the

isolate group. Possible differences and their direction between the social conditions again are not predictable from previous studies.

Two other concepts can be examined because the present study involves daily testing across the first two weeks posthatch. The data should reflect the presence or absence of a maturational period for the appearance of the most robust immobility. The findings of Prestrude (in press), Ratner and Thompson (1960) and Salzen (1963) would suggest that the period from Day 5 to Day 10 would reflect such an effect. The other concept which can be looked for is the decline of the response with repeated testing across days, as was found by Gilman, et al. (1950), Ratner and Thompson (1960) and Prestrude (in press).

METHOD

Subjects

Subjects for this experiment were 108 random bred White Leghorn chicks. They were hatched from eggs obtained from the Poultry Research Center of Virginia Polytechnic Institute and State University. The eggs were incubated for eighteen days in a model 416 Favorite Incubator located in the Psychology Department. On Day 19 they were transferred for hatching to an American Instrument Company Hatcher.

The subjects were housed in stainless steel rat cages in a room maintained at constant standard lighting and temperature of 34^{o}-37^{o} Centigrade. The chicks were kept in visual isolation but not auditory isolation. The visual isolation was effected by covering the front of each cage with black plastic. The interior illumination of the cages was measured at 1.5 ft. candles by a General Electric dual range light meter.

Water was available *ad libitum* from the time the chick was initially placed in the cage, while chick starter was available *ad lib* from the second day posthatch on.

The three rearing conditions: isolate, trio, and group of six were maintained in approximately equal density situations. Those subjects raised in isolation were housed in wired-off sections of single rat cages measuring 17.5 cm by 9.5 cm. The trio reared chicks were

housed in single rat cages measuring 17.5 cm by 24.5 cm. The chicks reared in groups of six were housed in double cages measuring 41 cm by 24.5 cm.

The subjects were assigned to one of the nine conditions of rearing and induction according to a table of random permutations as they were removed from the hatcher. Each of the experimental conditions contained twelve subjects. Additionally, in the case of the three lateral induction groups, six subjects from each group were restrained on their right sides and six were restrained on the left side across the fourteen day testing period.

The ages of all subjects were determined within a range of two hours. The average age of the subjects across groups when first tested on Day 1 was 16.7 hrs., with a range of from 11.0 hrs. to 20.4 hrs. for the various experimental groups.

Apparatus

The basic equipment for this study was a three-sided wooden chamber where the immobility tests were conducted. This was utilized to eliminate extraneous visual stimulation. The chamber measured 48 cm by 29 cm by 31 cm with the interior and exterior painted flat black. The fourth side consisted of a black opaque curtain split in the center for access to the interior of the box.

An observation window measuring 3 cm by 8 cm was cut in the top of the chamber 4.5 cm from the front edge centered lengthwise. The test room was darkened while the interior of the box was

illuminated by a 60-watt incandescent light bulb diffused through a piece of frosted glass measuring 12 cm by 20 cm set in the roof. Illumination in the box with the light on was measured at 70 ft. candles using a General Electric dual range light meter. This particular arrangement of the interior of the chamber lighted and the exterior room darkened allowed the experimenter to observe the subject during testing without the subject observing the experimenter. This latter condition has been shown to affect the duration of tonic immobility obtained (Gallup, Cummings and Nash, 1972).

All inductions of immobility were performed on a piece of black terry cloth located on the floor of the chamber. The cloth was folded so as to form a square with a depressed center; similar in purpose to the cloth trough utilized by Braud and Ginsberg (1974).

Two stopwatches were used to time confinement and immobility durations.

Procedure

The first stopwatch was started when a bird was removed from its cage and transported to the testing room located nearby. The chicks were carried in a small, round plastic container to minimize actual handling. The stopwatch was stopped when the subject was placed in the induction box. This provided a measure of handling and confinement prior to the induction of immobility and was recorded for later analysis. Gallup, Nash and Wagner (1971) suggested that

pretest conditions may have a pronounced effect on the variability of immobility durations.

As the subject was placed in the cloth depression and restrained in the appropriate induction posture, the second stopwatch was started. The subject was held in that position for 15 sec, the period determined to be optimal for inducing immobility to fowl (Gallup, Nash and Wagner, 1971).

Ventral placement consisted of grasping the chick and placing it in the cloth depression in a standing position with the feet close together. Pressure was then applied on the back and head with the fingers so that the ventral surface and beak contacted the cloth. The pressure was maintained for the remainder of the 15 sec period.

The dorsal induction technique involved placing the thumb between the legs and inverting the subject. The dorsal surface of the chick was then placed in the depression in the cloth so that the legs were pointing up. The thumb was then placed with the index finger on the keel for the rest of the restraint period.

Lateral placement on the right side consisted of placing the index finger between the legs of the chick and laying it in the depression. For lateral placement on the left side the same technique was used except that the thumb was used instead of the index finger.

At the end of the 15 sec restraint period for all methods the chick was gently released and the hand slowly withdrawn from the chamber. The criterion for a successful induction was a duration of

immobility of 6 sec. The duration of the response was considered terminated when the subject regained its feet in a standing position or when a period of 360 sec had elapsed.

Tests for immobility were conducted on each subject on each of the first fourteen days posthatch. The appropriate inductive procedure was repeated for a maximum of three trials if the preceding trial had not induced immobility. The intertrial interval was 5 sec. The duration of the first successful induction was recorded as the immobility score for that day. Three unsuccessful trials resulted in the subject receiving a 0 sec duration for that day. At the termination of immobility or with three unsuccessful induction attempts the subject was immediately removed from the chamber and returned to its cage. This procedure was followed for all subjects on each of the first fourteen days posthatch, with individual records maintained for all subjects.

In addition to the immobility durations, individual records included the age of the subject at the time it was tested, the duration of handling and confinement prior to induction, and the number of inductions (up to 3) necessary to obtain immobility.

RESULTS AND DISCUSSION

The mean immobility durations (in seconds) of the nine experimental groups for each of the fourteen daily trials are given in Appendix A. Also included are the average ages of the subjects (in hours) in each group at the time of testing and the mean number of inductions necessary to achieve immobility on each day. The mean duration of handling and confinement prior to testing for all subjects across all trials was 30.0 sec.

The duration of immobility shown by each subject on each testing day was examined by an analysis of variance test over the two between-subjects factors (rearing experience and inductive procedure) and one within-subjects treatment (the repeated testing over fourteen days).

The data however did not meet the assumptions of homogeneity of variance demanded by the analysis of variance. A transformation of the form $\log_{10}(\text{duration } x + 1)$ was performed to correct for this. This same transformation was utilized under similar circumstances on immobility durations by Maser, Gallup and Barnhill (1973).

An analysis of variance with repeated measures revealed that there were no differences in the durations produced by lateral inductions on the left and lateral inductions on the right. The durations for these two groups were therefore combined for all analyses.

The overall analysis yielded a significant main effect for inductive procedure, $F(99,2) = 3.36$, $p \leq .05$; and a significant rearing condition x days interaction, $F(1287,26) = 1.83$, $p \leq .01$.

Previous studies (Prestrude, in press; Ratner and Thompson, 1960; Salzen, 1963) have investigated the importance of a maturational period for the appearance of the immobility response. This period is theorized to terminate on or about Day 7 posthatch. In order to identify possible effects of maturation the data were divided into two blocks consisting of Days 1 through 7 and Days 8 through 14. Each block was then examined separately using the analysis of variance procedure described above.

In the first week posthatch the analysis of variance revealed a significant main effect for rearing condition, $F(99,2) = 17.40$, $p \leq .01$; and a significant main effect for days, $F(594,6) = 19.61$, $p \leq .01$. The same test performed on the data from the second week posthatch showed the origins of the overall effects. There was a significant main effect for inductive procedure, $F(99,2) = 3.12$, $p \leq .05$, and a significant rearing condition x days interaction, $F(594,12) = 2.55$, $p \leq .01$.

The rearing x days interaction is depicted graphically in Figure 1. The untransformed means for the three rearing conditions--isolates, groups of three and groups of six, are shown collapsed across the three induction procedures. This resulted in an n of 36 per condition. Separate one-way analyses of variance on the transformed data revealed that there were differences significant at the

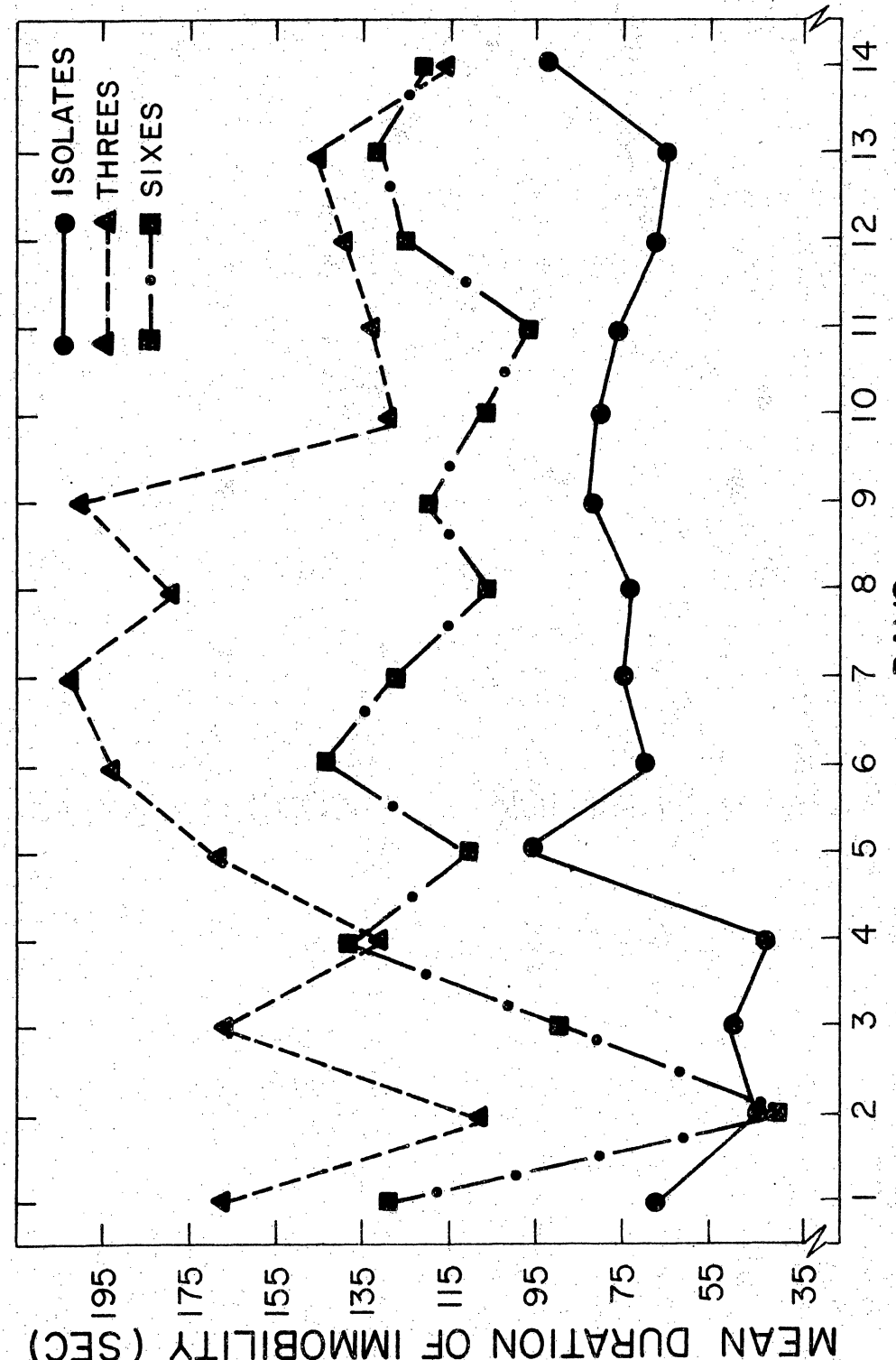

FIGURE 1

Mean Immobility Durations for the Three Rearing Conditions as a Function of Days

.05 level between the rearing conditions on Days 3, 4, 5, 6, 7, 8, 9, 12, and 13. The Neumann-Keuls sequential range test was used to identify which rearing conditions differed on each of the above days. The results revealed that on Days 3, 5, and 12 the isolates reared group differed from the trio reared group; that on Days 4, 6, and 13 the isolate reared group differed from both of the social rearing conditions, and that on Days 7, 8, and 9 the durations for the trio reared subjects were different from those of the isolate and the sixes.

The fact that there were significant differences between the isolates and the two social conditions on the days mentioned is not surprising. This is a confirmation of the findings of Salzen (1963) that social experience is necessary for the appearance of robust tonic immobility.

What is interesting is the significant difference between the two social rearing conditions on Days 7, 8, and 9 and the general lack of overlap of the trios and the groups of six. Intuitively one would predict that the mean durations of immobility for the latter group would be at least equal or greater than the former if social experience is the only factor. Such is clearly not the case.

One factor which may have affected the durations of the two social groups was the relative sizes of the two rearing areas. It was mentioned above that all subjects were housed in approximately equal density situations. The isolates were housed in an area of

166 sq cm and the groups of six were housed in an area of 1,002 sq cm or 167 sq cm per subject. The subjects reared in groups of three however were housed in an area of 429 sq cm or 143 sq cm per subject. These groups therefore were reared in a higher density situation than the groups of six. Rovee and Luciano (1973) found the most robust immobility in chicks that were housed in high density situations.

Within each of the rearing conditions there were differences among days, again revealed by the Neumann-Keuls sequential range test. Day 2 was significantly different from Days 5, 7, 9, 10, 11, 12, 13, and 14 for the isolate reared chicks and Day 3 was significantly different from Days 5, 7, 10, and 14. For the trio reared subjects Day 1 was significantly different from all days but 14; and Day 14 was different from Days 5, 6, 7, 8, 9, and 12. The duration for Day 2 was different from every other day for the groups of six, while Day 3 was different from Days 4, 5, 6, 7, 8, 9, 12, 13, and 14.

These differences across days within each of the rearing conditions demonstrate no habituation of tonic immobility with repeated testing. The possible exception may be the groups of three which show a significant decline in duration on Day 14. No downward trend is apparent prior to Day 14 however indicating that the drop may be spurious. This absence of habituation is unusual since similar studies (Braud and Ginsberg, 1973; Gilman, Marcuse and Moore, 1950; Ratner and Thompson, 1963) reported decreased susceptibility and lowered durations with repeated measures across days. Two

possible explanations are offered to explain the lack of habituation. The first of these is derived from the fear hypothesis. While other theories (see Klemm, 1971) have been proposed to account for the occurrence of tonic immobility, currently the theory generating the most research is the fear hypothesis.

In 1967 Ratner formally proposed this theory which had existed in some form since the work of Preyer in the 1870's (cited in Gilman and Marcuse, 1949). The fear hypothesis suggests that there is a close relationship between fear and manifestations of tonic immobility. Gilman et al. (1950) indicated that the habituation they observed may have resulted from the handling involved in two immobility trials per day. This handling had a taming effect resulting in a reduction in the level of fear. As a result of this decreased level of fear the susceptibility to and the duration of the immobility response declined. Recent work by Gallup (1974) has added empirical support to this concept. He and others have show that manipulations designed to increase fear, increase the subsequent duration of tonic immobility; while manipulations designed to decrease fear, decrease the duration of immobility (see Gallup, 1974, for a review).

In the context of the present study one test for immobility per day simply may not have involved sufficient handling to have brought about this taming effect. Gilman, et al. (1950) used two trials per day, Ratner and Thompson (1960) used three test sessions

per day, and Prestrude (in press) utilized either three or ten testing trials per day. Braud and Ginsberg (1973) however reported the effects of habituation beginning on Day 6 of testing while using only one test trial per day.

Why should this latter study find habituation and the present study did not? Here another explanation is offered. Braud and Ginsberg placed a maximum duration of 15 min on the immobility durations of their subjects, while the maximum duration allowed in this study was 6 min. They thus recorded mean durations in excess of 500 sec on Day 5 while the highest durations recorded in the present study were 208 sec on Day 7. The six min limit on duration of the response may have imposed an artificial ceiling on the mean durations. Such a ceiling may have been too low to have allowed a significant decrease across days. If those subjects that were terminated at 360 sec had been allowed a higher maximum duration or even self-paced termination, habituation might well have been demonstrated.

Another variable that is often examined in this type of research on tonic immobility is the frequency or percentage of subjects showing susceptibility to immobility in certain situations. Gilman, et al. (1950), Salzen (1963), Prestrude (in press) and Braud and Ginsberg (1973) examined their findings in this manner. Braud and Ginsberg defined susceptibility to the state as those subjects demonstrating immobility durations in excess of 30 sec. Figure 2 depicts the percentage of chicks in each rearing condition

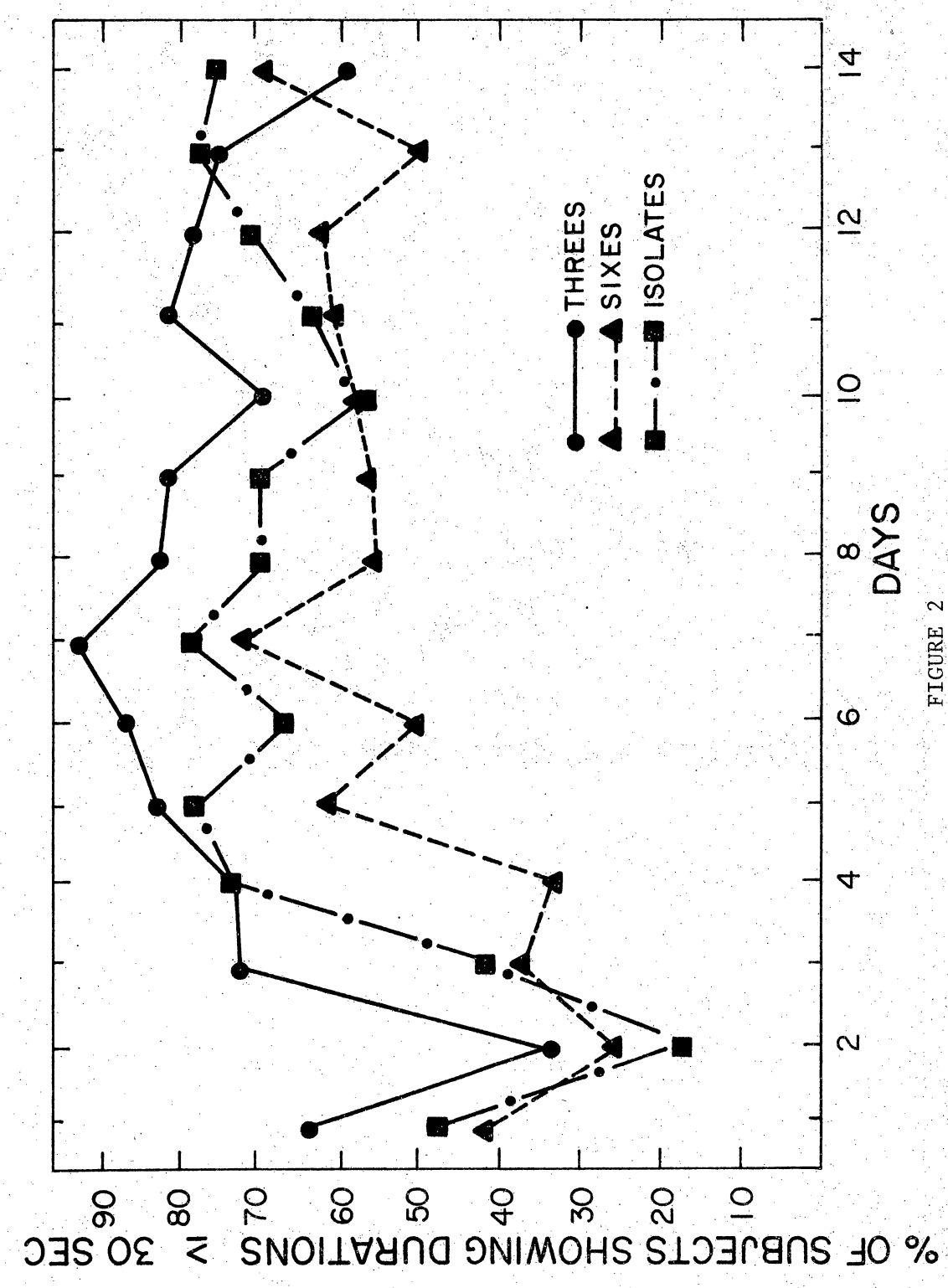

FIGURE 2

Percentage of Subjects in the Three Rearing Conditions Showing Susceptibility as a Function of Days

showing durations greater than 30 sec. The same pattern demonstrated in Figure 1 is again seen with the isolate reared group showing the lowest susceptibility, the trio reared group showing the greatest susceptibility and the group of six occupying a position midway between the above two groups. Here again the lack of habituation is apparent. Another point which was also evident in Figure 1 is demonstrated in Figure 2. This is the great decline in the susceptibility to and the duration of tonic immobility on Day 2.

The drop in duration on Day 2 was true for each of the experimental conditions. This decrease may be of interest if examined within the context of the fear hypothesis. If the low susceptibility to the state does indeed reflect an absence of fear, then this fits very nicely with the literature from another research area--i.e., imprinting. Imprinting is the rapid formation of a social bond in fowl and is a phenomenon known to occur during the first several days posthatch. It is thought that imprinting must occur during a sensitive period characterized by low fear. The end of this period has been suggested to occur sometime during the third day posthatch (Jaynes, 1957). Thus this period of low fear would be ongoing during the testing on the second day posthatch and would be over before testing commenced on Day 3.

The elevated durations of Day 1 would seem to contradict such an explanation. If there is a sensitive period for imprinting it would encompass Day 1 as well as Day 2. Other factors, however,

completely independent of fear may be in operation during Day 1 affecting the duration of tonic immobility. Testing on Day 1 in the great majority of cases came before the chicks were 24 hrs old. During this period chicks often demonstrate an inability to stand and walk normally; a problem which rapidly abates. However in testing for immobility, particularly using the dorsal and lateral inductive procedures, the chicks would often come out of the immobile state and begin to struggle to achieve the normal standing posture. Often times however they failed in their efforts and lapsed back into immobility. Such occurrences were seldom seen on ensuing days when chicks had more strength. It may also be that day old chicks fall asleep once they have become immobile. These two apparently confounding factors probably account for the high durations of immobility on Day 1.

The most significant finding of the present study may be the suggestion that there are differences in the effectiveness of the three methods of induction of tonic immobility. As mentioned above there was a significant main effect for inductive procedure. There were no differences between the three methods in the first week posthatch (Figure 3a). The main effect found was attributable to differences emerging in the second week posthatch (Figure 3b). When the overall results (Figure 4) were analyzed with a Neumann-Keuls sequential range test, each of the three procedures differed from each of the others. Dorsal placements produced the highest durations,

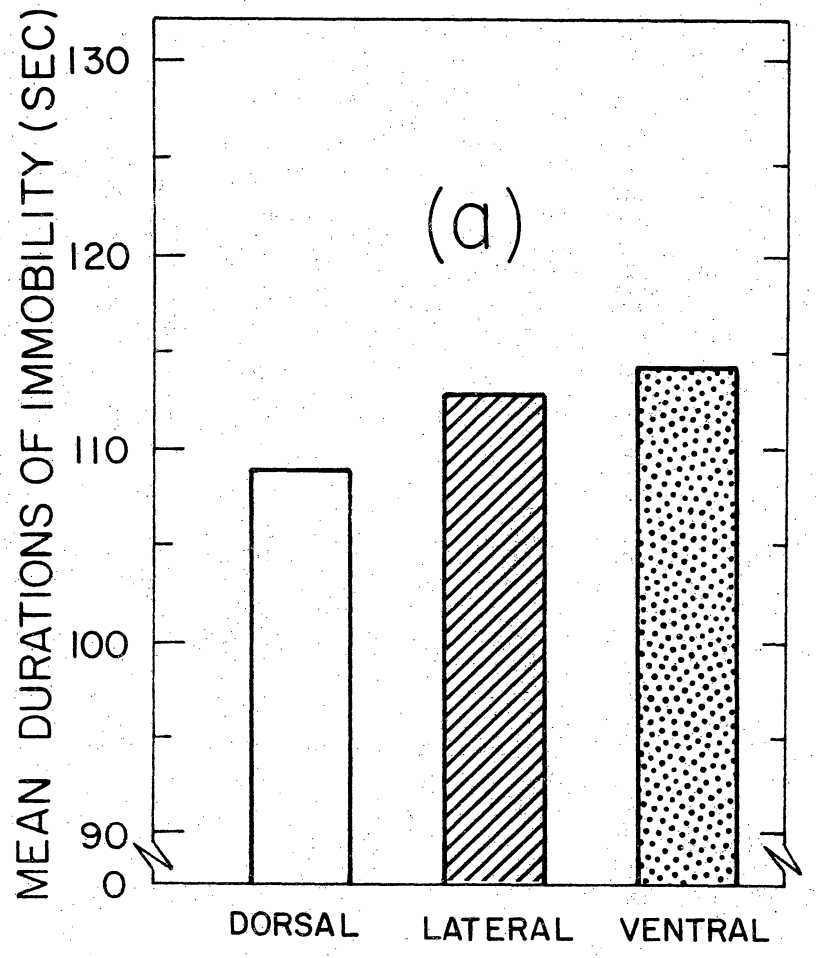

FIGURE 3a

Mean Immobility Durations as a Function of Inductive Procedure for Days 1-7

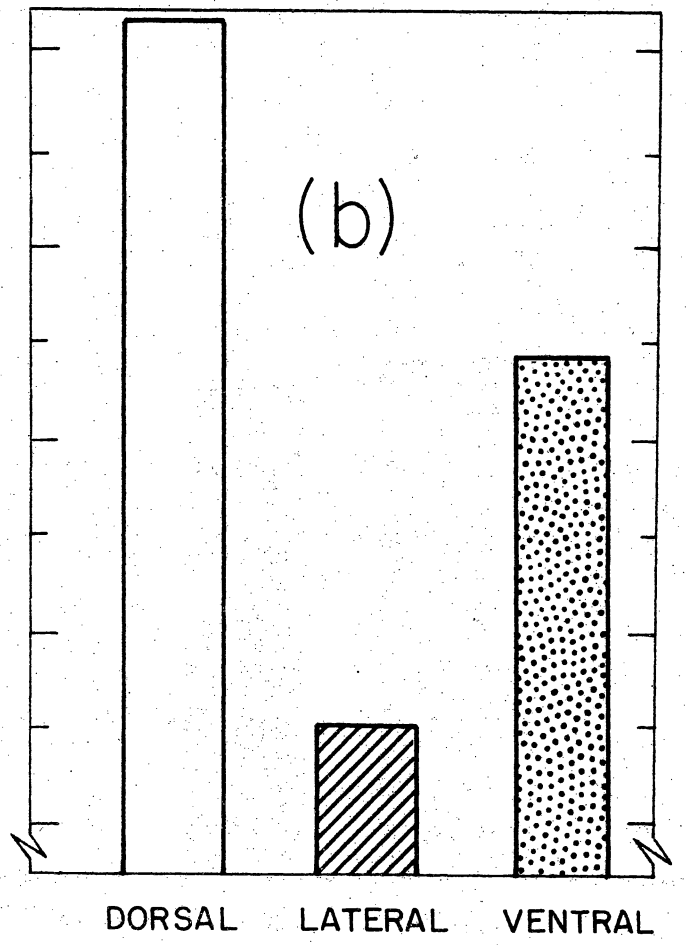

FIGURE 3b

Mean Immobility Durations as a Function of Inductive Procedure for Days 8-14

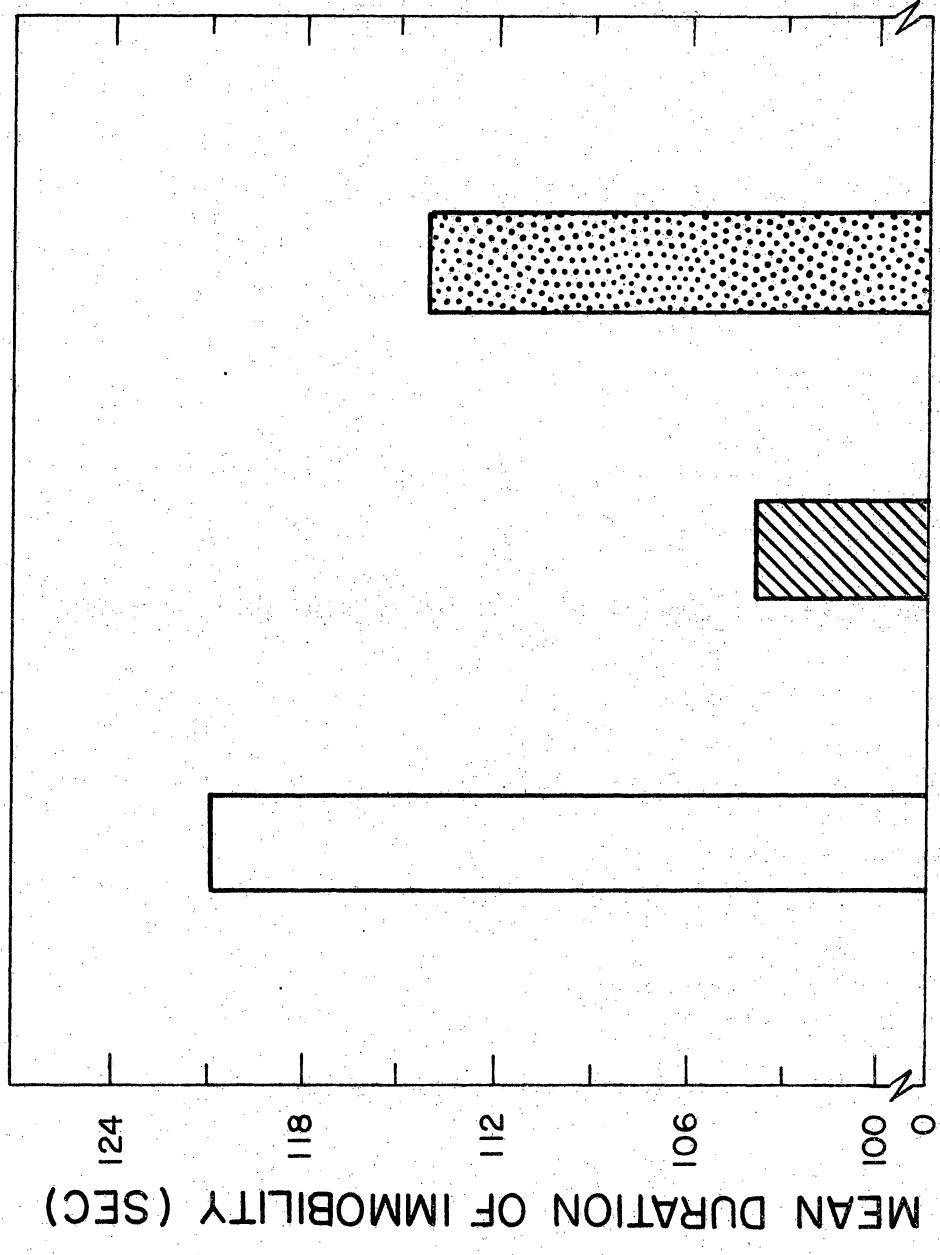

FIGURE 4

Mean Immobility Durations as a Function of Inductive Procedure for Days 1-14

followed in effectiveness by the ventral and lateral methods respectively.

Gilman, et al. (1950) utilized all three of the techniques studied in this experiment but presented no statistical analysis of the relative effectiveness of each. In a footnote, however, it was mentioned that the ventral procedure resulted in fewer responses and lower durations. This caused the use of the ventral method to fall into disfavor for over twenty years. Only recently have Rovee and her associates revived its use. A possible explanation for its ineffectiveness in the Gilman, et al. (1950) study is that they were working with nine month old chickens. These would be much stronger, particularly in the legs, than two week old chicks and would be much harder to restrain in the ventral position. Lateral and dorsal induction which involve inversion would thus be more effective at these later times.

Rovee and Kleinman (1973) noted that they chose the ventral method because pilot testing indicated that the lateral and dorsal techniques did not produce reliable immobility in very young chicks. Rovee and Luciano (1973) suggested that this method was successful with young chicks because it was compatible with the righting reflexes demonstrated by the chick during hatching. It may continue to be successful for a similar reason. It is the only procedure of the three that does not involve some form of inversion. Therefore ventral placement does not run counter to the postural reflexes of

the chicks. Such an advantage should remain until the strength of the chicken makes use of the ventral method unfeasible.

Rovee and Kleinman (1974) in their developmental study found that the susceptibility to the ventral method asymptoted between Days 7 and 10. The effectiveness of the ventral method in this study is shown in Figure 5, which shows the percentage of birds demonstrating susceptibility to immobility for each of the inductive procedures across days. Susceptibility is again defined as having an immobility duration greater than or equal to 30 sec. Ventral placement appeared to asymptote about Day 5. As was seen in Figure 3a the other two methods were equally effective in the first week in inducing immobility. This may be attributable to the use of a cloth trough.

Braud and Ginsberg (1973) were able to induce immobility dorsally in very young chicks when dorsal induction was performed in such a trough. This was the first reported use of a trough with fowl although such devices had been used previously in the study of immobility in rabbits (Klemm, 1971). They suggested that its success with young chicks might be due to two factors. One is that the trough prevented the chick from rolling over and spontaneously terminating the response. A second factor is that the snugness of the cloth may heighten the level of fear and thus increase the susceptibility of the chick to immobility.

Rovee and Kleinman (1974) pointed out that the time when the ventral method asymptoted (Days 7-10) was the period during which

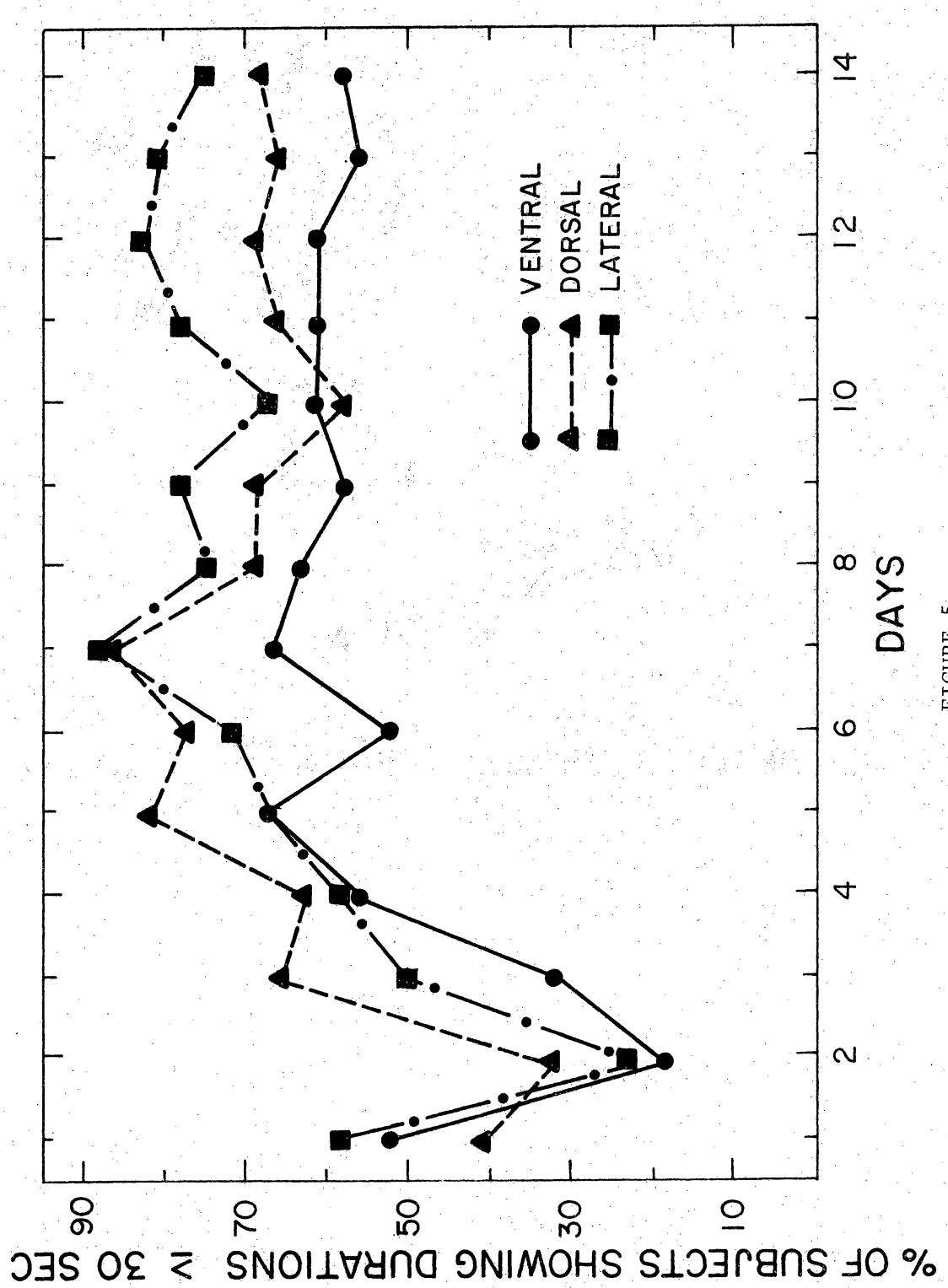

FIGURE 5

Percentage of Subjects Showing Susceptibility for the Three Inductive Procedures as a Function of Days

Ratner and Thompson (1960) and Salzen (1963) first found lateral and dorsal placements respectively effective in inducing immobility. Such a maturational period may account for the relative superiority of the dorsal method in the second week posthatch. When performed in a cloth trough all methods are relatively equal in the first week posthatch with the differences emerging in the second week.

It should be emphasized that the differences found between the three inductive procedures were obtained in the context of a within subjects design. Further research is necessary to determine if this difference is also obtainable in a strictly between subjects design.

The concept of a maturational period for immobility as proposed by Ratner and Thompson (1960) and later studied by Salzen (1963) and Prestrude (in press) is supported by certain data from this study. Figure 6 shows the percentage of all the subjects regardless of experimental condition that demonstrated susceptibility to tonic immobility on each of the first fourteen days posthatch. The maturational trend is fairly apparent with an increasing percentage of subjects demonstrating immobility across the first seven days. The highest percentage (80.6) being seen on Day 7. The percentage of all subjects showing 0 sec durations and the maximum 360 sec durations are also shown in Figure 6. The highest mean duration for all subjects was 136.7 sec occurring on Day 6.

Such data do lend support to the idea that a period of development is necessary for the appearance of the most robust

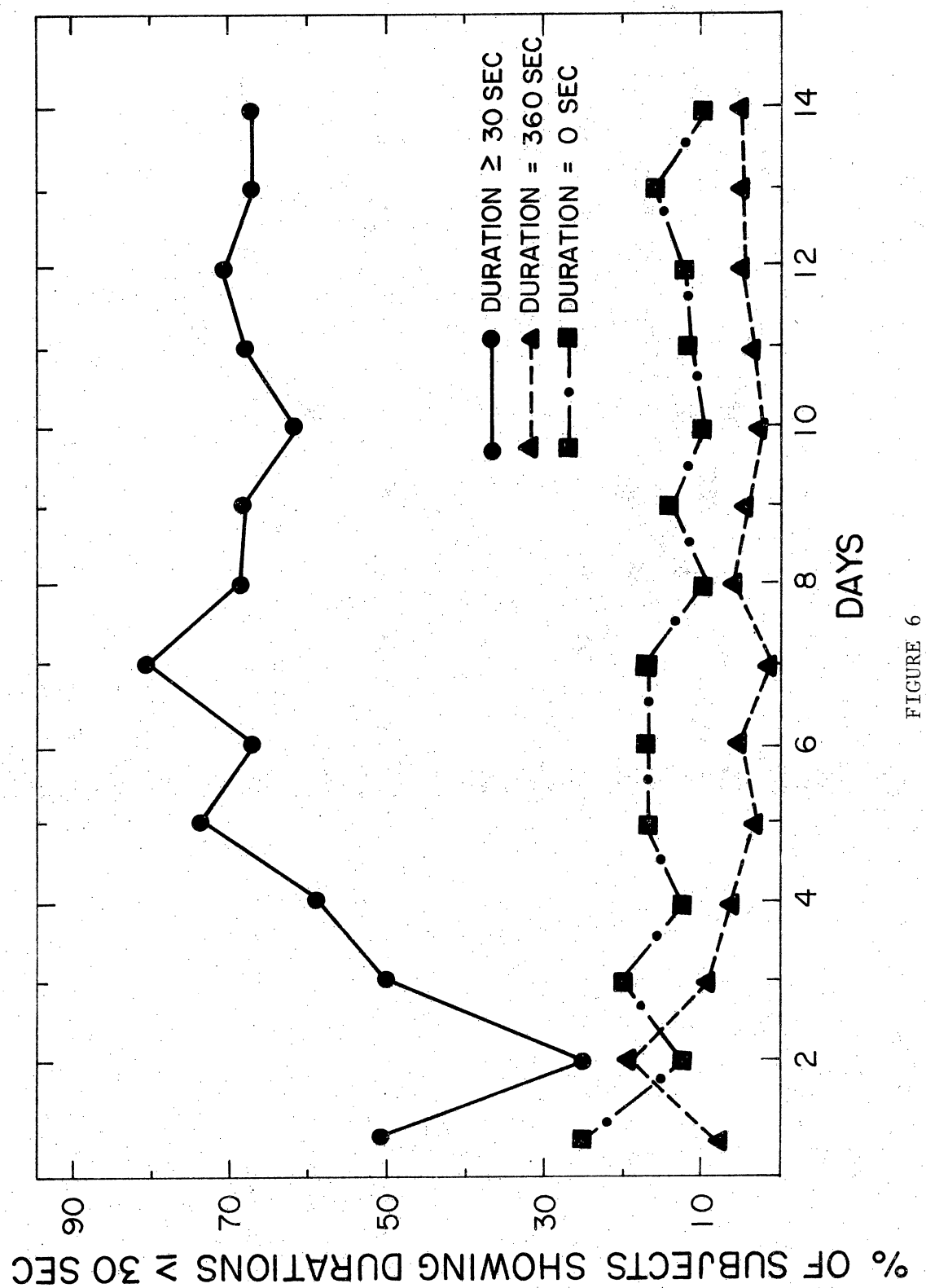

FIGURE 6

Percentage of Subjects Showing Varying Immobility Durations as a Function of Days

immobility. The present study supports previous findings that the end of this period occurs prior to Day 5.

SUMMARY AND CONCLUSION

The present study attempted to determine the effects of two procedural variables on the duration of tonic immobility in White Leghorn chicks. It involved repeated daily tests across the first fourteen days posthatch. Three commonly used methods of induction--dorsal, lateral, and ventral placements were systematically manipulated within the context of groups of varying social composition. The groups consisted of either isolates, groups of three, or groups of six.

A significant main effect was revealed for inductive procedure as well as a significant rearing condition by days interaction. There were no differences in effectiveness between the three induction methods in the first week posthatch. The differences emerged in the second week posthatch. Each of the methods were found to differ significantly in effectiveness from each of the others with dorsal induction producing the highest immobility durations followed by the ventral and lateral methods respectively.

Previous findings that social experience is necessary for robust immobility were substantiated. The two social conditions demonstrated significantly higher durations than the isolate condition. The two social groups also differed on several days, which was attributed to a higher rearing density for the chicks housed in

groups of three. Although other studies reported a decline in susceptibility to the immobility response with repeated testing across days no such decline in durations was found in this study. Two possible explanations were offered to account for this. One of these involved the fear hypothesis and said that testing utilizing one trial per day did not involve sufficient handling for taming to occur. Without taming there would be no reduction in the level of fear with the consequent decrease in immobility durations. An alternate explanation advanced was that the six minute limit placed on the duration of the response created an artificial ceiling on the data which was too low to allow a significant decline across days.

It has been proposed that a maturational period is necessary for the appearance of the highest immobility durations. Evidence supporting this concept was found. The highest percentage (80.6%) of all subjects showing susceptibility to the immobility response occurred on Day 7, while the highest mean duration across subjects (136.7 sec) occurred on Day 6.

The major finding of this study is the suggestion that the three common methods of induction vary in effectiveness. This was found in the context of a within-subjects design however and further research is necessary to determine if this is also true in a between-subjects design.

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APPENDIX A

Mean Ages (in hrs), Mean Number of Inductions to Achieve Immobility, and Mean Immobility Durations for the 9 Experimental Groups for the 14 Test Days

	Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Isolate-Ventral														
Age	16.7	39.9	63.8	88.4	103.5	126.2	160.2	183.4	207.6	231.5	255.5	279.8	303.5	327.4
Ind	1.67	2.17	1.92	2.09	1.73	2.00	1.75	1.92	1.75	1.83	1.92	1.67	1.50	1.83
Dur	103.3	52.0	37.3	60.3	125.1	74.7	83.7	75.3	80.9	67.2	109.5	66.4	54.0	99.6
Isolate-Dorsal														
Age	20.4	44.2	68.1	92.3	116.1	140.1	164.1	186.4	211.2	235.5	259.7	283.8	310.6	331.5
Ind	1.50	1.92	1.67	1.58	1.67	1.25	1.00	1.33	1.17	1.25	1.08	1.67	1.25	1.17
Dur	50.7	65.6	50.3	35.6	47.8	95.1	75.8	68.3	104.7	67.3	57.7	70.3	77.3	60.8
Isolate-Lateral														
Age	19.3	43.3	67.5	91.6	115.7	139.7	163.7	187.6	211.4	234.5	259.4	282.9	306.9	330.9
Ind	1.80	1.83	2.08	1.75	2.17	1.58	1.42	1.67	1.83	1.42	1.75	1.67	2.00	1.83
Dur	52.6	13.5	68.3	33.7	116.6	45.6	65.0	76.8	74.5	120.6	77.8	69.6	63.3	123.3
Threes-Ventral														
Age	19.9	43.3	66.5	91.8	115.0	139.5	163.4	186.7	210.7	234.7	258.5	283.4	306.1	330.1
Ind	2.08	2.33	1.	1.17	1.25	1.08	1.25	1.33	1.08	1.25	1.17	1.17	1.25	1.33
Dur	147.6	44.7	132.8	148.6	96.1	190.7	197.2	186.9	180.8	147.1	165.7	144.9	181.3	112.3
Threes-Dorsal														
Age	19.1	41.3	66.5	89.8	113.6	138.4	161.1	184.6	208.3	232.4	256.9	281.0	304.4	328.6
Ind	1.08	1.50	1.17	1.33	1.00	1.25	1.00	1.08	1.25	1.33	1.17	1.17	1.00	1.50
Dur	195.4	41.8	182.9	99.0	205.7	192.1	247.8	197.8	204.8	150.8	143.9	158.5	157.8	101.5
Threes-Lateral														
Age	12.8	35.8	60.4	84.1	108.2	133.0	156.6	178.9	203.3	227.7	251.5	275.8	299.0	323.2
Ind	1.00	1.42	1.08	1.17	1.00	1.17	1.08	1.08	1.08	1.00	1.33	1.17	1.33	1.08
Dur	151.1	231.5	176.4	156.4	202.8	196.7	163.5	154.6	218.1	91.8	88.6	124.3	98.8	118.2
Sixes-Ventral														
Age	12.4	34.2	59.0	83.2	107.0	130.8	155.4	180.0	202.9	226.6	250.9	274.8	299.0	323.5
Ind	1.25	2.08	1.42	1.33	1.42	1.25	1.17	1.17	1.00	1.08	1.00	1.08	1.00	1.00
Dur	244.0	34.8	76.08	165.7	102.1	136.9	147.3	77.3	124.5	98.1	87.1	122.1	138.0	89.1
Sixes-Dorsal														
Age	11.0	32.9	57.4	81.6	104.9	129.9	153.8	179.3	200.9	225.9	248.0	273.9	297.3	321.1
Ind	1.42	1.83	1.25	1.00	1.00	1.00	1.08	1.17	1.25	1.00	1.25	1.08	1.33	1.17
Dur	91.7	25.8	83.67	155.0	94.8	161.0	154.1	168.3	152.6	152.3	123.1	180.6	209.3	185.5
Sixes-Lateral														
Age	13.9	36.8	61.4	86.2	108.9	133.1	157.8	179.9	199.1	227.5	253.0	277.6	299.0	325.8
Ind	1.50	2.25	1.58	1.42	1.17	1.08	1.00	1.33	1.25	1.08	1.50	1.67	1.17	1.25
Dur	45.7	57.2	114.3	104.8	125.7	137.9	86.8	67.3	80.9	52.4	73.0	79.7	60.8	86.3

APPENDIX B

Summary of Analysis for Immobility Durations for Daily Tests (transformed data)

Days 1-14

Source	SS	df	MS	F
Rearing	40.86	2	20.43	14.06**
Induction	9.79	2	4.89	3.37*
Rearing x Induction	6.88	4	1.72	1.18
Days	45.42	13	3.49	11.68**
Rearing x Days	14.27	26	.55	1.83**
Induction x Days	10.05	26	.39	1.29
Rearing x Induction x Days	19.01	52	.37	1.22

Days 1-7

Source	SS	df	MS	F
Rearing	29.09	2	14.55	17.40**
Induction	3.94	2	1.97	2.36
Rearing x Induction	3.18	4	.79	.95
Days	39.86	6	6.64	19.61**
Rearing x Days	6.21	12	.52	1.53
Induction x Days	6.36	12	.53	1.56
Rearing x Induction x Days	4.48	24	.48	1.41

Days 8-14

Source	SS	df	MS	F
Rearing	13.66	2	6.83	5.41**
Induction	7.87	2	3.94	3.12*
Rearing x Induction	7.90	4	1.98	1.57
Days	.81	6	.14	.67
Rearing x Days	6.17	12	.51	2.55**
Induction x Days	1.66	12	.14	.68
Rearing x Induction x Days	3.33	24	.14	.68

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THE EFFECTS OF SOCIAL EXPERIENCE AND INDUCTIVE PROCEDURE ON TONIC IMMOBILITY IN DOMESTIC CHICKS

by

Robert G. Lythgoe

(ABSTRACT)

Previous studies on tonic immobility in fowl have used a variety of inductive procedures and rearing conditions. The present study sought to parametrically evaluate the effects of three common methods of induction: ventral, dorsal and lateral placements within the context of groups of varying social composition: isolates, groups of three and groups of six, on the duration of tonic immobility. To that end 108 White Leghorn chicks were assigned to the nine experimental groups and tested once daily for the first fourteen days posthatch.

Each of the three inductive procedures was found to differ significantly from each of the other two methods in the second week posthatch with dorsal placements producing the highest durations followed in effectiveness by the ventral and lateral methods respectively.

Previous findings that social experience is necessary for the appearance of robust immobility was confirmed, with the isolate reared chicks demonstrating significantly lower durations than the two social conditions.

No decline of the immobility response with repeated testing across days was found and two explanations for this were offered. Evidence supporting the concept of a maturational period was also noted and discussed.