THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

EARLY SOCIAL EXPERIENCE AND LATER TRAINABILITY IN THE BORDER COLLIE

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

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Norman, Oklahoma

1964

EARLY SOCIAL EXPERIENCE AND LATER TRAINABILITY

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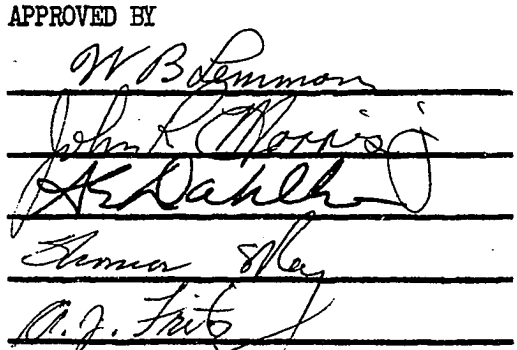
APPROVED BY



DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Dr. William B. Lemmon, who served as the director for the dissertation, and whose ideas began the germinal process that led to the present writing, and to the members of the committee, Drs. Thomas S. Ray, J. R. Morris, Arnold Dahlke, and A. J. Fritz. In particular the writer wishes to thank Dr. Vera M. Gatch, who shared the task of training, and Jack McGaugh and Joe Federico, who served as observers. Finally, the author wishes to thank his wife for her typing and her forbearance.

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EARLY SOCIAL EXPERIENCE AND LATER TRAINABILITY IN THE BORDER COLLIE

CHAPTER I

INTRODUCTION

A large number of experimental studies have supported the concept of the existence of "critical periods" in the process of behavioral development. As usually defined, critical periods are those during which the basis for particular kinds of behavior must be acquired, if it is to be acquired at all. Such a concept has far-reaching implications for a science of human development and pathology. One of the most important of these periods is that called the "critical period for socialization" (Scott, 1948). According to this theory, experience afforded the organism during the "critical period for socialization" largely determines the later development of social behavior. It seems clear, then, that the study of the critical period for socialization is of great interest to psychologists concerned with understanding the developmental roots of social behavior.

Socialization and imprinting. The existence of critical periods was hypothesized by Lorenz (1937) in an attempt to organize observations of behavior in birds. The effects of experience during critical periods in various kinds of birds have been extensively and intensively investi-

gated by Hess (1959), Lorenz (1952), Tinbergen (1948; 1953), Jaynes (1957) and many others, all of whom have been interested primarily in the first experience of the young bird with the parent or parental-surrogate. Lorenz (1952) described the kind of one-trial learning that apparently occurs as "imprinting".

The analogous process in mammals is different enough from "imprinting," as Lorenz used the term, to warrant the use of another term, "socialization." By "socialization" is meant the experience in mammals with another organism (or even an inanimate object) during the critical period for socialization. Of the differences between socialization and imprinting, one of the most striking is that in birds the imprinting process begins as soon as the young bird is out of the egg and lasts a matter of a few hours at most; while in mammals, who are born in a more helpless state, the critical period for socialization is reached days, weeks, or even months after birth, and may extend over a period of weeks or months.

Moreover, there appears to be more flexibility among mammals as to the range of acceptability of parental-surrogates or imprinting-objects. Tinbergen used a "lock and key" analogy to characterize his observations with birds that the imprinting object should fit some stimulus characteristics predetermined in the species. However, this analogy appears to be too mechanical to handle the degree of flexibility found in higher mammals. In addition, the importance of social organization in the survival of the individual becomes greatest in various mammalian species, and increasingly it appears that the foundations of social organization are largely determined in mammals by their experience during

a critical socialization period.

The function of the socialization process. During socialization a specific kind of relationship between the young organism and the "parent" organism is formed; in this relationship the "parent" organism serves both as a model and as a source of reciprocal patterned behavior which modifies and is modified by the behavior of the young organism. The behaviors learned are the all-important techniques of independent survival by the organism: How to choose a prey, stalk, kill, select a mate, and so on (Adamson, 1960). Such a process would be expected to be particularly important in those species in which the young go through a more or less extended period of dependence upon the parent, and who must eventually be weaned from the parents toward more independent existence.

Many early behaviors are thought to be genetically "built in" to the organism, but higher on the phylogenetic scale the young organism has more and more tolerance for variation in parental rearing techniques and more general adaptiveness of the organism to the environment. There appear to be "built in" to all organisms more or less restrictive limits to the stimulus characteristics of the acceptable parent or surrogate. For example, Lorenz (1952) reported in his attempt to imprint young greylag geese that, as long as he waddled along stooped down, the geese followed him, but when he stood up, they suddenly began acting as if he had completely disappeared: He no longer met the requirements for the acceptable stimulus-object. Even this restriction on the limits of what is acceptable to the organism seems to become more flexible or liberal higher on the phylogenetic scale.

During the socialization process the organism accepts some stimu-

lus-object as the "teacher," the acceptable model. The paradigm is, of course, that the immature organism learns to learn from the parent and to accept the parental organism as a model and a complement for some kinds of behavior. (Indeed, this acceptance of a model during the socialization period seems in some respects identical with the process called "identification" by Freud).

Socialization in man. The question must be raised as to the justification for the use of such concepts as "critical period for socialization" in describing the developmental process in man. In a number of mammalian species more or less phylogenetically close to man, theories relating to the existence of a critical period for socialization have been strongly supported: dogs (Scott, 1958), chimpanzees and monkeys (Harlow, 1958; 1959) and goats (Blauvelt, 1955). In addition, Gray (1958), Bakwin (1942), and Goldfarb (1944; 1947) have suggested in longitudinal studies with humans that social experience during the first six months of life is in many respects more important than any other period for later social development. Thus while it seems reasonable to attempt to shed light on the socialization process in humans through careful examination and experimental manipulation of the analogous process in lower animals, the exact extent to which generalization across species can be made is uncertain. However, it is hoped that as such work progresses it will be possible to generalize with more certainty and build a comparative psychology of social behavior.

Socialization and adult behavior. Experiences during the critical period for socialization have a great impact on adult behavior. Kortlandt (1955) has theorized that early behavior organized around simple

instincts is integrated into later behavior satisfying more complex and subtle instinctive drives, and thus it would be expected that changes in degree and kind of socialization would lead to changes in adult behavior in many ways. In fact, Harlow & Harlow (1962) have found that monkeys who are deprived of socialization experience with adults during the critical period for socialization are ineffective and abnormal as regards both sexual and parental behavior in adult life.

There is much evidence that social deprivation during the socialization period in humans leads to personality disturbances in later life. Gray (1958) cites many studies in support of his contention that children hospitalized during the age of three to six months have later personality disturbances which include depression, continual weeping, withdrawal, weight loss, and so on. Bakwin (1942) points out that children institutionalized for more than eight months of the first year had personality disturbances so severe that they could not be tested. Bowlby has hypothesized that it is these children deprived of parental love at about this age who are most likely to become incorrigible delinquents (1951). Goldfarb (1944; 1947) found that children admitted to institutions before the age of six months were very much more poorly adjusted than were those admitted after six months: "Since we find that most of the maladjusted children entered the institution below the age of six months and most of the well adjusted children entered above that age, the lasting importance of the first half year in the child's life is strikingly indicated" (1947, p. 456). Goldfarb adds that this effect is relatively permanent, and that he has not seen even one example of significantly favorable response to treatment by traditional methods of child psychiatry in

these cases.

Socialization as a continuum. The studies cited above are concerned with the effects of socialization as an "all or none" process. Since adult human behavior can rarely be organized precisely and clearly into dichotomized categories, we must look for determinants which can vary along a continuum. Humans are rarely completely isolated during any kind of institutionalization, so it can be inferred that the isolating conditions mentioned by Goldfarb (1944; 1947), Gray (1958), Bowlby (1951), and Bakwin (1942) in their separate studies refer to some relative degree of isolation during the critical period for socialization. There are no available studies dealing with the effects of varying degrees of socialization during this critical period on adult behavior; the validation of a concept such as partial socialization in lower mammals provides a theoretical basis for the understanding of degrees of asocial behavior in humans.

The concept of degree of socialization is not an easy one to deal with experimentally. In ducks, as reported by Hess (1959), a single exposure to the appropriate stimulus resulted in complete (or nearly complete) imprinting. However, in mammals the socialization period is more extended, and it does not seem likely that a "flash learning" process (Kortlandt, 1955) would be involved in a period lasting weeks or months. "Flash learning" is yet to be established in mammalian socialization; partial socialization is still a possibility.

The "fit" of the object to the organismic requirements. Lorenz (1937) and Tinbergen (1948), in describing the imprinting process for birds, have made use of a "key and lock" analogy to describe the process

by which the young birds choose one object to imprint to in preference to any other. According to Lorenz and Tinbergen, the young organisms can imprint to any object which meets the general requirements built into the young organisms. Gray, (1958) however, suggests that imprinting, at least in mammals, ". . . need not be directed to one object but can encompass other individuals in the environment. . . . the young animal will react to the degree with which the false parent-object can supply the proper releasers, and will continue to so react when it is grown" (p. 156). In effect, Gray is suggesting that imprinting or socialization will be proportional to the degree of appropriateness or "fit" of the object in the environment during the critical period for socialization. Additionally, Gray states:

> Contrary to prevalent opinion, I must conclude that siblings can, and sometimes do, imprint upon each other. The joining response of infant siblings is undoubtedly prompted by releasing stimuli similar to that which the normal parent possesses but in reduced form so the young imprint mainly on the parent. If siblings are fostered on a parent-surrogate the siblings themselves may constitute more natural imprinting objects, so that attachment to the surrogate is minor (1958, p. 156).

The implication is, clearly, that in the absence of an appropriate imprinting object, the next most appropriate imprinting object will become the primary object of the socializing process; in effect, the readiness to engage in socialization is redistributed over the remaining available environmental objects. These may even include inanimate objects such as a particular pen or location: Scott (1958) cites Thorpe as quoting considerable evidence that there is a process of primary "localization" in which a young animal becomes psychologically attached to a particular physical environment. Thus it seems likely that the degree of socialization to a particular object could be controlled by manipulating the

presence or absence of other more or less appropriate parental-surrogates.

Behavioral development in the dog. For both theoretical and practical reasons dogs were chosen as the mammalian species for the experiment in which socialization during infancy was manipulated. In particular, Scott's (1958) many studies, as well as those of Thompson & Heron (1954), Bahrs (1927), Clarke, Heron, Fetherstonhaugh, Forgays & Hebb (1951) and many others, have described the critical period for socialization in the dog.

The behavioral development of the dog falls naturally into several periods. During the neonatal period, that is, from birth until the eyes open, it is very difficult or impossible to establish stable conditioning. Fuller, Easler & Banks (1950) report that before the age of 18 days there was no reliable evidence of conditioning to light or sound. Between 18 and 20 days they found scattered evidence of conditioned reflexes but they are poorly defined and occur only sporadically. From 20 days onward conditioned reflexes were found to be definite and highly predictable. James & Cannon (1952) following the Fuller et al. (1950) design, agreed that they found no evidence of conditioning before the third week. Cornwell & Fuller (1961) found, however that tactile conditioning was possible before the 11th day, and a 50% criterion level was reached by the 15th day. At any rate, learning through the auditory and visual sense modalities does not seem possible much before the 18th day. This first 18 days of life is called the neonatal period. Vision is not possible until after the 10th day, hearing not until the 18th day (Scott & Marston, 1950; Scott, 1958), although the puppy is apparently sensitive to tactile, olfactory and gustatory stimuli from

birth. The period from the 18th day until about the age of weaning, which is nearly always completed by around the sixth to eighth week, has been called by Scott the "critical period for socialization." This period is of crucial importance for further development.

The effects of isolation during the critical period for socialization. A number of experimenters have studied the effects of isolation during the critical period for socialization upon later behavior. Clarke, et al. (1951) report that partial isolation for an unspecified period resulted in poor comparative performance on various tests, avoidance of humans and inability to respond to them, as well as pecularities in behavior.

> These results clearly confirm the previous findings with rats in showing that animals reared under restricted conditions are more inferior in problem-solving ability to those reared in a more complex environment. In addition, they suggest that marked disturbances of social behavior and motivation may occur in restricted animals (1951, p. 156).

Thompson & Heron (1954) restricted dogs in varying degrees for the first seven to ten months of their lives; these animals showed more exploratory behavior than non-restricted control animals. In a later experiment, Thompson, Melzack & Scott (1956) reported that of the eleven severely restricted animals of the 1954 experiment, eight have demonstrated "whirling fits":

> . . . very rapid, jerky running in a tight circle; shrill, agonized yelping; barking and snarling; and tail snapping and tail biting. The syndrome may last from 1 to 10 minutes. . . . although many of the fits appear to occur spontaneously (in that the immediate causes are not known), they usually seem to be set off by some change in the stimulus environment (1956, p. 939).

The authors add that no physical abnormalities in the dogs have been

noted, and the animals remain in otherwise good health.

Melzack & Thompson varied the degree of isolation of dogs during the first seven to ten months of life, maintaining littermates of the dogs as pets for control purposes.

> After the restricted dogs were released, all dogs were given a series of tests of social behavior. Tests for dominance showed that the restricted dogs were strikingly inept in a competitive situation, as compared with the high degree of dominance behavior displayed by the normal controls. Similarly, the restricted dogs did not exhibit the sustained, well-oriented curiosity toward other dogs that was observed in the control dogs. . . (1956, pp. 89-90).

Other differences were described in the report. Melzack (1954) raised pairs of dogs "from puppyhood to maturity" in restricted environments. Controls were raised in homes or laboratory. After release from the restricted environment all dogs were treated with "seven innocuous but emotion-provoking objects." Melzack reported that the restricted dogs, three to five weeks after they were released, showed a predominance of diffuse emotional excitement, while the control dogs tended to avoid the test objects. Ten to twelve months later, the groups were reported to have made equal avoidance responses, but controls displayed some aggression while the experimental animals continued to display diffuse emotional excitement.

Trainability and the critical period for socialization. Pfaffenburger & Scott (1959) found that later trainability in guide dogs was significantly negatively affected by maintaining the dogs in kennels past the 12th week of age, although if the dogs were cared for in homes sometime before the 12th week, they did well. Freedman, King & Elliott (1961) isolated litters of dogs, and gave each litter one week of contact and play with humans, at which point the litter was returned

to the isolation field. They found that the seventh week is the most receptive period, but that the critical period ranges from 9 to 13 weeks. "The pups manifested an increasing tendency to withdraw from human beings after five weeks of age and unless socialization occurred before 14 weeks of age, withdrawal reactions from humans became so intense that normal relationships could not thereafter be established" (Freedman et al., 1961, p. 1016). Thus, it might be hypothesized that only to the degree that the human is accepted by the dog as an adequate parental-surrogate during the critical period for socialization can the dog be taught by the human the modified hunting-stalking behavior which we call herding.

Herding behavior in the working dog is grossly similar to the stalking behavior of wolves and coyotes (Scott, 1950; 1954) and contains many of the components of stalking behavior in untrained or wild dogs. In the wild, the techniques of stalking and herding apparently are acquired by young dogs from the dam at about the time of weaning, which is considered by Scott to be the end of the critical period for socialization. It has been established by trainers for many years that dogs cannot be taught herding behavior by human trainers unless they have had ample opportunity during puppyhood to establish relationships with humans (Fuller, 1953; Fuller & Scott, 1954). Scott & Marston have pointed out that

> . . . dogs have been studied under more or less free and natural conditions, from which it was possible to conclude that the behavior patterns exhibited by dogs toward human beings are essentially the same as those exhibited toward dogs, and that one sort of social relationship which can be set up between men and dogs is essentially similar to the parent-offspring relationship in either species (1950, p. 25).

Equivalent findings have been made by Fuller (1953) who states that where the dog-human attachment is strong, there is less tension in the strange test situations.

In summary, kind and amount of contact (including isolation) between humans and dogs during the early weeks of life, have definite effects upon their later adjustment, including trainability, ability to form close relationships with humans, dominance/submission relationships, and so on. The actual length of the period in which an adequate socialization process can be initiated, described by Scott as the critical period for socialization, has not been adequately established. There are grounds for the supposition that the length of this period may vary among different breeds of dogs. The effects of isolation on other aspects of canine behavior, such as sexual development, maternal behavior, and so on, have not been reported.

In the present study early experience of dogs with humans will be varied in amount and kind to determine the effects on later behavior, including trainability.

CHAPTER II

PROBLEM

Examination of the literature has led to the conclusion that surrogate stimulus-objects will be accepted in proportion to their availability and suitability during the critical period for socialization. It is posited that the strength of the relationship between the puppy and the stimulus-object will be greatest when the stimulus-object most closely meets the general requirements of the organism and less to other stimulus-objects present during the critical period for socialization. Thus, humans will be accepted as parental-surrogates to the extent that there are fewer more "suitable" stimulus-objects available during the critical period for socialization. Border collies (and most domesticated breeds of dogs) have been selected for generations on the basis of the finding that stimulus qualities of humans were within the range of acceptability. Since humans "fit" the stimulus requirements (which probably include affection and playfulness) for acceptable socializing objects, there will be some degree of acceptance of a human as parental surrogate if there is any contact with humans during the critical period for socialization. Such acceptance of humans as parental surrogates should be manifested by a readiness for physical contact with humans.

The literature already cited supports the contention that train-

ability in dogs would be affected by amount and kind of contact with humans during the critical period for socialization. A theoretical basis for this assumption has been provided to the effect that one of the functions of the infant-parental relationship is learning by the young organism.

Finally, support is found in the literature cited for the conjecture that various broad behavioral characteristics or traits in dogs such as friendliness, submissiveness, and so on, are modified by early socialization conditions.

The following hypotheses are to be tested:

I. Border collies will express a readiness for contact and affiliation with humans to the degree that fewer more satisfactory socialization objects were present during the critical period for socialization. Dogs raised under the following conditions during the critical period for socialization should exhibit such readiness, in order from less to more: 1) isolation from humans, with dam and littermates; 2) contact with humans, with dam and littermates; 3) contact with humans, with littermates, isolation from dam; 4) contact with humans, isolation from dam and littermates.

II. Later trainability in the border collie will be affected by amount and kind of contact with humans during the critical period for socialization (18 days to 8 weeks), greater trainability being associated with fewer more satisfactory socialization objects present. Dogs raised under the following conditions during the critical period for socialization should exhibit trainability in order from less to more: 1) isolation from humans, with dam and littermates; 2) contact with humans, with

dam and littermates; 3) contact with humans, with littermates, isolation from dam; 4) contact with humans, isolation from dam and littermates.

III. General behavior traits and characteristics of border collies, (such as submissiveness, friendliness and so on) will vary with the kinds of experience afforded the dog during the critical period for socialization.

IV. Trainability of border collies will be positively related to their readiness to engage in contact and affiliation with humans.

CHAPTER III

METHOD

Subjects. Border collies were chosen as subjects since these dogs have been selected for 300 years on the basis of their trainability; consequently, it seems safe to assume that all puppies of this breed are potentially educable. Four female Border collies, consisting of three siblings and their dam, were bred to a male of the same line. The first two litters of two and six pups were born a day apart, and two pups from the larger litter were cross-fostered to the smaller litter. The remaining two litters of four pups each were born at approximately three-week intervals, which made systematic cross-fostering impossible. Each puppy was given a color-coded collar.

All pups were raised by their dam for the first 17 days of life in their home pen. On the 18th day, the litter was assigned to its experimental condition, where it remained until the end of the seventh week. Thus, each experimental group consisted of a litter of four pups.

Experimental treatments. All dogs were kept with their dam until 18 days old, at which time they were introduced to the following conditions, summarized in Table 1.

Group DL. The litter assigned to the DL (Dam, Littermates) condition was placed with its dam in the isolation pen on its 18th day.

Table 1

Chronological Summary of Experimental Treatments and Tests

Age	Conditions			
Birth	With dam			
18 days	Assigned to experimental conditions:			
	DL Isolated from humans--dam and littermates present	HDL Humans, dam, and littermates present	HL Isolated from dam--humans and littermates present	H Isolated from dam and littermates--humans present
8 weeks	All dogs to individual pens			
10 weeks	First Approach Trial All dogs handled 5 minutes daily, for one month			
14 weeks	Second Approach Trial			
16 weeks	Heeling training begun			
18 weeks	First Heeling Test			
19 weeks	Second Heeling Test; straggler training for one week			
20 weeks	"Down," "there," "come" training begun			
22 weeks	Final tests, and final Approach Trial			

This pen was approximately 10' x 10' and 8' tall; two adjacent sides were covered to their full height with beaverboard to render them opaque. In this way the dogs were unable to see the experimenter bringing the daily food. The remaining two sides of the pen, which faced a wooded area, were covered with heavy wire, so that the dogs had nearly free vision in these directions. The location of the isolation pen was such

that it was highly unlikely that the dogs would be able to see any human being in this direction. The dogs were fed and watered through a slot in one opaque wall; this slot was covered at all times except when food was actually being placed in the pen. Only visual isolation was accomplished by these measures; no effort was made to prevent the dogs from hearing or smelling the experimenters. By the end of the seventh week, it was noted that all pups became quite excited when hearing the experimenter's voice as he approached. Even visual isolation was only relative, as on two occasions the experimenter had to enter the pen to administer worm medication. However, the total amount of direct exposure to humans during this period amounted to less than five minutes. Weaning was begun by the dam during the sixth week; from this time on the dam was released from the cage to be fed, and the puppies were given food twice a day during the absence of the dam.

Group HDL. The litter assigned to the HDL (Humans, Dam, Littermates) condition was removed at 18 days of age, with its dam, to the experimenter's home. The dogs were penned in a 10' x 10' pen, whose walls were low enough for the dam to be able to jump out at will, though of course the puppies could not. The puppies were removed from the pen four or five times per day to be handled and played with by the experimenter and his wife; this handling was conducted with the puppies as a group, and was carried on for a total of one hour per day. As the dam began to wean the pups, during the sixth week, the pups were hand fed during each handling. During the handling the pups did a great deal of mock-fighting, both with one another and with the experimenters.

Group HL. The litter assigned to the HL (Humans, Littermates)

condition was separated from its dam at 18 days of age and raised as a litter. During the experimental period the pups were allowed no visual contact with an adult dog. They were kept in a 10' x 10' pen, and removed four or five times a day for handling which was carried on for a total time of one hour daily. They were handled and fed as a litter by the experimenter and his wife. Although they were weaned two or three weeks earlier than groups DL and HDL, their rate of weight gain was nearly the same.

Group H. The litter assigned to the H (Humans) condition was separated from its dam, and the pups separated from each other at 18 days of age. They were kept in a pen divided into four 8' x 8' pens; the sides facing the inside of the square were made of plywood to afford visual isolation from the other pups. Portions of the outside of the pens were lightly screened so as to allow the experimenter to remove pups from their pen without compromising the visual isolation. The pups were handled and fed in isolation from one another four or five times daily for a total of one-half hour daily per pup. Although they were weaned earlier than the HDL and DL pups, their weight gain was comparable.

At the end of their seventh week, all pups were placed in an individual wire pen, in which they had considerable exposure to dogs around them, though physical contact was limited to touching noses through the wire. The dogs were fed by the experimenters twice daily, but had little physical contact with the experimenters for the next two weeks.

Training procedures. For the next month each dog was "gentled," that is, he was handled 5 minutes daily at feeding time. Two weeks later when the pups were 16 weeks old, heeling training was begun.

Heeling training. Heeling training was conducted by two trainers, each dog being trained half the time by each trainer. Normally, the training periods were alternated among trainers. The other trainer did not know the experimental conditions under which the dog was raised. (In the training process itself, trainers responded at the dog's own pace.)

Heeling training was conducted for a total of three weeks. For the first two weeks each puppy was trained on ten occasions (each training period lasting 20 minutes). During the third week of heeling training the pups were trained three times.

The fourth week of training was devoted to working with dogs from any group that were not ready to go on to the next stage. Only two dogs (from Group DL) required additional training during this straggler period.

"Down," "There," "Come" training. The final two weeks of the training period were devoted to teaching the dogs to go down on command, to stay in one place until called, and to come when called. At the end of the first week of this training the first Down Test was administered. Two more training days intervened before the final Down Test was given.

Measures

Approach Trial. Two weeks after the dogs were placed in individual pens, a measure of readiness for contact and affiliation with humans was obtained. This will be referred to as an Approach Trial. Each dog was placed, one at a time, in a 3' x 3' x 3' cage. The experimenter handled the dog briefly to attract his attention and calm him, then re-

treated to a spot 25' distant facing the cage door and upwind from the dog. While the experimenter called the dog, the cage door was opened by an assistant who pulled the release wire from a concealed position, a stop-watch was started, and the time for the dog to come to the experimenter was recorded. If the dog had not left the cage at the end of one and one-half minutes, or had not reached the examiner at the end of three minutes, the test was scored as a failure. The Approach trial was conducted on three occasions for each dog: the first as described, the second after the period of gentling and immediately before training was begun, and the third immediately after training was completed.

Heeling Test. At the end of the second week of heeling training, after ten heeling training sessions, the first Heeling Test was administered. This Heeling Test was followed by three more heeling training sessions and a second Heeling Test which completed the first half of the training.

The Heeling Test was conducted in the following manner: The trainer attempted to get the dog to heel (on lead) during a ten or fifteen minute walk in the presence of an observer who did not know to which group the dog belonged. The observer chose a five minute interval during this period and allowed a stop watch to run during the time when the dog was in approximately the correct heeling position and stopped the watch when the dog was not. Thus, the score was the total time during the five minute period when the dog was in the correct heeling position. This correct heeling position was defined as bounded by a square on the left of the experimenter; the front edge of the square could be no further forward than the experimenter. The right hand edge of the

square was defined by the experimenter's left side. The boundaries of the square furthest from the experimenter were defined by the length of the lead. In general the dog was scored as being within the correct heeling position if it was to the left of and slightly behind the experimenter and close enough to the experimenter that the lead was somewhat slack. This kept the dog no further than two feet from the experimenter. The experimenter did not know at which time the interval was being scored by the observer. The same observer scored all dogs on all Heeling Tests.

Down, There, Come Tests. The dog's ability to respond to the commands "down," "there," and "come" was measured by simple scales. On the Down Test, the dog was given the command to go down, and given a score of 3 if he went down immediately, 2 if he had to be told "down" a number of times, and 1 if he had to be forced to go down physically. This command and the scoring were given 20 times (10 times by each trainer) and the dog's score was his total number of points.

The There Test score was given in approximately the same way. The dog, while down, was told "there" while the experimenter backed away six paces. If the dog remained there until called he was given 3 points. If he did not remain in the same position, but had to be told several times to stay "there," he was given 2 points. If he came all the way to the trainer in spite of repeated commands to stay "there," he was given only 1 point. This item was repeated 20 times (10 by each trainer) and the dog's score was the total number of points he had obtained.

The Come Test was given while the dog was off the lead running free. The experimenter called the dog to "come" at some point when the

dog was at least 10 feet away from the experimenter. If the dog came immediately, he was given a score of 3 points. If he had to be called a number of times he obtained a scored of 2 points. If he ignored the command or did not come at all, he was given a score of 1 point. This was repeated 20 times (10 by each trainer) and his Come Test score was the number of points he obtained on these 20 repetitions.

Rating Scales. In addition to the performance test scores (Heeling Test scores, Down, There, and Come Test scores, and Approach Trial scores) throughout the training period the dogs were rated on a series of Rating Scales. These rating scales are divided into two parts: the Pre-Trial Ratings and the Post-Training ratings.

Pre-Trial Ratings. On arriving at the pen containing the dog to be worked, the trainer marked the dog's behavior in the pen on five four-point scales: 1) activity--passivity, 2) avoidance--approach, 3) quietness-noisiness, 4) uprightness-crouching, and 5) shyness--friendliness. The trainer then entered the pen and rated the dog again on the same variables while inside the pen with the dog. These two ratings were called, respectively, Pre-trial I and Pre-trial II ratings. When the trainer and the dog left the pen to proceed with training, the dog was rated additionally on his eagerness or reluctance to leave the pen.

Post-Training Ratings. Following each training session the experimenter then rated the dog on the four Post-Training rating scales: Obedience, activity, timidity, and ease of training. Behavior was judged on a five-point scale in each category as shown in Table 2. The numbers in parentheses represent numerical scores which were assigned

to each category.

Table 2

Post-Training Ratings

Obedience:

(0)	(1)	(2)	(3)	(4)
Does not obey	Obeys only after many commands	Obeys fairly well, few commands	Obeys quite well, 2 or 3 commands	Obeys almost instantly

Aggressivity:

(-2)	(-1)	(0)	(+1)	(+2)
Very passive	Quiet but sometimes active	Moderate amount of movement	Active, somewhat aggressive	Aggressive, highly active

Friendliness:

(-2)	(-1)	(0)	(+1)	(+2)
Is afraid--avoids trainer	Stays away much of time	Neither avoids nor seeks out trainer	Frequently comes to trainer	Is friendly, seeks out trainer often

Ease of Training:

(0)	(1)	(2)	(3)	(4)
Does not learn	Learns very slowly	Learns well	Learns quite rapidly	Learns extremely rapidly

CHAPTER IV

RESULTS

The data are presented in the order in which they apply to the hypothesis.

Readiness for contact with Humans

The first hypothesis concerned readiness of the dog to contact and affiliate with humans. The hypothesis was:

I. Border collies will express a readiness for contact and affiliation with humans to the degree that fewer more satisfactory socialization objects were present during the critical period for socialization. Dogs raised under the following conditions during the critical period for socialization should exhibit such readiness, in order from less to more: 1) isolation from humans, with dam and littermates; 2) contact with humans, with dam and littermates; 3) contact with humans, with littermates, isolation from dam; 4) contact with humans, isolation from dam and littermates.

The group means and standard deviations for the three Approach Trials are presented in Table 3 and the trends are presented graphically in Fig. 1.

Since the Approach Trial scores were quite heterogeneous under any transformation attempted, the non-parametric Kruskal-Wallis one-way

Table 3

Means and Standard Deviations of Approach Times

(Units are Seconds)

Group		Approach Trial I	Approach Trial II	Approach Trial III
H	Mean	18.25	41.75	4.00
	S. D.	5.38	53.79	.41
HL	Mean	52.75	35.25	5.25
	S. D.	40.84	56.55	2.63
HDL	Mean	13.50	14.50	10.50
	S. D.	2.08	16.14	9.99
DL	Mean	96.00	62.00	3.17
	S. D.	48.00	51.92	.75

analysis of variance was used upon each Approach Trial separately. This analysis showed that for both the Approach Trials given before training was begun, group differences were significant ($p < .05$). The difference between experimental groups supports the expectation that later affiliation need for humans is significantly affected by experimental treatment during the critical period for socialization, although the rank order of the groups was not as predicted. For the Approach Trial following training the differences between groups were not significant, since all groups were performing near their physical limit in covering the 25-foot distance between cage and experimenter.

Trainability: Performance Tests

Hypothesis II: The second hypothesis stated: Later trainability

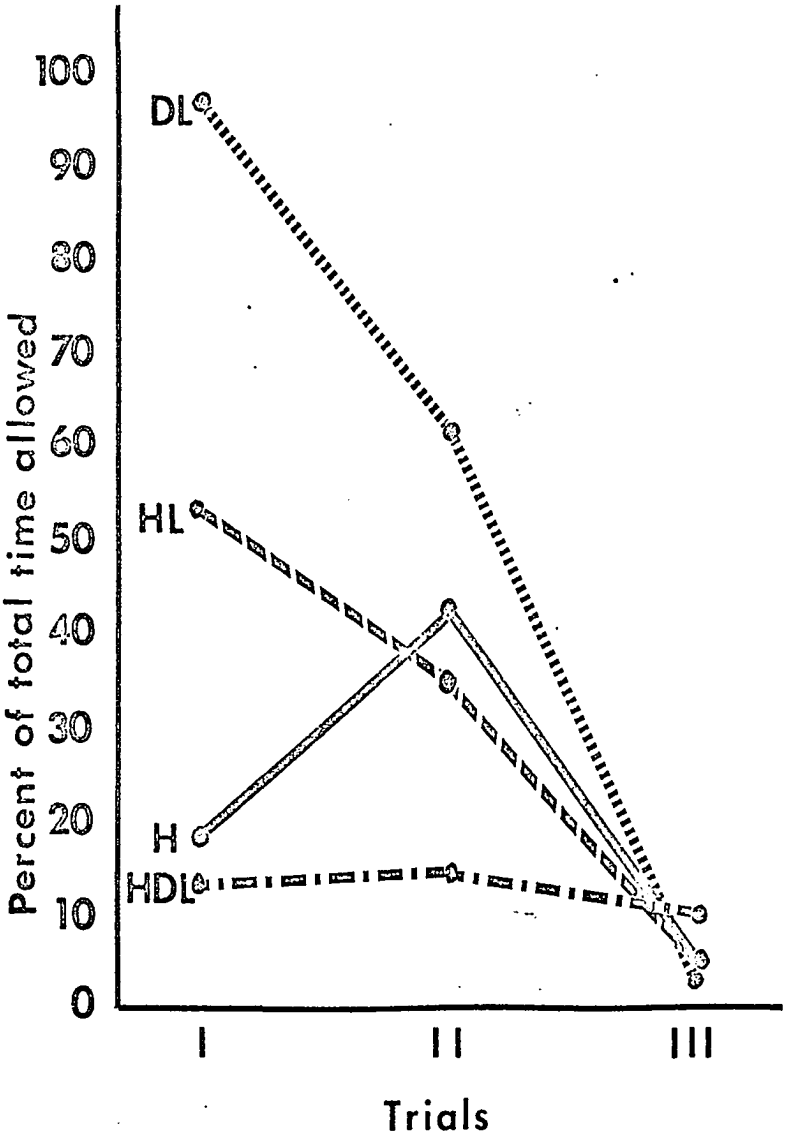

Fig. 1. Approach times: Mean percent of total time allowed for each group immediately before gentling, immediately after gentling, and following training.

in the border collie will be affected by amount and kind of contact with humans during the critical period for socialization, greater trainability being associated with fewer more satisfactory socialization objects present. Dogs raised under the following conditions during the critical period for socialization should exhibit trainability in order from less to more: 1) isolation from humans, with dam and littermates; 2) contact with humans, with dam and littermates; 3) contact with humans, with littermates, isolation from dam; 4) contact with humans, isolation from dam and littermates.

Heeling Test. One of the measures of trainability was obtained from the Heeling Test scores. Heeling Test scores did not meet the demand of homogeneity of variance until transformed into radians. The means and standard deviations of the transformed heeling times are presented in Table 4 and the trends are shown graphically in Fig. 2.

The analysis of variance of heeling-time scores is presented in Table 5. The overall difference between groups (G) is significant ($p < .05$) and the overall difference between trials (T) is significant ($p < .01$). It may be seen in Fig. 2 that groups tend to converge on a near perfect scoring level yet the groups by trials interactions (G x T, Table 5) was not significant.

Differences between groups on Heeling Test scores were significant which favors the notion that early experience has effects on later trainability. However, the order predicted from least to most was DL, HDL, HL, H, while the actual order of group means on Test I was DL, H, HDL, HL (Fig. 2).

Down, There and Come Tests. The concurrent reliability of the

Table 4

Means and Standard Deviations of Transformed Heeling Test Scores, After Two and Three Weeks of Training

(Radians)

Group		Test I	Test II
H	Mean	2.1178	2.7686
	S. D.	.163	.167
HL	Mean	2.8645	2.8203
	S. D.	.122	.162
HDL	Mean	2.5972	2.8774
	S. D.	.148	.126
DL	Mean	1.8696	2.4398
	S. D.	.874	.389

Table 5

Analysis of Variance of Transformed Heeling Test Scores

Source	d.f.	MS	F	p
Total	31			
Between Subjects	15			
Groups (G)	3	.768	4.60	.05
Error (b)	12	.167		
Within Subjects	16			
Trials (T)	1	1.061	11.14	.01
G x T	3	.199	2.09	- -
Error (w)	12	.095		

Down, There, and Come Tests was tested by having two judges observe and independently rate the performance of the dogs on each test. The intra-class correlations between the two judges for the Down, There, and Come

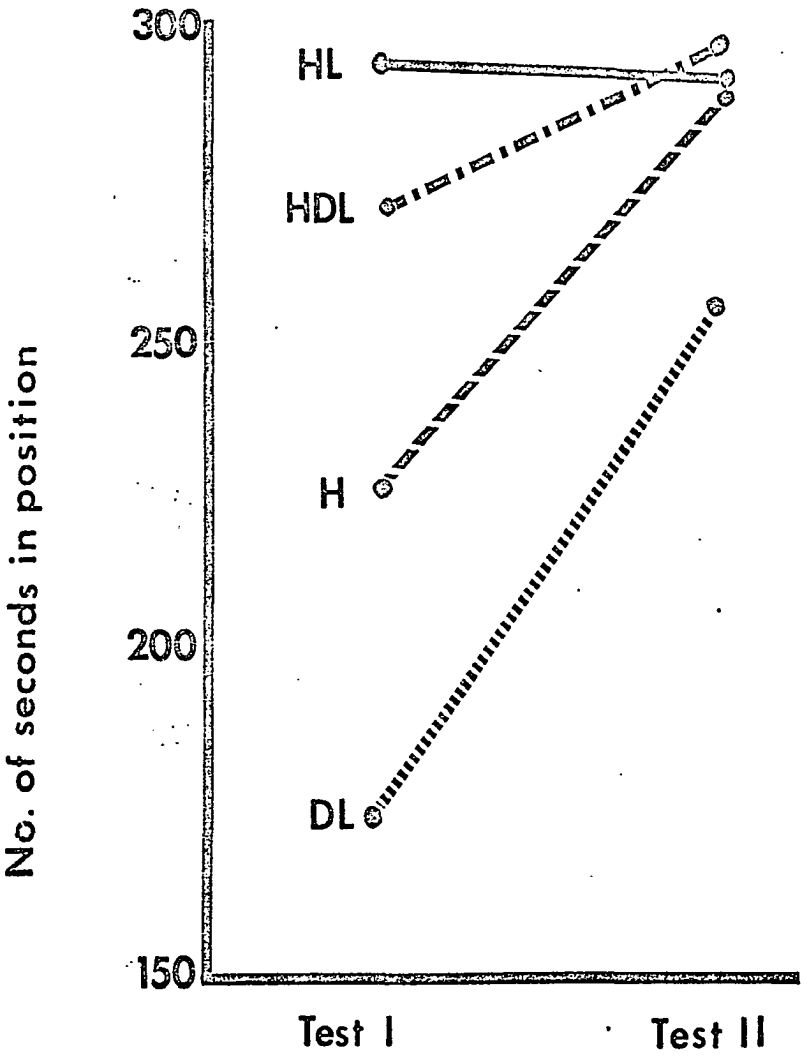

Fig. 2. Heeling times: Mean number of seconds in correct heeling position for each experimental group after two weeks and three weeks of training.

Tests were .987, .985, and .998 respectively, indicating that the techniques are reliable and that others should be able to apply the technique in a comparable way.

Down Test scores were too heterogeneous to meet the assumptions appropriate to the analysis of variance technique, even after transformations; consequently, the non-parametric Kruskal-Wallis one-way analysis of variance was used. The means and standard deviations of the Down Test scores are presented in Table 6.

Table 6

Means and Standard Deviations of Down Test Scores

Group		Test I	Test II
H	Mean	58.25	58.75
	S. D.	2.22	1.26
HL	Mean	60.00[a]	59.50
	S. D.	0.0	.50
HDL	Mean	49.50	58.50
	S. D.,	6.56	1.73
DL	Mean	53.75	55.00
	S. D.	6.84	3.16

[a]All dogs in this group received perfect scores.

The results of the Kruskal-Wallis analysis are given in Table 7.

Tests for homogeneity of variance on There Test scores revealed heterogeneity of variance. Under all transformations, subsequent tests for homogeneity of variance indicated that the homogeneity assumption could not be met. The means and standard deviations of the There Test

Table 7

Kruskal-Wallis One-Way Analysis of Variance for Down Test Scores

	H	p
Trial 1	10.47	.05
Trial 2	5.86	- -
Trials 1 + 2	9.79	.05

scores are presented in Table 8. The non-parametric Kruskal-Wallis one-way analysis of variance was applied to the original data. The results of this analysis are given in Table 9.

Table 8

Means and Standard Deviations of the Transformed There Test Scores

(Radians)

Group		Test I	Test II
H	Mean	2.8550	2.9235
	S. D.	.116	.048
HL	Mean	2.7586	2.8755
	S. D.	.091	.129
HDL	Mean	2.2599	2.7026
	S. D.	.333	.136
DL	Mean	2.5399	2.7888
	S. D.	.564	.124

The scores on the final objective test, the Come Test, met the homogeneity assumption for the analysis of variance technique. The

Table 9

Kruskal-Wallis One-Way Analysis of Variance for *There* Test Scores

	H	p
Trial 1	8.42	.05
Trial 2	7.05	- -
Trials 1 + 2	8.74	.05

means and standard deviations of the *Come* Test scores are presented in Table 10.

Table 10

Means and Standard Deviations of *Come* Test Scores

Group		Test I	Test II
H	Mean	54.75	56.00
	S. D.	4.99	3.74
HL	Mean	58.50	59.75
	S. D.	1.41	1.50
HDL	Mean	49.75	54.25
	S. D.	6.75	6.02
DL	Mean	52.50	50.25
	S. D.	2.38	3.50

The results of the analysis of variance of *Come* Test scores are given in Table 11.

For *Down*, *There* and *Come* Tests, it was found that early experience with humans during the critical period for socialization significantly affects later trainability.

Table 11

Analysis of Variance of
Come Test Scores

Source	d.f.	MS	F	p
Total	31			
Between Subjects	15			
Groups (G)	3	101.78	4.14	.05
Error (b)	12	24.59		
Within Subjects	16			
Trials (T)	1	11.28	.976	--
G x T	3	15.19	1.31	--
Error (w)	12	11.553		

Individual comparisons of the *Down* Test scores, using Fisher's exact method and a pass-fail criterion of 58 out of 60 possible points per dog, revealed that only the DL and HDL vs. HL and H comparison was significant ($p < .001$). Individual comparisons of the *There* Test scores using the Scheffé multiple comparison technique show that only the same grouping (DL and HDL vs. HL and H) is marginally significant ($.10 > p > .05$). The same grouping of *Come* Test scores was found to be the only significant grouping using the Scheffé test ($p < .05$). The HL and H groups, therefore, are consistently better trained as predicted, while DL and HDL consistently learned less well. Thus, the presence of the dam during the critical period for socialization seems to be an important variable while other possible groupings do not yield equally consistent or significant results.

The hypothesis received partial support, in that trainability as measured by *Down*, *There* and *Come* Tests was significantly affected by ex-

perimental conditions, and it can be seen that while the hypothesis was not supported as to specific order of groups, the only consistent differences found (between DL and HDL vs. HL and H) were in the predicted direction.

General Behavior Traits

The third hypothesis stated:

III. General behavior traits and characteristics of border collies will vary with the kinds of experience afforded the dog during the critical period for socialization.

The rating scales, Pre-Trial Tests I and II and Post-Training Ratings, were intended to identify general behavioral characteristics which might be affected by the experimental conditions. The rating scale scores were divided into two parts: The Pre-Trial ratings made on arrival of the trainer at the dog's pen at the beginning of the training session and the Post-training ratings made following the completion of each training session. The Pre-Trial ratings and Post-training ratings were based on descriptive items of behavior of the dog, not on his ability to perform in some fashion. Thus, these ratings may help clarify the manner in which early experience affects the general behavior of the dog.

The reliability of the Pre-Trial ratings was tested by the concurrent method, that is, having both judges simultaneously and independently rate the dog on each of the six Pre-Trial scales under two conditions: One set of ratings was given with the judge outside the pen and the second set with him inside the pen. The ratings given outside the pen were called Pre-Trial I ratings; the ratings inside the pen

were called Pre-Trial II ratings. The intraclass correlations between judges are given in Table 12.

Table 12

Intraclass correlations between judges on concurrent Pre-Trial I and Pre-Trial II ratings

Scale	Pre-Trial I		Pre-Trial II	
	R	p	R	p
Activity	.805	.01	.870	.01
Avoidance	.899	.01	.966	.01
Shyness	.65	.01	.57	.01
Quietness	.35	- -	- -	- -
Uprightness	.55	.05	.07	- -
Leave Pen			.889	.01

The Pre-Trial scales consisted of the following items, each rated on a four-point continuum: active--calm, avoidant--comes near, shy--friendly, quiet--noisy, and upright--crouches. Except for Quietness and Uprightness scales, the trainers were able to develop independently a fairly consistent set of criteria as is demonstrated by the reliability scores. Since the Pre-Trial ratings were given throughout the training process, in order to determine the extent and direction of change, the final scores for each dog were in three parts, representing the first, middle, and last thirds of training. These scores were constructed from the first, middle, and last pairs of scores given by one of the trainers. All sets of scores were homogeneous.

The means and standard deviations of the Activity scale scores for each third of the training period are presented in Table 13.

Analysis of variance of Activity scale scores is presented in

Table 13

Means and Standard Deviations of Activity Scale Scores for Each Third of the Training Period[a]

Group		First Third	Second Third	Final Third
H	Mean	5.25	5.38	5.63
	S. D.	1.670	1.407	1.058
HL	Mean	7.00	5.13	4.38
	S. D.	.926	1.356	1.058
HDL	Mean	7.00	5.50	5.13
	S. D.	.926	1.722	1.959
DL	Mean	5.75	6.38	5.38
	S. D.	2.375	1.924	2.445

[a]Higher scores reflect greater activity.

Table 14. The overall difference between groups (G) was not significant while overall differences between Thirds of Training (Th) were significant. Differences between Pre-Trial I and Pre-Trial II tests (Te) were not significant overall.

The only test of interaction which was significant was between groups over thirds of training (G x Th). This interaction reflects the differential change in activity by groups over thirds of training which may be seen graphically in Fig. 3.

The means and standard deviations of the Avoidance scale scores are presented in Table 15 and the trends are depicted graphically in Fig. 4. Table 16 contains the results of the analysis of variance of the Avoidance scores. The overall difference between groups (G) was not significant. Differences between tests (Te) and thirds of training (Th)

Table 14

Analysis of Variance of Activity Scale Scores

Source	d.f.	MS	F	p
Total	95			
Between Subjects	15			
Groups (G)	3	1.14	.088	- -
Error (b)	12	12.97		
Within Subjects	80			
Thirds (Th)	2	9.69	8.50	.01
Tests[a] (Te)	1	.04	.035	- -
Th x Te	2	.14	.123	- -
G x Te	3	.123	.11	- -
G x Th	6	5.13	4.50	.01
G x Th x Te	6	.177	.158	- -
Error (w)	60	1.14		

[a]"Tests" refers to Pre-Trial I vs. Pre-Trial II.

Table 15

Means and Standard Deviations of Avoidance Scale Scores for Each Third of the Training Period

Group		First Third	Second Third	Final Third
H	Mean	5.25	4.25	3.88
	S. D.	1.035	1.488	1.246
HL	Mean	3.38	5.50	5.38
	S. D.	2.066	2.268	.744
HDL	Mean	3.75	4.88	4.75
	S. D.	2.252	1.807	1.282
DL	Mean	5.13	3.13	5.00
	S. D.	3.091	1.356	1.927

Note: Higher scores reflect greater degrees of avoidance

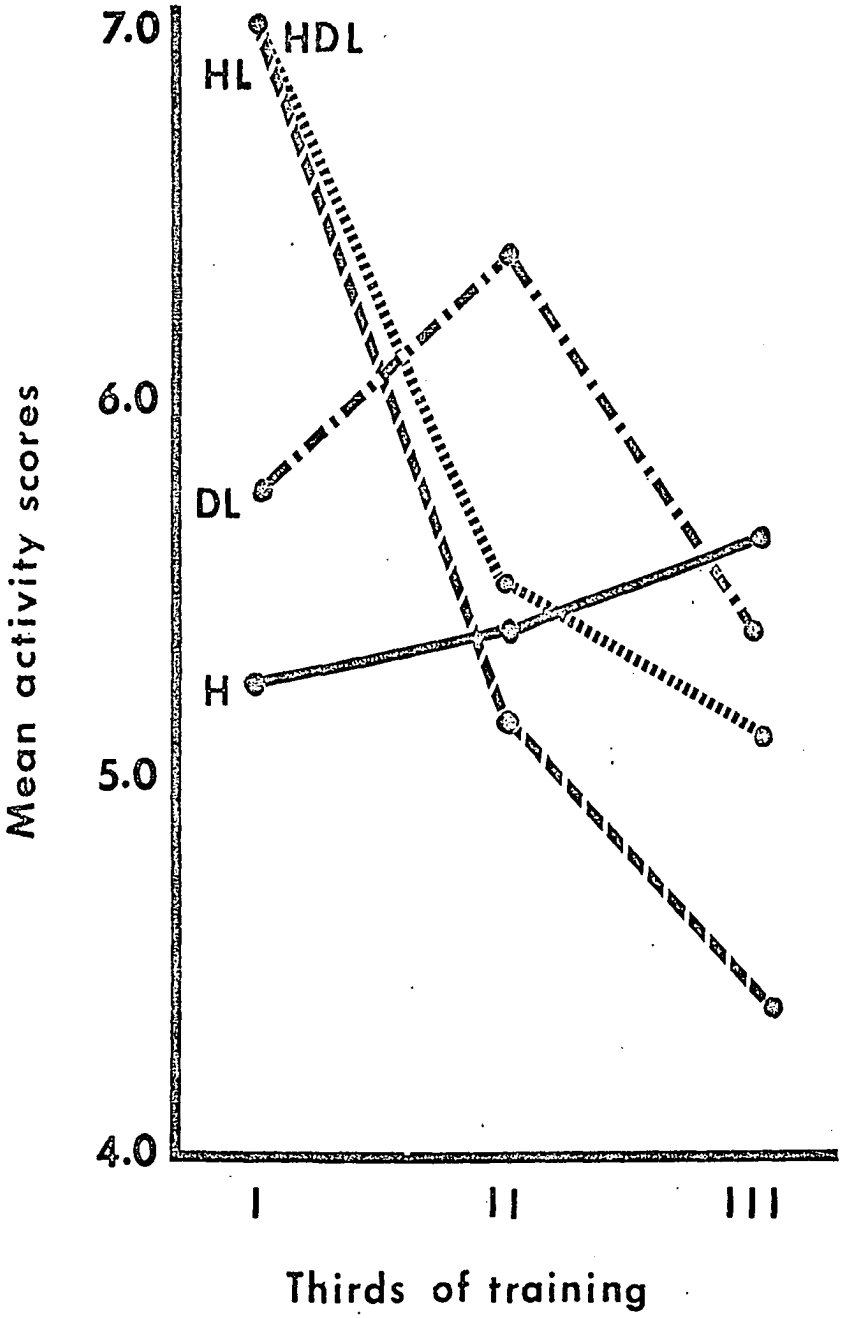

Fig. 3. Mean activity scores for each experimental group for the first, middle and final thirds of the training period.

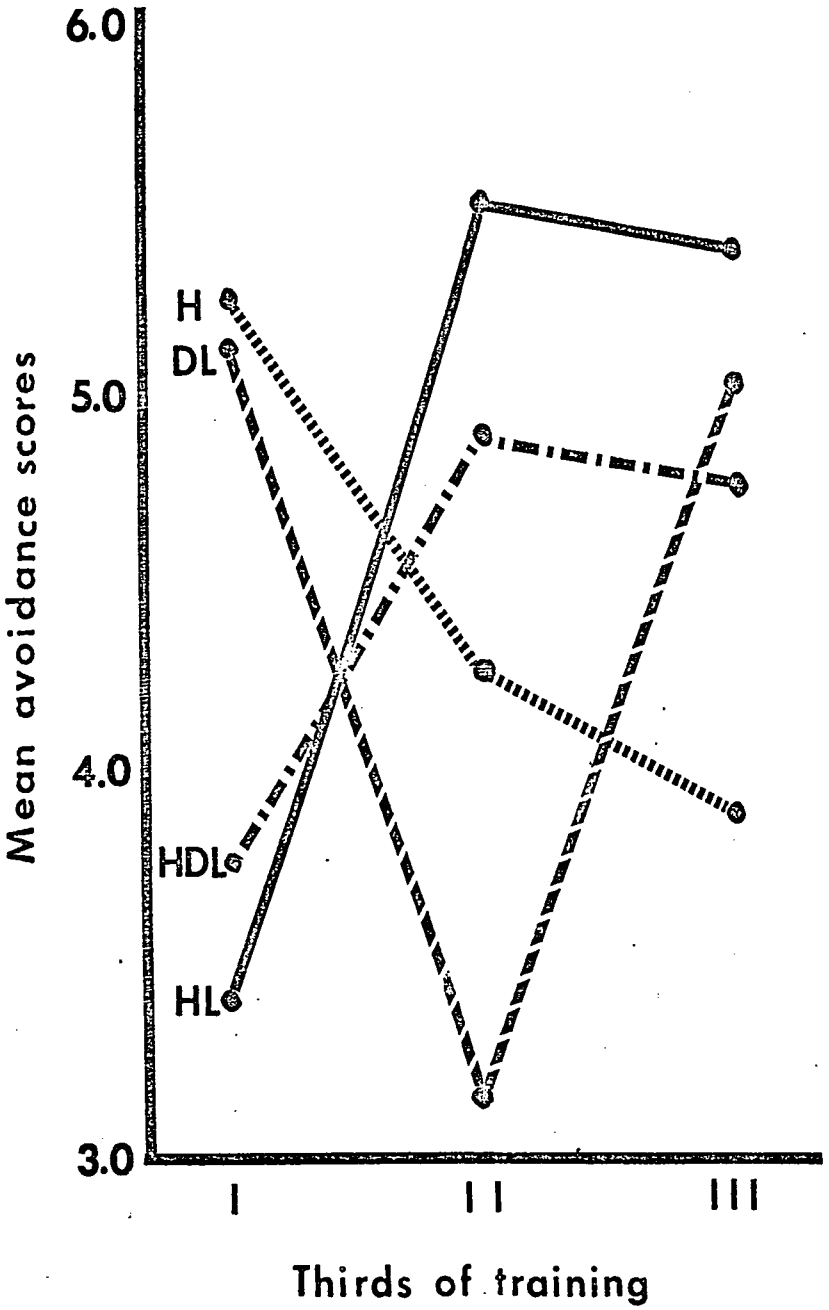

Fig. 4. Mean avoidance scores for each experimental group for the first, middle and final thirds of the training period.

Table 16

Analysis of Variance of Avoidance Scale Scores

Source	d.f.	MS	F	p
Total	95			
Between Subjects	15			
Groups (G)	3	.8	.067	- -
Error (b)	12	12.14		
Within Subjects	80			
Thirds (Th)	2	1.1	.52	- -
Tests[a] (Te)	1	3.0	1.41	- -
Th x Te	2	.95	.45	- -
G x Te	3	1.13	.53	- -
G x Th	6	8.63	4.05	.01
G x Th x Te	6	.35	.16	- -
Error (w)	60	2.13		

[a]"Tests" refers to Pre-Trial I vs. Pre-Trial II.

were not significant. Of the interaction effects, only the interaction concerning group differences over thirds of training (G x Th) was significant ($p < .01$). This interaction reflects differential change in avoidance by groups over the thirds of training, which is depicted graphically in Fig. 4.

The means and standard deviations of Shyness scale scores are presented in Table 17 and the trends are presented graphically in Fig. 5.

The analysis of variance of Shyness scale scores is shown in Table 18. The overall difference between groups (G) was not significant; differences between tests (Te) and thirds of training (Th) were also not significant. Of the interaction effects, the only significant finding was between groups over thirds of training (G x Th). This interaction

Table 17

Means and Standard Deviations of Shyness Scale Scores for Each Third of the Training Period

Group		First Third	Second Third	Final Third
H	Mean	3.25	2.63	2.63
	S. D.	1.035	.744	.517
HL	Mean	2.88	3.63	4.50
	S. D.	1.457	1.847	1.195
HDL	Mean	2.50	2.88	3.38
	S. D.	.756	1.126	1.302
DL	Mean	3.63	2.13	3.13
	S. D.	2.722	.111	.990

Note: Higher scores reflect greater degrees of shyness.

Table 18

Analysis of Variance of Shyness Scores

Source	d.f.	MS	F	p
Total	95			
Between Subjects	15			
Groups (G)	3	3.57	.62	- -
Error (b)	12	5.80		
Within Subjects	80			
Thirds (Th)	2	2.85	2.52	- -
Tests[a] (Te)	1	1.76	1.56	- -
Th x Te	2	.51	.45	- -
G x Te	3	.54	.48	- -
G x Th	6	3.23	2.86	.05
G x Th x Te	6	.79	.70	- -
Error (w)	60	1.13		

[a]"Tests" refers to Pre-Trial I vs. Pre-Trial II.

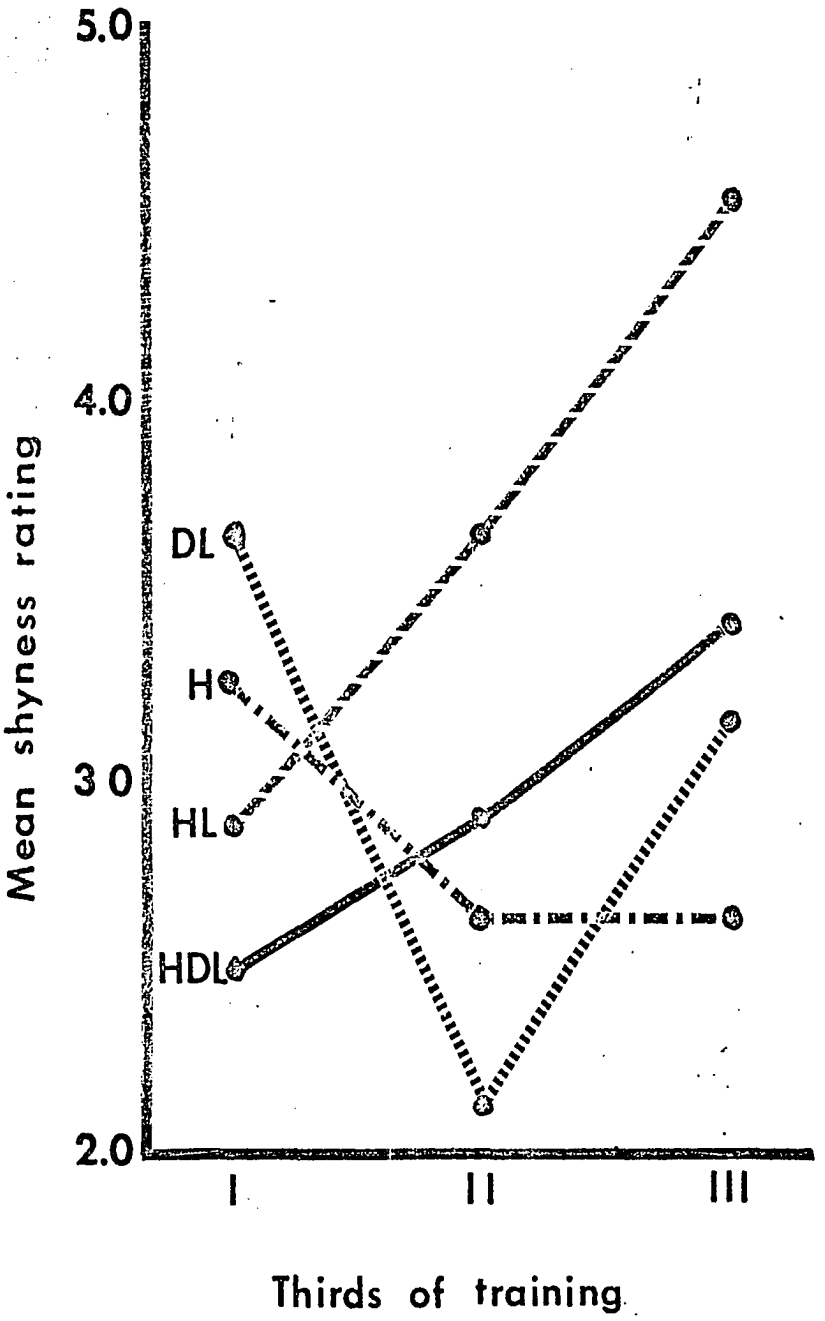

Fig. 5. Mean shyness scores for each experimental group for the first, middle and final thirds of the training period.

reflects differential change in shyness by groups over the thirds of training, which is depicted in Fig. 5.

The Quietness scores were not analyzed, both because of the extremely low reliability, and because it became apparent that all of the dogs in this experiment scored consistently at the extreme "quiet" end of the scale.

Although the reliability of the Uprightness scale scores was low, this particular variable seemed to be important for theoretical reasons, since the tendency of the dog to crouch when the trainer enters the pen is probably related to dominance relations, as well as territoriality, and so forth.

Means and standard deviations of Uprightness scale scores are presented in Table 19. An analysis of variance was performed on this

Table 19

Means and Standard Deviations of Uprightness Scale Scores for Each Third of the Training Period

Group		First Third	Second Third	Final Third
H	Mean	6.75	6.50	6.38
	S. D.	1.488	1.773	1.767
HL	Mean	6.13	5.75	6.50
	S. D.	2.475	2.659	2.268
HDL	Mean	5.63	4.38	5.25
	S. D.	2.134	2.326	2.053
DL	Mean	4.88	5.38	5.75
	S. D.	2.100	1.767	1.035

Note: Higher scores reflect greater uprightness.

data, the results of which are shown in Table 20. The overall difference between groups (G) was not significant; the differences between thirds of training (Th) were also not significant. The overall differences between tests were highly significant ($p < .0001$), reflecting a great deal of change in the dog's behavior along the uprightness--crouching dimension when the trainer entered the dog's pen.

Table 20

Analysis of Variance of Uprightness Scale Scores

Source	d.f.	MS	F	p
Total	95			
Between Subjects	15			
Groups (G)	3	11.07	1.32	- -
Error (b)	12	8.37		
Within Subjects	80			
Thirds (Th)	2	1.88	.74	- -
Tests[a] (Te)	1	63.38	24.85	.0001
Th x Te	2	7.03	2.76	.10
G x Te	3	2.07	.81	- -
G x Th	6	1.46	.57	- -
G x Th x Te	6	1.69	.66	- -
Error (w)	60	2.55		

[a]"Tests" refers to Pre-Trial I vs. Pre-Trial II.

Of the interaction effects, only the differences between tests over the training period (Th x Te) was even marginally significant ($.10 > p > .05$). This indicates that the dog's response to the trainer entering the pen along this dimension changed during the course of training.

Means and standard deviations of Eagerness to Leave the Pen Scale scores are presented in Table 21.

Table 21

Means and Standard Deviations of Eagerness-to-Leave-Pen Scale Scores for Each Third of the Training Period

Group		First Third	Second Third	Final Third
H	Mean	4.50	5.00	5.25
	S. D.	2.646	2.160	2.217
HL	Mean	3.75	3.75	4.50
	S. D.	2.062	2.062	2.082
HDL	Mean	3.00	5.50	5.25
	S. D.	.817	2.646	3.202
DL	Mean	3.75	7.25	4.75
	S. D.	.958	.958	2.500

Note: Higher scores reflect greater eagerness to leave the pen.

The results of the analysis of variance of Eagerness-to-leave scale scores are shown in Table 22. Since no significant differences were found this variable does not seem to be affected by experience with humans during the critical period for socialization.

Considering the data for all the rating scales, the general trends over the training period seemed to be toward less activity (except for group H), greater shyness (except for group H), and greater avoidance (except for group H). Group H became more active, friendly, and approached more during the course of training.

Table 22

Analysis of Variance of Eager-to-Leave Scale Scores

Source	d.f.	MS	F	p
Total	47			
Between Subjects	15			
Groups (G)	3	3.41	.84	- -
Error (b)	12	4.06		
Within Subjects	32			
Thirds (Th)	2	11.31	2.31	- -
G x Th	6	3.54	.72	- -
Error (w)	24	4.89		

Post-Training Ratings

The Post-Training Rating scales for two of the trainers were examined for reliability. Since trainers gave ratings on alternate days, this situation approximates the test-retest technique for assessing reliability. The reliability scores reported in Table 23 are based on Post-Training Ratings during the first three weeks of training.

Table 23

Intra-Class Correlations Between Judges on Post-Training Ratings

Scale	R	p
Obedience	.717	.01
Aggressivity	.215	- -
Friendliness	-.35	- -
Ease of Training	.359	- -

The means and standard deviations of the Post-Training Ratings are presented in Table 24. These data are means of 18 scores per dog

Table 24

Means and Standard Deviations of the Post-Training Ratings

Scale	H		HL		HDL		DL	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Obedience	1.83	.346	2.89	.400	2.30	.557	1.72	.900
Aggressivity(dev)[a]	2.83	.100	3.26	.152	3.27	.114	2.84	.594
Friendliness(dev)[a]	2.44	.164	2.84	.182	2.87	.152	2.77	.114
Ease of Training	1.84	.200	3.03	.500	2.57	.472	2.11	.785
Experimenter Preference	2.29	.164	3.08	.566	2.63	.309	2.34	.592
Trainer Preference	2.52	.224	2.86	.182	2.45	.283	2.12	.592
Observer Preference	1.50	.230	3.07	.130	3.21	.173	2.59	.630

[a]Aggressivity and Friendliness scales are presented as deviations from zero on a bipolar scale (-2, -1, 0, +1, +2) where zero is a judged optimum.

taken throughout six weeks of training. Although the reliability was satisfactorily high for only one of the variables, the data from all four variables plus the composite score were subjected to the analysis of variance technique. (All sets of scores met the requirements for homogeneity of variance.) The results of these analyses of variance are reported in Table 25.

Group differences are shown graphically in Fig. 6. As can be seen, the relative position of groups stays the same across scales. Groups H and DL are consistently rated poorest, while HL is consistently the best rated and HDL is generally second best.

When the direction of sign, rather than deviation scores on Post-

Table 25

Analysis of Variance of Post-Training Ratings

Source	d.f.	MS	F	p
		Obedience		
Total	15			
Treatments	3	1.135	3.118	.10
Within groups	12	.364		
		Aggressivity (dev)		
Total	15			
Treatments	3	.261	2.688	.10
Within groups	12	.097		
		Friendliness (dev)		
Total	15			
Treatments	3	.178	8.44	.005
Within groups	12	.021		
		Ease of Training		
Total	15			
Treatments	3	1.099	3.907	.05
Within groups	12	.281		

Training scales were considered, on group differences the Aggressivity and Friendliness scales were non-significant.

In order to determine how the experimenter, trainer and observer rated each group in general, the ratings for each dog were recalculated in terms of their deviation from the best point on each scale, the "best" rating on each scale being scored zero, and increasing scores with increasing deviation from this position. The scores could then be summed across scales to get a mean deviation score for each dog and rater; the greater the deviation score the greater the deviation from optimal of

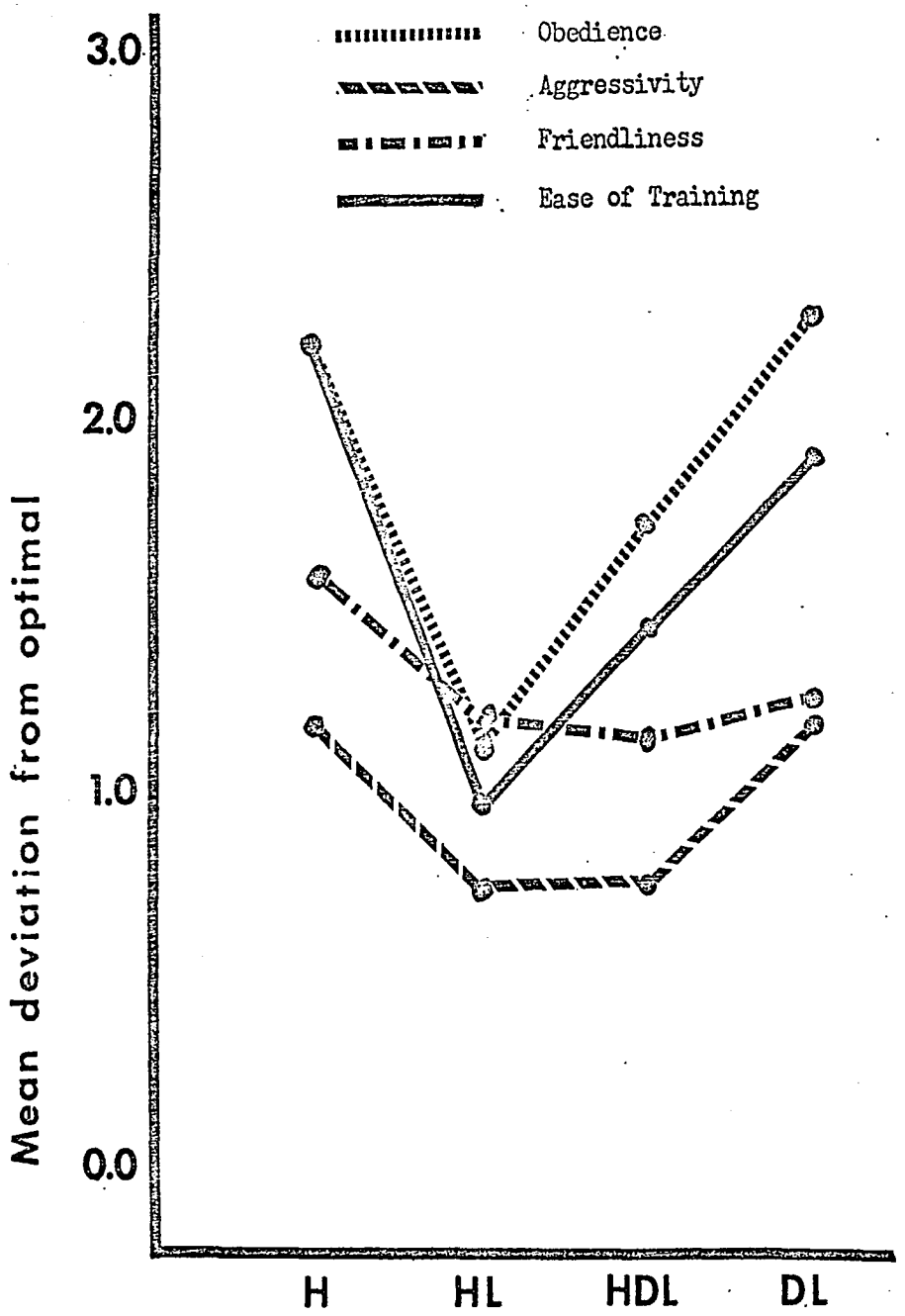

Fig. 6. Mean deviation from best score on Post-trial rating scales for each experimental group.

the dog's rated performance. This deviation score was reversed by subtracting it from 4.00, thus giving a trainer preference scale in which higher scores reflect greater positive rating by the trainer. These scores were also given in Table 24. The preference scores were treated by the analysis of variance technique to determine of the liking or disliking of dogs by trainers and observer were related to group differences. The results of the analysis are given in Table 26. From these results it is clear that each trainer not only distinguished between groups in terms of liking or disliking, but that each trainer had his own individual preferences which were not the same as those of the other trainers.

Table 26

Analysis of Variance of Trainer and Observer Preference Ratings[a]

Source	d.f.	MS	F	p
Total	47			
Between Subjects	15			
Groups (G)	3	1.94	5.72	.05
Error (b)	12	.339		
Within Subjects	32			
Trainers	2	.035	.551	- -
G x Trainers	6	.650	10.09	.01
Error (w)	24	.063		

[a]Values analyzed on summed scores from Obedience, Aggressivity, Friendliness, and Ease of Training scales.

In general the highly subjective Post-Training ratings indicated the reactions of the trainers differed among the experimental groups. The lack of reliability between trainers on these scales may reflect the

tendency of trainers to react differentially to dogs raised under the various experimental conditions. For a single trainer, the ratings may be more consistent. The fact that trainers' preferences were significantly different over groups, and the significant group differences for all Post-Training rating scales suggests that the scales, as used, are valid.

Since most of the variables describing general behavioral characteristics were significantly different for the experimental groups, it can be considered that the third hypothesis was supported. That is, general behavioral traits are significantly affected by conditions during the critical period for socialization.

Relationship between Trainability and Affiliation With Humans

The fourth hypothesis stated: Trainability of border collies should be positively related to their readiness to engage in contact and affiliation with humans.

The hypothesis that trainability in border collies is directly related to affiliation need for humans was tested by correlating Approach Test scores with the objective performance scores. The failure to find a significant correlation indicates that the hypothesis is not supported.

Relation between Performance Scores and Rating Scales

Finally, it was considered of some interest to correlate the various measures of performance, both performance scores and rating scales. Since the rating scale scores were complete before the performance scores were obtained, a significant correlation between the two sets

would suggest in what way performance might be predicted by rating scale estimates. Additionally, a significant correlation between individual trainer's preferences and actual performance of the dog might suggest that trainer behavior differed in some way toward favored or disliked dogs so as to produce differential performance. Finally, the Uprightness score describing behavior of the dog in the cage was thought to be possibly relevant to learning ability. All significant correlations are included in Tables 27 and 28.

Table 27

Correlations Between Scores

Scale	Rating Scales					Preference		
	Obed.	Aggr.	Friend.	E. Tr.	Upr.[a]	Exp.	Tr.	Obs.
Obedience	X	-.801		.935		.939	.753	.598
Aggressivity Deviation		X		-.837		-.750	-.757	-.718
Friendliness Deviation			X		.670			-.689
Ease of Training				X		.941	.699	.658
Uprightness[a]					X			-.449
Experimenter Preference						X	.665	.604
Trainer Preference							X	
Observer Preference								X

[a]Score on Pre-Trial I and II Uprightness scales.

Only two significant correlations were found between the rating scales and the performance scores: Obedience and Heel Scores; Obedience

Correlations Between Scores--Continued

Scale	Performance Scores				
	Heel	Down	There	Come	Ap. T.
Obedience	-.460			.568	
Aggressivity Deviation					
Friendliness Deviation					
Ease of Training					
Uprightness[a]		.487	.416		.452
Experimenter Preference				.515	
Trainer Preference				.420	
Observer Preference					
Heel	X	.547			
Down		X	.783		
There			X		
Come				X	
Approach Time					X

[a]Score on Pre-Trial I and II Uprightness scales.

and Come Scores. The failure to find other correlations suggests that most of the rating scale scores have little to do with actual performance of the dog. The correlation between the Obedience ratings and Heeling Test scores was negative, which indicates surprisingly, that the poorer the Obedience rating, the better the Heeling time tends to be.

The Come Test score was also correlated with the experimenter and trainer preference; it might be posited that both Come Test score and

trainer preference score might be a function of some positive relationship between dog and trainer. The general independence of trainer preferences and performance of the dog on other objective tasks suggests that the trainers' feelings about the dog have little or nothing to do with the way in which the dog learns. The strongest relationship is between uprightness and deviation scores on the Friendliness scale. Similar to classical "U" curve phenomena, uprightness may be associated either with great friendliness or unfriendliness.

Down Test scores tend to be highly correlated with Heeling Test scores and There Test scores, suggesting that these tasks may involve common learning factors. The Come Test score was independent from the remaining performance test scores suggesting that this task involves few or no dimensions common to the other performance tests. The only rating scales that directly related to performance scales to any degree were the Uprightness score (from the Pre-Trial ratings) and the Obedience score. As can be seen, the Uprightness of the dog was correlated with his ability to learn to "go down" on command, and to "stay there"; in addition the approach time tended to be slower with greater uprightness of the dog.

Summary of Results

In summary, all but the fourth hypothesis received at least partial support. The second hypothesis, most crucial to the position developed in this paper, was supported in all but the specific prediction as to the ordering of groups. The two groups predicted to be most trainable (H and HL) were in fact superior on performance tests,

and the two predicted to be poorest (HDL and DL) were, in fact, the poorest performers. Not supported was the prediction that trainability would be in the order of H, HL, HDL, and DL on all tasks, since the order varied from task to task except as just described.

CHAPTER V

DISCUSSION

Affiliative behavior. The scores on the Approach Trials may be taken either as a measure of need for contact with humans or as a measure of the dog's ability to express a need, which may be the same for all groups. It was originally inferred that dogs which did not readily come to the experimenter under the conditions of the Approach Trials were exhibiting little need for people. However, in view of the behavior of the dogs, an alternative point of view should be considered. The slowest times on this test were obtained, as expected, from the dogs in Group DL, who were isolated from humans during the first eight weeks of their life. These dogs, however, did not avoid humans, and in fact seemed to relate to humans with marked intensity; when being handled the dogs in Group DL exhibited strong signs of interest, including extremely active licking, trembling, rigidity and urination. It might be suggested that these dogs simply had not had experience in how to handle what appeared to be almost overwhelming feelings until some training had gone on. It is worthy of note, for instance, that the dogs in Group DL were the fastest in approaching humans following training, although this difference was not significant.

The failure to find a significant relationship between affiliative

behavior and performance on training tasks is of particular interest. One can draw the obvious conclusion that the dog's early affiliative behavior as expressed through his readiness to approach the experimenter has little or nothing to do with his ability to learn from humans. This finding will be somewhat surprising to professional trainers of dogs.

Another possibility follows from the finding that the differences between groups on the Approach Trials diminished to non-significance and near identity by the completion of training. Since most training test scores were given toward the end of training, it may be that the failure to find a relationship between Approach Times and Training test scores was due to the decreasing differences between groups on Approach Trials through the course of training.

In addition, the failure of subjective ratings reflecting positive or negative feelings by the trainers for the dogs to be related to later performance indicates that a positive relationship between trainer and dog, on the part of either dog or trainer, has nothing to do with how well a dog can learn from a trainer.

Trainability. Two of the findings in this study have caused some doubt to be thrown on the idea that there is a general trait of trainability. The inconsistency of a particular group's level of performance and the inconsistency of the performance of a particular dog suggests that different kinds of abilities are involved with each training task. A factor analysis of the performance of dogs on various training tasks by Anastasi, Fuller, Scott & Schmitt (1955) suggests the presence of five general factors: Activity, impulsiveness, docility or responsiveness to human trainer, manipulation, visual observation, and persistence

of positional habits. Further experimentation to determine if and how these factors are modified by early experience with humans would be of considerable interest.

Scattergrams of paired performance scores for each group suggested that the kinds of relationships between performance test scores were, at least in part, a function of the conditions of early experience. No conclusions were drawn, however, due to the smallness of the groups. Future experiments in which the stimulus conditions are held constant during the critical period for socialization, may find quite different correlations between performance test scores. Massing the data across groups, as was necessary in this experiment, may tend to conceal correlations.

Dominance as an intervening variable. The Uprightness score was significantly related to a number of the performance scores, including the Approach Trial scores and Down and There Test scores. Since the Uprightness score spanned a continuum of behaviors ranging from uprightness to crouching, it is a reasonable supposition that the Uprightness variable is related to dominance-submission relationships between trainer and dog. Thus it is not surprising to find Uprightness related to the Friendliness (deviation) rating scale or to the affiliative behavior as measured by the Approach Trial. On the applied level, many dog trainers have held that dominance of the trainer had to be established before training could take place. It is therefore somewhat unexpected to find that the greater the tendency of the dog to show submissive, crouching behavior, the poorer his performance on the Down and There tests. Paradoxically, the greater the tendency of the dog to crouch in response to humans the more difficult it is to teach the dog to "down" or to "stay

there" on command. It may be that a more readily frightened or "cowed" dog is more difficult to train.

There remain two possibilities: One, that dominance of the trainer is negatively related to the training process, or two, that there is some optimal range of dominance-submission for maximal success in training, and that too much dominance by the trainer (or too much submission by the dog) is detrimental to the training process. This problem could be settled relatively easily, given enough subjects.

Isolation and trainability. Of the two groups that were generally superior (Groups H and HL), Group HL, the human plus littermates group, was generally superior to Group H, the humans only group. This finding would not have been predicted by the theory presented in this paper. One would have expected the group with no other socialization-objects than humans (Group H) to show greater readiness to approach humans and consequently greater learning, but this was not the case. A possible answer may be found in a recent study by Harlow & Harlow (1962) in which they demonstrated with young chimpanzees that the otherwise crippling effects of isolation from their mother could be mitigated by the presence of littermates. It will be recalled that Group H in the present experiment was entirely isolated during the critical period for socialization except for handling by humans during approximately one hour out of 24. It is entirely possible, therefore, that this group suffered more from long periods of social isolation and relative absence of contact, but that longer and more frequent periods of contact with humans would have produced the predicted results. It seems likely that one of the crucial elements of the critical period for socialization is simply contact

comfort. For Group HL, it may be that the presence of littermates modified the dis-integrating effects of isolation while still providing an increased socialization response toward humans. Future experiments should attempt to control amount of contact across groups.

Some variables affecting socialization. There now seem to be at least three factors which strongly affect the process of socialization. The amount of exposure to an appropriate stimulus-object during the critical period for socialization is one of these variables; the second variable, based on the findings in this study, is that of the presence or absence of other more or less suitable stimulus-objects during the critical period for socialization. The degree to which a given stimulus-object may be involved in the socialization process will be determined by the interaction of the two variables described above.

A third factor which may interact with the two described or which may affect later behavior independently is that of contact comfort. While this factor has not been definitely established as affecting the socialization experience in this experiment, it seems likely that contact comfort (or the absence of contact comfort) at the very least strongly affects the later integration of the dog. Certainly the group which had the least opportunity for contact in this experiment (Group H) was atypical in many respects. Among the other groups, Group H most closely resembled Group DL in terms of general behavioral characteristics, but in general was more extreme in amount of deviation from the other groups. For example, over the course of training, while the other groups became more shy, less active and more avoidant, Group H became less shy, more active, and less avoidant. The same was true to a small

extent for Group DL, but for Group H the differences were marked. One might account for these findings by inferring that Group H (and to a lesser extent Group DL) were learning to express their need for contact comfort toward humans.

The length of the critical period for socialization. While the effects of varying conditions of exposure to humans during the critical period for socialization are significant for all of the kinds of training involved in this experiment, it is worthy of note that differences in performance among various groups of dogs, particularly toward the end of training, are not extremely large. Even Group DL, for instance, predicted to be the poorest in trainability because of their isolation from humans, given sufficient training, were still able to learn most tasks adequately. When one considers the violent and dramatic effects of isolation, both total and just from humans, reported in the literature, it is surprising that these dogs were capable of learning from humans at all.

There are several ways in which these findings can be accounted for. It may be, for instance, that the effects of isolation during the critical period for socialization are not so permanent as have been thought, and that differences arising from variation in experience during the critical period for socialization are fairly readily obliterated by later experience. Again, it may be that the border collie is so sensitive to imprinting-like learning that even the two or three minutes exposure to humans received by Group DL during the critical period for socialization was enough to allow them to accept humans as parental surrogates. The most likely explanation, however, is that the critical

period for socialization is of greater length than was originally described by Scott (1958), at least for border collies. Studies previously cited (Pfaffenberger & Scott, 1959; Freedman, King & Elliott, 1961) suggested that for some breeds, at least, the critical period for socialization extends into the 13th week.

If the critical period for socialization for border collies extended to the 13th week, in the present experiment, which kept the pups in the primary experimental conditions for only 8 weeks, it is possible that essential socialization was accomplished inadvertently to some degree. It would be expected, for instance, that Group DL would originally exhibit a deficit in readiness for training, but would eventually begin to catch up to the other groups, as actually occurred. In order to settle this issue, a partial replication of this experiment is being planned in which the experimental conditions (involving isolation from humans) will be maintained until the end of the 13th week.

Socialization in humans. One value of animal studies is that questions can be asked which have heuristic value in the formation of theories involving the development of man. Some of the findings in this study may be translatable into relevant questions about the developmental process in man.

One finding of particular interest is that apparently it is possible for an organism to change or to learn if there has been any positive experience at all with an appropriate stimulus-object during the critical period for socialization; this capacity to learn is at the least related to the amount of contact with an appropriate stimulus-object. This is an essentially optimistic picture, since it is diffi-

cult to imagine the survival to adulthood of any organism without any such positive contact, and thus one can say that almost any surviving organism is potentially educable.

In attempting to explore the characteristics of critical period for socialization in humans, it seems reasonable that one should consider some of the variables inferred to be relevant on the basis of the present study: Amount of exposure to the stimulus-object, the presence or absence of more or less suitable stimulus-objects, the amount of contact comfort provided, and the time during the critical period for socialization when exposure to stimulus-objects takes place. Additionally, it appears likely that the later integration of such early experiences, at least in terms of trainability or educability, is not a simple factor. Various factors included in the concept of educability may be affected by early experience in unique ways.

Summary of findings. In this experiment it was found that early experience with humans, dam and littermates did affect the dog's readiness to engage in contact with humans, though not in the ways specifically predicted (Hypothesis I). Later trainability was modified by this early experience (Hypothesis II), and the two groups predicted to be superior on training tasks were superior. General behavior traits, as measured by rating scales, were also modified by early experience (Hypothesis III). It was found that trainability was not correlated with readiness to engage in contact and affiliation with humans (Hypothesis IV).

CHAPTER VI

SUMMARY

The importance of early experience in determining later behavior has been the subject of widespread investigation. Most recently, the concept of "critical periods" in development has been dealt with experimentally in many kinds of birds and animals. Various investigators have suggested that there might be a "critical period for socialization" occuring early in life, in which the groundwork for later social behavior is laid down.

One of the variables considered important during this critical period for socialization is amount or kind of exposure to stimulus-objects, whose model is the parental organism. The range of stimulus-objects for a particular species, while limited, allows some variation. The concept that the process of "imprinting" to this stimulus-object is permanent and relatively irreversible is widely accepted. There is also a great deal of evidence that more than one stimulus-object can take part in the socialization process.

In this experiment the importance of the socialization process during the critical period for socialization for later trainability was explored. Border collies were chosen as experimental subjects, since they have a high capacity for learning complex tasks from humans, and

because humans fit within their range of acceptable stimulus-objects.

It was hypothesized that the exposure or non-exposure to humans during the critical period for socialization in the presence or absence of more natural or suitable stimulus-objects, such as dam and/or littermates, would strongly affect later trainability, as measured by performance on simple obedience tasks and need for humans.

Four female border collies, consisting of three litter-siblings and their dam, were bred to a male of the same line. The litters of pups were assigned to four experimental conditions. The puppies in group H (humans only) were exposed only to human beings from their 18th day to their 8th week. The puppies in group HDL (humans, dam, littermates) were raised as a litter in the presence of their dam and the experimenter during this same period. The puppies in group HL (humans, littermates) were raised as a litter in the absence of their dam by the experimenter during the same period. The puppies in group DL (dam, littermates) were raised as a litter in the presence of their dam in nearly complete isolation from humans during this same period. Amount of exposure to humans in the three relevant groups was held as nearly constant as possible.

Following the completion of the experimental manipulations, the pups were given a test to estimate their affiliation need for humans. This test was given immediately after the experimental manipulations, several weeks later following a period of handling the dogs, and finally once again following training. The test involved measuring the duration of time it took the pups to cross a given distance from a cage to the experimenter.

The dogs were trained, beginning at about three and one-half months of age, in simple obedience tasks, including heeling, going down on command, staying in one place, and coming when called. In addition, three trainers rated the dogs along certain subjective dimensions, including ease of training, aggressivity, timidity, and obedience. The training period lasted for six weeks, and contained 13 twenty-minute training sessions devoted to heeling training, and 10 twenty-minute sessions devoted to "down," "there" and "come" training.

It was found that trainability is affected by exposure to humans under the various experimental conditions. All variables showed significant group effects. The hypothesis that the fewer more suitable stimulus-objects, the greater the relative importance of the human being present and consequent greater later trainability was only partially supported. The two groups which were generally poorest were, as predicted, the DL and HDL groups, while the generally best were the HL and H groups. Beyond this level of prediction, the specific predictions as to which group would be superior did not hold up. Readiness for contact and affiliation with humans was affected by the conditions of exposure to humans during the critical period for socialization. The hypothesis as to the degree to which each group would exhibit need for humans was not supported. The hypothesis that general behavioral traits would be affected by experience during the critical period for socialization received support. The variables describing behavioral characteristics which significantly distinguished between experimental groups were Activity, Avoidance, Shyness, Uprightness, Eager-to-leave-pen, and Ease of Training. The only variable which did not distinguish between exper-

imental groups was Quietness. Finally, the hypothesis that readiness for contact and affiliation with humans was related to trainability was not supported.

The lack of correlation between scores on different training tasks suggested that different abilities are involved for many of the tasks, and that these abilities might be affected by the experimental conditions in varying ways. Thus, the concept of a general trait of "trainability" had to be abandoned. In addition, it was suggested that the presence or absence of dam or littermates may well have effects beyond that of simply affecting the adequacy of socialization toward the human.

It was suggested that the length of the critical period for socialization might be greater than had been thought; if this were the case the results of the experimental conditions might well be attenuated in the manner found. Further studies were suggested.

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APPENDIX

INDIVIDUAL SCORES (RAW DATA)

Individual Approach Times

(Units are seconds)

Group	Dog	Time 1st Trial	Time 2nd Trial	Time 3rd Trial
H	1	25	120 (Fail)	3.5
	2	15	9	4.5
	3	13	34	4
	4	20	4	4
HL	5	104	120 (Fail)	3
	6	41	10	5
	7	6	4	4
	8	60	7	9
HDL	9	13	3	12
	10	14	38	2
	11	16	12	4
	12	11	5	24
DL	13	120 (Fail)	120 (Fail)	2.5
	14	120 (Fail)	90	3.5
	15	120 (Fail)	30	4
	16	24	8	2.5

Individual Scores On the
Down, There, Come Tests

Group	Dog	Down		There		Come	
		Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
H	1	59	60	60	60	54	51
	2	59	59	59	59	58	57
	3	60	59	59	59	59	60
	4	55	57	57	60	48	56
HL	5	60	60	59	60	59	57
	6	60	60	57	57	60	60
	7	60	58	57	60	55	60
	8	60	60	58	59	60	60
HDL	9	57	59	44	58	44	57
	10	53	59	57	58	44	46
	11	44	60	51	58	54	54
	12	44	56	41	54	57	60
DL	13	55	54	59	59	54	52
	14	48	51	34	58	49	54
	15	55	58	57	59	54	46
	16	57	57	59	56	53	49

Individual Mean Scores on Post-Training Rating Scales

Group	Dog	Obed.	Aggr.	Friend.	Ease Tr.	Exp. Pref.	Train. Pref.	Obs. Pref.
	1	1.534	1.266	1.600	1.800	1.800	1.458	2.625
H	2	1.867	1.066	1.466	2.134	1.550	1.291	2.250
	3	1.600	1.133	1.400	1.667	1.900	1.375	2.375
	4	2.308	1.230	1.769	1.770	1.600	1.800	2.750
	5	2.278	.944	1.055	2.389	1.625	1.333	1.041
HL	6	3.223	.777	1.444	3.334	.833	1.000	.916
	7	3.223	.666	1.055	3.500	.250	1.250	.750
	8	2.834	.555	1.055	2.889	.958	.958	1.000
	9	1.556	.833	.944	2.056	1.958	1.750	.916
HDL	10	2.883	.647	1.235	3.118	1.041	1.250	.550
	11	2.278	.833	1.055	2.334	1.333	1.833	.791
	12	2.474	.631	1.263	2.790	1.166	1.357	.916
	13	.667	1.666	1.111	1.112	2.375	2.125	2.250
DL	14	1.278	1.666	1.388	1.834	1.875	2.464	1.450
	15	2.612	.777	1.166	2.723	1.083	1.178	1.200
	16	2.316	.526	1.263	2.737	1.291	1.464	.750

Individual Heeling Times

Group	Dog	Test 1		Test 2	
		Seconds	Radians	Seconds	Radians
	1	215	2.0264	280	2.6062
H	2	205	1.9391	295	2.8801
	3	250	2.2916	282	2.6467
	4	240	2.2143	297	2.9413
	5	296	2.9131	287	2.7189
HL	6	298	2.9741	298	2.9741
	7	295	2.8801	297	2.9413
	8	285	2.6906	281	2.6467
	9	290	2.7762	297	2.9413
HDL	10	272	2.5319	288	2.6906
	11	283	2.6467	296	2.9131
	12	265	2.4341	300	2.9646
	13	235	2.1652	271	2.4981
DL	14	100	1.2239	196	1.8755
	15	85	1.1152	288	2.7389
	16	298	2.9742	281	2.6467

Individual Mean Scores for Activity, Avoidance, and Shyness on Pre-Trial Ratings for Each Third of Training Period

Group	Dog	Activity			Avoidance			Shyness		
		1	2	3	1	2	3	1	2	3
H	1	12	14	11	12	7	10	7	5	5
	2	9	10	11	10	11	9	6	6	5
	3	7	7	11	12	11	7	9	6	5
	4	14	12	13	8	5	7	4	4	6
HL	5	12	9	8	13	14	11	10	6	8
	6	13	7	6	6	15	11	5	13	12
	7	16	13	10	4	10	10	4	5	6
	8	15	12	11	4	5	11	4	5	10
HDL	9	14	13	4	14	11	12	6	8	10
	10	12	7	12	6	12	7	6	5	7
	11	14	9	13	6	11	6	4	6	5
	12	16	15	12	4	5	10	4	4	5
DL	13	13	13	10	5	4	11	5	4	6
	14	14	16	16	4	5	4	4	4	4
	15	15	15	13	16	6	13	4	4	6
	16	4	7	4	16	10	12	16	5	9

Individual Mean Scores for Quietness, Uprightness, and Leave Pen on Pre-Trial Ratings for Each Third of Training Period

Group	Dog	Quietness			Uprightness			Leave Pen		
		1	2	3	1	2	3	1	2	3
H	1	16	12	16	16	15	11	2	7	2
	2	16	16	16	10	9	9	5	5	6
	3	16	16	16	12	13	16	3	2	6
	4	14	16	16	16	15	15	8	6	7
HL	5	16	16	16	13	4	6	2	6	2
	6	16	16	16	15	16	16	2	2	5
	7	16	16	16	11	13	14	5	2	7
	8	15	16	16	10	13	16	5	5	4
HDL	9	13	11	15	8	12	14	3	8	2
	10	11	14	12	11	10	10	3	5	8
	11	9	16	16	12	5	5	2	2	8
	12	16	14	15	14	8	13	4	7	3
DL	13	16	16	10	7	12	11	5	8	4
	14	10	10	13	8	14	13	4	8	8
	15	14	16	10	14	7	10	3	6	2
	16	16	16	16	10	10	12	3	7	5