69-5218

CHAPMAN, Jane Ellen, 1932-

THE EFFECTS OF VARYING ACTIVATION LEVELS UPON VISUAL DEPTH PERCEPTION AND THE MOTHER-NEONATE RELATIONSHIP IN SHEEP.

The University of Oklahoma, Ph.D., 1969
Psychology, clinical

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE EFFECTS OF VARYING ACTIVATION LEVELS UPON VISUAL DEPTH PERCEPTION AND THE MOTHER-NEONATE RELATIONSHIP IN SHEEP

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

JANE ELLEN CHAPMAN

Norman, Oklahoma

1968

THE EFFECTS OF VARYING ACTIVATION LEVELS UPON VISUAL DEPTH PERCEPTION AND THE MOTHER-NEONATE RELATIONSHIP IN SHEEP

APPROVED BY

W B Lemmon

John [illegible] Jr

[illegible]

Dudley A. Foster

Blanche Sommers

DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

Few graduate students would have the privilege of pursuring a theoretical idea when a professor has already decided to retire from a long series of research projects in a given area. To Dr. W. B. Lemmon is given deep respect and appreciation for listening, for sharing his rich experience, and for giving support throughout yet another sheep project. His confidence in a farm girl-turned-researcher who thought she remembered something about sheep is unforgettable.

Appreciation is also felt for the willing assistance of the members of the Dissertation Committee: Dr. Dorothy Foster, Dr. Mildred Jacobs, Dr. Blanche Sommers, and Dr. John R. Morris.

With much fondness and gratitude, thanks is extended to the many graduate students and friends who volunteered to work throughout day and night regardless of their own busy schedules. Special thanks is given to Joe Bogan and Jerry Witten whose enthusiasm, comradeship, and strong backs held through the very last hour. To Dr. Harry Chapman goes much warm appreciation for understanding.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THE EFFECTS OF VARYING ACTIVATION LEVELS UPON VISUAL DEPTH PERCEPTION AND THE MOTHER-NEONATE RELATIONSHIP IN SHEEP

CHAPTER I

INTRODUCTION

Bijou (1968) has said that developmental psychology is the "study of progressive changes in interaction between a biologically changing organism (maturing and aging) and sequential changes in environmental events through a series of life periods" /p. 420/. He has further explained that "developmental psychology is most like comparative psychology, which concentrates on similarities and differences in interaction within and between species" /p. 420/. Within the pastten years there seems to have been a blending of these two areas of psychology as reflected by the research reviewed. A proliferation of this research has focused on the early experience of the developing human and infra-human mammal and the influence of varying stimulus conditions upon subsequent performance.

However, the concept "early experience" seems vague in the over-all view of the developmental continuum wherein time is relative. This observation has been underscored by Gesell (1945) and more recently by Beach (1961). They stressed that ontogenesis

includes the zygote, the embryo, as well as the prenate and neonate, and that there is a dynamic continuity between physical and psychological growth. Because of the gradual process of growth, it is generally not apparent in the form of sudden transitions. Therefore, in an attempt to understand and bring order to the empirical observations of development, the concepts of "developmental stages" and "critical periods" have evolved.

Within this list of stages or periods, the prenatal aspect of the developmental continuum has become an increasingly rich source of research in psychology (Broadhurst, 1961; Thompson, 1957; Sontag, 1966). It would seem that psychology has reached the point in experimentation at which antecedent environmental events as well as on-going interactive events must be considered in the study of the living organism at any post-conception point in its development.

In those early experience studies which reach to the beginnings of the developmental continuum, the fact of the very early dependency of the fetal and postnatal mammal dictates that the infant cannot be studied without consideration of the cental position that maternal behavior occupies in the life of offspring. Rheingold (1963) stated:

> For the mother, parturition, an event of considerable biologic importance, signals maturity, and her behavior is profoundly modified by presence of the young. For the offspring, the behavior of the mother is crucial not only for life itself but for its own subsequent adjustment to the environment into which it is born. In this environment other members of its species are prominent elements; the extent to which it has contact with them and the nature of this contact are mediated by the behavior of its caretaker.

> Furthermore, maternal behavior, intimately related to the state of maturity of the young at birth, constitutes a trait possessing adaptive value for the preservation of the species. . . . Maternal behavior during the animal's infancy may be viewed as the main source of environmental events affecting the behavior of the young. It is a source from which arises the major set of variables labled early experience /p. 2/.

There continues to be insufficient knowledge available regarding the complex interaction of psychological and biological behaviors in the mother-neonate relationship and general principles remain elusive. However, some factors in both maternal behavior and neonate behavior have been elucidated and some of these factors seem to qualify as early experience variables. For example, beginning in 1964 at the University of Oklahoma, a series of four research projects began in the study of the early postnatal relationship between the neonate lamb and its mother (Patterson, 1965; Little, 1966; Baumgold, 1967). Variables in the mother-neonate relationship that were identified as influencing effective visual perception of depth were such factors as the presence or absence of mother and varying restrictions on response ability of either mother or neonate.

The present study is an extension of this research program and an attempt to view the variables of the mother-neonate relationship within the broad frame-work of an activation level hypothesis. The following sections will elaborate the above overview.

Developmental Stages

The ancient Greeks felt that a pregnant female viewing

the beauty of classic sculpture would have enhanced the possibility of producing an attractive offspring; medival Europeans believed that viewing animals during the prenatal period would contribute to offspring with birth defects; hence, the term "harelip". With the four-fold influence of Darwin's evolutionary theory, increased sophistication in embryology and genetics, and Freud's hypothetical constructs in regard to the fixative influence of events within the early development of human children, scientific thought became focused on the concept of developmental stages. Within these series of stages, it seemed that there were critical times when, if certain events did or did not occur, further development would be favorably or adversely affected.

In his review of human development, Bijou (1968) stated that developmental stages may be identified using three different criteria:

(1) Time since birth, or age.

(2) Hypothetical constructs, in combination with actual or assumed environmental events.

(3) Empirically defined biological, physical and social interactions /pp. 422-423/.

"Time Since Birth, or Age" as a Criterion

Arnold Gesell is perhaps most representative of the age-as-criterion group of theorists. For Gesell, to understand the maturity of a growing organism, its age must be known, measured first from absolute zero (conception) and again from the time of birth. Gesell (1960) felt that to evaluate the human infant an

examination of four fields of behavior representing different aspects of growth is required, e.g., motor behavior, adaptive behavior, language behavior, and personal-social behavior. With respect to the above behaviors, he described the key ages of post-fetal development (infancy) as 4, 16, 28, 40 weeks and 12, 18, 24 and 36 months. While it seems that Gesell has attempted to make possible the descriptions of normative behavior at a given age level, his use of time is vague.

> Infancy proper begins at the end of the fetal period. The end of infancy is variously defined: It may be the end of the first or second year, or it may end on the attainment of walking. By law, infancy is the period of minority under 21 years of age (Gesell, 1945, p. 16).

Much of Gesell's age criteria for developmental stages are difficult to reconcile because of his central theoretical concept of maturation. He believed that maturation was an innate, regulatory process that determined what the developing infant would do with his environment and what within his environment he would use. Although Gesell developed normative schedules and test materials for each of his key ages, they have been felt by many to have limited usefulness for research. Cattell (1960) criticized the scales feeling that they lent themselves primarily to description, therefore having their greatest value clinically, but of little value in scientific study of individual growth.

"Hypothetical Constructs, in Combination with Actual Assumed Environmental Events" as Criterion

Bijou (1968) felt that the theorists using the hypothetical construct approach to developmental stages have a similar logic: behavior at a given time is "explained" in terms of the

hypothetical construct. Freud and Erikson are theorists exemplifying this position.

Freud's postulated stages of infantile development grew out not of direct observations of human infants, but from clinical reports of adult patients which consistently revealed infantile material. Munroe (1956) interpreted Freud's theorizing:

> By virtue of his biological equipment, the child goes through a fairly regular progression which depends on the coming into prominence of various organ systems. The psychological aspects of the very earliest stages, birth and primary narcissism, are relatively generalized. The mouth, the excretory organs, and the genital organs appear to become the foci of more specific distributions of psychic energy---that is, of the libido. These states may be roughly assigned to age levels /pp. 174-175/.

The stages of infantile development which Freud formulated were "oral", "anal", and "phallic." The stages approximate birth to one year; the end of the first year to approximately the third year; the third year to about the fifth year. The behaviors at each of these stages are explained in relation to the psychosexual satisfaction or tension reduction experienced by the child. In the event that excessive frustration should occur during one of these stages of development, the construct fixation is utilized to explain resultant stereotyped behaviors which may be manifest some years later. When such later behaviors occur, reminescent of earlier developmental stages, regression is the explanatory construct.

Erikson (1950) accepted the Freudian model of a psychosexual, energy-laden organism. However, Erikson reached beyond Freud in his focus upon the successful solution of developmental crises throughout life. This is in contrast to Freud's more intensive study of the etiology of pathological development, the root of

which he saw in the very early years. Erikson viewed the developing human as more interactive with its social environment. He defined growth as:

> . . . a differentiation of preplanned parts during a given sequence of critical periods. In personality growth, it is the task of the ego (in the psychoanalytic sense) and of the social process together to maintain that continuity which bridges the inescapable discontinuity between each of these stages (Erikson, 1956, p. 7).

The developmental stages postulated by Erikson are referred to as phases and the developing individual strives to master the "phasal theme" and to overcome its pitfalls (Maier, 1965, p. 30). The first five phases encompass infancy, childhood, and adolescence and the acquisition of: (1) a sense of basic trust while overcoming a sense of basic mistrust, (2) a sense of autonomy while combating a sense of doubt and shame, (3) a sense of initiative and overcoming a sense of guilt, (4) a sense of industry and fending off a sense of inferiority, and (5) a sense of identity while overcoming a sense of identity diffusion.

As with Freud, Erikson's developmental phases can be roughly approximated with chronological age; however, Erikson is far less emphatic than Gesell about numerical correlates and his writings rarely make direct reference to age. Rather, Erikson relates his phasal themeconstructs to observed biological and social behaviors.

Maier (1965) explained:

> An individual develops into his next phase as soon as he is biologically, psychologically, and socially ready, and his individual readiness is matched by societal readiness /p. 29/.

"Biological, Physical and Social Interactions" as Criteria for Stages

Organism-environment interactive hypotheses (Stendler, 1964) are apparent in much of Erikson's formulations; however, present developmental theorizing and subsequent research is increasingly complex and emphasizes the basing of criteria on empirically defined biological, physical, and social interactions. It would seem that in using these criteria, much of developmental and comparative psychology can unite in formulating theory and empirical laws regarding growth.

Bijou (1968) has cited Kantor (1924, 1959) as an exemplar of this approach wherein development is divided into three periods. The first stage is described as the period which extends from birth to the onset of functional verbal behavior; the second stage, referred to as the "basic stage", extends to early childhood and is characterized as the first period free from gross biological limitations. The third stage (the societal stage) extends from early childhood to the end of the developmental cycle, an interval characterized by intimate interpersonal and group conditions.

Scott (1965) has couched his work on developmental stages within an interactional framework of "critical periods". Like Kantor (1959) and Bijou and Baer (1961), Scott focused his attention on behavior of the organism. Scott (1965) explained:

> . . . each developmental period is not time sequence but the fact that each represents a major developmental process. Thus, the neonatal period /italics mine/ is chiefly characterized by the process of neonatal nutrition. . . . The transition period is characterized

> by the process of transition to adult methods of nutrition and locomotion and the appearance of adult patterns of social behavior, at least in immature form. The period of socialization is the period in which primary social bonds are formed /p. 272/.

Scott described in addition a juvenile period during which the young organism begins to be independent of its parents and is observed in increased exploration of the environment. This is followed by a pubertal period reflecting the development of sexual relationships and a parental period. Scott emphasized that the newborn lamb is the "transition period" and almost immediately enters into the "socialization period" (Scott and Marston, 1950).

Scott's concept of critical periods seems to grow out of his theory that both growth and behavioral differentiation are based on organizing processes:

> This suggests a general principle of organization: That once a system becomes organized, whether it is the cells of the embryo that are multiplying and differentiating or the behavior patterns of a young animal that are becoming organized through learning, it becomes progressively more difficult to reorganize the system. That is, organization inhibits reorganization. Further, organization can be strongly modified only when active processes of organization are going on, and this accounts for critical periods of development (Scott, 1965, pp. 283-284).

Scott (1965) postulated three kinds of critical period phenomena. These involve optimal periods for the formation of primary social attachments, optimal periods for learning, and optimal periods for infantile stimulation. During critical periods the behavioral processes proceed most rapidly, though the behavioral processes are not necessarily limited to the periods in which they are most prominent.

Schneirla and Rosenblatt (1965a) offered a somewhat different view of development. They feel that their social ontogeny theory and research supports not just one or a few chronologically marked changes in behavior pattern, but indicate rather that each age period is crucial for the development of a particular aspect in a complex progressive pattern of adjustment. They conclude that events of maturation may differ significantly in their influence upon ontogeny, both in the nature and in the timing of their effects, according to what relations to the effects of experience are possible under the existing conditions.

> Those who examine this theory and related considerations will find an emphasis upon the fusion of maturation (growth-contributed) and experience (stimulation-contributed) processes at different stages in behavior ontogeny, together with the contention that the contributions of maturation and of experience (the latter including, but not confined to, conditioning and learning), as well as the interrelations of these contributions, may differ greatly according to stage in any animal. This theory thus differs sharply from Scott's with its emphasis upon factors of maturation presumably specific for "critical periods" and its apparent assumption that "learning" is a distinct and probably a delayed contributor (Schneirla and Rosenblatt, 1965, p. 288).

Summary. It seems that the approach considering the interaction of biological, physical and social factors is presently the most emphasized in developmental theory and research. However, molar and molecular approaches still seem justified under the broad umbrella of "interaction" (Cairns, 1966; Thompson, 1966).

As to the matter of role of temporal factors in development, it seems that time and age must be dealt with, however relatively, if only for communication and/or research purposes. All of the views have the additional theme in common: within the earli-

est phases of postnatal development, there occur rapid behavioral changes and there seem to be ways of interrupting the interactive developmental process so that deviations from normal expectancies can be observed at a subsequent time.

Studies of Maternal Influence

The importance of maternal behavior seems relative to the state of dependency of the infant mammal. In the prenatal phase of development, neither mother or fetus are passive partners, an observation supported by the research of Hooker (1964) and Sontag (1966). Sontag (1966) demonstrated that prenatal events such as external sounds or strong maternal emotions can influence the fetus. In a follow-up of eight infants he found that those who had mothers who were profoundly upset at some point late in pregnancy, developed into irritable, hyperactive babies. Thompson (1957) earlier found that increased emotionality in rat offspring could be produced by increasing the anxiety of the mothers during pregnancy.

The effects of the presence or absence of adequate mothering is well known in the study of human infants. Bowlby (1967), in a recent review of literature on maternal deprivation, stated that the evidence to date suggests that three somewhat different mothering experiences can each produce an affectionless and psychopathic character:

(1) Lack of <u>any</u> opportunity for forming an attachment to a mother figure during the first three years (Powdermaker, 1937; Bender, 1941; Lowrey, 1940; Goldfarb, 1955).

(2) Deprivation for a limited period of time---at least three months and probably more than six---during the first three or four years (Bowlby, 1946; Spitz and Wolf, 1946).

(3) Changes from one mother-figure to another during the same period (Levy, 1937).

Bowlby's recent review reflects Yarrow's (1961) earlier concern that the concepts of maternal separation and maternal deprivation have been used synonymously. For the purposes of theory development and research, Yarrow (1966) felt that four different maternal-child situations should be distinguished: maternal separation, maternal deprivation, multiple mothering, and distortions in maternal care. Yarrow (1966) explained:

> Deprivation of maternal care in the sense of a quantitative lack of tactile, kinesthetic, auditory, and other kinds of stimulation normally provided by a mother-figure, or a lack of sensitive individualized adaptation to the child's needs frequently follows physical separation from the mother. In multiple mothering, which sometimes follows separation, a number of different mother-figures simultaneously provide care for the child, with varying degrees of responsibility and differentiation of functions. Distortions in maternal care, that is, disturbances in the mother-child interaction, involving hostility and ambivalence, which are usually rooted in personality deviations in the mother, may be an antecedent of separation and sometimes may follow it. Maternal separation in its purest sense involves a break in the continuity of relationship with a mother-figure after a meaningful focused relationship has been established /p. 90/.

Many of the studies regarding deviation in human mother-infant relationships focus on the infant's immediate behavioral reaction to separation, and attempts have been made to identify critical periods during which these deviations will have the most

profound effect. Several studies (Spitz and Wolf, 1946; Robertson and Bowlby, 1952) reported similar behavioral reactions of children under two years of age following placement in institutions. Similar patterns of response seem to be observed in sequential order: acute anxiety in the form of crying and strong protest; active rejection of adults; symptoms of severe depression; decreased activity level; loss of appetite; withdrawal from people and objects within the environment. Spitz and Wolf (1946) found that the depressive syndrome was accompanied by a progressive drop in the Development Quotient and an increase in physical symptoms such as weight loss, recurrent colds and skin disorders. In some cases the physical deterioration continued to the point of death. In each of the three studies noted above and also later reported by Goldfarb (1955), some of the children developed a possessive, anxious attachment to a substitute mother if one was available; often this contact-seeking was indiscriminate.

The above studies must be considered suggestive in that they describe reactions to events with little evidence provided as to the specific variables occurring at the time of the event. Also, many of the human infant studies within this research area were carried out in institutional settings. Several researchers have considered the variables within environmental settings and the concordant lack or presence of external stimuli. These direct studies of institutional settings (Goldfarb, 1955; Rheingold, 1960, 1961), describe more than just the lack of a mother-figure with whom the child develops close contact; the environments are deviant

in a number of respects. Yarrow (1966) summarized:

> The low caretaker-infant ratio is associated with inadequate kinesthetic, tactile, social, and affective stimulation. The affective blandness characterizing many institutional environments means that the children are exposed to little strong positive or negative emotional expression. Often the environment is lacking in appropriate equipment, and the conditions for the learning or practicing new skills are limited. The changing caretakers and the rigid routinization of care result in deviant learning conditions. The caretakers' actions tend to be based on predetermined schedules and set techniques rather than being responsive to the child's behavior /pp. 99-100/.

Provence and Lipton's (1962) research seems to provide some of the most clear cut data on the influences of environmental deprivation. They followed the development of 75 infants in an institution during the first year of life. They reported evidence of retardation and deviation in motor, language and social skills as early as the second month. They observed that those skills which seem to be dependent on the maturation of neuromuscular apparatus develop normally, whereas retardation is found in those functions which are dependent upon environmental stimulation. Provence and Lipton (1962) used a "psychic drive" model to explain two types of motor deviations: a diminished impulse to reach out for people and objects, and an impairment in the capacity to modulate motor impulses to produce smooth motor movements. Variation in expression of auto-erotic activity was also observed either in its absolute absence or in excessive amounts, e.g., rocking, head-banging, masturbation and thumbsucking.

Yarrow (1966) has also pointed out that there has often been the tendency to dramatize the extreme cases and to gloss over

cases which do not show striking behavioral changes. If one considers that not all institutionalized children develop serious intellectual and behavioral disturbances (Fisher, 1952; DuPan and Roth, 1955) and that serious disturbances can occur within mother-present situations, the resultant behaviors seem more linked to the degree of environmental deviation and deprivation. For example, Coleman and Provence (1957) found an "institutional syndrome" among children living within very depriving family environments. Yarrow (1966) emphasized that:

> . . . the etiological agent in these personality, social and developmental disturbances is not maternal separation per se, or some mysterious attribute of institutional environments, but specific environmental conditions which are commonly associated with institutional care /pp. 101-102/.

Several research projects with infra-human primates corroborate Yarrow. Harlow (1965) demonstrated that restricted environments contribute to profoundly deviant social behavior, but that there are no significant differences in learning between the environmentally restricted and control rhesus. Davenport and Rogers (1968) reared a group of seven chimpanzees in cribs for two years wherein the environs were monotonous and relatively unstimulating. These restricted animals were observed to behave in stereotypic, self-stimulating ways, e.g., swaying, rocking, eyepoking, lying prone and pushing the shoulders up and down (Davenport and Menzel, 1963). A group of mothered chimpanzees who had been raised in the wild until approximately one year of age were used as controls. Davenport and Rogers (1968) summarized:

> Insofar as one may generalize from this delayed

> response experiment, the findings indicate that restricted early rearing does indeed produce, in the chimpanzee, behavioral characteristics which hinder learning at a later age. Among these, distractibility is of major importance; however, with proper experience distractability may decrease. The findings also give presumptive support to the contention that the distractability and greater difficulty in bringing to bear task-oriented behaviors on learning and performance problems accounts in large part for poor academic progress and intelligence test scores of human children raised in socially deprived and unstimulating environments /pp. 680-681/.

Kaufman and Rosenblum (1967) did a comprehensive study with five-month-old infant monkeys which were separated from their mothers for a period of four weeks. All infants had been reared in a group living situation and remained so during the isolation-from-mother experience. Observations showed an immediate separation reaction very clearly followed by a depressive period, similar to the anaclitic depression described by Spitz. The initial reaction was that of a high level of motoric, visceral-autonomic, vocal and expressive activity; in three of the four infants this was followed in a day by a deep depression characterized by postural collapse, immobility, withdrawal from the environment, and reduction in visceral-autonomic, vocal and expressive activity. Two of the three infants showed abnormal penis sucking. The fourth infant, whose mother was the dominant female, did not show the marked depression. However, this infant did show significant decrease in play and significant increases in self-directed behaviors and inanimate object exploration.

Patterson (1965) reported a response in lambs similar to that described by Spitz in which mother-deprived infants were characterized by apathy and high death rate. In Patterson's study,

four lambs were isolated individually in wire pens following removal from their mothers at birth. Following removal from the mother, they were cleaned and stimulated until they were able to stand. They were bottle-fed through apertures in the walls of their isolation pens on an every four hour feeding schedule. Patterson (1965) observed that:

> Within 24-36 hours, however, these lambs were observed to loose muscle tone and appetite and collapse and die with dramatic speed apparently as a direct result of being isolated /p. 43/.

It is likely that Kaufman and Rosenblum's monkeys did not regress to terminal collapse due to several factors; first, their infants were five months old when they were separated, and secondly, the peer-group living might, in part, have compensated for the loss of contact stimulation derived from the mother. However, the importance of normal mother-infant interaction is dramatized in both situations.

Summary

As Yarrow (1966) has pointed out, there may be a number of variables interacting simultaneously in the depriving process of infants studied, e.g., chronological developmental age of the child, durations of the deprived experience, constitutional biological factors inherent within the infant, and quality of the relationship with mother prior to, during and after the interval of deprivation. Both Yarrow (1966) and Casler (1961) point to the crucial variable of handling as a source of external stimulation. In the operational sense, it is the mother, or mother-surrogate

who, in an effective reciprocal relationship, is the immediate and continuing source of external stimulation either through her own behaviors or through ever-broadening sources of stimulation which she may bring to the relationship or allow to occur.

Mothering as a Source of External Stimuli

Ribble (1938) has contended that tactile, kinesthetic stimulation is important in the very early biologic functioning of the human infant. In her description of the primal maternal rejection of a newborn, she stressed the stimulation potential of the mothering figure by presenting a case history of an unstimulated, rejected infant who became comatose, dyspneic and who had pallor and reduced sensitivity. While Cannon (1963) did not speak of the concept of stimulation per se, his homeostatic notions about the newborn are similar to those of Ribble:

> Before birth, of course, the baby has the benefit of the mother's "milieu interne." At birth he is suddenly exposed to very different and quite variable surroundings, when his own "milieu interne," though formed, has not been subjected to any stress which might alter it. . . . The elaborate complex of adjustments for the homeostasis of temperature. . . is only gradually developed, perhaps as the consequences of exercise and training. The control of blood sugar is similarly the results of a developmental process. . . . It seems not improbable that study of other homeostatic regulations would prove that they too are unstable at the start and only by experience acquire the efficiency seen in adults /pp. 301-302/.

Montagu (1950, 1953) defined clearly what Cannon vaguely referred to as "experience." For Montagu cutaneous stimulation is crucial for survival directed, adaptive behavior in infraprimate mammals as well as human infants. Additional support for Montagu's position is underscored in Bronson's (1963) review of Conel's

morphological study of the infant cortex:

> From neurological data the infant in the first weeks following birth must be largely dependent on innate reflexes mediated at lower neural centers, and would be primarily responsive to internal stimuli (pain, hunger) which have little direct representation in the neocortex. With maturation the increasing responsiveness to the external environment is mediated through tacticle and, to a lesser extent, auditory and visual input. One would predict therefore that tactile experience during these earliest months would be particularly salient /pp. 57-58/.

A fifteen-year sequence of research on infantile handling (stimulation) of mice and rats by Denenberg (1964) has consistently demonstrated that handled animals perform more effectively. Denenberg stated two hypotheses: (1) that emotionality is reduced in proportion to the amount of stimulation; and (2) the "Yerkes-Dodson law", namely that the best performance in a test situation results from a moderate degree of motivation rather than from a very small or a very large amount. Motivation is directly related to emotionality produced by early stimulation, and the net result in many types of performance is an inverted U-shaped function related to the degree of early stimulation. Subsequent research has shown that adult learning in mice varies in a curvilinear fashion with the amount of stimulation given at weaning (Denenberg, 1959; Denenberg and Bell, 1960); handled animals are less emotional than undisturbed controls (Denenberg and Morton, 1964; Denenberg, 1964).

Carlson (1961) demonstrated that in the rat, the mother's behavior not only influences the behavior of offspring, but that the offspring's behavior also influences the mother. He found that rat mothers which reared "low emotional" pups were significantly

more active (less emotional) when tested in an open field at the time of weaning than mothers rearing "high emotional" pups. Hudgens, Denenberg, and Zarrow (1964; 1966; 1967) have subsequently done a series of experiments in cross-fostering litters of mice and rats and have demonstrated that the activity of mice reared by rat mothers is greatly reduced compared to that of mice reared by mouse mothers. In their most recent study (1967) it was observed that fights were most likely to occur if one member of the pair had been reared by a high-active mouse mother as compared to a low-active mouse mother.

As one moves up the phylogenetic scale, the importance of kinesthetic and tactile stimulation may be even greater and have more complex implications, as exemplified by Harlow's classic observations of "monkey love" (Harlow, 1958; 1959). In these experiments, the type of cutaneous stimulation was important in that it was not just any surrogate mother to which the infant rhesus monkey would cling; rather they showed definite preference for the terry cloth "mother" over the wire frame "mother" regardless of the potential for food reward. Follow-up of these infants into maturity demonstrated deviant mating and mothering behaviors with their own young, attributed by Harlow (1962) to the deprived early infant experience in interacting with a "good" mothering figure.

Adequate mothering undoubtedly also acts as the vehicle for optimal visual stimulation of the infant. Physiological work with the withholding of light and the reduction of degrees of visual stimulation has established that visual deprivation in the infancy

of various animals results in permanent and temporary tissue changes and deviations in visual reflexes (Chow, Riesen, and Newell, 1957; Riesen, 1950, 1960). Riesen (1961) explained that in the absence of sensory input the motor neurons do not remain quiescent and visual perception is impaired:

> They become hypersensitive (Cannon and Rosenblueth, 1949), and locomotor sequences may be initiated following minimal excitiation and coordinated on the basis of purely internuncial and efferent sequential activity (Weiss, 1941). Where sensory control is deficient or absent during development, motor patterns evolve either in accordance with genetically determined potentialities and restrictions or as a consequence of intrinsic neural oscillatory sequences. Neither of these guarantees the establishment of motor integrations that will be effective under a given set of environmental conditions, including the conditions under which an organism typically lives /pp. 76-77/.

Riesen's research also has demonstrated that with chimpanzees, exposure to patterned visual stimulation is necessary for adequate visual perception. There is strong suggestion that movement within the patterned visual stimuli is also necessary in adequate visual-motor development (Riesen, 1958). Kagan (1968) studied 160 human infants and found that both visual pattern and movement to be important factors in the infants' visual attentiveness. For the first six to nine weeks, he found that the infant maintains long spans of attention to stimuli that move and to stimuli that contained a high degree of physical or black-and-white contrast.

Held (1963) has demonstrated in his work with neonate kittens that motor and visual factors can be interactively studied in early development. His study demonstrated that the kind of movement of the organism was critical, i.e., movement per se in

the presence of a dependable visual surround was insufficient for normal visual-motor development. Kittens whose movements were externally-produced rather than self-induced did not develop normally. In a later study by White and Held (1966), three environmental factors were controlled simultaneously: increased tactual stimulation; increased motility potential; enriched visual surround. Institutionalized infants were used as subjects. The findings suggested that for about a month, the visual enrichment was actually ineffective and perhaps unpleasant as evidenced by the infants' tending to ignore the visual surround and engaging initially in more crying than control infants. However, once positive responses to the surround began to occur, visual attention and visual activity sharply increased over the control group. The enriched group demonstrated a delay in the onset of hand regard and swiping which supports the idea that the discovery of the hands is, in some measure, a function of the availability of interesting visible objects. An optimal level of stimulation is obviously required; with slight decrements of stimuli, the infant will bring motor behaviors into play to increase visual stimulation potential.

A number of current studies of the human mother-child relationship stress the importance of maternal responsiveness. Escalona (1965) demonstrated that active babies tend to exhibit their entire repertoire of behavior under conditions of minimal stimulation. Even when contacts with their mothers were at the minimum necessary for good physical care, the babies seemed to

make normal progress. However, normal progress was found among inactive infants only if they had mothers who interacted with them frequently; inactive babies who had less responsive mothers were comparatively immature. Kagan (1968) cited a similar evaluation of human mother-infant dyads in a study carried out by Rubenstein. She classified mothers as high-attentive, medium-attentive, or low-attentive, depending upon the number of times they looked at, touched, held, or talked to their infants. Infants with highly attentive mothers were found to spend longer times studying and manipulating a novel stimulus than did infants of mothers who were rated as low-attentive. Brody (1956) had previously noted in a handling study of human infants that infants who received moderate handling were consistently more visually attentive than those receiving minimal handling.

White and Held (1966), following up Brody's work, found similar results with institutionalized human infants. From the age of six days through thirty-six days, infants were administered twenty minutes of extra handling each day. While other developmental measures were obtained through the age of 152 days on the experimental and control groups, no changes were found in any developmental process except the growth of visual attention.

Summary

Several major themes seem to emerge from the above research directed at the effects of early infant stimulation: regardless of sense modality, the presence or absence of external stimulation early in infancy does contribute to a host of observed

differences in later behavior. Second, there seems to be an "optimal" level of stimulation required before it is maximally effective in the developmental process. Third, in situations wherein the stimulation level is low, the infant engages in behaviors which seemingly increase stimulation levels. Thus, early infant stimulation cannot be viewed with the infant as merely a passive recipient of stimulation; rather he is an "interactor" with his environment and participates in the moderating or increasing of his own level of stimulation. Presence of a maternal figure seems crucial in the immediate environment of the infant; it is increasingly clear that she is the major vehicle through which optimal stimulation levels are made possible.

The Infant as a Source of Stimulation

The process which is going on with the infant in the beginning mother-infant relationship has been viewed in a number of ways. Observations of infant mammal behaviors such as sucking, head-turning, crying, clinging, grimacing (smiling), and following have been viewed as stereotypic behaviors emanating from innate processes which are directly related to survival value. Lorenz (1957) was impressed, however, by the fact that a young bird, for example, does not instinctively recognize adult members of its own species; its instinctive endowment only predisposes it to follow the first moving thing it encounters. These observations led to his formulation of the concept of imprinting, a phenomena that differs from learning in two regards: (1) the object acquisition can take place only within a brief critical period in the

life of an individual wherein a very specific state in the young animal's development is required to accomplish it; (2) once the physiological critical period is over, the young animal knows the imprinted object exactly as though this knowledge were innate and, this process seems irreversible.

Within the field of ethology IRM (innate releasing mechanism) refers to a single stimulus which is always followed by the same characteristic behavior. Hess (1962) explained that imprinting refers to a sudden change in the behavior of a young animal in which a single IRM is selected from a large range of potential IRMs. The selected one is so strengthened that only to it does the animal respond. Hess (1959) and Scott (1962) both support Lorenz's observations that a critical period exists during which imprinting may take place and that the length of this critical period may vary between species. Both researchers have observed that the critical imprinting period terminates with the onset of fear behavior in the animal.

Hess (1959, 1962) has maintained that imprinting is directly related to the effort expended by the infant in moving toward a source of stimulation. His studies concluded that the intensity of imprinting does not depend on the time of exposure to the moving, retreating object, but rather on the distance covered. Hess interpreted this to be a measure of the effort exerted or the energy expended by the infant in the process of following. The "law of effort" is further supported by the observation that animals imprinted under the influence of muscle relaxant drugs have

their subsequent imprinted behavior interrupted (Hess, 1962).

Though imprinting has mainly been observed in birds, behavior in other species which establishes the young animal's relationship with its own kind has been likened to imprinting. Hersher, Richmond and Moore (1963), for example, observed that in sheep and goats, a mother-neonate bond is formed within hours after birth. Thereafter the mother rejects any strange infant. Visual and locomotor following of the human infant has been likened to the imprinting process even though in the human species it develops later than in lower organisms (Barnett, 1961).

Traditional drive theorists have explained the early behaviors of infants within the frameworks of drive-reduction of primary maintenance needs or drives (e.g., hunger, thirst, sex, pain) and/or secondary reinforcement theories. However, the drive-reduction theorists staying within the framework of what Morgan (1959) called "visceral drives," were confronted with the necessity of explaining a general category of observations and research that was emerging: the areas concerning curiosity, exploration and manipulation (Barnett, 1958, Berlyne, 1958; Butler, 1953; Butler and Harlow, 1957; Welker, 1956). Within this area of experimentation, it became clear that animals, in the absence of traditional reinforcing agents or events have a strong "motive" to explore and/or manipulate, and learning seems to be established on the basis of these motives. Thus, a case was made for the existence of an independent exploratory drive (Montgomery, 1954), similar to what Morgan (1959) called a "somatic drive" and Berlyne (1958) referred to as a "curiosity drive."

Many researchers feel that exploration is not the only motive per se and that novelty is not the only characteristic of the life situation which appears to incite exploratory behavior (White, 1959). The theory has been advanced by many observers that a generalized need obtains on the part of the organism for the maintenance of an activity or arousal level (Hebb, 1955; Malmo, 1959; Fiske and Maddi, 1961; Schultz, 1965). Wedded to the concept of need for activation of the organism is the concept of optimal stimulation levels (Leuba, 1955; Pribram, 1960; Fox, 1959; Butler and Rice, 1963; Schultz, 1965; Hunt, 1965).

Neurophysiological research regarding cortical arousal has paralleled psychological theorizing regarding activation level hypotheses and behavior. The first relevant finding in the field of neurophysiology was that of Moruzzi and Magoun (1949) who described a medial core primarily in the midbrain and hindbrain which was capable of activating the cerebral cortex. This system has been called the ascending reticular activating system.

Lindsley (1961) noted that marked behavioral disturbances occur under conditions of sensory deprivation and overload. He reasoned that the reticular formation functions as a moderator of stimuli, both of sensory input and output. Lindsley (1961) explained:

> The adjustment or adaptation level of the reticular formation as it monitors both incoming and outgoing messages becomes very much a part of the process of learning and habit formation, just as it does for the more elementary perceptual processes. Its changes and adjustments depend upon the ebb and flow of activity in the afferent or efferent systems and when these are restricted, compensatory adjustments are made within limits. When

> this fails, under more widely deviating conditions of restriction, behavior becomes disorganized /p. 181/.

It has been found that a sensory stimulus of any modality, whether interoceptive or exteroceptive, can affect the arousal system (Moruzzi and Magoun, 1949; Herandez-Peon, Scherrer, and Jouvet, 1956). Lindsley's further work suggests that it is the sudden change in stimulus conditions, rather than just stimulus onset, which is responsible for cortical and behavioral arousal (Weinberger and Lindsley, 1964).

Routtenberg (1968) postulated that there is yet another arousal center within the limbic-midbrain section (Arousal System II) which functions interactively with the reticular system (Arousal System I), but which mediates different aspects of behavior. Routtenberg's hypothesis is that Arousal System I is important in the organization of response aspect of behavior (response energy, drive); Arousal System II is important in reinforcement, or increasing the probability that a particular response will occur again (incentive). Routtenberg stated:

> Perhaps a more accurate view is that the two systems are in a constant state of activity, and that reciprocal suppression allows for Arousal System I and Arousal System II to be in dynamic equilibrium; first one active, then the other. One might assume therefore, that the organism regulates its behavior such that there exists a dynamic balance of activity between these two systems /p. 63/.

Within the framework of neurophysiological research and theories, several psychological theories resembling the concepts of optimal activation levels and intrinsic motivation have evolved. For example, Hebb (1949) has long emphasized the importance of

stimulation in his neuropsychological theorizing of the determinants of effectiveness of performance. Hebb (1955) used an inverted U model to demonstrate the relationship between arousal function of stimulation and potential (actual level of cue function) of stimulation. McClelland et al. (1953) have proposed that affective arousal is distressing if large discrepancies between the stimulus input and an adaptation level of the organism occur.

Fox (1959) in explaining his research with the light-reward behavior of monkeys, postulated the concepts of acute activation level and chronic activation level. He viewed bar-pressing response for light after light deprivation as a need for sensory reward determined by the reduction in activation of non-specific areas of the brain stem. He accounted for an increased need for light when monkeys were drugged with amphetamine by proposing an intrinsic or chronic activation level. This activation level represented all previous sensory input and especially that occurring early in the history of the animal. The chronic activation level was viewed as being relatively permanent and changing slowly over time. The acute activation level is induced by transient stimulation; the animal's immediate need for stimulation is a function of the match (or lack of match) between the acute and chronic activation levels. Butler and Rice (1963) inferred the following from Fox's postulations:

> (1) A match between the two levels of activation corresponds to a lack of interest. . . . A stimulus source may initially produce a match between the acute and chronic activation levels, but soon thereafter the stimulus may lose its capacity for producing acute activation. It is

> expected, therefore, than an organism will be induced to scan its environment and orient to other stimuli.
>
> (2) When the chronic activation level is higher than the acute level, adient behavior toward an activating stimulus will follow. . . .
>
> (3) When the acute level is higher than the chronic level, the stimuli producing the acute level will be avoided, will assume an aversive character. In other words, the positive valence and negative valence of stimuli correspond to a state of the organism in relation to stimuli; they are not intrinsic characteristics of the stimuli themselves /p. 88/.

Butler and Rice (1963) proposed that acute and chronic activation levels could explain a developmental drive in organisms:

> Maintenance drives serve to replenish and supply the organism. They may produce acute activation levels below the chronic level (low strength) and may rise until the acute level is above the chronic level (high strength). . . . Developmental drives /italics mine/ are characterized by chronic levels of activation that are above the acute level /pp. 94-95/.

Walker (1964) proposed the concept of optimal complexity for the organism which incorporates both complexity (incongruity) and arousal. Psychological complexity is dependent upon the complexity of stimulus that initiates the event; the arousal properties of the event; the frequency and recency of past occurrences of the event; selective readiness for that class of events. A central principle of Walker's formulation concerns adaptation to repeatedly encountered events or inputs. As each level of complexity is repeatedly encountered, complexity falls below the optimal level resulting in the organism seeking an increased level. Walker's formulations are similar to those of Hunt (1965):

> . . . an optimal standard of incongruity of stimuli

> supplies a motivation for behavior change and learning that is inherent within the organism's informational interaction with its circumstances; inherent with seeing and hearing. Repeated encounters with given, static organizations of input lead to adaptation. In the investigations of the orienting response this adaptation shows as a loss of attention value and of arousal reaction. . . . This fact that repeatedly encountered static organizations of input become subjectively passé prompts organisms to turn away from unchanging circumstances to those providing moderate degree of incongruity. This supplies an explanatory interpretation of both exploratory and manipulative behavior /p. 227/.

Hunt related his formulations of intrinsic motivation and the principle of optimal incongruity to Piaget's observations of the psychological development of his own three children. From these observations, Hunt postulated that there are roughly three developmental stages of intrinsic motivation in the first two years of the human infant's life. In stage one, the infant can be said to be attentive and responsive to changes in ongoing input. During stage two, the infant shows the beginning of intentions toward keeping or gaining perceptual contact with sources of input which have just become recognizable through repeated encounters. In stage three, the child becomes interested in novelty, and it is within stage three that the principle of optimal incongruity becomes clearly operative.

In relating stage one of intrinsic motivation to the infant deprivation studies (Spitz, 1945, 1946; Dennis, 1960), Hunt (1965) stated:

> Because the condition associated with retardation was absence of maternal contact, Spitz inferred that the retardation he found in the "Foundling Home" was attributable to an absence of mothering. But there is another inference possible. One of the important consequences of "mothering" is probably the opportunity

> to encounter many variations in receptor input. Another is probably an opportunity to encounter sequentially organized receptor inputs. Still another is the opportunity of the infant to get change of input from his own actions. Although hunger and thirst are of the essence for survival, opportunities for such informational interaction are very likely of the essence for interest in objects, persons, and places. Without such opportunities during the earliest weeks and months, the infant remains apathetic. Since the neonate's only standard for informational interaction is that of on-going input, the absence of change presumably means the absence of motivation and responsiveness. This, by definition, is apathy /p. 234/.

During stage two, the infant is no longer merely responsive; the infant appears to anticipate the goal of his action, and to act in the absence of some previously experienced event implies more than mere attention to the changes in ongoing input as during the first stage of intrinsic motivation. Hunt (1965) explained, "It is 'intention' in the sense that the instigation of action is based on incongruity with a standard within the infant"/p. 237/.

Hunt felt it is only at or after stage two that a human infant begins to show fear of strange objects, persons, and places or to show distress at the absence of familiar ones.

> These emotional reactions presumably make their appearance because the infant has acquired, through repeated encounters with familiar objects, persons, and places, central processes representative of them. The central processes constitute standards with which the inputs from the strange are incongruous. . . Not only does the strange frighten him, but, also, loss of perceptual contact. . . can be a source of what has been called "separation anxiety", although it might better be called 'separation grief' (Hunt, 1965, p. 239).

For Hunt the attachment to objects with recognitive familiarity leads not only to efforts to regain or obtain perceptual contact, but also to expressions of delight or to expressions of distress

when perceptual contact cannot be regained.

Hunt sees an analogy between the first and second stages of intrinsic motivation of the human infant and the following responses of animals which provide evidence for imprinting. Likewise analogous to imprinting is the onset of fear responses. The human infant's efforts to maintain or regain perceptual contact with objects are functionally equivalent to affiliative attachments in animals. Hunt pointed out that the duration of perceptual contact required to produce recognition cathexis increases up the phylogenetic scale. For example, in ducks and geese, the duration of perceptual contact may be as little as minutes; in sheep and goats, a matter of hours; in the monkey from ten days to two weeks; in the chimpanzee about two months; in the human infant, five or six months.

It would appear that in observing stage one and stage two of intrinsic motivation in the lower organism, there is a telescoping of time effect. Not only is there a shorter duration of perceptual contact required to establish evidence of attachment to the mother figure, but shorter periods of time are required for the lower organism to interact with the environment and develop perceptual skills. This may explain the controversy regarding visual depth perception wherein it has been difficult to reconcile the findings of von Senden (1960) whose human subjects post-cataract surgery required a considerable period of time before developing adequate visual perception, and the findings of Kurke (1955) whose dark-reared chicks demonstrated as adequate depth

perception as did light-reared chicks.

In connection with the concept of time of perceptual experience, it is likely that the neurological endowment of the organism at birth is a crucial factor. Hunt (1965) pointed out the increasing ratio of intrinsic portions of the brain to extrinsic portions of the brain as one goes up the phylogenetic scale, suggesting that the time required to develop central processes to mediate discriminative attachments and perceptual integrations takes longer in brains where the intrinsic portion is large. Neuromuscular development and coordination endowment at birth is similarly related. For example, the length of time for the normal neonate to demonstrate visual depth perception follows a hierarchial sequence dependent upon visual and locomotor abilities at birth. This has been demonstrated by the depth perception studies of Gibson and Walk (1960) who used the visual cliff apparatus:

> The survival of a species requires that its members develop discrimination of depth by the time they take up independent locomotion, whether at one day (the chick and the goat), three to four weeks (the rat and the cat) or six to ten months (the human infant) /p. 55/.

The exact nature of external stimuli necessary for integration of perceptual skills and affiliative attachments would also seem relative to the degree of neurological complexity of the organism and its competency for functioning at birth. Butler and Rice (1963) in their review of the research on early infant stimulation stated:

> What the studies on both stimulus deprivation

> (improverished experience) and unusual amount of stimulation seem to indicate is that in a relative way the amount of stimulation may be more important for younger organisms and the complexity of stimulation more important for older organisms /pp. 84-85/.

The imprinting studies, particularly those of Hess (1962) who researched the effects of energy expended during the imprinting (attachment) period, suggest that for the lower organism such as the gosling or the chick, the amount (intensity and variability) of stimulation instigated by external sources may be more important than the complexity or the meaningfulness (patterning) of the stimuli.

While stimulus meaningfulness and complexity would seem to become more important relative to increasing neurological complexity of the neonate organism observed, these stimulus characteristics would also seem relative to the kind of behavioral development being studied. This view seems supported by the work of Pearce (1967) in his study of "good" and "bad" mothering patterns in sheep, and Baumgold (1967) in his study of visual depth perception of lambs. Pearce found that "good" sheep mothers normally groom their young for prolonged periods and permit their young to interact with them, resulting in an interacting dyad of stereotypic mother/young behaviors. "Bad" mothers typically resist all attempts at interaction by their young, at times butting them with vigor. Thus the typical patterns of stimuli and responses were absent from the interaction, but intensity and variability of stimulation were certainly present. Stimulus patterning seemed crucial in this situation for resultant attachment behavior of the mother and her young, whereas,

with Hess' lower animals it seems that the factor of stimulus intensity alone was sufficient. However, for the development of visual depth perception of Baumgold's lambs, the absence of the complexity and meaningfulness characteristics of the stimulus setting did not seem to have negative effects. "Bad" mothered lambs demonstrated visual cliff perception as soon as did "good" mothered lambs. Baumgold's observations can be interpreted as evidence that, for the development of visual depth perception in the lamb, an optimal activation level of the animal is prerequisite. This activation level is dependent upon the intensity and variability of external stimulus conditions rather than their complexity or meaningfulness.

Summary

At any level of the phylogenetic scale, the infant emerges as an active organism, not just a reactive one. The degree to which the infant participates in the transactions with his environment seems a function of its neuromuscular endowment at birth.

In the organism's further development of perceptual/motor processes, from birth onward, optimal levels of stimulus intensity seem an underlying given in the infant maintenance of an optimal level of activity. As the organisms chosen for study become more complex in terms of their immediate neonatal neurological endowment and potential for future complex transactions with the world (e.g., cognitive abilities), the needs for stimulus complexity and meaningfulness become more crucially intertwined with stimulus intensity variables.

The duration of perceptual contact and interaction also seem related to the complexity of the organism studied, i.e., longer periods of time seem to be required for those organisms which are more dependent in the neonatal period, but at the same time are destined to interact more complexly with their environment at maturity.

Finally, it would seem that even though a number of developing behaviors within a neonate's repertoire are observed to be occurring at the same point in time, it is unlikely that the identical stimulus conditions are prerequisite for the simultaneously evolving behaviors.

The focus of present study is the investigation of the mother-infant interaction in sheep with particular reference to the influence of varying activation levels of the ewe-lamb pair on the visual depth perception of the neonate lamb.

Related Sheep Studies

The present study grew out of related research in the department of psychology at the University of Oklahoma (Patterson, 1965; Little, 1966, Baumgold, 1967; Pearce, 1967). With the exception of Pearce, who studied the characteristics of mothering patterns in ewes, the primary focus of this research was the development of visual cliff depth perception in the neonate lamb. Patterson, Little and Baumgold's studies dealt with the manipulation of the ewe-lamb relationship and the effects of these variations on the onset of depth perception in the lamb. Appendix I shows a summary of visual cliff perception performance for the above studies.

Patterson (1965) worked from the general hypothesis that differential treatment of the young of many species in relation to the mother-neonate interaction may produce dramatic differences in a variety of later behaviors of the offspring. He postulated that mothered lambs would avoid the visual cliff, i.e., perceive depth, at a significantly earlier age then would unmothered lambs. In order to determine if the acquisition of the tendency to avoid the visual cliff were visually mediated in the mothered lambs, goggles were used to prevent patterned vision to a group of otherwise normally mothered lambs. All mothered lambs achieved the criterion avoidance response to the visual cliff situation before their unmothered pair-mates whether or not the mothered lambs had access to patterned vision. Patterson (1965) concluded that the early appearance of avoidance behavior in mothered lambs represented a primitive form of "ego" functioning operating through species-specific behavior, and that such "ego" functioning is of survival value to the infant /p. 54/. Patterson's conclusion, stated in holistic terms, seems more acceptable to present day theorizing, i.e., that the differential results can be explained on the basis of efficient establishment of a basic organismic equilibrium in the normal mother-neonate relationship. As to the importance of visual stimuli in the development of depth perception, Patterson concluded that such perception was not dependent upon visual learning, but is probably more closely related to gratification of contact needs.

Walk, Gibson, and Tighe (1957) earlier had concluded that

depth discrimination occurs independently of learning. They tested 90-day-old light-and dark-reared rats on the visual cliff, and found that animals from both groups reliably chose the shallow (safe) side. Nealey and Edwards (1960) replicated the work of Walk et al., allowing the dark-reared rats to light-adapt under translucent hoods to avoid the opportunity for patterned vision. Their findings supported those of Walk et al.

Little (1966) chose to study the mother-neonate relationship more closely. He controlled a number of mother-neonate interactional processes systematically in order to determine which of the processes were most significantly related to either the appearance or to the suppression of depth perception. Comparing all experimental groups with normally mothered lambs, Little found that avoidance of the visual cliff varied proportionately as the quality and quantity of the mother-neonate relationship decreased. The earliest appearance of the avoidance response, progressing to the latest, occurred in the following sequence: (1) natural mothering; (2) natural mothering except for nursing; (3) lamb free to have contact and nurse but no response possible by ewe; (4) lamb free to have contact but no nursing or response possible by ewe; (5) lamb and ewe free, with lamb contained within a pen inside the pen of the ewe: no interaction except through visual contact; (6) lamb and ewe permitted complete interaction, but cross-fostered and oil of anise applied to nose and anus; (7) lamb and ewe (own mother) permitted complete interaction, but oil of anise applied as above; (8) lambs unmothered except for human

contact in feeding.

Baumgold (1967), alluding to the effects of various types of stimulation during a critical developmental period, chose to manipulate variables primarily related to the neonate lamb which would have a direct bearing upon the infant's ability to interact with its mother. He proposed that tranquilizers and sedatives would decelerate an infant's interaction with its mother during the critical period and indirectly, that these drugs would delay the development of visual depth perception. Conversely, he proposed that accelerating the infant's interaction with the mother should lead to the earlier development of visual depth perception. Thus, one group of lambs received a stimulant at birth. To demonstrate that visual depth perception is not a function of conditioning or learning as mediated by locomotor abilities, Baumgold gave one group of lambs a voluntary-muscle relaxant at birth. That tranquilizing and sedative drugs have no direct effect upon the lambs' ability to perceive depth was demonstrated by administering these drugs to lambs who had already achieved the avoidance response and then retesting them for depth perception.

Baumgold's findings supported the majority of his proposals. Both sedatives and tranquilizers effectively diminished the infant's ability to interact with the mother and significant differences between these groups and normally mothered lambs were found. Lambs which had already successfully developed visual cliff perception were unaffected by the direct effects of the drugs upon retest. Likewise, lambs given the voluntary muscle relaxant

differed significantly from control lambs. The lambs treated with a stimulant did not differ significantly from control animals, but fewer hours were required to develop the avoidance response. Baumgold reasoned that more dramatic differences might have been found if drug dosage levels had been more appropriate.

While all three studies (Patterson, 1965; Little, 1966; Baumgold, 1967) supported the general theory that any interrupting factors in the mother-neonate relationship would have direct effects on the development of visual depth perception, the elaboration of mediating factors has not been clear. Baumgold (1967) speculated that Patterson, Little and Pearce's work supported the theory of adequate stimulation being necessary in the neonate's first hours of life. However, while he found his lambs to have retarded perceptual development when they were unable to interact normally with the mother, observations of the ewes showed no decrease in the amount of stimulation they provided the lamb through bleating, licking and nuzzling. Yet, Baumgold (1966) stepped away from a full stimulation hypothesis:

> It may be the case, therefore, that during the first few days (or perhaps hours) of the infant's life perception is integrated in terms of the mother. She appears to be the major compelling source of all stimuli, and all responses seem to be focused upon her. This process obviously involves visual, tactual, kinesthetic, olfactory and gustatory cues. Although many of these cues are obvious (such as bleating, licking, and nuzzling) the process probably is mediated by additional cues which are of a highly subtle nature. The integration of perception clearly involves the integration of the several sensory modalities. Yet, the process itself appears to transcend the individual senses. That is, this integration probably takes place in terms of a series of elaborate gestalten /p. 55/.

From the review of research concerned with early stimulation, optimal stimulation levels and the mediating role of the limbic and reticular activating system of the brain, it seems likely that the related sheep studies to date could have been explained by a theoretical model incorporating a framework of acute and chronic activation levels similar to that presented by Butler and Rice (1963). For example, a theory of chronic and acute activation levels implies that for the neonate lamb there is an intrinsic chronic activation level probably maintained by the interactions of the reticular activating system and the limbic system. An optimal, on-going level of extrinsic transient stimulation (acute activation level) with which the neonate interacts is necessary for neurological integration. This is required for locomotor and visual coordination, as well as perceptual skills. In Hebb's terms, optimal levels of acute activation are essential for neural pathways to become integrated with the cortex from the lower centers via the brain stem systems.

Immediately at birth it would seem that the ewe's vigorous licking of the infant could serve as the activating stimulus which contributes to the development of the infant's intrinsic chronic activation level. Butler and Rice (1963) hypothesized that if the acute activation level is much higher than the intrinsic chronic activation level, stimuli will be avoided. However, in the newborn lamb which cannot yet stand and cannot actively avoid in order to reduce the acute activation level, the action of the external stimulation would contribute to an increase of the lamb's

chronic activation level. One might say that the neonate changes internally to effect a situation of optimal stimulation, i.e., a balance of acute and chronic levels. When the lamb becomes ambulatory and can participate in the interaction with its mother, it is likely that through approach and withdrawal behaviors it can contribute to the moderating of its own acute activation level. What would seem to be necessary, however, is that the stimulus object (mother) be capable of actively producing stimulus intensity through physical contact, and not simply an object which the lamb passively bumps into in its exploratory search.

According to the activation level hypothesis, when the intrinsic chronic activation level is higher than the acute level, adient behavior will occur, i.e., the lamb would actively seek the activating stimulus (ewe). Normally, an encounter of licking, sniffing, and movement of the lamb by the ewe would frequently occur in the normal mother-neonate relationship. However, if this stimulation is chronically not forthcoming from the ewe the chronic activation level of the lamb will change (lower) and descriptively, the animal would become bored or apathetic. External stimulation, when it does occur, may then take on an aversive, disorganizing character. Butler and Rice (1963) used the example of the human infant, who, when its chronic activation level is relatively high during waking, will demonstrate orienting and curiosity behavior in response to the sound of a clicker; when the infant is falling asleep, and its chronic activation level is low, the sound of the same clicker often produces a startle response, prolonged wake-

fulness and crying.

From the past sheep studies, it would seem that Patterson and Little's unmothered lambs were victims of imbalance between the chronic and acute activation levels, i.e., lack of optimal levels of stimulation in the total situation. Little's progressive inhibition of the potential for interaction seemed to be a progressive reduction of acute activation levels from the primary stimulus source (mother). Little's observations that the experimental lambs engaged in much exploratory behavior, yet did not exhibit avoidance visual cliff response as did mothered controls, supports the hypothesis that the neonate requires the intensity of maternal stimulation and that what it passively encounters in its environment is inadequate. This also may be why Baumgold's lambs who had "bad" mothers as rated by Pearce (1967) exhibited the criterion avoidance visual cliff response as soon as well mothered lambs. The aggressive rejection of the lamb by butting and vigorous movements in a small pen to avoid contact with the lamb may well have been an adequate determinant of acute activation level facilitating normal integration of the depth perception capacity. Additionally, Little's mother-neonate pairs which were anointed with oil of anise and which took the longest to reach the criterion avoidance response would seem to be somewhat different than Pearce's "bad" mothers. While Little's recorded observations of these mother-neonate pairs are not sufficiently detailed to make direct comparison with those of Pearce, it would seem that Little's mothers avoided the anointed lambs with little vigor, e.g., they would begin

to sniff and lick the anointed lamb, then suddenly break the action pattern, or back away from the lamb. In this situation, the chronic activation level of the lambs may have become so labile from the intermittent stimulation that the amount of acute activation from the present, avoiding mother became disorganizing.

Baumgold's drugged lambs were in a situation in which they received stimulation at similar acute activation levels as normally mothered lambs; yet a delay in their developing visual depth perception occurred. This situation might be interpreted as the lamb having a chronic activation level considerably lower than normal lambs because of the tranquilizers, sedative or relaxant. In the presence of a normal, active mother the discrepancy between the chronic activation level of the infant and the acute activation from the mother could then assume an aversive character. It is likely that the stimulation contributed to neural disorganization until the lambs gradually developed a higher chronic activation level in optimal balance with the acute activation level; hence, some 20 hours later the lambs developed visual depth perception. That all of the experimentally treated lambs in the above studies were gradually able to adapt their intrinsic chronic activation level seems supported by the fact that while visual cliff perception was delayed, they all eventually demonstrated the visual cliff response.

Finally, Baumgold's mystery as to why there were not significant differences in the direction of shorter time to reach the criterion avoidance response with his drug-stimulated lambs

may be related to Fox's (1959) explanation as to why his drug-stimulated, light-deprived monkeys showed an increased need for light. Fox postulated that the stimulant raised the animals' chronic activation level, thus increasing the discrepancy between the chronic and acute activation levels. In Baumgold's stimulated lambs, it is also possible that their chronic activation level was raised and the acute activation level provided by "normal" ewe behaviors was not high enough to provide the balance of optimal stimulation required for "better" performance.

From the above integration of an activation level hypothesis and various mother-infant relationships, the generalization might be made that an optimal level of stimulation is required in the relationship, with both animals contributing. It seems likely that specific response patterns per se are not at issue, but rather, the intensity of stimulation in any given situation. It seems likely that frequency and movement in the form of body contact contribute to the intensity characteristic of the stimulation in the total interactive situation.

The present study will explore further the activation level hypothesis in the mother-infant interaction. It will utilize drugs to reduce the acute activation potential of the ewe in the mother-neonate pair; additionally, it will utilize drugs to reduce comparably both the chronic activation level of the lamb and the acute activation potential of the ewe in the mother-neonate pair.

CHAPTER II

PROBLEM

Past research has demonstrated that any interference with the mother-neonate relationship in sheep results in changes in the onset of depth perception in the neonate lamb. A theoretical formulation involving activation levels (Butler and Rice, 1963) has been proposed to explain the results of previous sheep studies carried out at the University of Oklahoma (Patterson, 1965; L ttle, 1966; Baumgold, 1967). The present study attempts to verify the proposed theory.

The activation level formulation proposes that the developmental process of depth perception in the neonate lamb is directly related to the optimal stimulation level in the total mother-neonate relationship. This optimal stimulation level is a balance of an intrinsic chronic activation level of the lamb and the extrinsic, transient acute activation level which is primarily contributed to by the active stimulus object---mother.

Known characteristics of visual depth perception seem directly related to an activation level explanation. Visual depth perception seems to have a relatively sudden onset in many lower animals, the time being predictable by the organism's locomotor prowess during the early neonatal period. Thus, the early and

rapid onset become critical factors in that mobile infants require such perception for survival's sake. Additionally, the development of visual depth perception seems to come about in the absence of reinforcement and patterned visual stimuli. It seems resistant to extinction. Thus, the development of visual depth perception is unexplainable in terms of traditional learning theory models.

Because of the characteristics noted above, the development of visual depth perception in lower animals seems similar to the imprinting process. Just as an activating stimulus is necessary in the environment of birds before the following response is elicited, it would seem that an optimal level of stimulation is prerequisite to the adequate, efficient development of visual depth perception in the neonate lamb.

The first hypothesis of the present study deals with the influence of a reduced extrinsic, acute activation level in the mother-neonate lamb interaction:

> Hypothesis 1. Neonate lambs of ewes whose activity level potential has been reduced through tranquilizing drugs will avoid a visual cliff at a significantly later age than control lambs experiencing an optimal stimulation level interaction (normal mother-neonate relationship).

The activation level formulation of optimal stimulation level proposes that "optimal stimulation" is a balance of both the intrinsic chronic activation level of the lamb and the extrinsic acute activation level maintained by the ewe. It seemed reasonable to assume that if the "balance" concept holds, then both chronic and acute levels could be reduced comparably with an optimal stimulation level for the total mother-neonate situation still main-

tained. Hypothesis two was conceived to explore the concept of optimal stimulation level:

> Hypothesis 2. In mother-neonate relationships in which the activation level potential of each partner has been reduced comparably by tranquilizers, a mutually lowered, but optimal stimulation level will result, and the time at which these lambs avoid a visual cliff will not differ significantly from that of control lambs.

Several additional aspects of the early development of neonate lambs were explored in the present study. Skinner (1968) studied the pharmacological effects of magnesium pemoline and thyroxine on the visual cliff perception of neonate lambs; additionally, he obtained blood samples from all groups of lambs both before and after they demonstrated the criterion avoidance response on the visual cliff. The blood samples were analyzed for steroid hydrocortisone. While Skinner found differences between experimental groups in terms of time to the criterion avoidance response, it appeared that some factor was affecting all lambs across all groups, as exceedingly long periods of time were taken for his control as well as his experimental population to achieve the avoidance response. Appendix I shows that the mean number of hours to achievement of the criterion avoidance response on the visual cliff seems to have gradually increased over the years of sheep research; however, Skinner's data seems markedly skewed. In evaluating what had occurred to the neonate lambs across all Skinner's groups, two factors emerged. First, all lambs had 5 cc of blood drawn at two different intervals. It was reasoned that physiological stress resulting from this procedure may have effected the subsequent delay in visual perception. Second, for the first time in the history of the flock, a new vermi-

fuge had been fed to the sheep. This preparation contained 40 per cent of the active chemical ronnel, one of the class of organophosphates having the specific classification, O, O-dimethyl O-2, 4, 5-trichlorophenyl phosphorothioate. Skinner (1968) explained the actions attributed to organophosphates:

> Organophosphates are anticholinesterase agents. Thus, they bring about an accumulation of acetylcholine and are potentially capable of producing effects equivalent to continuous stimulation of cholinergic fibers in the central and peripheral nervous systems. Further, organophosphates are known to have a longer lasting effect than other anticholinesterase (anti-ChE) agents and have been described as "irreversible" for that reason. There seems little reason to doubt that ronnel could reach the fetus in utero via the "placental barrier", especially since organophosphates are known to have high lipid solubility (which may also facilitate their penetration of the central nervous system) [p. 71].

Gershon and Shaw (1961) reviewed the literature regarding organophosphates and presented their study of 16 human subjects who had neurological symptoms after chronic exposure. Koelle (1965) similarly noted that ". . .several organophosphorus compounds can produce a peculiar syndrome of neural degeneration, associated with demyelination, following chronic exposure" [p. 452].

In the present study, a small group of ewes were fed the ronnel-based vermifuge following the procedure used by Skinner.

> Hypothesis 3. Lambs whose mothers have been fed the ronnel-based vermifuge during the prenatal period will avoid a visual cliff at a significantly later age than control lambs.

The final aspect of the present study was exploratory rather than hypothesis testing. Further data seemed necessary concerning the effects of complete isolation of the neonate lamb from the normal mothering process. Hersher, Moore and Richmond (1958)

in their study of goats and kids, separated the infants from their mothers ten minutes after birth for varying periods of time. At two, and again at three months the same infants were subjected to two stressful emergency situations. During a subsequent normal pasturing period of six months, 10 of the 21 experimental kids died in contrast to 3 of the 22 control animals. Liddell (1961) found that classical conditioning experiments with lambs and kids which took place for as brief a period as one hour in the absence of the mother were almost always fatal within a few weeks or months. Patterson (1965) described the apathy, coma and finally death of lambs in isolation from their mothers whose only contact was human-feeding every four hours through an aperture in wire cages. Clearly, complete isolation experiences have subsequent behavioral after-effects including premature death.

In the present study four different isolation situations were used. It was hoped that through twenty-four hour a day observation and recording, additional information would be obtained about the behaviors of lambs during an isolation process. It was also hoped that some clarification might be obtained regarding the dichotomy which Yarrow (1966) has emphasized contrasting "maternal deprivation" and "maternal separation." For the purposes of this study, it was assumed that maternal separation was predicated upon a previous relationship with the mother. Although all lambs in the isolation experience would indeed be deprived of the mothering figure at some time, the definition of maternal deprivation in this study referred to lambs which had never experienced contact with

their mothers. Additionally, further exploration of the influence of visual patterning of environmental stimuli was carried out. Thus, four isolation conditions were used: maternal deprivation (full vision allowed); maternal deprivation (patterned vision denied); maternal separation (full vision allowed); maternal separation (patterned vision denied).

CHAPTER III

METHOD

Description of Subjects

The subjects were lambs born of 48 registered Suffolk ewes which were bred to the same registered Suffolk ram. The ram was introduced into the flock on November 19, 1967 resulting in a 32 day lambing period from April 12 through May 13, 1968. The over-all distribution of births was skewed in that 45 ewes delivered within the first 21 days followed by an eight day lag; three ewes delivered consecutively on the three remaining days. The 21 day portion of the birth distribution was comparable to those reported by Little (1966) and Baumgold (1967). A uniform birth distribution of both the prenatally treated and untreated groups of ewes was observed.

The results of the time of day at which births were recorded showed a distribution of 11, 9, 10, 4, 5, 9 births for each four hour segment beginning at midnight. Thus, 29 (60%) of the 48 ewes delivered between 8 p.m. and 8 a.m. This distribution is the reverse of that reported by Little (1966) and Baumgold (1967), but more in keeping with Patterson (1965) who reported that the period of greatest delivery activity occurred before

sunrise and after sunset. Skinner (1968) reported about equal frequency of birth times. A summary of the birth data from five years are consistent with the findings of Hersher, Richmond and Moore (1963) that sheep show no tendency to deliver at any particular time of day.

The 48 ewes gave birth to 65 lambs of which 23 were males and 42 were females. Among the 65 lambs there were 31 single birth animals and 17 sets of twins. A summary of delivery data for all sheep studies (1965-1968), respective of deliveries producing single or multiple lambs, is presented in Appendix II. Seven lambs were not used as subjects; four lambs because the experimental procedure with the respective ewes would have resulted in false data; one set of twins because of prematurity and one singleton lamb because of death.

Treatment of Subjects

Prior to the onset of breeding, a program of parasite control for the flock was instituted. This program included pasturing the sheep in well drained fields, pasture rotation, and two oral administrations of thiobendazol (bolus preparation). Throughout the prenatal period a vermifuge preparation of phenathiazine in minerals and salt was given once a week as a supplement in the feeding to all animals.

Because of the prenatal design of the experiment, each ewe was randomly assigned and marked according to one of each of the four treatment groups prior to the introduction of the ram

into the flock. These groups were as follows:

Group C-1: Ewes which were given no special treatment during the prenatal period.

Group C-2: Ewes which were given no special treatment during the prenatal period, but treated immediately postpartum with short-acting fluphenazine hydrochloride in order to lower the activity level of the ewe only.

Group H: Ewes which were given long-acting fluphenazine enanthate injectable throughout a portion of the prenatal period in order to sustain a lowered activity level of the ewe and her lamb.

Group X: Ewes which were given the anthelmintic agent ronnel preparation throughout the prenatal period.

From the time the ram was introduced into the flock and until one week before lambing began, the flock was kept in a series of large, open pastures. In order that the flock could be kept intact and yet subject to differential drug treatments, a portable corral was built which was entered by a Y-sorter apparatus. Each time that the prenatally treated groups were to be administered their respective drugs, the entire flock was herded through the sorter which led to separate pens. Thus, Group X ewes ate their oral ronnel preparation separate from the remaining groups; Group H animals were injected as they came through the main chute leading to the separated pens.

A routine feeding schedule was established for the flock. Ample grazing land was available until snowfall when alfalfa was

used as a supplement. Additionally, the flock received grain feed-meal four times a week at a ratio of one pound of feed-meal per ewe at each feeding. For Group X receiving the ronnel preparation during the prenatal period, 9 ounces of the vermifuge preparation was mixed with the group's meal ration. This amount of the ronnel preparation was a best estimate of what had been given in Skinner's 1968 study as at that time the vermifuge was not recognized as a variable. Consistent with Skinner's (1968) procedure, the ronnel was administered beginning the first day of the breeding period and was discontinued approximately a week before the first lamb was born.

Subcutaneous bimonthly injections of fluphenazine enanthate were not started with Group H until nine weeks after introduction of the ram to ensure that no difficulties in impregnation would occur. Himwich (1960) reported that menstrual irregularities and libido changes have been reported in human patients receiving phenothiazine and phenothiazine derivatives. While unpublished reports (1967) of The Squibb Institute for Medical Research indicated that no teratogenic effects of fluphenazine enanthate occurred in a study of 300 fetuses of rats and rabbits, the nine weeks waiting time before drug administration insured no possible interference with early fetal development.

During the lambing season, the flock was moved to a fenced enclosure comprised of approximately 1500 square yards. While the enclosure was geographically concentrated, the ewe beginning labor was able to isolate herself from the flock. The

flock was observed continuously throughout each twenty-four hour period. The characteristic behavior of the ewe nearing the time of delivery was consistent with what Pearce (1967) reported:

> The first sign that parturition is near occurs when the ewe withdraws or isolates herself from the rest of the flock. She typically locates herself on the outer perimeter of the flock, lies down and remains in this location until parturition. Isolation occurs well before parturition and. . . was observed to occur as much as eight hours before birth in some instances. As parturition nears, the ewe's head typically droops and she remains in a prostrate position. . . . With the passage of time the ewe becomes increasingly more active physically, particularly with the onset of labor contractions. A yellowish-brown bag extrudes from the ewe's vagina shortly before birth and when the bag bursts the ewe frequently rises to her feet and sniffs the ground where the contents of the bag are spilled.
>
> Shortly before giving birth, when the labor contractions are most intense, the ewe points her nose upward in conjunction with each contraction, wrinkles her nose, and emits a very shrill bleating sound /pp. 26-27/.

When the lamb was born, it was immediately taken from the ewe before she could have any contact with it. While the lamb was being taken to the laboratory for a standard cleaning procedure, the ewe was guided to and confined in a small sheltered pen. The confinement pen measured approximately 4 feet by 8 feet and contained clean bedding hay. The gate of the pen was constructed of heavy wire fencing to allow for observation of ewe-lamb interaction at a distance that would not interfere with the mothering process.

After being carried to the laboratory in burlap sacking, the lamb immediately was weighed, tagged and the umbilicus painted

with iodine. A standard cleaning procedure, simulating the ewe's early maternal behavior, consisted of rubbing the animal with burlap beginning with the snout, head and neck and working backwards over the spine to the rump. This procedure was continued until the lamb was able to stand on all four legs. Observations made during this laboratory procedure were consistent with those made by Pearce (1967) regarding lamb behavior in the natural setting:

> The newborn lambs are mobile at birth and attempt to rise on all fours within the first few minutes of life. Although not usually successful on the first attempt, the newborn lambs are usually able to stand on all fours within thirty minutes after birth (p. 28).

Lambs of ewes from the control group (C-1), the prenatal fluphenazine enanthate group (H) and the prenatal ronnel group (X) were then returned to their respective mothers in the confinement pens. Lambs of the fluphenazine hydrochloride after-delivery group (C-2) were not returned until the ewe had been milked and received adequate drug dosage to meet the criteria established for a lowered activity level. The amount of time for the appropriate drug reaction to occur and the length of time it took for the laboratory procedure to be administered to the lamb approximately coincided.

Because pilot study data regarding drug dosage clearly showed how quickly fluphenazine hydrochloride affected the nursing infant through the milk, each ewe of Group C-2 was fitted with a brassiere after delivery. In order to prevent the lamb from sucking medicated milk through porous material, the brassieres were constructed from plastic shower caps to which cords were attached

for fitting around the ewe's belly and back legs.

The impeding of nursing imposed by the brassiere was felt to pose minimal if any influence on subsequent visual depth perception. This decision was based on the results of Little's (1966) study in which one group of ewes and their lambs were treated similarly to Group C-2:

> Lambs were left with a loose, but brassiered mother in the stall. Although the ewe in this case could not nurse her own young, maximal lamb-ewe interaction was permitted in other respects /p. 36/.

In comparing this above described group with his control group regarding mean hours until the avoidance of the visual cliff, Little (1966) found no significant difference between the two groups, 6.4 and 5.8 mean hours respectively.

Three ounces of colostrum milked from the Group C-2 mother before the administration of drug was given to her lamb as soon as it was able to stand on its feet. Denying the lamb any nourishment or sucking experience until this time was done to keep initial feeding experience consistent with the treatment that lambs from other groups received from their own ewe-mothers. Until the conclusion of the testing situation, the lambs of Group C-2 were bottle fed 4 ounces of formula on an every four hour basis. The formula consisted of 2 ounces of evaporated milk and 2 ounces of water.

Twin sets were used both for the hypothesis testing aspect of the experiment and as subjects in the isolation aspect of the experiment. At the time of birth, twin lambs were subjected

to exactly the same standard laboratory procedure described. When the lambs were able to stand adequately, one of the twin-pair was randomly assigned to go into the isolation group condition and was bottle fed 3 ounces of colostrum; the twin-mate was returned to its mother. Those lambs placed immediately in isolation were labled "Maternal Deprivation" condition. The twin-mates who were returned to their mothers until reaching the criterion of avoidance of the visual cliff, and which subsequently were placed in the isolation laboratory, were labled "Maternal Separation" condition. Assignment of a twin to either isolation condition setting was randomized according to birth weight as typically one of each twin-pair is the heavier.

In addition to the assignment of each of a twin-pair to a deprivation or separation condition within the isolation aspect of the experiment, alternative assignment of sets of twins was made in terms of the lambs having full visual experience during the isolation experience. Thus, a twin-pair might have been assigned a full vision denied isolation condition with one twin being placed immediately into the isolation laboratory and the twin mate returned to the mother until it had completed the treatment group aspect of the experiment.

Although seventeen sets of twins were born to the flock, lambs from fourteen twin sets were used in the isolation aspect of the experiment. One set of twins was not used because of prematurity; two other sets were not used because of experimenter error in returning both lambs to the mother. Thus, two singleton

lambs, matched for treatment group and weight, were substituted in the isolation condition denying full visual experience. Overall, fourteen lambs were placed in the maternal deprivation condition, seven of which were denied patterned vision; fourteen lambs were placed in the maternal separation condition with seven lambs also denied patterned vision.

The isolation laboratory was a large, windowless room measuring 13 feet high x 19 feet long x 23 feet wide. The walls and ceiling were painted flat white; the flooring was grey cement. Three room-length rows of flourescent lights continuously illuminated the three rows of wire cages below. Each row of cages was 12 feet long divided into six compartments, each measuring 36 inches high x 24 inches long x 36 inches wide. Construction was of heavy welded one-inch mesh wire. The floor of each cage was kept covered with three layers of newspaper.

Each lamb was placed in an individual compartment for an isolation experience of 168 hours. Those lambs which were denied full visual experience during the isolation period were fitted with plastic translucent goggles. These goggles were held in place by 1/4 inch-wide elastic bands around the head and posterior aspect of the snout. At no time was there any interference with breathing, sucking or swallowing. Goggled and non-goggled lambs were alternated in adjoining compartments to minimize between wire interaction.

During the isolation experience, the lambs received no human contact except for during an every four hour feeding and

cleaning schedule. Each contact per animal varied from 4 to 10 minutes. Following is the contact procedure which was rigidly carried out for each animal:

(1) Hand-feed each lamb the prescribed amount of formula every four hours.

(2) Massage each lamb during feeding with a sponge dampened with mineral oil. Work from the head, over the spinal area to the rump.

(3) Replace soiled newspaper flooring of the cage.

Those lambs which were placed in isolation in the maternal deprivation condition were fed 4 ounces of formula for approximately 72 hours. At this time, the formula was increased to 6 ounces every four hours. Lambs placed in isolation after reaching the criterion avoidance response on the visual cliff were increased to 6 ounces per feeding after approximately 36 hours. Lambs which remained on 4 ounces of formula throughout the isolation experience were those of comparatively light birth weight and smaller stature.

Detailed observations were recorded every four hours during each lamb's isolation experience. General observations of the group were made between the contacts via an unobtrusive peephole in the laboratory door. Recording included: Feeding behavior, excretory pattern, bleating pattern, muscle tonus, motor ability, general activity level.

If the lamb survived the isolation experience, it was removed from the laboratory and its visual cliff perception tested. During this aspect of the testing situation the lamb was kept with a peer group of other post-isolation lambs in an outdoor wire pen

measuring 4 feet high x 8 feet long x 4 feet wide.

Experimental Design

For all aspects of the experiment, the experimental day was divided into segments of four hours each, beginning at 8:00 A.M., noon, 4:00 P.M., 8:00 P.M., midnight and 4:00 A.M. When born into its respective prenatal or postnatal treatment group each lamb was given its standard cleaning procedure and tested on the visual cliff apparatus at the onset of the next occurring time period. Each lamb was then tested on the visual cliff at each succeeding time period until it exhibited the criterion avoidance response. Those animals requiring hand feeding were fed immediately after testing to minimize lethargy. Between trials the lambs were kept with their mothers in the confinement pens.

Lambs which survived the 168 hour isolation experience were placed on the visual cliff apparatus immediately after their isolation period was completed. Lambs which had been goggled did not have their goggles removed until placed on the apparatus for the first time. In order to keep within the consistent, every four hour schedule of trials on the cliff apparatus, animals were removed from isolation at the time period closest to 168 hours. Each post-isolation lamb was tested on the visual cliff at each successive time period until the criterion avoidance response was demonstrated, or until it had completed ten trials. As all of the post-isolation animals required bottle feeding, each lamb was fed immediately after testing. Between trials these lambs were kept

in the outdoor wire pen confined with their peers.

The Visual Cliff

The visual cliff apparatus was the same as that used by Little (1966), Baumgold (1967) and Skinner (1968).

The over-all structure resembled a large box measuring 73½ inches high x 46 inches long x 31 inches wide. The surfaces of the structure consisted of 3/4 inch plywood with an outer reinforcing frame constructed of 2 inch x 4 inch wooden stock. All interior and exterior wood surfaces were painted with flat black enamel to reduce glare. Little (1966) described the apparatus:

> The top of the apparatus was fitted with a 17" x 31" hinged flap through which the lamb was placed on a platform. The hinged flap was edged with rubber strips to eliminate all external sources of light. The glass surface utilized for the test situation measured 44 3/4" x 29 7/16" and was fitted into slotted grooves to eliminate cues. From the surface of the glass to the inside top of the apparatus measured 24", while beneath this was a 48" simulated drop. The glass platform onto which the lamb was introduced through the top measured 29 7/16" x 12". Directly beneath the glass surface of the platform was fitted with a /sic/ red and white 1 1/2" checkerboard cotton material which dropped from the front edge of the platform perpendicular to the bottom of the apparatus. From that point it was flush on the bottom to the end opposite the platform. The platform was lighted from beneath by two vending machine fluorescent lights /pp. 38-39/.

The lamb was placed on the interior platform and the ceiling flap was closed. Typically, in the early postnatal period, the lambs explore the walls of the enclosure freely and walk off the platform ("safe" side) onto the portion of the glass below which is the apparent drop. At the time of the development of the avoidance response, the lambs, when placed on the platform,

either refuse to move or move cautiously keeping safely away from the apparent drop. Lambs also exhibit a characteristic posture in their refusal to move which consists of stiffening of the forelegs and "back-pedalling" of the hind legs in an apparent effort to move further back from the edge of the cliff. Additionally, they tend to nose towards the floor of the platform and seem to be visually taking the apparent drop into account. A low, gutteral fear-bleat frequently accompanies the onset of the avoidance behaviors.

When a lamb remained on the safe-side platform for three minutes without placing either of its front hooves beyond the edge of the drop, the criterion avoidance response was considered to be attained. Occasionally a lamb would not demonstrate the characteristic "back-pedalling" behaviors during the three minute test period though it remained on the safe side. In these cases, the experimenter gave the lamb a gentle push toward the drop to demonstrate the "back-pedalling," thus clearly establishing the avoidance response.

The age at which the criterion avoidance response was first elicited was recorded in terms of hours and minutes after birth. This was the critical measurement utilized in the hypothesis testing aspect of the experiment.

The identical criterion avoidance response was utilized with those lambs which were placed in the visual cliff apparatus immediately after removal from the isolation experience. In this case the time at which the criterion response was demonstrated or ten trials were completed was recorded in terms of hours after

removal from isolation. Because the lambs were removed exactly at one of the four hour segments of the experimental day and were run on the apparatus every four hours, all times were recorded in whole hours.

Drugs

Drug-induced change in the ewes' level of activation was carried out by means of the phenothiazine derivative, fluphenazine. Berger (1957) and Irwin (1966) described the phenothiazine (chlorpromazine-like) drugs as autonomic suppressants which are believed to reduce arousal mechanisms through depressing components of the mesodiencephalic activating system. These drugs antagonize the autonomic hormones such as acetylcholine, epinephrine, and histamine, and depress conditioned reflexes. Irwin (1966) stated:

> . . . the primary actions of chlorpromazine-like drugs of therapeutic relevance would seem their ability to reduce behavioral arousal, responses to environmental stimuli (including active avoidance) and locomotor activity, without impairing discrimination /p. 262/.

Meprobamate, not of the phenothiazine class, and barbituate-like drugs are also able to reduce behavioral arousal (when the subject is undisturbed). However, Irwin (1966) pointed out that these drugs increase, rather than decrease, motor responses to external stimuli, impair discrimination and judgment, and are not locomotor suppressants. For the purposes of the present study, selecting a drug from the phenothiazine category seemed most appropriate.

One of the prenatal treatment groups, (Group H), required a relatively long period of drug administration. Thus, drug selec-

tion was also dependent on it being easily and accurately administered to animals. Fluphenazine seemed to be such a drug as it is prepared as a long-acting injectable compound. Additionally, fluphenazine is prepared in a short-acting formula which allowed for a comparable drug effect on ewes who were to experience a rapid reduction of activity level immediately postpartum, (Group C-2). Regarding the compound fluphenazine, Kurland et al. (1964) reported:

> Dosage-wise, it is one of the most potent of these (phenothiazine) compounds. Its comparatively small effective dosage may have suggested the possible long-lasting effect of the subcutaneous administration of a large amount of the drug in a relatively small volume of a vehicle such as sesame oil. This method would allow the drug to be slowly absorbed by the body fluids and provide a continuous and fairly constant level of medication.
>
> The obvious advantage of such a preparation would be the removal of the necessity of administering medication several times daily. It would also help in eliminating the uncertainties associated with oral consumption of the medication /p. 137/.

Burke et al. (1962) utilized the long-acting fluphenazine (fluphenazine enanthate) in pharmacological research with rats and dogs. These investigators demonstrated that a single dose of enanthate inhibited the conditioned avoidance response in rats for twelve to fifteen days. Inhibition of apomorphine-induced vomiting in dogs was prolonged for up to four weeks after a single dose. Toxicity and pharmacological effects of the long-acting enanthate were found to be comparable with that of the short-acting fluphenazine hydrochloride.

Fluphenazine has been used with mice (Squibb, 1967), rats (Burke et al., 1962), cats (Irwin, 1966), dogs and rabbits,

(Squibb, 1967). Several studies have been carried out with human subjects (Kurland et al., 1964; Kurland and Richardson, 1966). No research data was found using sheep as subjects and the problem of establishing the minimal effective dose of fluphenazine remained.

Baumgold (1967) encountered a similar difficulty in establishing dosage levels in sheep using the drug chlorpromazine. As a result of his pilot study work, he established a .75 mg/pound dosage level. This amount of drug approximates, though is slightly higher than the initial dose of chlorpromazine for human adults. Irwin (1966) reported that in comparing human and animal dosage, there is generally a greater resistance of smaller mammals (e.g., mouse, rat, and cat) to drugs on a mg/kg basis, while for animals larger than man, smaller mg/kg doses of drug are usually required. Therefore, it seemed that Baumgold's (1967) findings supported the hypothesis that a human dosage level established for the phenothiazine derivatives would be approximately comparable for sheep.

A pilot study using eight non-experimental sheep was carried out to establish the minimal effective dose for both fluphenazine enanthate (long-acting) and fluphenazine hydrochloride (short-acting). Four yearling sheep were tested using the enanthate preparation. In most human subjects, researchers are in agreement that a single bi-monthly (every two weeks) injection of 25 mg of this preparation is as effective as daily oral doses of fluphenazine hydrochloride (Kinross, Vogt, and Choralampous, 1963). Initial pilot study doses were established at very low levels and gradually

increased in order to obtain information on graded effects of the drug as suggested by Irwin (1966). For example, two sheep were started on one-third of the adult human dose (8.3 mg) of enanthate and two sheep were started on one-sixth of the adult human dose (4 mg). When no observable behavioral effects were obtained with either dosage level, the amount for each pair was increased to one-half of the human dose (12.5 mg) and full human dose (25 mg) respectively. No observable behavioral effects were noted at these dosage levels.

During the time the pilot study on the enanthate preparation was being carried out, a delivered adult ewe (two-weeks postpartum) was added to the study. This animal, together with the other four yearlings were given a dosage of 30 mg fluphenazine enanthate. Within 72 hours, the first observed effects were noted. All of the sheep seemed less responsive to external stimuli and allowed humans to approach and touch them without the previously noted avoidance responses. The lack of avoidance behavior was particularly noticeable with the newly delivered ewe and her lamb. The defensive behavior, typical of the mother ewe when approached by humans, seemed absent and she was observed to actively approach the experimenter. Likewise, the lamb seemed less frightened and allowed the experimenter to approach without the usual startle response seen in young lambs. The amount of distance which the lamb and ewe allowed between them seemed increased. The changes in the lamb suggested that the drug was being transmitted via the ewe's milk. The time of onset of observable behavioral changes

after the injection of the drug was in keeping with what has been reported. A review of fluphenazine enanthate in Modern Drug (1967) stated that onset of action appears between 24 to 72 hours after injection and effects become significant within 48 to 96 hours.

The starting dosage established for the prenatal treatment group (Group H) was 30 mg given subcutaneously every 14 days. At the same time, the newly delivered pilot study ewe was given a dosage increased to 37.5 mg. No observable changes were noted in the Group H treatment group during the fourteen days following their 30 mg dose. However, the pilot study ewe was showing further behavioral changes with the 37.5 mg dose. These changes included standing quietly for long periods of time with head and ears slightly drooped; increased distance from the flock; decrease in eagerness of approach at feeding time.

On the basis of changes in the pilot ewe, the second injection of enanthate given to Group H was increased to 37.5 mg. Within three days, the treatment group animals were responding in almost identical fashion to that of the pilot ewe. Throughout the remainder of the prenatal period the 37.5 mg dosage level was used on an every fourteen day schedule.

Four additional yearling sheep and a two-day postpartum ewe were used in the pilot study to determine dosage levels of the short-acting fluphenazine hydrochloride. Once again, a graded increment of drug dosage was used, with two yearlings receiving one-third of an adult human dose (.42 mg) and two receiving one-

sixth of an adult human dose (.21 mg). Within twelve minutes all animals were observed to lower their ears, make a yawning motion with their lips, and lie down. When approached by the experimenter after twenty minutes, all of the sheep arose, moved several feet and lay down again. Within forty-five minutes, all sheep were up and about eating with no observable drug effect.

Because the delivered ewe most directly emulated the Group C-2 animals who were to be given the short-acting drug immediately after delivery, this sheep became the major pilot animal. Three-fourths of the starting dose for adult humans (.94 mg) was injected intramuscularly. Notes on this observation period are presented in Appendix III. Subsequent trials using the full dose recommended for humans (1.25 mg) and a dose of 1.88 mg increasingly lowered the ewe's activity level without interfering with consciousness. The length of time that the initial doses seemed to be effective in lowering activity was approximately two hours. If a subsequent 1.25 mg dose was then administered, the lowered activity effect lasted approximately four hours. Further dosages of .63 mg on an every four hour basis seemed adequately to maintain the desired sustained reduced activity level of the ewe.

At the time that the Group C-2 ewes began to deliver, they were started on a 1.88 mg dose of fluphenazine hydrochloride injected intramuscularly. Observation notes were kept on each animal. As Appendix IV shows, some individual differences occurred in the starting dose and subsequent doses given to the postnatally treated ewes.

CHAPTER IV

RESULTS

In testing the formulated hypotheses, the measured dependent variable was the age (hours and minutes) from the time of birth at which the lamb first exhibited the criterion avoidance response on the visual cliff apparatus. Table 1 presents the hours of age in terms of the range, mean and standard deviation for the three experimental groups and the control group.

Table 2 presents the results of the application of the $\underline{t}$ ("Student's") statistic (Walker and Lev, 1963, pp. 156-158) to the experimental and control data. Because all of the samples were small (under N=30), a correction factor suggested by Walker and Lev (1953, p. 157) was applied when the $\underline{t}$ statistic for unequal variances was utilized. Prior to the selection of the appropriate $\underline{t}$ statistic, Hartley's F max test (Walker and Lev, 1953, pp. 192-193) for homogeneity of variance of samples of non-uniform size was applied to each of the two groups whose means were being compared.

The first hypothesis tested was that lambs of ewes whose activity level potential has been reduced through tranquilizer drugs (Group C-2) will avoid the visual cliff at a significantly

TABLE 1

MEANS, RANGES, AND STANDARD DEVIATIONS OF HOURS TO THE CRITERION AVOIDANCE RESPONSE FOR ALL GROUPS OF LAMBS

Group	N	Range	Mean	Standard Deviation
Control (C-1)	10	2.25-13.25	5.23	3.22
Mother-neonate Optimal Stimulation Level Lowered (H)	14	1.25-10.25	5.15	2.53
Mother Activity Level Lowered (C-2)	11	8.00-80.45	48.43	24.81
Ronnel Prenatally (X)	7	1.08-20.45	11.02	6.65

TABLE 2

$\underline{t}$ TESTS BETWEEN ALL PAIRS OF MEAN HOURS TO THE CRITERION AVOIDANCE RESPONSE

Group	C-1	H	C-2	X
C-1	-	.069 ns	5.72*	2.33**
H	-	-	5.76*	2.87*
C-2	-	-	-	4.72*
X	-	-	-	-

* significant beyond .01 level of confidence
** significant at .025 level of confidence

later age than control lambs (Group C-1) experiencing an optimal stimulation level interaction. The t statistic utilized in comparing Group C-2 with Group C-1 data was that accounting for unequal variances. The obtained t of 5.72, with 10 degrees of freedom, indicated a difference in means in the predicted direction beyond the .01 level of significance.

Hypothesis two stated that in a mother-neonate relationship wherein there is a comparably lowered, but optimal stimulation level (Group H), the age at which the lambs avoid the visual cliff will not differ significantly from that of control lambs (Group C-1). Applying the t statistic for equal variances, with 22 degrees of freedom, gave a non-significant t - score of .069. This score indicates that the difference in means between the two groups is not significant, thereby confirming the hypothesis.

The third hypothesis stated that lambs whose mothers have been fed the ronnel-based vermifuge during the prenatal period (Group X) will avoid the visual cliff at a significantly later age than control lambs (Group C-1). The t statistic for equal variances was applied to these two groups and rendered, with 15 degrees of freedom, a t - score of 2.33. This score indicated a difference in the means in the predicted direction at the .025 level of significant (one-tailed). Thus, hypothesis three was also confirmed.

When Group X mean hours were compared with that of Group H (lowered, but optimal stimulation level condition), a t - score of 2.87 (19 degrees of freedom) was obtained indicating a difference

beyond the .01 level of significance (one-tailed).

Skinner (1968) had indicated that the extremely high mean hours which he observed across all of his groups may have been due to the physiological stress resulting from drawing blood samples on his lambs. This procedure was replicated with two lambs whose data was not used in the above groups. Thirty minutes after the birth of each of the lambs,-5 cc of blood was drawn from the saphenous vein of the hind leg. Subsequently, a Group X lamb achieved the criterion avoidance response on the visual cliff at 3.83 hours of age; a Group C-1 lamb at 8.75 hours.

Isolation Conditions Results

A total of 28 lambs were placed in the isolation conditions for a period of 168 hours. Fourteen lambs were taken from their mothers immediately after birth (Maternal Deprivation Condition); 14 lambs were taken from their mothers after they had achieved the criterion avoidance response on the visual cliff (Maternal Separation Condition). In addition, one-half of both groups of lambs were allowed full vision (Full Vision Allowed Condition) and half of them were denied patterned visual experience (Full Vision Denied Condition). Detailed recordings were taken twenty-four hours a day throughout the isolation period.

Deaths of lambs as reported by Patterson (1965) were observed in only one case. This lamb was in the Maternal Deprivation (Full Vision Denied). While the pre-terminal pattern of this animal was very similar to that of isolated lambs described by

Patterson, its twin-mate who had been allowed to stay with its Group C-2 mother also expired. Both of these animals were full term, vigorous lambs at birth; by 24 hours of age both animals showed signs of motor weakness, lethargy, and sucking and respiratory difficulties. Massaging of these animals was to no avail; at 33.25 hours of age the maternally deprived lamb expired and at 28 hours of age the lamb mothered by the lowered activity level ewe expired.

The twenty-four hour a day observation notes taken over the entire isolation period were evaluated for behavioral themes. Frequency of observed behavior were tabulated in the following categories: vocal behaviors, feeding behaviors, excretory behaviors, locomotor behaviors. Within the category of locomotor behaviors, general neuromuscular condition and the ability to adequately ambulate was tabulated separately from the self-stimulating behaviors observed. Appendices V and VI show the detailed break-down of the frequency of motor and feeding problems and the number of lambs demonstrating self-stimulation behaviors.

Several behavioral patterns emerged as common to all isolated lambs regardless of the specific experimental conditions. All lambs, for example, bleated loudly and incessantly for approximately the first 24 hours. This bleating pattern showed no change if the caretakers moved silently in the laboratory; if any noise was made, the frequency and pitch of the bleating raised considerably. After the first day, the incessant bleating ceased and the animals were observed to lay quietly curled up in a corner of

their cages until the door of the laboratory was opened for the feeding procedure. The door-opening seemed to act as an activation stimulus as much bleating and general body activity would begin. During the feeding and massaging of the back, all animals reacted hyperactively to the body contact. After the feeding procedure the lambs would once again curl up and appear to "sleep" for the four hours until the next feeding period.

Between approximately 80 and 100 hours into the isolation period, a dramatic onset of postfeeding behavior began to occur in 100 per cent of the lambs. As soon as the lamb was fed, it would begin to engage in patterns of behavior which were labled "self-stimulation." These behaviors included: pacing, jumping on the wire cage, leaping straight up in the middle of the cage, twirling of the head, nibbling of the wire cage, chewing of the paper flooring, pawing of the floor with the front legs, and body spinning. These behaviors would last approximately 15 minutes and then be followed by sleeping until the next feeding.

Not all the self-stimulating behaviors began at exactly the same time and not every animal was observed to engage in each of the kinds of behaviors mentioned above. However, each lamb demonstrated some of these behaviors. Whether or not the lamb had full visual experience seemed to make a slight difference in the kind of self-stimulating behavior and the time of its onset. For example, none of the animals having full vision demonstrated pacing behavior, i.e., repetitive walking back and forth along cage sides; 9 out of 14 of the goggled lambs paced. Eight goggled

lambs (contrasted to 13 Full Vision Allowed lambs) demonstrated the jumping-on-wire behavior and the onset time for this behavior was 20 hours later than for ungoggled animals. Likewise with the chewing-of-paper behavior; 6 out of 14 of the goggled lambs demonstrated this behavior in contrast to 13 out of 14 Full Vision Allowed lambs. For the goggled lambs, this chewing behavior did not appear until some 30 hours after the average onset time for lambs having full vision.

Twenty out of the 28 isolation animals demonstrated neuromuscular coordination difficulties serious enough to impair locomotion and sucking ability. Table 3 shows the number of lambs relative to Maternal Deprivation and Maternal Separation which demonstrated feeding and motor problems. Ten out of 14 lambs (71 per cent) of each group demonstrated either one or the other of these neurological problems. An identical number of lambs from each group, 4 out of 14 (29 per cent), had <u>both</u> feeding and motor problems during the course of the isolation period. Thus, when one looks at both the Maternal Deprivation group and the Maternal Separation group, the difference in mothering experience seemed to have no effect on whether or not there would be neuromuscular coordination difficulty <u>in general</u>. However, a dramatic difference seems apparent in terms of the kind of difficulty relative to the two isolation conditions: 5 out of 10 Maternal Deprivation lambs with problems had feeding problems, whereas 10 out of 10 Maternal Separation lambs having problems had feeding problems. When comparing the two groups for motor problems, a reversal is seen: 9 out

TABLE 3

NUMBER OF MATERNAL DEPRIVATION AND MATERNAL SEPARATION LAMBS HAVING FEEDING AND MOTOR PROBLEMS

Isolation Condition	Problem			
	Feeding	Motor	Feeding & Motor	Feeding &/or Motor
Maternal Deprivation (N=14)	5	9	4	10
Maternal Separation (N=14)	10	4	4	10

of 10 of the Maternal Deprivation lambs having problems had motor problems, whereas only 4 out of 10 Maternal Separation lambs with problems had motor problems.

The Fisher Exact Probability Test (Siegel, 1956, pp. 96-104) was utilized in comparing the differences in frequency of feeding and motor problems between the two groups. In comparing the frequency of feeding problems, the observed D=0 has a two-tailed probability of occurrence of $p=.05$. Thus, the number of feeding problems for the Maternal Separation group is significantly different than that for the Maternal Deprivation group. In comparing the difference in the frequency of the motor problems between the two groups, the observed D=1 has a two-tailed probability of occurrence of $p=.10$. The number of motor problems is significantly different between the two groups, though not as great.

Table 4 shows the isolation condition group of lambs combined as to Full Vision Allowed and Full Vision Denied relative to feeding and motor problems. Using the Fisher's Exact Probability Test, no significant differences were found between groups on the Feeding, Motor, Feeding and Motor problem dimensions. Eight out of 14 lambs (57 per cent) having full vision allowed experienced problems in general in contrast to 12 out of 14 lambs (86 per cent) which were denied patterned vision. The two-by-two contingency chi-square statistic utilizing Yates' correction (Walker and Lev, 1953, pp. 103-108) was applied to the frequencies observed for all problems between the two groups. The obtained

TABLE 4

NUMBER OF FULL VISION ALLOWED AND FULL VISION DENIED LAMBS HAVING FEEDING AND MOTOR PROBLEMS

Isolation Condition	Problem			
	Feeding	Motor	Feeding & Motor	Feeding &/or Motor
Full Vision Allowed (N=14)	6	6	4	8
Full Vision Denied (N=14)	9	7	4	12

X_y^2 of 1.02 (1 degree of freedom) is not significant. Thus, it seems that the differences observed relative to feeding and motor problems for all isolation conditions are attributable to the effects of the quality or lack of mothering experiences with the availability or lack of visual experience not contributing significantly.

In view of the survival of 27 of the 28 lambs during the 168 hour isolation period, it was decided to place each lamb on the visual cliff apparatus immediately upon removal from isolation. Every four hours thereafter, the lambs were placed on the visual cliff until the criterion avoidance response was demonstrated or until ten trials had been run with no criterion response observed. Between trials the lambs were kept in a peer-group pen.

Table 5 shows the number of lambs which achieved the criterion avoidance response to the visual cliff on the first trial. It is notable that none of the goggled animals achieved the avoidance response on the first trial; 5 of the 14 lambs which had been allowed full vision during the isolation period achieved the avoidance response immediately. Using the Fisher Exact Probability Test, this observed difference (C=0) is significant at the .05 level (two-tailed).

Nine of the total group of 26 lambs failed to achieve the avoidance response within ten trials; 5 of these lambs had had full vision allowed and 4 had had patterned vision denied. However, there was considerably more difference between the visual condition groups relative to those 18 lambs which eventually did achieve the criterion avoidance response within ten trials (Table 6):

TABLE 5

NUMBER OF LAMBS REACHING THE CRITERION AVOIDANCE RESPONSE IMMEDIATELY AFTER ISOLATION VERSUS THOSE NOT ACHIEVING CRITERION IN TEN TRIALS

Isolation Condition	Response	
	Immediate	None
Maternal Deprivation		
Full Vision Allowed (N=7)	3	2
Full Vision Denied (N=6)	0	1
Maternal Separation		
Full Vision Allowed (N=7)	2	3
Full Vision Denied (N=7)	0	3

TABLE 6

MEAN NUMBER OF TRIALS TO THE AVOIDANCE RESPONSE AFTER THE ISOLATION EXPERIENCE FOR LAMBS REACHING CRITERION IN TEN TRIALS

Isolation Condition	N	Mean Trials
Maternal Deprivation		
Full Vision Allowed	5	1.8
Full Vision Denied	5	4.2
Maternal Separation		
Full Vision Allowed	4	1.5
Full Vision Denied	4	4.5

for the Full Vision Allowed groups, mean trials to the criterion response of 1.8 and 1.5 were obtained; for the Full Vision Denied groups, mean trials of 4.2 and 4.5 were obtained. The Median Test (Siegel, 1956, pp. 111-116) was used to test the differences between median trials of the Full Vision Allowed and Full Vision Denied groups. Because of the small samples, the Fisher's Exact Test tables were used to find the probability of the observed values (Siegel, 1956, p. 115). An obtained D=1 in testing the difference between the two visual conditions within the Maternal Deprivation Group approaches, but does not reach significance at the .10 level (two-tailed). When comparing median trials between the two visual conditions within the Maternal Separation Group, the D=0 obtained is significant at the .05 level (two-tailed). Considering the separation and deprivation conditions, no significant differences were observed between the lambs relative to immediately achieving the criterion avoidance response, never demonstrating the avoidance response, or in terms of the mean trials for those lambs which did achieve the avoidance response within ten trials.

Therefore, the following generalizations may be made: it appears that depriving lambs of a mothering relationship affects the development of visual depth perception, and separating lambs from a mothering relationship affects the infant's ability to retain depth perception once it has been previously demonstrated on the visual cliff. Additionally, it seems that visual experience during isolation is a contributing factor in how long it takes for

depth perception to develop or to be regained after the isolation experience has terminated.

CHAPTER V

DISCUSSION

The past research with sheep concerning the effects of varying mother-neonate conditions upon visual depth perception (Patterson, 1965; Little, 1966; Baumgold, 1967) has supported the general theory that any alterations in the interactive response ability of either ewe or lamb will affect the length of time for depth perception to develop. In the present study, an activation level and optimal stimulation level hypothesis similar to that proposed by Butler and Rice (1963) was utilized to explain the results of past sheep research. Additionally, the present study proposed two major hypotheses to test the activation level and optimal stimulation level proposals. Both hypotheses were supported.

A third major hypothesis was proposed concerning the findings of the past sheep research of Skinner (1968) in which he found inordinately greater time lapses before criterion performance across all groups of lambs. The hypothesis that Skinner's findings were in part related to the prenatal feeding of a ronnel-based vermifuge was also supported.

An exploratory study with isolated lambs was carried out as a part of this year's study to add further knowledge to

the observations of Patterson (1965) concerning the rapid onset of death in unmothered lambs. Isolation conditions were established in order to explore further the role of visual experience as well as to clarify the concepts of maternal separation and maternal deprivation.

Activation Level and Optimal Stimulation Level

The activation level formulation proposed that the developmental process of depth perception in the neonate lamb is directly related to the optimal stimulation level in the total mother-neonate relationship. This optimal stimulation level is a balance of an intrinsic, chronic activation level of the lamb and the extrinsic, transient acute activation level which is primarily contributed to by the active stimulus object: mother. The first hypothesis proposed that if this optimal stimulation level was altered through lowering the activation level of the mother, the lamb will avoid a visual cliff later than control lambs experiencing an optimal stimulation level relationship. On the other hand, if the stimulation level is lowered in the relationship, but is done so comparably for both mother and lamb, the stimulation level should remain optimal. Thus, the second hypothesis proposed that lambs in a lowered, but optimal stimulation level relationship would not differ significantly from lambs in a "normal" mother-neonate relationship. Both hypotheses were supported, thereby lending stronger support to the activation level and optimal stimulation level explanations as the conditions contributing to the

development of visual depth perception.

In evaluating the results of this study, the question can be asked as to how much confidence can be placed in the statement that the activity levels of the ewes in Group C-2 and the mother-neonate pairs in Group H were indeed lowered.

As reported in Chapter III, detailed observations of the prenatally tranquilized group of ewes (Group H) consistently demonstrated reduced activity levels during the ten week period prior to delivery. In addition, a small group of ewes from each of the activation level groups was randomly selected to observe in detail during the early postpartum hours. Preliminary work on these data by Bogan (1968) are not only interesting from the standpoint of new knowledge about mother-neonate interaction, but lend considerable support to the activation level and optimal stimulation level hypothesis. Bogan (1968) developed a taxonomy of ewe-lamb interaction behaviors which can be divided into the general categories of Vocal, Manipulatory, Oral, Locomotor. Bogan used (personal communication) the following kinds of categorized behaviors: Manipulatory behavior of the ewe involved such active behaviors as pushing the lamb with her nose, or pawing at the lamb with her forelegs; for the lamb these behaviors included "punching" of the ewe indiscriminately with its head, pawing at the ewe, or crawling up on the resting ewe. Oral behaviors consisted of the licking and nuzzling of the ewe, and for the lamb these behaviors were nuzzling, mouthing movements on wool tags of the ewe, or actual nursing. Locomotor behaviors for both the ewe

and the lamb involved the process of walking towards each other and making physical contact, or the movement from standing to circling of each other as body contact is maintained. For the purposes of this presentation, the category of Vocal Behavior was not utilized.

In demonstrating the observable behavioral activity levels of the ewes and their lambs for the first two neonatal hours after they were returned to their respective mothers, Bogan (1968) tabulated and categorized the frequencies of behaviors observed; the mean number of behavioral elements of each group of ewes and lambs were calculated. Recognizing that Manipulatory Behaviors are not directly equivalent to Oral Behaviors or to Locomotor Behaviors, the behavioral elements were viewed as "bits" of activity having contact-stimulation value. Figures 1, 2 and 3 show the levels of the observable behavioral activity for the ewes and lambs of the three groups compared: Group C-1 (control; "normal" optimal stimulation level), Group C-2 (activity level of the ewe only lowered), Group H (lowered, but optimal stimulation level). Appendix VII shows the breakdown of the mean number of behavioral elements per thirty-minute interval for all groups of ewes and lambs.

Bogan's data reflects what was generally observable between the three groups during the course of the study and adds further support to what the activation level hypothesis would predict. For example, dramatic examples of stimulation seeking were seen in the Group C-2 lambs, and are reflected in Figure 2 during the 60-90 minute interval. It was at this time that the activity of the lambs became heightened and they were observed to "punch"

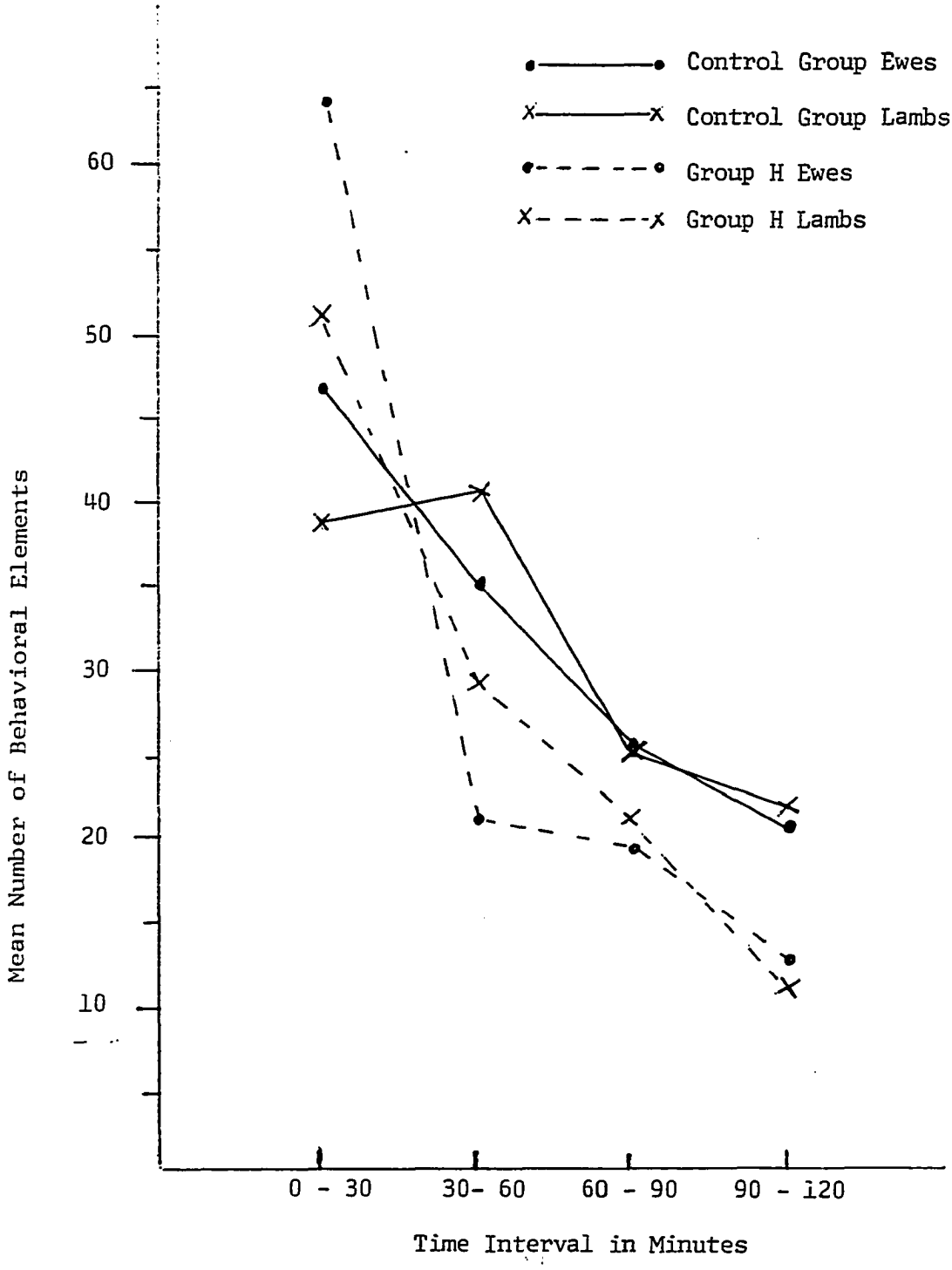

Fig. 1. Levels of observable behavioral activity for lambs and ewes of Group C-1 and Group H.

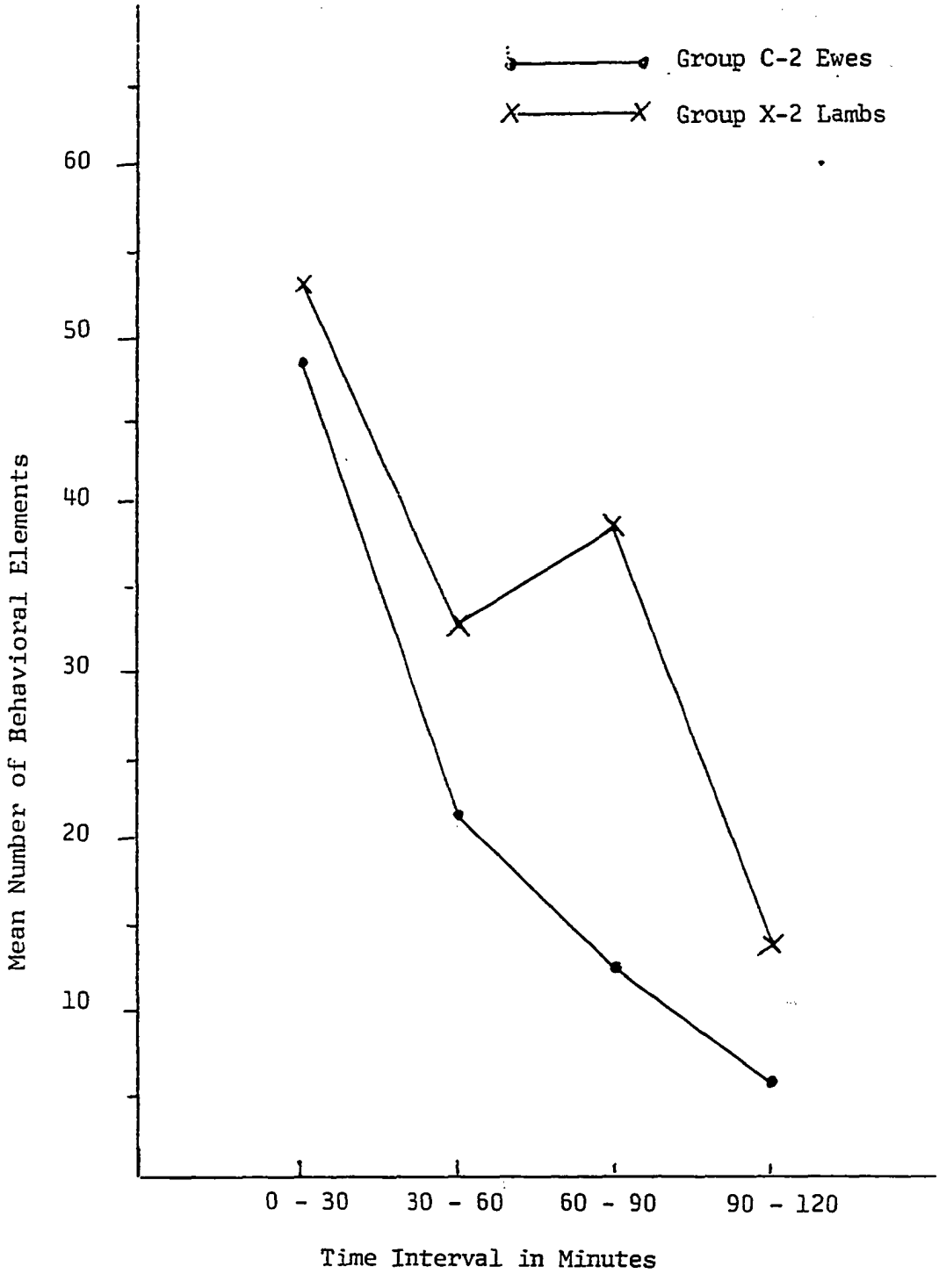

Fig. 2. Levels of observable behavioral activity for Group C-2 ewes and lambs

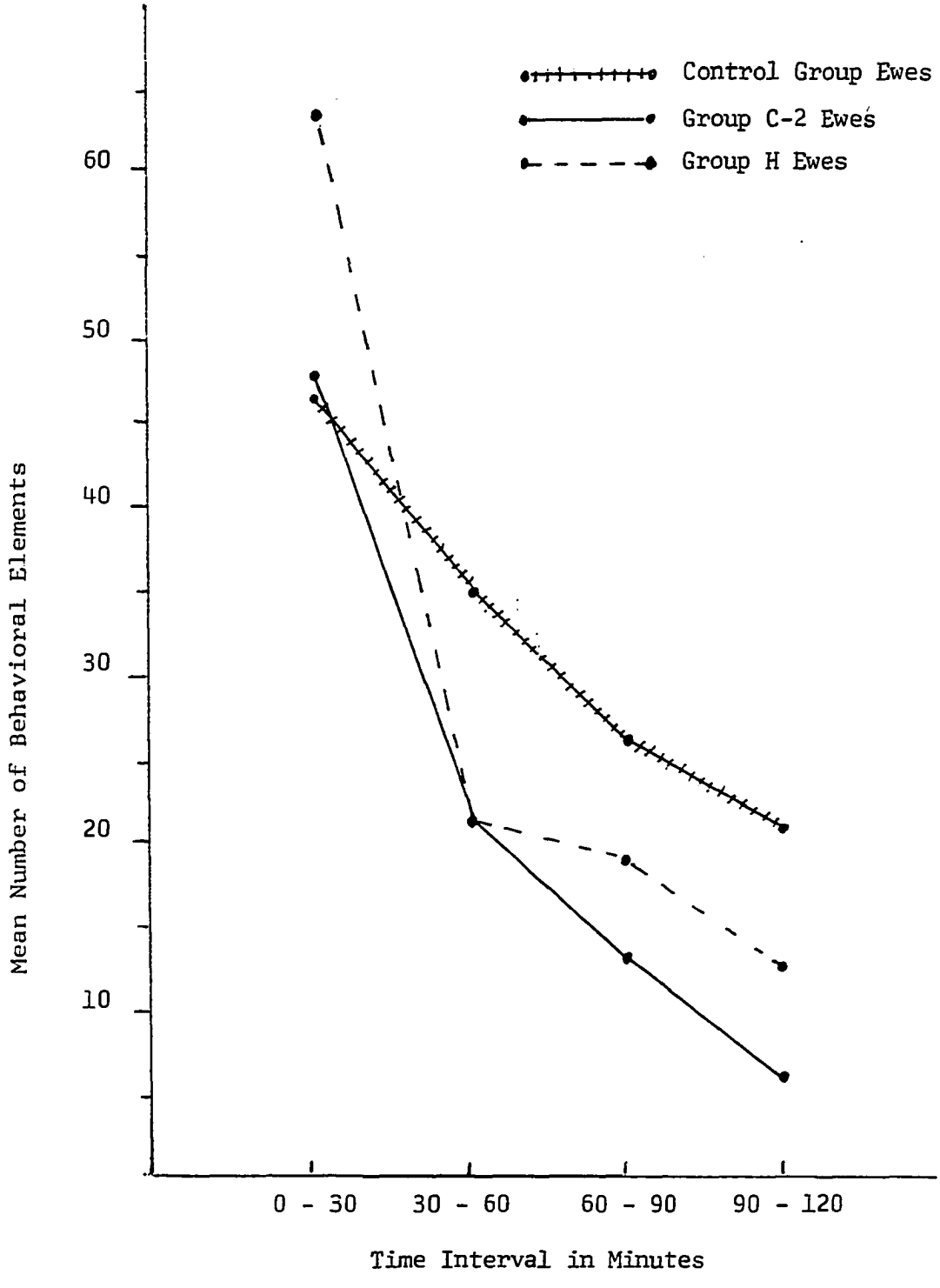

Fig. 3. Levels of observable behavioral activity for ewes of Group C-1, Group C-2 and Group H

the mother vigorously whether she were standing or calmly lying down; further, as if the lambs were bent on forcing the passive mother to react, it would paw the mother and would walk on top of her. Following this period, as Figure 2 also shows, the C-2 lambs would behave as if they "gave up trying" and would be observed to begin to rest quietly near the mother or retire to a corner of the pen some 4 to 5 feet away.

All undelivered ewes had to be penned away from the experimental, neonatal pens, as in two cases in the beginning of the study, a curious ewe standing by the wire gate became an interactive stimulus source for a C-2 lamb who attempted to "relate" with her. Both of these situations occurred during the time of the lambs' heightened activity with their own passive mother. In general, the observational picture of the surge of activity followed by the quiet, sleeping behavior dramatically fits with the predictions of Butler and Rice (1963) from the activation level hypothesis:

> When stimuli from the external environment are mild, the acute level of activation tends to be below the chronic level; approach behavior ensues, and an effort will be made to produce a new or changed environment. If this is unsuccessful, the chronic level will change and the animal becomes, descriptively speaking, bored and finally apathetic /p. 95/.

Further behavioral observations of the Group C-2 lambs beyond two and one-half hours of age (which are not reflected in Bogan's data) demonstrated these lambs to have spent much time sleeping in a corner between their bottle feeding and trials on the visual cliff every four hours. When they were picked up and

carried to the visual cliff apparatus, they were markedly hyperactive and often difficult to hold. At no time did they bleat while being carried. This behavior was in marked contrast to the lambs of both the Control Group and Group H lambs which showed initial fear at being separated and frequently bleated as they were being carried away. While the Group C-2 lambs did not bleat when carried away, their mothers bleated similarly in their absence as did the ewes of the other two groups. When returning the Group C-2 lambs to their mothers after test trials, each ewe immediately approached its lamb and briefly licked it, only to leave passively in a matter of seconds. Ewes of the other two groups would spend considerable time after return of their lambs in nuzzling, licking and frequently immediately initiating or allowing nursing.

The hyperactivity observed when the Group C-2 animals were handled did not diminish over time; also, as each animal became older, e.g., 24-36 hours, their behavior in the visual cliff apparatus became increasingly hyperactive. Whereas the Control Group and Group H lambs showed a typical pattern on the visual cliff of increasingly taking the apparent drop into visual account and becoming more cautious and fearful (demonstrated by fear-bleating and back-pedalling), the Group C-2 lambs became increasingly more hyperactive and disorganized in their locomotor patterns. The recorded observations of trial behaviors of these Group C-2 lambs showed that a lamb would frequently turn around rapidly without ever lowering its head and would walk immediately

out onto the apparent drop. However, a further pattern began to emerge; following the period of heightened hyperactivity in the apparatus, a gradual change over trials seemed to appear. First, a C-2 lamb would be observed to begin to visualize in the vertical plane and step back sharply, only to seemingly be propelled forward over the drop by the hyperactive motor movements. Gradually over trials, the hyperactivity would seem to drop out, as the fear-like responses became more dominent. Generally, the trial before a C-2 lamb finally demonstrated the classic avoidance response seen earlier in the other two groups, a low, gutteral fear-bleat would begin when the lamb first dropped its head and seemed to be taking the visual schema into account. While the hyperactivity of the Group C-2 lambs eventually diminished in the visual cliff apparatus and they did eventually reach the criterion response, the hyperactivity when handled continued throughout. This hyperactivity was very similar to the hyperactivity observed in all of the isolation condition animals.

A further note regarding the Group C-2 lambs and mothers would seem to have implications for any further study of attachment behavior in sheep. While the lowered activation level in the mother-neonate relationship indeed affected the onset of visual depth perception, it also affected the mother-neonate attachment which is usually quite stereotyped. However, the lack of following behaviors and fearfulness was observed only <u>during</u> the time of the lowered activation level; after the Group C-2 lambs achieved the criterion avoidance response (in 5 out of 11 lambs taking 2½ to 3

days), the drug administered to the mothers was discontinued. Within 8 hours after the last dose of drug, the mothers became increasingly active and a seemingly typical, reciprocal mother-neonate relationship became established. None of the Group C-2 ewes rejected their lambs after the experimental procedure. Likewise, no difficulty in lactation occurred as a consequence of the ewes being hand-milked or under the influence of the tranquilizer. Keeping the Group C-2 mother and lamb pairs penned together until they had established attachment seemingly contributed to the ease with which the attachment occurred. This phenomenon is similar to that related by Hersher, Richmond, and Moore (1963) in their study of modifiability of the critical period for the development of maternal behavior in cross-fostering experiments between sheep and goats. By preventing maternal isolation (butting away other young) and enforcing contact between mothers and cross-species young, eventual development of maternal care behavior was observed.

The dramatic behavioral changes observed in the Group C-2 mother-neonate interaction were not observed similarly in the pre- and postnatally tranquilized Group H mother-infant pairs and from the visual cliff data and Bogan's data, a lowered, but optimal stimulation level is inferred.

A somewhat different labor pattern was observed in the Group H ewes, however. The group was observed to behave consistently less actively throughout the ten-week prenatal period during which they were injected with tranquilizer: standing quietly away from the flock with heads slightly lowered and ears drooped. At

the onset of labor, the usual restlessness and pawing of a dirt nest away from the flock was observed. During the last stages of labor however, when the ewe usually becomes extremely restless and frequently gets up and down from a lying position, the Group H ewes were more calm. Between contractions, whereas ewes usually arise and circle, emitting low bleats, the Group H animals remained lying down. Immediately upon birth of their lambs, however, their activity sharply increased and they demonstrated the typical intense preoccupation with the newborn, and emitted the usual stress bleat when the lamb was taken to the laboratory. Bogan's data in Figures 1 and 3 seem to underscore this sharp rise, a rise in activity which is higher than that of the control group of ewes. That this initial sharp change in activity level from prenatal levels occurred immediately after delivery and for the first 30 minutes after the lamb returned, may have been due to the intense stimulation of the parturition events on the Group H ewes' lowered intrinsic chronic activation level. This may not be too unlike the observations made during the pilot drug study work when a very sharp, loud noise in the environment would cause a drugged animal to startle more than a non-drugged animal.

It is interesting to note, however, that all three groups of ewes and lambs demonstrated higher observable behavioral activity levels within the first 30 minutes that the mother and neonate were together. Of particular interest, is the very similar activity levels demonstrated by the Control Group ewes and the Group C-2

ewes during this initial period (Figure 3). Yet, there were wide differences between the mean ages at which their respective lambs achieved the criterion avoidance response on the visual cliff. It would seem therefore, that while optimal stimulation levels are required for the development of the visual depth perception, the amount of stimulation occurring within the first hour of life is not "critical." Bogan's tabulations suggest that if optimal stimulation levels were a necessity during the first hour of life, (one-half hour the lamb was in the laboratory being cleaned; one-half hour in the initial interaction with the mother), then all groups of lambs would achieve the avoidance response approximately the same time; they did not. Figure 2 suggests that what critically occurs in the relationship relative to optimal stimulation level and visual depth perception may well be beginning with the time period of 1½ to 2 hours after birth when the neonate is fully able to ambulate and reciprocate in the stimulus situation.

One can only speculate as to the pattern of the activity levels after the two-hour period observed by Bogan. While all three groups of mother-neonate pairs show a progressive drop, it is likely that if the data had been carried further, one might see the pattern for the Control Group and Group H stabilize. However, from the general observations made throughout the many hours before the C-2 lambs achieved the criterion response, it is predicted that substantial drops in activity (e.g., to zero) could have been demonstrated.

Inferences from Isolation Conditions Data

Little data was gained from this study with lambs to add clarification to the possible differential effects of maternal separation and maternal deprivation as suggested by Yarrow (1966) in the study of human infants. However, a fairly vivid picture was obtained as to what happens when lambs, within the first ten days of life, are isolated for a week, regardless of a previous mothering relationship. Three general behavioral effects can be described: (1) the effects on the neonate at the time of being isolated, (2) the course of the effect on the neonate as the isolation persisted, and (3) the effect on the subsequent development of the infant.

At the time the lambs were placed in isolation, there was incessant vocalization in the form of shrill bleating. After twenty-four hours the bleating behavior dropped out except at feeding times and was replaced by sleeping in a curled-up position. Some 36 to 76 hours later, evidence of self-stimulating behavior began for a fifteen-minute period following feeding. This observed pattern of vocalization followed by passivity is exceedingly close to what Kaufman and Rosenblum (1967) found in their maternal separation study with Macaca nemestrina monkey infants:

> The immediate reaction to physical separation of mother and infant. . . consisted of loud screams by both, and massive struggling to regain each other. When the infant was replaced in the pen he was highly agitated. Pacing, searching head movements, frequent trips to the front door and windows, sporadic and short-lived bursts of erratic play. . . seemed constant. Cooing, the rather plaintive distress call of the young macaque, and intermittent screeching were frequent. This reaction persisted

> throughout the first day, during which time the infant did not sleep. All observers were struck by a sense of intense acute distress.
>
> After 24-36 hours the pattern changed strikingly in 3 of the 4 infants, B, C, and D. The infant sat hunched over, almost rolled into a ball with his head often down between his legs. . . . Movement virtually ceased except when the infant was actively displaced /pp. 654-655/.

Kaufman and Rosenblum (1967) proposed several theoretical explanations in relation to their observations. They discussed the stages of distress and apathy from the view-point of adaptive significance. For example, the distress calls of the macaque (similar to the distress bleating of the lamb) would surely have the effect, in the wild, of bringing the mother back, were she able. However, the increased movement and vocalization eventually increase the risk of provoking aggression from predators, and secondly, the heightened activity is exhausting. Thus, the second stage observed (apathy) has survival value also.

Kaufman and Rosenblum felt that the apathy behavior could not be rationalized as depletion of energy or massive fatigue entirely, as they observed their monkeys (as observed with the lambs) to move quite rapidly in circumstances when food was put into their pens. Rather, they felt that the curled-up, almost complete flexion of the body acts in the natural setting as a way for the animal to cut down heat loss and literally makes the infant smaller so that he presents less of a visual stimulus to other animals. Incorporating the neurobiological considerations of Engel (1962), Pribram (1968), and Schneirla (1959) with their survival considerations,

Kaufman and Rosenblum (1967) summarized their position which seems to have applicability to the findings of the present study and relativity to the activation level hypothesis:

> In sum, we propose that at an undifferentiated level the removal of the mother's biotaxic stimuli first produces in the infant a facilitated distress reaction. . . . We presume that it is accompanied by an undifferentiated unpleasant affect of apprehension (the precursor of anxiety) based on uncertain incongruity. If comfort-producing stimuli do not materialize, distress persists, but through its catabolic effects suppression occurs. . . . We presume that it is accompanied by an undifferentiated unpleasant affect of pessimism (the precursor of depression) based on unmanageable sensory incongruity. This conservative reaction preserves the organism's integrity until comfort-producing stimuli may arise. It is suggested that both stages of the distress reaction are mediated by neural mechanisms integrated at midbrain, diencephalic and paleocortical levels /pp. 670-671/.

Kaufman and Rosenblum did not discuss in theoretical terms the self-stimulation behaviors they observed. However, it would seem that these behaviors in the monkeys (as with the lambs) might be interpreted as the way in which the animal attempts to bring "comfort-producing stimuli" into his environment. Or within the framework of the activation level hypothesis, these behaviors are the animal's mode of attempting to bring forth higher levels of acute activation in response to its dangerously low intrinsic, chronic activation level. As discussed previously, similar attempts were made to increase stimulation by the Group C-2 lambs.

The incidence of 20 out of 28 of the isolated lambs having serious enough neurological difficulties to impair locomotion and nursing further attests to the influence of mothering and the concomitant stimulation upon basic survival. The observation notes

clearly indicate that during and following the massaging of the backs of the lambs during the feeding period, muscle tonus, motor coordination, and the sucking reflex seemed to gradually improve. Had the variable of massage not been introduced and had the lambs been fed through an aperture in the wire cage as in Patterson's (1965) study, it seems certain that the lambs having neurological difficulties would have expired through either not being able to ambulate to the nipple or through failure to obtain milk through poor sucking ability.

As to the effects of isolation on the subsequent development of the infant, the only measures utilized were the development or the retention of visual depth perception. Patterson (1965) inferred from his comparison of unmothered and goggled-mothered lambs that visual depth perception was not itself dependent upon visually mediated experience /p. 45/. This inference may well be justified considering the experimental procedure carried out by Patterson. Because of the differences observed in this study between those lambs who had full visual experience and those who did not, particularly in regard to the number of trials required to regain or to develop visual depth perception after isolation, the factor of visual experience should be further explored. It is likely that had Patterson compared visual depth perception development in goggled and ungoggled lambs which had been divided into mothered and unmothered groups, he would have found strong interaction effects between visual experience and lack of stimulation with this condition having the most devastating effects upon the

development of visual depth perception. It seems that in the presence of adequate mothering, visual experience is not critical; however, in the absence of adequate mothering (stimulation), visual experience takes on increasing importance.

Additionally, the fact that 6 out of 14 lambs which had once demonstrated visual depth perception failed to demonstrate the criterion response within 10 trials (36 hours) after the isolation experience, casts doubt on any previous references to visual depth perception being irreversible (Skinner, 1968, p. 65). In normal mother-neonate interactions, or in situations where, after an experimental procedure, the lamb has achieved the avoidance response and is returned to adequate stimulation conditions, the theory of irreversibility may hold. However, this study suggests that isolation can affect the retention of depth perception ability. As 3 of these above described lambs had full visual experience and 3 did not during the isolation period, it is likely that the lack of contact stimulation and its affect on central mediating processes is the most critical factor.

Prenatal Treatment with Ronnel-based Vermifuge and Fluphenazine

The third hypothesis testing aspect of this study was to verify that the ronnel-based vermifuge fed to Skinner's (1968) ewes subsequently lengthened the time before their lambs developed visual depth perception. For the offspring of the Group X ewes fed ronnel in the present study, significant differences were found as compared to the lambs of the Control Group of ewes. However,

in the present study, the mean hours to the criterion avoidance response was 11.02 hours where in Skinner's control group a mean of 32 hours obtained. While an attempt was made in the present study to replicate Skinner's ronnel-feeding procedure exactly, it may have been that the amount of ronnel administered per feeding this year was not as great or as regular since an estimate dosage was made from a farmhand's recall as to what was given previously. If the influence of ronnel is studied further, pilot study work would seem essential in determining differential effects of varying dosage levels.

Regarding the prenatally administered fluphenazine enanthate, no demonstrable negative effects of the drug were noted. At no time during the prenatal period were side effects as described in some subjects observed; with the exception of a decrease in restlessness during the final stages of labor, no differential effects of the drug were noted during the labor and delivery process. No interference with lactation occurred in the drugged ewes.

Suggestions for Further Research

The results of this study add further support to the importance of adequate stimulation levels in the life of the neonate lamb. Results from the testing of the activation level and optimal stimulation level hypotheses imply that intensity of stimulation rather than patterning of stimulation is the more critical in the adequate development of visual depth perception of

the neonate lamb. Support for this can be gained from Bogan's (1968) observations that in ewes whose activation levels were lowered, the modes of behavior through which they provided contact stimulation were the same, but the frequency and effort which they expended in making the contact was reduced. It has also been suggested that while the neonate lamb is capable of ambulating, exploring his environment, and making vigorous attempts to get the mother to react, the stimulation the lamb receives from this behavior is not adequate to maintain the optimal stimulation level required in the total situation. It seems that the infant requires the stimulus object to react to his effort.

These inferences might be explored further to clarify the critical stimulus characteristics in the optimal stimulation level situation. For example, lambs might be placed with an artifical mother who would react passively (e.g., move or swing back) in response to the lambs' contacts with her; another experimental group would be placed with an artificial mother who, when nudged, would react actively (e.g., move or swing forward) ensuring that contact stimulation was returned. If lambs in this latter situation achieved a criterion avoidance response comparable to that of normally mothered lambs, a stronger case might be made for the importance of stimulus intensity over species-specific stimulus patterns.

With the exception of Baumgold's (1967) study of the effects of a stimulant drug on neonate lambs, no work has been done within the present series of sheep studies on the effects of

over-stimulation. If the theory of optimal stimulation levels in the mother-neonate relationship holds, increasing stimulation of the neonate beyond a certain point should result in withdrawal behaviors of the lamb and possible disorganizing effects reflected in the time of onset of visual depth percpetion.

The optimal stimulation level concept within the early mother (or caretaker) - infant relationship has a host of implications for human developmental study, and much research impetus has been seen in this area within the past five years. Pertinent applications of activation level and optimal stimulation level theorizing have and can be made to the study of other than "normal" infant development. For example, optimal conditions seem requisite for the developmental processes of infants who are born at varying stages of prematurity, those who are born with varying kinds of observable congenital defects such as cardiac defects, oral abnormalities, and endocrine deficiencies which contribute to lowered activation levels, or infants detected very early to be mentally retarded, or visually or auditorily impaired. Most "normal" human infants are adequately equipped, given a "good" mothering situation, to be able to participate in their own stimulation level situation. For the infant deprived of the adequate endowment to participate as effectively, it would seem that further knowledge as to the extra efforts needed on the part of the parent or caretaker would be valuable in the possible prevention of further deficient functioning of the defective child.

CHAPTER VI

SUMMARY

The influence of stimulation upon the developing human and infra-human organism from conception to maturity has been subject to much research in both developmental and comparative psychology. Of particular interest has been the concept of optimal stimulation levels as they might be related to various critical periods in prenatal and neonatal life and the effective development of various skills basic to survival.

Previous studies of both human and infra-human mother-neonate relationships have clearly demonstrated that depriving the infant of mothering contact leads to subsequent disruption in the infant's developmental process. This study evaluated previous studies of varying disrupted mother-neonate relationships in sheep and the subsequent effects upon visual depth perception in the neonate lamb. An activation level and optimal stimulation level theory was utilized to explain these past results. The activation level formulation proposed that the developmental process of visual depth perception is directly related to the optimal stimulation level in the total mother-neonate relationship. This optimal stimulation level is a balance of an intrinsic, chronic

activation level of the lamb and the extrinsic, transient acute activation level which is primarily contributed to by the active stimulus object: mother.

Two major hypotheses were proposed in this study. The results demonstrated that relationships in which the activation level of the mother is reduced through drugs, the neonate lamb will develop a criterion avoidance response on a visual cliff at a significantly later age than control lambs experiencing an optimal stimulation level in a normal mother-neonate relationship. In a mother-neonate relationship in which the activation levels of both the mother and infant have been lowered comparably through drugs, an optimal stimulation level seemed to be maintained and lambs from this relationship did not differ significantly from control lambs as to the age of the development of the criterion avoidance response on a visual cliff.

In an attempt to determine if a ronnel-based vermifuge fed to pregnant ewes in a past study had contributed to delayed onset of visual depth perception of their offspring, a third group of ewes were included in this study. Results demonstrated that the organophosphate ronnel fed to ewes does contribute to significant differences in the performance of their offspring on a visual cliff.

An exploratory aspect of this study was concerned with further differentiating the concepts of maternal separation versus maternal deprivation. While no fine distinctions were found between

two groups of lambs who were differentially isolated from a mothering relationship, a clearly demonstrated three-stage behavioral pattern in response to sensory deprivation was established. Tests of visual depth perception after an isolation period provided additional support for the necessity of stimulation for adequate perceptual development as well as called into question the notion that visual depth perception is resistant to extinction once it has been attained.

BIBLIOGRAPHY

Barnett, S.A. Exploratory behaviour. British Journal of Psychology, 1958, 49, 289-310.

Barnett, S. A. The behaviour and needs of infant mammals. The Lancet, May 20, 1961, 1067-1071.

Baumgold, J. V. The Relationship Between Visual Depth Perception and Pharmacologically Induced Alterations of the Mother-Neonate Bond in Sheep. Unpublished Ph.D. dissertation, University of Oklahoma, 1967.

Beach, F. A. The individual from conception to conceptualization. In J. F. Rosenbluth and W. Allinsmith (Eds.), The Causes of Behavior II. Boston: Allyn and Bacon, Inc., 1966, 35-44.

Bender, L. & Yarnell, H. An observation nursery. American Journal of Orthopsychiatry, 1941, 97, 1158-1174.

Berger, F. M. Classification of psychoactive drugs according to their chemical structures and sites of action. In L. Uhr & J. G. Miller (Eds.), Drugs and Behavior. New York: John Wiley, 1960, 86-105.

Berlyne, D. E. The present status of research on exploratory and related behavior. Journal of Individual Psychology, 1958, 14, 121-126.

Bijou, S. W. Ages, stages, and the naturalization of human development. American Psychologist, 1968, 23, 419-427.

Bijou, S. W. & Baer, D. M. Child Development: A Systematic and Empirical Theory. Vol. 1. New York: Appleton-Century-Crofts, 1961.

Bogan, J. Behavior of the Neonate Lamb. Unpublished master's thesis (in progress), University of Oklahoma, 1968.

Bowlby, J. Forty-four juvenile thieves. International Journal of Psychoanalysis, 1944, 25, 1-57.

Bowlby, John. Maternal care and mental health. New York: Schocken Books, 1967.

Broadhurst, P. L. Analysis of Maternal Behavior in Mammals. New York: John Wiley and Sons, Inc., 1963.

Brody, Sylvia. Patterns of Mothering. New York: International Universities Press, 1956.

Bronson, G. A. Neurological perspective on ego development in infancy. Journal of American Psychiatric Association, 1963, 11, 55-65.

Burke, J. C., High, J. R. Laffon, E. J. & Ravaris, C. L. Depot action of fluphenazine (Prolixin) enanthate in oil. Federation Proceedings, 1962, 21, 339.

Butler, R. A. Discrimination learning by rhesus monkeys to visual-exploration motivation. Journal of Comparative and Physiological Psychology, 1953, 46, 95-98.

Butler, R. A. & Harlow, H. F. Discrimination learning and learning sets to visual exploration incentives. Journal of General Psychology, 1957, 57, 257-264.

Butler, J. M. & Rice, L. N. Adience, self-actualization and drive theory. In J. N. Wepman & R. W. Heine (Eds.), Concepts of Personality. Chicago: Aldine, 1963, 79-110.

Cairns, R. B. Attachment behavior of mammals. Psychological Review, 1966, 73, 409-426.

Cannon, W. B. The Wisdom of the Body. New York: W. W. Norton and Co., Inc., 1963.

Carlson, P. V. The Development of Emotional Behavior as a Function of Diadic Mother-young Relationships. Unpublished doctoral dissertation, Purdue University, 1961.

Casler, L. Maternal deprivation: a critical review of the literature. Monograph of Social Research and Child Development, 1961, No. 26.

Chow, K. L., Riesen, A. H. & Newell, F. W. Degeneration of retinal ganglion cells in infant chimpanzees reared in darkness. Journal of Comparative Neurology, 1957, 107, 27-42.

Coleman, R. W. & Provence, S. Environmental retardation (hospitalism) in infants living in families. Pediatrics, 1957, 19, 285-292.

Davenport, R. K. & Rogers, C. M. Intellectual performance of differentially reared chimpanzees: I. Delayed response. American Journal of Mental Deficiency, 1968, 72, 674-680.

Denenberg, V. H. Interactive effects of infantile and adult shock levels upon learning. Psychological Reports, 1959, 5, 357-364.

Denenberg, V. H. Critical periods, stimulus input, and emotional reactivity: a theory of infantile stimulation. Psychological Review, 1964, 71, 335-351.

Denenberg, V. H. & Bell, R. W. Critical periods for the effects of infantile experience on adult learning. Science, 1960, 131, 227-228.

Denenberg, V. H., Hudgens, G. A., & Zarrow, M. X. Mice reared with rats: Modification of behavior by early experience with another species. Science, 1964, 143, 380-381.

Denenberg, V. H., Hudgens, G. A., & Zarrow, M. X. Mice reared with rats: Effects of mother on adult behavior patterns. Psychological Reports, 1966, 18, 451-456.

Denenberg, V. H. & Morton, J. R. C. Infantile stimulation, pre-pubertal sexual-social interaction and emotionality. Animal Behavior, 1964, 12, 11-13.

Dennis, W. Causes of retardation among institutional children: Iran. Journal of Genetic Psychology, 1960, 96, 47-59.

Engel, G. L. Psychological Development in Health and Disease. Philadelphia: Saunders, 1962.

Erikson, E. H. Childhood and Society. New York: W. W. Norton, 1950.

Escalona, S. K. Some determinants of individual differences. Transactions of the New York Academy of Science, 1965, 27, 802-816.

Fiske, D. W. & Maddi, S. R. Functions of Varied Experience. New York: The Dorsey Press, 1961.

Fox, S. S. Sensory Deprivation and Maintained Sensory Input in Monkeys. Unpublished Ph.D. dissertation, University of Michigan, 1959.

Gershon, S. & Shaw, F. H. Psychiatric sequelae of chronic exposure to organophosphorus insecticides. The Lancet, June 24, 1961, 1371-1374.

Gesell, A. The Embryology of Behavior. New York: Harper, 1945.

Gesell, Arnold & Amatruda, Catherine S. Developmental Diagnosis. New York: Paul B. Hoeber, Inc., 1960.

Gibson, E. & Walk, R. D. The "visual cliff." Scientific American, 1960, 202, 64-71.

Goldfarb, W. Emotional and intellectual consequences of psychological deprivation in infancy; a re-evaluation. In P. Hoch & J. Zubin (Eds.) Psychopathology of Childhood. New York: Grune and Stratton, 1955, 105-119.

Harlow, H. F. The nature of love. American Psychologist, 1958, 13, 673-685.

Harlow, H. F. & Zimmerman, R. R. Affectional responses in the infant monkey. Science, 1959, 130, 421-432.

Harlow, H. F. & Harlow, M. K. The effect of rearing conditions on behavior. Bulletin of the Menninger Clinic, 1962, 26, 213-224.

Harlow, H. F. Total isolation: Effects on Macaque monkey behavior. Science, 1965, 148, 666.

Hebb, D. O. Organization of Behavior. New York: John Wiley, 1949.

Hebb, D. O Drives and the C.N.S. (conceptual nervous system). Psychological Review, 1958, 13, 152-156.

Held, R. & Hein, A. Movement-produced stimulation in the development of visually-guided behavior. Journal of Comparative and Physiological Psychology, 1963, 56, 872-876.

Hernandez-Peon, R., Scherrer, H., & Jouvet, M. Modification of electrical activity in cochlear nucleus during "attention" in unanaesthetized cats. Science, 1956, 123, 331-332.

Hersher, L., Moore, A. U., & Richmond, J. B. Effect of postpartum separation of mother and kid on maternal care in the domestic goat. Science, 1958, 128, 1342.

Hersher, L., Richmond, J. B. & Moore, A. V. Modifiability of the critical period for the development of the maternal behavior in sheep and goats. Behavior, 1963, 20, 311-320.

Hess, E. H. Two conditions limiting critical age for imprinting. Journal of Comparative and Physiological Psychology, 1959, 52, 515-518.

Hess, E. H. An approach toward the complete analysis of behavior. In T. M. Newcomb (Ed.), New Directions in Psychology, New York: Holt, Rinehart and Winston, 1962, 157-266.

Himwich, H. Biochemical and neurophysiological action of psychoactive drugs. In L. Uhr & J. G. Miller, (Eds.), Drugs and Behavior. New York: John Wiley, 1960, 41-85.

Hooker, D. The sequence in human fetal activity. In C. B. Stendler (Ed.), Readings in Child Behavior and Development. (2nd ed.) New York: Harcourt, Brace and World, Inc., 1964, 11-17.

Hudgens, G. A., Denenberg, V. H., Zarrow, M. X. Mice reared with rats: Relations between mother's activity level and offsprings behavior. Journal of Comparative and Physiological Psychology, 1967, 63, 304-308.

Hunt, J. McV. Intrinsic Motivation and its role in psychological development. In D. Levine (Ed.), Nebraska Symposium on motivation: 1965. Lincoln: University of Nebraska Press, 1965, 189-282.

Irwin, S. Considerations for the pre-clinical evaluation of new psychiatric drugs: A case study with phenothiazine-like tranquilizers. Psychopharmacologia (Berl.) 9, 259-287 (1966).

Kagan, J. The many faces of response. Psychology Today, 1968, 1, 22-27.

Kantor, J. R. Principles of Psychology. Vol. 1. Bloomington, Ind.: Principia Press, 1924.

Kantor, J. R. Interbehavioral Psychology. (2nd ed.) Bloomington, Ind.: Principia Press, 1959.

Kaufman, C. & Rosenblum, L. A. The reaction to separation in infant monkeys: Anaclitic depression and conservation-withdrawal. Psychosomatic Medicine, 1967, 29, 648-675.

Kinross-Wright, J., Vogt, A. H. & Charalampous, K. D. A new method of drug therapy. American Journal of Psychiatry, 1963, 119, 779-780.

Koelle, G. B. Anticholinesterase agents. In L. S. Goodman & A. Gilman (Eds.), The Pharmacological Basis of Therapeutics. New York: Macmillan, 1965, 441-461.

Kurke, M. I. The role of motor experience in the visual discrimination of depth in the chick. Journal of Genetic Psychology, 1955, 86, 191-196.

Kurland, Albert A., Gruenwald, F., Vega, L. & Wittig, B. Fluphenazine (Prolixin) enanthate - a phenothiazine preparation of prolonged activity. Current Therapeutic Research, 1964, 3, 137-147.

Kurland, A. & Richardson, J. A comparative study of two long acting phenothiazine preparations, fluphenazine-enanthate and fluphenazine-deconate. Psychopharmacologia (Berl.) 9, 320-327 (1966).

Leuba, C. Toward some integration of learning theories: the concept of optimal stimulation. Psychological Reports, 1955, 1, 27-33.

Levy, D. M. Primary affect hunger. American Journal of Psychiatry, 1937, 94, 643-652.

Liddell, H. S. Contributions of conditioning in the sheep and goat to an understanding of stress, anxiety and illness. Lectures on Experimental Psychiatry, University of Pittsburgh Press, 1961, 227-235.

Lindsley, D. B. Common factors in sensory deprivation, sensory distortion, and sensory overload. In P. Solomon et al. (Eds.) Sensory Deprivation. Cambridge: Harvard University Press, 1961, 174-194.

Little, E. L. Visual Cliff Performance of Domestic Lambs as a Function of Various Mothering Conditions. Unpublished Ph.D. dissertation, University of Oklahoma, 1966.

Lorenz, K. Morpholcgy and behavior patterns in closely allied species. In B. Schaffner (Ed.), Group Processes. New York: J. H. Macy Found., 1955.

Lorenz, K. Companionship in bird life; fellow members of the species as releasers of social behavior. In C. H. Schiller (ed.), Instinctive Behavior. New York: International Universities Press, 1957.

Lowrey, L. G. Personality distortion and early institutional care. American Journal of Orthopsychiatry, 1940, 10, 576-585.

Malmo, R. B. Activation: a neurophsychological dimension. Psychological Review, 1959, 66, 367-386.

Maier, H. W. Three Theories of Child Development. New York: Harpers, 1965.

McClelland, D. C., Atkinson, J. W., Clark, R. A., & Lowell, E. L. The Achievement Motive. New York: Appleton-Century, 1953.

Montagu, M. F. A. Constitutional and prenatal factors in infant and child health. In M. J. Senn (Ed.) Symposium on the Healthy Personality. New York: Josiah Macy, Jr. Found., 1950.

Montagu, M. F. A. The sensory influences of the skin. Texas Reports of Biological Medicine, 1953, 11, 291-301.

Montgomery, M. F. The role of exploratory drive in learning. Journal of Comparative and Physiological Psychology, 1954, 47, 60-64.

Morgan, C. T. Physiological theory of drive. In S. Koch (Ed.), Psychology: A Study of Science. Vol. I. New York: McGraw-Hill, 1959, 644-671.

Moruzzi, G. & Magoun, H. W. Brain stem reticular formation and activation of the EEG. Electroencephalography and Clinical Neurophysiology, 1949, 1, 455-473.

Munroe, Ruth L. Schools of Psychoanalytic Thought. New York: The Dryden Press, 1955.

Nealey, S. M. & Edwards, B. "Depth perception" in rats without pattern-vision experience. Journal of Comparative and Physiological Psychology, 1960, 53, 468-469.

Patterson, G. H. Visual Cliff Performance of Mothered and Unmothered Domestic Sheep. Unpublished Ph.D. dissertation, University of Oklahoma, 1965.

Pearce, B. L. A Rating Scale of Maternal Behavior in Suffolk Sheep. Unpbulished master's thesis, University of Oklahoma, 1967.

Powdermaker, F., Levis, H. T. & Touraine, S. Psychopathology and treatment of delinquent girls. American Journal of Orthopsychiatry, 1937, 7, 58.

Pribram, K. H. A review of theory in physiological psychology. Annual Review of Psychology, 1960, 11, 1-40.

Pribram, K. H. Emotion: steps toward a neuropsychological theory. In Proceedings of the Russell Sage Foundation-Rockefeller University Conference on Biology and Beahvior, 1968, (in press).

Prolixin enanthate. In "New Drugs Section", Modern Drugs, April-June, 1967, 283-286.

Provence, S. & Lipton, R. Infants in Institutions. New York: International University Press, 1962.

Rheingold, H. L. The measurement of maternal care. Child Development, 1960, 31, 565-573.

Rheingold, H. L. Maternal Behavior in Mammals. New York: John Wiley and Sons, Inc., 1963.

Riesen, A. H. Arrested vision. Scientific American, 1950, 183, 16-19.

Riesen, A. H. Plasticity of behavior: psychological aspects. In H. F. Harlow and C. N. Woolsey (Eds.), Biological and Biochemical Bases of Behavior. Madison: University of Wisconsin Press, 1958, 425-450.

Riesen, A. H. Effects of stimulus deprivation on the development and atrophy of the visual sensory system. American Journal of Orthopsychiatry, 1960, 30, 23-36.

Riesen, A. H. Stimulation as a requirement for growth and function in behavioral development. In D. W. Fiske & S. R. Maddi (Eds.), Functions of Varied Experience. Homewood, Illinois: The Dorsey Press, 1961, 57-80.

Ribble, M. A. Clinical studies of instinctive reactions in newborn babies. American Journal of Psychiatry, 1938, 95.

Routtenberg, A. The two-arousal hypothesis: reticular formation and limbic system. Psychological Review, 1968, 75, 51-80.

Schneirla, T. C. An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In D. Levine (Ed.), Nebraska Symposium on Motivation. Lincoln: University of Nebraska Press, 1959, 1-42.

Schneirla, T. C. & Rosenblatt, J. S. Letters: I. "Critical periods." In T. E. McGill, (Ed.) Readings in Animal Behavior. New York: Holt, Rinehart, and Winston, Inc., 1965, 287-289.

Schultz, D. P. Sensory Restriction: Effects on Behavior. New York: Academic Press, 1965.

Scott, J. P. Critical periods in behavioral development. In T. E. McGill (Ed.), Readings in Animal Behavior. New York: Holt, Rinehart and Winston, Inc., 1965, 271-286.

Scott, J. P. and Marston, N. V. Critical periods affecting the development of normal and mal-adjustive social behavior of puppies. Journal of Genetic Psychology, 1950, 77, 25-60.

Siegel, S. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill, 1956.

Skinner, P. P. The Effects of Magnesium Pemoline and Thyroxine on the Development of Visual Depth Perception in Lambs: Endocrinological Aspects. Unpublished Ph.D. dissertation, University of Oklahoma, 1968.

Sontag, L. W. Implications of fetal behavior and environment for adult personalities. Annals of the New York Academy of Science, 1966, 134, 782-86.

Spitz, R. A. Hospitalism: an inquiry into the genesis of psychiatric conditions of early childhood. Psychoanalytic Study of the Child, 1945, 1, 53-74.

Spitz, R. A. Hospitalism: a follow-up report. Psychoanalytic Study of the Child, 1946, 2, 113-117.

Spitz, R. A. & Wolf, K. Anaclitic depression. Psychoanalytic Study of the Child, 1946, 2, 313-342.

Squibb, E. R., Company. Prolixin Enanthate (Manual A-2653). New York: August, 1967.

Stendler, C. B. Readings in Child Behavior and Development. (2nd ed.) New York: Harcourt, Brace, and World, Inc., 1964.

Thompson, W. R. Early experiential and genetic influences on flexibility. In O. F. Harvey (Ed.) Experience Structure and Adaptability. New York: Springer, 1966, 67-93.

Thompson, W. R. Influence of prenatal anxiety of emotionality in young rats. Science, 125, 1957, 698-699.

von Senden, M. Space and Sight: the Perception of Space and Shape in Congenitally Blind Patients, Before and After Operation. English translation, London: Methuen, 1960.

Walk, R. D., Gibson, E., & Tighe, T. J. Behavior of light-and dark-reared rats on a visual cliff. Science, 1957, 126, 80-81.

Walker, E. L. Psychological complexity as a basis for a theory of motivation and choice. In D. Levine (Ed.), Nebraska Symposium on Motivation: 1964. Lincoln: University of Nebraska Press, 1964, 47-95.

Walker, H. M. & Lev, J. Statistical Inference. New York: Holt, Rinehart, and Winston, 1953.

Weinberger, N. & Lindsley, D. Behavioral and EEG arousal to contrasting novel stimulation. Science, 1964, 144, 1355-1357.

Welker, W. I. Some determinants of play and exploration in chimpanzees. Journal of Comparative and Physiological Psychology, 1956, 49, 84-89.

White, B. L. & Held, R. Plasticity of sensorimotor development in the human infant. In J. Rosenbluth and W. Allensmith (Eds.), The Causes of Behavior II. Boston: Allyn and Bacon, Inc., 1966, 60-70.

Yarrow, L. J. Maternal deprivation: toward an empirical and conceptual re-evaluation. Psychological Bulletin, 1961, 58, 459-490.

Yarrow, L. J. Separation from parents during early childhood. In Hoffman, L. W. and Hoffman, M. L. (Eds.) Review of Child Development Research. New York: Russell Sage Found., 1966, 89-136.

APPENDIX I

MEAN HOURS TO CRITERION AVOIDANCE RESPONSE ON THE VISUAL CLIFF FOR ALL SHEEP STUDIES, 1965-1968

Study	Mean Hours
Patterson (1965)	
Mothered lambs (Study 1)	3.15
Unmothered lambs	6.38
Goggled mothered lambs (Study 2)	5.30
Unmothered lambs	8.60
Little (1966)	
Control (mothered) lambs	5.80
Nursing restricted	6.40
Activity of ewe restricted (nursing allowed)	10.40
Activity of ewe restricted (nursing restricted)	13.40
Visual and auditory contact only	15.80
Foster mother; both anointed with oil of anise	18.60
Actual mother; both anointed with oil of anise	24.00
Unmothered lambs	29.20

Study	Mean Hours
Baumgold (1967)	
Control (mothered) lambs	7.07
Tranquilized lambs	28.67
Sedated lambs	30.13
Stimulant-treated lambs	5.17
Muscularly relaxed lambs	14.72
Skinner (1968)	
Control (mothered) lambs	32.00
Magnesium Pemoline treated lambs	17.81
Thyroxine treated lambs	31.25

APPENDIX II

DELIVERY DATA FOR ALL SHEEP STUDIES, 1965-PRESENT

Study	Deliveries[a]			Lambs			
	N	Number with Multi-Lambs	Per cent with Multi-Lambs	N	Number Single Lambs	Number Multi-Birth Lambs	Per cent Multi-Birth Lambs
Patterson (1965)	42	14	33	56	28	28	50
Little (1966)	34	9	26	43	25	18	42
Baumgold (1967)	31	10	32	41	21	20	49
Skinner (1968)	39	9	23	49	30	19	39
Chapman	48	17	35	65	31	34	52

[a]Delivery defined as birth process of one ewe regardless of number of infants delivered.

APPENDIX III

PILOT DRUG OBSERVATION EXAMPLE

Date: December 9, 1967
Subject: Ewe (2 days postpartum)

Drug: Fluphenazine hydrochloride
Dose: 3/4 of human adult dosage
(3/4 of 1/2 cc or .94 mg)
Route: Intramuscularly in neck tissue

2:20 P.M. Ewe eating
.94 mg drug given intramuscularly
Ewe bleated repeatedly; watches lamb
Ewe allowed lamb to nurse

2:25 P.M. Lamb walked away about 1 foot
Ewe walked over and sniffed anus of lamb
Chewing cud; ears momentarily down

2:28 P.M. Ewe standing; head tilting
Ewe has difficulty keeping eyes open
Ewe hypersensitive to sound; turns head sharply in direction of noise

2:30 P.M. Lamb lay down; unnoticed by ewe

2:31 P.M. Ewe sniffed lamb; head lowered to sniff and had trouble getting head up until raised it sharply when observer cleared throat

2:32 P.M. Ewe turned head; sniffed lamb
Lay down next to lamb
Ewe yawning

2:33 P.M. Ewe made very low bleat when lamb got up
Ewe has difficulty holding head up but adjusted
Lamb walked by ewe's head; ewe's head went down on the ground after what appeared like an effort to sniff lamb's anus as it went by
Ewe bleated lowly; lamb 7 feet away

2:37 P.M. Lamb lay down by self 7 feet away after sniffing the ground
Ewe still lying down with head up, but eyes closed

2:40 P.M. Ewe and lamb still in same position
Ewe has head up, but eyes closed; ewe not responding to banging metal on shed

2:49 P.M. Ewe lay head down; breathing deep and regular
Lamb still alone, lying down 7 feet away

2:50 P.M. Ewe's head rolled over on ground, but immediately picked up alert to distant, but sharp noise in the field
Ewe bleated lowly; curled upper lip
Lamb did not respond

2:55 P.M. Ewe got up and went up to lamb and sniffed it. No response from lamb
Ewe walked up to feeding tray

2:57 P.M. Ewe bleated; eating alfalfa
Lamb continues to lay in same spot with head down

3:05 P.M. Lamb still "sleeping"; Ewe walking slowly around alfalfa and eating
Observer woke lamb up and placed by mother
Much nuzzling by lamb to find teat; Ewe sniffed lamb's anus (interaction seemed "normal")
Ewe allowed lamb to nurse; lamb punching hard in teat area; found teat after 3 punches (Lamb nursed little over 1 minute)

3:09 P.M. Ewe walked away; lamb followed
Ewe bleated; lamb attempted to nurse, but ewe walks away and is 10 feet from lamb
Lamb attempts to nibble hay
Ewe chewing cud

3:13 P.M. Ewe appeared hypersensitive to ranch hands walking and talking about 100 feet away; bleated
Lamb lay down and immediately tried to get up; hind legs only seem to function; lamb tried 3 times to get up; then walked to ewe and attempted to nurse; punching hard to find teat

3:15 P.M. Ewe walks away; lamb trots after her nuzzling for teat, but ewe continues to walk away

3:17 P.M. Ewe walks back to lamb and sniffs lamb's anus

3:20 P.M. Lamb lay down between wall and garbage can about 3 feet away from ewe

3:21 P.M. Lamb gets up with considerable difficulty with front legs again
Lamb walks to ewe and sniffs her anus
Ewe lays down; lamb standing by ewe's rump

3:24 P.M. Lamb has continued to stand by ewe's rump
Lamb yawns; tried to put front feet up on ewe's rump

3:26 P.M. Lamb moved away from ewe; edged shakily against the wall
Lamb stood between wall and garbage can; yawning
Lamb has head down with arch in neck;
Motor coordination appears stiff; walking slowly back to ewe edging against the wall
Sniffed ewe
Ewe's eyes half-lidded, chewing cud
Lamb lay down next to ewe

4:00 P.M. Ewe and lamb in same position

4:30 P.M. Ewe and lamb in same position

4:45 P.M. Ewe standing 3 feet away from lamb; lamb lying down awake

5:00 P.M. Ewe seems more active; lamb up and about with no motor difficulty

APPENDIX IV

AMOUNT OF INITIAL DOSAGE OF FLUPHENAZINE HYDROCHLORIDE TO GROUP C-2 EWES BEFORE ONSET OF TYPICAL INITIAL DRUG REACTION[a] AND LOWERED ACTIVATION LEVEL

Ewe Number	Amount of Drug[b] (in cc's)
4	.75
8	.75
15	1.00
17 (twin lambs)	1.00
22	.75
31	1.25
34	.75
44	1.00
48 (twin lambs)	2.00

[a]Typical drug reaction: yawning, lowered ears, lowered head, and fixed visual stare followed by pawing with front legs.

[b]Fluphenazine Hydrochloride in a preparation of 2.5 mg per cc.

APPENDIX V

NUMBER OF LAMBS DEMONSTRATING SELF-STIMULATION

BEHAVIORS DURING ISOLATION EXPERIENCE

Isolation Conditions	N	Behaviors							
		Pacing	Jump on Wire	Leaping	Head Twirl	Nibble Wire	Chew Paper	Paw Floor	Body Spin
Maternal Deprivation									
Full Vision allowed	7	0	7	7	7	7	7	2	0
Full Vision Denied	7	4	4	6	5	4	3	1	2
Total	14	4	11	13	12	11	10	3	2
Maternal Separation									
Full Vision Allowed	7	0	6	7	7	6	6	4	0
Full Vision Denied	7	5	4	7	7	4	3	2	0
Total	14	5	10	14	14	10	9	6	0

APPENDIX VI

NUMBER OF MATERNAL DEPRIVATION AND MATERNAL SEPARATION LAMBS HAVING FEEDING AND MOTOR PROBLEMS

Isolation Conditions	N	Problems			
		Feeding	Motor	Feeding & Motor	Feeding &/or Motor
Full Vision Allowed					
Maternal Deprivation	7	2	4	2	4
Maternal Separation	7	4	2	2	4
Total	14	6	6	4	8
Full Vision Denied					
Maternal Deprivation	7	3	5	2	6
Maternal Separation	7	6	2	2	6
Total	14	9	7	4	12

APPENDIX VII

MEAN NUMBER OF BEHAVIORAL ELEMENTS PER THIRTY MINUTE INTERVAL FOR ALL GROUPS OF EWES AND LAMBS

Groups	N	Time Interval in Minutes			
		0 - 30	30 - 60	60 - 90	90 - 120
Control Group					
Ewes	6	47.0	35.0	26.2	20.7
Lambs	6	38.7	40.1	25.8	23.8
Group C-2[a]					
Ewes	4	48.2	21.8	13.0	5.8
Lambs	4	53.2	33.0	38.5	14.8
Group H[b]					
Ewes	4	64.0	21.8	19.0	13.0
Lambs	4	50.8	29.0	21.5	10.2

[a]Activity level of ewe lowered.

[b]Optimal, but lowered stimulation level.