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VISUAL CLIFF PERFORMANCE OF MOTHERED AND UNMOTHERED DOMESTIC SHEEP

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VISUAL CLIFF PERFORMANCE OF MOTHERED AND UNMOTHERED DOMESTIC SHEEP

CHAPTER I

INTRODUCTION

In warm-blooded animals, parental care-giving behavior is almost uniformly required for species survival (Hafez & Scott, 1962). Harlow (1961) and Lorenz (1952) have reported the long-lasting results of incomplete or unusual parental care in monkeys and in geese, respectively. The mechanisms and systems intervening between early infantile experience and later behavior have only recently come to the attention of investigators (Sackett, 1963). Further description of the relationship between early experience and later behavior obviously depends upon additional investigation of factors affecting the perceptual process.

Historical Review

It has been pointed out (Fenichel, 1945) that when instincts are discussed, the physiological needs or somatic changes which cause certain urgent sensory experiences are usually taken as models. Obviously, need satisfactions for hunger, thirst, oxygen, defecation, and

urination are vital and can be postponed only for a short time; further, the aims of these needs cannot be appreciably altered (Fenichel, 1945). Such a rigid model for instinctive behavior had led not only to some misunderstanding of the psychoanalytic concept of the sexual instincts, but also perhaps to intolerance for the use of the word, "instinct," itself. In marked contrast to the imperative physiological instincts, the sexual instincts, as defined by Freud (1949), have the capacity to change or to make themselves apparent in various ways and in different disguises. Most important, the sexual instincts may even be subject to alteration of their objects or aims, a feature which seems dramatically absent in the physiological instinct doctrine. In order to clarify the distinctions between physiological and sexual instincts Beach (1960) has defined species-specific behavior as follows:

> Species-specific behavior patterns constitute the normal behavioral repetoire. They are present in the same or very similar form in all or nearly all members of the species of the same age and sex (Beach, 1960, p. 2).
>
> The determinants of behavior can be subdivided into three broad categories: historical determinants, environmental determinants, and organismic determinants (Beach, 1960, p. 5).

Kortlandt (1955) points out that psychoanalysis closely links the experience-susceptible features of the sexual instincts, or the environmentally determined aspects of species-specific sexual behavior, to critical developmental psychosexual stages. More than one non-analytic theorist has emphasized the importance of critical developmental periods

in the lives of organisms (Beach & Jaynes, 1954; Hess, 1959; Tinbergen, 1951). Among psychoanalytic theorists, Erikson (1950) defines eight stages of ego development with their characteristic inner psychological conflicts, physiological maturational possibilities, and observable social behavior. He calls his eight stages "a list of ego qualities--criteria by which the individual demonstrates that his ego, at a given stage, is strong enough to integrate the timetable of the organism with the structure of social institutions (1950, p. 218).

Furthermore,

> The emerging ego identity, then, bridges the early childhood stages, when the body ego and the parent images were given their specific meanings, and the later stages, when a variety of social roles became available and increasingly coercive. A lasting ego identity, we have said, cannot begin to exist without the trust of the first oral stage; it cannot be completed without a promise of fulfillment which from the dominant image of adulthood reaches down into the baby's beginnings and which, by the tangible evidence of social health, creates at every step an accruing sense of ego strength (1950, p. 218).

The general concept of critical periods assumes that there are specific periods in ontogeny during which the organism is sensitive to certain types of stimulation and, furthermore, that the particular characteristics of the given stimulation can be related to important features of subsequent behavior. Such a concept is stated by Freud in his theory of psychosexual development (1949). In a similar manner, Lorenz (1937) states:

> There are specific and restricted periods during which the stimuli which will evoke certain instinctive responses are permanently determined. After the critical period has passed, the environment cannot alter the nature of the effective stimulus. (p. 248).

Moltz (1963) disagrees with such a formulation. Describing his own approach as "epigenetic," he hypothesizes a period of development during which behavioral arousal is largely or exclusively determined by stimulus intensity and that this period terminates as the animal's perceptual environment expands to permit greater specificity of afferent control. Moltz contends that during the early neonatal period, the imprinting or following response functions to modulate the gross sensory input provided by the imprinting object so as to make it fall within the range necessary to evoke a parasympathetically-governed organic process of selective learning, with fear reduction functioning as the reinforcing agent. Supporting this reinforcement model for imprinting phenomena, James (1959) found that precocial birds will move toward a stationary flashing light if initial exposure takes place during the critical period. Moltz (1963) suggests that moving toward a flashing light and following a moving imprinting object both are initiated by a given stimulus magnitude acting on the central nervous system and both serve to adjust these magnitudes until an optimal level of excitation prevails.

In further contrast with the epigenetic approach is the critical period theory of Scott and his colleagues at the Jackson Memorial Laboratory (Scott, 1945, 1958, 1962; Scott & Marston, 1950; Williams & Scott, 1953).

Critical Periods

Scott (1958, 1962) specifically postulated the following critical periods with certain basic processes by which they are delineated. These periods are the neonatal, in which there is establishment of neonatal nutrition, i.e., nursing. Next, is a transition period while development of adult sensory and motor capacities takes place. Next is the socialization period during which primary social relationships develop. Then follows a juvenile period when there is development of physical skills and growing independence from parents. During the pubertal period, development of sexual relationships takes place, and finally, in the parental period there is development of the relationship with offspring. Scott, Fredericson, and Fuller (1951) divided this sequence into specific periods for the puppy as follows: neonatal, ten days; transition, ten days to three weeks of age; socialization, three weeks to ten weeks of age; juvenile, from ten weeks to sexual maturity.

A similar sequence has been worked out for the mouse (Williams & Scott, 1953) and the experimental evidence for the critical period hypothesis was clearly validating. Scott and Marston (1950) re-interpret some older (Scott, 1945) findings as further validating evidence of critical period phenomena in lambs. They point out that the lamb is born with adult motor and sensory capacities, i.e., the usual acquisitions of the transition period. This means that the socialization period is already underway at birth, and it may be speculated that any experimental

interference introduced will have dramatic and almost immediately observable effects. Indeed, the striking findings of Blauvelt (1955), Collias (1956), Liddell (1955), and Moore (1960) in this regard lead to the conclusion that stimulation of certain kinds during the transition period in sheep and goats is profoundly crucial to adequate social adjustment and ultimately to survival.

Erikson's Stages

Erikson's (1950) eight theoretical stages of ego development, as mentioned above, are based upon physical maturation, social expectations, and inner conflicts characteristic of the various stages. The first stage, the oral-sensory, is based upon attaining a homeostasis of bodily functions, i.e., ease of feeding, depth of sleep, and relaxation of bowels. Consistency of the environment, according to Erikson, leads to a basic sense of trust or distrust upon which the whole of identity is based.

> Mothers create a sense of trust in their children by that kind of administration which in its quality combines sensitive care of the baby's individual needs and a firm sense of personal trustworthiness within the trusted framework of their culture's life style (1950, p. 221).

The second stage is the muscular-anal, and, as the term implies, is based upon maturation of bowel and bladder control. Out of this stage, the infant derives either a feeling of autonomy or feelings of shame and doubt concerning his own ego.

The third stage, the locomotor-genital, is the ambulatory stage and that of infantile genitality. The sense of initiative in attack and

conquest vie with "a sense of guilt over the goals contemplated and the acts initiated in one's exuberent enjoyment of new locomotor and mental power" (1950, p. 224).

With the appearance of the latency period, the child who has mastered the ambulatory field and the organ modes sublimates the necessity to be aggressive and now learns to win recognition by producing things. If, by reason of a lack of steady attention and diligence, the industrious productivity falls short of attaining the pleasure of work-completion, then there exists the danger that a sense of inferiority may result.

Identity versus role diffusion is the conflict of the stage of puberty and adolescence. The advent of physical genital maturity upsets the sense of continuity and sameness. "The integration now taking place . . . is the accrued experience of the ego's ability to integrate childhood identifications with the vicissitudes of the libido . . . and with the opportunities offered in social roles" (1950, p. 228). If such integration fails because of previous doubt of sexual identity there is a danger of role diffusion or over-identification.

After the identity struggles, the ego is prepared for the sixth stage, that of young adulthood which involves primarily the ability to attain and maintain intimacy. Failure leads to isolation.

Generativity versus stagnation is the conflict of the stage of adulthood. "Generativity is primarily the interest in establishing and

guiding the next generation or whatever in a given case may become the absorbing object of a parental kind of responsibility" (1950, p. 231).

The final stage of maturity involves "the acceptance of one's one and only life cycle as something that had to be and that, by necessity, permitted of no substitutions" (1950, p. 232). "The lack or loss of this accrued ego integration is signified by despair, fear of death" (1950, p. 232).

As with Scott's (1962) critical period hypothesis, Erikson (1950) also indicates that the processes of early socialization are crucial in building ego integration. In contrast, however, Scott's is a theory based upon behavioral indices while Erikson is theorizing about inner processes. For Scott the neonatal period is primarily spent in physiological maturation and is therefore behaviorally unimportant. This first period for Erikson is the most structurally important stage, where trust is acquired. Scott (1962) places more emphasis on the motor sensory accomplishments of the transition period. This transition period seems to have some of the attributes of Erikson's first, second, and third stages.

Early Experience in Sheep and Goats

Scott and Marston (1950) conclude that the lamb at birth is already in Scott's transition period. This is the period of greatest susceptibility to environmental manipulation. Supporting this contention are the numerous studies of the striking results of very early interference in the development of sheep and goats. For example, Moore (1958) found

that six of seven kids conditioned to raise a foreleg to a signal when they were less than four hours old died within a few months, even though none of twenty non-conditioned kids of comparable age were lost. Liddell (1956) found that the pattern of conditioning in adults is affected by early separation from the mother. He separated four kids from their mothers at birth and bottle-fed them, leaving their twins (controls) with their mothers. At three weeks of age all the kids were given twenty conditioning trials per day for 50 days. Signals (dimming lights) were 10 seconds in duration and were terminated by a mild electric shock to the foreleg. Trials were separated by intervals of two minutes. The separated kids received the conditioning trials alone and the non-separated were conditioned with the mother present in the same room. Liddell reported that during this training period the separated kids were lethargic and lost muscle tone, whereas the non-separated kids did not. The separated kids remained isolated for one year, at which time they joined the flock. They were re-conditioned with the same method at two years of age, for two hours a day for 24 days. Interval between trials was increased to six minutes. It was found that during these later trials the non-separated goats showed "fretful" movements during the rest interval for the entire 24 days as contrasted to the orphaned goats which ceased making fretful movements shortly after the start of the conditioning trials. Mothered animals failed to respond to 25% of the conditioned stimuli, but separated goats missed 25% of the

conditioned stimuli at the start of the 24-day period and increased their failures to 45%. In other words, unmothered animals when re-conditioned as adults failed to react adaptively to stress.

Similarly, kids and lambs adopted by foster mothers and kids and lambs reared by hand (Moore, 1962) showed a pattern of conditioning different from normally reared controls. Adopted and bottle-fed kids and lambs conditioned earlier, had more vigorous conditioned responses, and responded to a greater number of signals than did their controls. The unmothered bottle-fed animals also were more active but spent less time near the wall in an open field test, had higher heart and respiration rates, and were low in dominance (Moore, 1962; Hersher, Moore, Richmond & Blauvelt, 1962). Moore and Amstey (1962) report that none of the adopted or bottle-fed animals was susceptible to tonic immobility, whereas all normally reared lambs and kids were susceptible.

Isolation of the Infant Rhesus

Harlow (1962) in summarizing his extensive work with infantile rhesus reports on a variety of rearing situations, including total isolation, partial isolation, either in individual bare wire cages in a colony room for two years or longer, or in individual wire cages with access to one or two mother surrogates for at least the first six months, and, finally, situations with real or surrogate mothers plus contact with other infants for the first year or two of life. Total isolation for two years resulted

in failure to display social or sexual behavior in the next two years, spent in a joint living cage. Results after six months of such isolation suggest severe, but not complete, social deficits. Only mild effects have been observed thus far in monkeys isolated through the first 80 days of life (Mason, 1960).

Partial isolation in infancy produced behavioral aberrations in many monkeys, including sexual inadequacy in all males and in all but one female. Four females were impregnated, in spite of inadequate posturing, and proved to be completely inadequate mothers (Mason, 1961). Infants raised by live mothers were more advanced in social and sexual behavior than infants raised by surrogate mothers in a controlled playpen situation (Harlow & Harlow, 1962). The mother's role is not entirely clear, however, because in a more stimulating playroom situation, surrogate-mothered babies have shown normal social and sexual behavior. Over all, it appears that the longer and the more complete the social deprivation, the more devastating are the behavioral effects.

Mason (1960) concludes that social organization among nonhuman primates is characteristically orderly and efficient. Presumably, these regular social relationships are dependent upon stable interindividual stimulus-response tendencies. Mason points out that sexual presentation, presentation for grooming, grasping the hips preparatory to mounting, and the threat pattern are a few of the highly stereotyped responses described for rhesus monkeys which ordinarily function as social cues,

eliciting appropriate reciprocal responses from other animals. Further, these stimulus-response relationships form the basis for social coordination, communication, and social control in feral groups (Chance, 1956). Insofar as the findings of Harlow and Harlow (1962) and Mason (1960, 1961a, 1961b) bear on this problem, they suggest that among animals whose socialization has been restricted, the cue function of many basic social responses is poorly established if not absent altogether.

Meier (1964) found differences in conditioning parameters in infant monkeys attributable to mode of birth. Birth by surgical means, compared with vaginal delivery, induced an effect on the behavior of the infant, such that the infant so born was much less active and much less readily aroused than an infant born vaginally. The mechanism by which such differences are induced, Meier speculates, may be maternal and endocrinal whereby a hormone having an effect on arousal varies predictably in quantity toward natural parturition.

Further Studies of Sheep and Goats

Not all kinds of early tampering with the mother-neonate bond are harmful to sheep and goats. Blauvelt, Richmond, and Moore (1959) report that kids reared by sheep and lambs reared by goats grow faster, gain weight more rapidly, and appear healthier than kids and lambs reared by their own mothers, although living with animals of the other species does not permanently change the basic behavior patterns of the

adopted animals. Goats do not behave like sheep, nor sheep like goats. The behavioral differences between the two species of adopted animals, according to Scott (1958), are approximately the same as one finds between normally reared sheep and goats. Hersher, Richmond, and Moore (1963) note that any behavior of the adopted animals similar to the behavior of the fostering social group is likely to be short-lived. Although occasionally an adopted lamb will climb onto elevated objects as kids characteristically do, most of the time it will not. A kid raised with lambs may tend to be slightly less active and more subdued than kids raised with other kids. Infrequently, a lamb living with kids will return a butt rather than submit to the greater aggressiveness and activity of its kid foster siblings. The authors note that goats and sheep characteristically butt in very different ways. The goat will rear up on hind legs and butt sideways as it comes down. Year-old male goats that have been reared with sheep continue to fight in this way. After several years of living with sheep, however, a male goat may be observed using the charging body-butt with four feet on the ground used characteristically by sheep. Staying on the ground in their charge, rams can knock over a rearing goat (Hersher, Richmond, & Moore, 1963).

These same authors also point out that unspecies-like behavior may appear in the foster mothers of lambs and kids, presumably as a result of the maintenance of species-specific behavior in the young and the mothers' inability to adjust to it. For example, old ewes seem to

expect their lambs to follow them quite closely. Such close following, however, is not a feature of the kid's behavior. When a kid is fostered by a ewe, the ewe may become disturbed at not being able to keep her "lamb" near her; she may have to spend more time away from the flock seeking the kid than do the other ewes whose lambs stay closer to them. Thus when a ewe is given a kid to rear, the kid's behavior causes the ewe to behave more like a goat in regard to spending more time away from the flock (Hersher, Richmond, and Moore, 1963).

Scott (1945) also observed that adult sheep tend to follow a single leader consistently, generally the oldest ewe. Goats show much less tendency to follow a single leader. Scott (1958) elsewhere attributes the species difference in leadership-following behavior to the greater tendency of new-born kids to remain immobile while separated from their mothers as opposed to the lamb's tendency to follow strongly and seek contact immediately, so that the habit of following the mother in sheep is more strongly established early in life and continues throughout adulthood. The stronger tendency to flock in sheep, then, may be a largely innate piece of species-specific behavior.

Early Feeding Experience

According to Hafez and Scott (1962) the lamb at birth soon rises on wobbly legs and directs its head towards the body of the mother. After many attempts the neonate finds the nipple and begins to suckle; a few days later, it can run directly to the udder and begin to suckle

immediately. Between each few sucks, the lamb pushes suddenly with its head, almost like butting, except that the mouth is directed forwards. While suckling, the lamb rapidly wiggles its tail. Usually single lambs alternately suckle both nipples taking two to three sucking periods of 20 to 50 seconds before changing from one to the other. With twins, each has its own nipple (Hafez & Scott, 1962). The lamb may suck standing, kneeling, or lying down. Suckling is forestalled by the slightest leg movement of the mother and the lamb then grazes, or returns to whatever its activity was before attempting to suckle (Hafez & Scott, 1962).

After parturition, the mother usually allows suckling at any time of the day or night and for any length of time. During the first week, the interval between sucklings may be one hour or even less (Hafez & Scott, 1962). Twin lambs were observed to suckle 33 times during the night and 45 times during the day, making a total of 78 times in 24 hours (Sojetado, 1952). Twin lambs suckled or attempted to suckle 15 to 45 times over a period of 16 hours observation (Munro, 1955). The times at which the lamb suckles alternate with periods of rest. After the first week, the mother does not go to the lamb for nursing but the lamb comes to the ewe who, in turn, limits the time spent in suckling by walking away (Hafez & Scott, 1962). Lambs four to six weeks of age suckle only six times daily (Barnicoat et al., 1949; Brown, 1959).

The duration of suckling from each of the two nipples of the ewe is related to age of a lamb (Munro, 1956). In the first two weeks after

lambing, each suckle may last ten minutes; the lamb suckles some five times from each nipple (Munro, 1956). The duration of each suckling is shorter for older lambs than younger ones and shorter at night than during the day (Hafez & Scott, 1962).

The estimation of milk yield in the ewe has been based on lamb weight increases when suckling occurred at three and four hour intervals under experimental conditions (Wallace, 1948; Barnicoat et al., 1949). Munro and Inkson (1957) showed that the milk consumption of lambs suckling at four hour intervals was similar to that of lambs suckling at one hour intervals.

When there is no "creep" feeding (supplemental feeding of lambs), the pre-weaning growth rate of the lambs is related to the amount of milk drunk during suckling; when the creep feeding is present, the relationship declines. This relationship is of great importance in twin-producing breeds and in areas of limited pasture, since milk yield is reduced as a result of a low level of nutrition during late pregnancy (Hafez & Scott, 1962). Ewes suckling twins yield considerably more milk than those with single lambs, especially when the plane of nutrition is high. The external stimulus of suckling influences milk yield rather than any possible prenatal influences, since twin-bearing ewes rearing single lambs yielded no more milk than single bearing ewes (Barnicoat et al., 1949). When one lamb of twins or triplets is weaned several weeks after birth milk production drops. Even so, the presence of two

or three lambs for the first few weeks seems to stimulate milking capacity for the whole lactation (Hafez & Scott, 1962).

Self Concepts of Animals

The important early process of nutrition has been related to early psychological processes by some theorists. Erikson (1950) and others (Angyal, 1941; Rogers, 1951) have emphasized the importance of the early assumptions about the self in the formation of ego- and self-concepts. Lorenz (1937) suggests that the early imprinting of some fowl is a means of own species identification, hence of self-identification. Without drawing such conclusions as to self-concept of the particular animals, Scott (1945) reported that sheep reared by humans showed a sense of familiarity with enclosures, a tendency to follow humans without fear, and some tendency toward independence of other sheep. When a female lamb was separated at birth and returned to the flock after nine days, she tried to join the other sheep but was butted off by all the ewes including her own mother. Scott reports that she never developed social behavior, except for a short period when she returned to the flock during oestrus at the age of one year. When she had lambs of her own she showed a marked decrease in care-giving behavior and did not butt strange lambs away, although she permitted none to nurse. Furthermore, she seemed to react only mildly to frequent separation from her lambs. Scott also reports that a male lamb, not a true orphan; was isolated from the 4th to the 12th day of life and was subsequently also

driven off by the ewes when he tried to rejoin the flock; he did finally successfully return during the rutting season. His later sexual behavior, however, was reported to be not as aggressive as normal male sexual activity. Scott attempts to relate these two cases of social maladjustment to frustration of affiliative needs and to the negative reinforcement of being butted away from other sheep. It is difficult to see how these factors alone could bring about the observed results, particularly in the light of Hess' theory of imprinting, relating strength of imprinting to energy expended (Hess, 1956, 1957). Hess' experimental findings would suggest that if an animal is still within the imprinting period, the more energy he expends in following, the greater will be the tendency to continue to follow in later social relationships. Since the opposite was observed in Scott's (1945) sheep we cannot conclude with Scott on the sufficiency of butting in the generation of later social isolation. The Lorenz (1937) theory of animal self-concept seems to offer a plausible explanation. It may also be possible that a number of kinds of formative relationships other than the mother-infant relationship, have their effects upon self-identification very early in life. For example, Imanishi (1960) in studying Macaca fuscata in the natural state notes that it is convenient to speak of two kinds of dominance ranking: "basic," and "dependent."

> That is, given two infants and their respective mothers, the one whose mother is more dominant in basic rank manifests its dominance in basic rank, even if the latter infant

> is more dominant than the former in terms of their own basic rank. Behavioral expression of such "dependent rank" is usual among the female and immature Japanese monkeys observed in the field. When such a dependent dominance status is fixed by social conditioning, it may become a basic dominance status. The basic rank is, therefore, not always attributable to physical and/or physiological factors (1960, p. 399).

If anything approaching such complex ranking is present in the flocking of sheep, then Scott's (1945) two animals may have been denied participation in the formation of rankings, and so denied an essential part of the data of self-concept formation. It may be that they stayed away from the flock not because they were low-ranked but because they were not ranked at all in the flock's organization.

Visual Depth Discrimination in Animals

Depth discriminations may be observed in animals by recording certain properties of their behavior when confronted with a cliff or precipice. However, visual, somesthetic and kinesthetic sensory inputs may be confounded in studies employing this method (Shinkman, 1962).

Yerkes (1904) placed tortoises individually on a 30 x 60 cm. board at various heights (30, 90, and 180 cm.) above a net and measured the interval between the time the animal was placed on the board and the time it fell off the board and into the net. He observed three species of tortoise on the apparatus; a water tortoise (Chrysemys picta Schneider), an amphibious tortoise, (Nanemys guttata Schneider), and a land tortoise (Terrapene Carolina Linnaeus). Four tortoises from each species were

each given one trial a day for 10 days. The average time per trial (in minutes) spent on the board by animals of the three species for all the three heights was as follows: Water species, 5.6; amphibious species, 45.5, and land species, 52.0. These data show clear main effects for species as well as for height. Yerkes (1904) interpreted the height effect as evidence that vision plays a part in determining the responses, and the species effect as a reflection of differences in the evolutionary importance of depth discrimination for animals of the same family who live in different environments. Evolutionary differences may have been confounded, however, with differences in the amount of experience land and water tortoises had had in situations resembling Yerkes' actual cliff. Thorndike (1899) had made similar observations on chicks aged 95 hours. He placed them individually on platforms at varying heights above the table, and noted when they jumped to the table. He reported that chicks always jumped quickly from heights between 1 and 10 inches, hesitated a long time before jumping from a height of 22 inches, and almost never jumped from a height of 39 inches. He concluded that chicks discriminate depth innately; however, it is not clear to what extent he controlled the visual experience of his subjects. In a similar experiment, Kurke (1955) gave domestic chicks 10 days of "enforced vertical experience" in a special brooder containing a raised platform. When tested on another platform whose height varied, these chicks jumped down to the table from a greater average height than chicks given only "restricted vertical

experience." Waugh (1910) placed mice individually on a small disc attached perpendicularly to a movable vertical rod passing through a hole in the table. He then raised the disc to various heights above the table and observed how much time elapsed before the mouse jumped down. A mild electric shock was used to induce the animal to jump. Waugh found a positive correlation between the time to jump and the distance to the table, and inferred that mice discriminate depths up to 18 cm., which was the greatest height he used. It is apparent, however, that he left uncontrolled the kinesthetic and vestibular sensory inputs afforded the animal during the ascent of the disc.

A principal defect in the cliff studies cited above is the confounding of visual with non-visual stimuli. Recently, studies of a similar nature have been done using a simple apparatus which eliminates all non-visual cues, thus enabling the experimenter to obtain discriminations based solely on visual stimuli. The apparatus, known as the visual cliff (Walk & Gibson, 1961) consists of a runway board with a large sheet of clear glass directly underneath it. The glass extends on either side of the central runway parallel to the floor. The runway and glass are in a large box several feet square, and are attached to the sides of the box at about two feet above the bottom. The bottom of the box is covered with some pattern, for example a red and white checkered pattern. Paper bearing the same pattern covers the underside of the glass sheet on one side of the runway, which is called the shallow side since the optic

pattern is almost level with the runway. The other side is called the deep side, since the patterned surface is about two feet below the runway. Animals are tested for depth discrimination by placing them on the runway and noting to which side they go if they leave the runway. Latencies and number of times the runway is crossed may also be measured, as well as time on or off the runway. When animals consistently choose one side over the other, they are certainly responding differentially to whatever visual depth cues the pattern affords. Clearly, at least two classes of experimental variables may be manipulated in studies using this apparatus; one is the optic relation between the two fields adjoining the runway, and the other is the past history of visual stimulation of the animals who are tested.

Gibson and Walk (1960, 1961) and Walk and Gibson (1961) tested chicks, turtles, rats, lambs, goats, pigs, kittens, and dogs, using a visual cliff with a red and white checkered pattern, and found that all these species reliably chose the shallow side of the visual cliff. Chicks and goats always went to the shallow side by age 24 hours, and cats did the same at age 4 weeks. Cats placed by hand on the deep side showed freezing behavior, which did not extinguish even after many trials. Tallarico (1961) observed a tendency for chicks to choose the shallow side as early as three hours after hatching.

In a series of control experiments, Gibson and Walk (1960) covered the underside of the glass in the visual cliff with plain gray paper on

both sides of the runway. In this situation, the proportion of rats leaving the runway on either side was not significantly different from one-half. As an additional control, tests were made with no paper under the glass on either side, so that both sides were deep. Rats in this series simply failed to leave the runway.

Two major cues were presumed to determine side preference: relative motion parallax (rate of displacement on the retina of the images of the pattern elements on each side as the animal moves along the runway) and the size of the retinal images of the pattern elements (Walk & Gibson, 1961). Gibson and Walk have endeavored to isolate these cues and to assess their relative importance. Differential image size was eliminated by making the pattern elements on the shallow side sufficiently smaller, so that the pattern elements on the two sides gave rise to retinal images which were equal in size. With motion parallax presumably the only remaining differential depth cue, day-old chicks and adult rats almost invariably chose the shallow side. It will be noticed that other cues to depth remained besides the supposedly isolated motion parallax (e.g., differential accommodation). Next, differential motion parallax was eliminated by covering the underside of the glass on both sides of the runway with patterned paper containing elements somewhat smaller on one side than on the other, thus isolating size as a depth cue. In a series of trials under this condition, day-old chicks chose the two sides about equally as often; adult rats tended to choose the side with larger pattern elements.

Walk, Gibson, and Tighe (1957) tested 90-day-old light- and dark-reared rats on the visual cliff using size and parallax cues, and found that animals from both groups reliably chose the shallow side, supporting the interpretation that depth discrimination in rats can occur without prior learning. Nealey and Edwards (1960) noted that the dark-reared animals in the Walk et al. (1957) experiment had been allowed a 20-minute period to adapt to the light before being tested. These authors performed an experiment designed to control for the possibility that very rapid learning, analogous to imprinting, had occurred during that time. They replicated the Walk et al. procedure, obtaining the same results. Two additional control groups were tested; one was a 90-day dark-reared group, for whom the 20 minutes of light adaptation took place under individual translucent hoods, thus excluding any opportunity for pattern-vision. Seventy-five percent of the rats in this group chose the shallow side of the visual cliff; this finding supports the Walk et al. conclusion that depth discrimination occurs independently of learning. In the second control group, the rats were surgically blinded, to control for any non-visual cues that might have been present. These rats did not discriminate between the shallow and deep sides.

Shinkman (1962) reports that Nealey also replicated the Walk et al. (1957) study, without parallax ewes, with dark- and light-reared rats 10-months-old, and a pattern consisting of only three wide lines on either side parallel to the runway. These lines all subtended the same visual

angle when viewed from the runway. He found that the light-reared rats chose the shallow side, and the dark-reared rats failed to make the discrimination. The same dark-reared rats were tested immediately thereafter, using the original Walk et al. size stimulus pattern, and still did not discriminate. This suggests that the rats raised in the dark for 10 months may have suffered impaired vision. The impairment was apparently temporary, however, because when the rats were tested after a month in the light, they consistently chose the shallow or large pattern side. In a subsequent experiment, Shinkman (1962) also reports that Nealey tested the hypothesis that the Walk et al. rats discriminated on the basis of sharpness of focus. He projected sharp and blurred patterns of equal size onto the two sides of a ground glass screen which was in the position originally occupied by the clear glass sheet in the visual cliff. It was found that light-reared rats descended equally often on both sides, thus ruling out focus as the critical cue controlling rats' behavior on the visual cliff.

The capacity to react discriminatively to the distance of a visual stimulus appears to characterize a great many species, ranging from insects to primates. In the case of insects, birds, and rats, it is evident that displacement of the images on the retinal mosaic is a very important factor in depth discrimination. Wallace (1959) demonstrated with the desert locust Schistocerca gregaria forskal, the importance of visual scanning behavior (which necessarily gives rise to motion parallax).

Pumphrey (1948) and Grinnell (1921) noted the occurrence of scanning responses in birds in the natural environment, and Gibson and Walk (1960) showed the critical importance of motion parallax in depth discrimination by chicks, performing under more controlled conditions. The findings support the general statement that stimulus image displacement and the resulting motion parallax are intimately linked with depth discrimination.

Neurological Considerations

Sackett (1963) proposed a sub-receptor (but supra-central) afferent sensory unit or units to account for preferences in visual stimuli, features which he thinks underlie unlearned following behavior in some animals. Overlapping development of the activity of these units in an uneven sequence contributes to the onset and disappearance of the critical period in the development of visually controlled behavior. Foster group preference in sheep and goats (Hersher et al., 1963) discussed earlier, is consistent with this theorizing, as is the concept of imprinting behavior in fowls.

Lindsley (1939) found that the human neonate will respond to both light and sound. Lindsley and others (Bayer & Bayley, 1959) have found that the EEG alpha rhythm is poorly developed at birth but begins to differentiate rapidly at about two months of age, indicating that the visual cortex is likewise developing rapidly.

Citing the work of Senden and of Riesen, Hebb (1949) points out that newly seeing human beings (after congenital cataract removal) and

chimpanzees reared in darkness, though they readily discriminate two figures when both are given together, and though they perceive unity in the primitive sense, are amazingly poor in the perception of figures or objects. They have great difficulty in recognizing figures and in having, with regard to them, an experience of figural identity. Learning is required to bring out the potentialities of the way things look. According to Hebb, the human learning under these circumstances goes through a process of separate attention to each part of the figure and only gradually arrives at an identification of the figure as a whole. Hebb reports that without an extended learning period generalization of perception cannot be accomplished. He also notes that objects whose names have been learned may fail to be recognized, i.e., named, when their previous surroundings have been changed. Dember (1960) has similarly noted that in tachistoscopic presentation of simple stimuli, the process of detecting the presence of a figure requires the shortest presentation duration; the detection of a change in the stimuli with the direction unspecified requires a slightly longer duration of presentation. A still longer duration is required for a subject to recognize a stimuli as one previously or subsequently presented, and the longest duration is required for the process of identifying a stimuli without giving comparison stimuli from which to choose.

Hebb (1949) reasons that it is possible that a normal human infant goes through a process similar to that exhibited in the cataract patients.

The immediate correctness and apparent utter simplicity of our adult perceptions of objects and forms may be entirely misleading as to the genesis and physiological basis of these perceptions. Very early in life, perhaps before the age at which the traditional gestalt experiments with infants were performed, there may have been this same piecemeal, repetitive, and summative process demanding eye movements and many separate visual fixations; so that as adults we are able to perceive a square at a glance only by virtue of this earlier complex learning.

Summary

It has been known in anecdotal reports (e.g., Grabowski, 1941) for many years that remarkable differences in adult sheep behavior could be introduced by adopting a new lamb to human foster parents. Naturalistic observation has led to the formulation of theories that early experience in all animals, including man, sets the course of later behavior in many important respects. The task of experimental investigation and articulation of the effects has only recently begun.

The focus of the present study is the investigation of mothering experiences of lambs and the effects of such experiences on early survival behavior.

CHAPTER II

PROBLEM

The review of relevant literature presented in the preceding chapter contains numerous indications that differential treatment of the young of many species within and in relation to mother-neonate interaction produces dramatic effects in the character and directedness of later behavior. Particular note was taken of studies of sheep behavior.

In the present investigation, the behavior of lambs in regard to a critical self-preservation situation was studied in order to determine the effects of normal mothering and the lack thereof on a survival reaction of the young animal. This crucial function brought under study was the perception of and reaction to a simulated visual cliff. This method of investigating depth perception and survival reaction on a visual cliff was used to evaluate two hypotheses. The first hypothesis dealt with the general theory that unmothered animals show slower development of adjustive behavior than do normally mothered animals:

> Hypothesis 1. In a visual cliff situation, mothered lambs will avoid the cliff at a significantly earlier age than will unmothered lambs.

The second hypothesis concerned the isolation of the mediating mechanism through which the survival response is acquired by the lamb. If the first hypothesis were to be supported and if the mothered lambs avoided the visual cliff at an earlier age, the question would remain as to how the acquisition of this ability is accomplished. Two general possibilities regarding means of acquisition might be suggested. The more mechanistic possibility might be that the lamb acquires skill through tuto red imitation or some other direct experience controlled by visual contact with the mother and the environment. The second possibility regarding the theoretical means of acquisition of the survival reaction might be the postulation that the lamb acquires a more general alertness or "ego" effectiveness through general contact with the mother, and that such early "ego" development may have little to do with strictly visually mediated behavior.

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.

Thus:

> Hypothesis 2. With the opportunity to learn visual patterns virtually eliminated up to the time of first testing, otherwise normally mothered lambs in a visual cliff situation will avoid the cliff at a significantly earlier age than will unmothered lambs whose vision has been unimpaired by any experimental means.

Stated formally, the aim of the present research project was to determine if a relationship exists between the early experience of being attended by a same-species mother and the rate of development of a survival response in a visual cliff situation. A second aim of the project was to evaluate the role of visual experience in the major relationship of the first hypothesis.

CHAPTER III

METHOD

Description of Subjects

The subjects were lambs born into a flock of registered Suffolk ewes which had been bred to the same registered Suffolk ram. The ram was separated from the ewes until the first of October, and consequently, all but five lambs were born between February 28 and April 5. Between these two dates 51 births were recorded, 26 of which were twin births. One twin birth and three single births were observed after April 5. The distribution of lambings between the 28th of February and the 5th of April appeared to be bimodal with peaks about the end of the first week in March and another about the third night of April. There were only two births recorded between the 17th and the 30th of March. During the first period of greatest activity, between February 28 and March 17, the times before sunrise and after sunset were the periods of greatest activity as far as delivery was concerned. During this 18 day period only six deliveries were observed between 8 A.M. and 6 P.M., two of which were twins. Throughout the same period 32 deliveries took place between 6 P.M. and 8 A.M. During the second peak period of lambing

activity, in the first week of April, the distribution of times of deliveries seemed to be spread throughout the daylight hours rather than during the nighttime hours with most of the deliveries occurring after 8 A.M. According to Hersher, Richmond, and Moore (1963) their sheep showed no such tendency to deliver at any particular time of day. In the present study, however, the modal time of day for delivery was between 5 A.M. and 7 A.M. with 20 deliveries (eight single births and six twin births) occurring during this period. Another peak period was between 6 P.M. and 8 P.M. with 14 births (four single and five twin). Appendix A gives the actual distribution of single and twin births by times of day across the spring lambing season. It appears that the times of deliveries are not randomly distributed throughout the 24 hours of the day, a finding conflicting with that of Hersher et al. (1963).

Treatment of Subjects

In the first stage of the experiment thirteen pairs of twin lambs (Twenty-six animals in all) were used. One member of each twin pair was removed from the mother and sibling to become the unmothered or human-reared member of the twin pair. First- and second-born twins were selected alternately to be removed, therefore, all deliveries had to be observed by the experimenter in order to make proper alternating selections. The use of alternate twins precluded matching of subjects by sex since sheep twins may be of like or unlike sex. However, first

born twins were characteristically larger, and therefore, relatively large and small animals were alternately put into the two conditions.

Immediately after delivery, ewes were observed to commence cleaning the lamb which remained with them by licking it vigorously starting at the head and working backwards. This cleaning procedure sometimes lasted more than an hour. The mothered lambs remained with the ewes in individual indoor stalls for the duration of the testing procedure. Feeding of the mothered lambs was by normal nursing during this period.

An attempt was made to provide the separated unmothered lambs with similar kinds of early tactual and nutritional experiences. Each unmothered animal was rubbed and cleaned with a warm dampened sponge and dried with burlap and terrycloth until it stood alone. When able to stand, the lamb was bottle-fed its first meal of colostrum taken from its own mother or from another lactating ewe. This procedure paralleled the sequence observed in normal ewe-lamb interaction where the lamb is denied nourishment until able to stand and approach. After the initial feeding the unmothered lambs were given additional bottle feedings of colostrum or a mixture of canned milk and water at intervals of two to four hours for the duration of the testing period.

The subjects of the second stage of the experiment were five matched pairs of Suffolk lambs (ten animals in all). Matching variables were sex and weight at birth. All lambs were the offspring of different

ewes so that no twin pairs were included. As in the first stage of the experiment, all deliveries were observed, and, in addition, the lambs were immediately weighed. The first five observed births were of two females and three males. These animals were removed from the ewes and reared in the manner described above for the unmothered twins. Continued observation of deliveries and weighing of lambs led to selection of five more lambs (two females and three males) of appropriate weights to be matched with the animals already selected. This second group of lambs were used as goggled, mothered subjects. The heads were wiped free of membrane material and plastic translucent goggles were affixed. These goggles were held in place by elastic bands around the head and neck. The elastic bands were tight enough to prevent dislodgement by the licking of the ewe. Previous observations of nonexperimental lambs fitted with similar goggles failed to show any interference in breathing or swallowing, although a slight puffiness around the mouth was noted in some of the non-experimental lambs after the goggles had been worn for periods of twenty-four hours. It may be noted that none of the experimental lambs remained goggled for longer than ten hours.

Experimental Design

In the first stage of the experiment, using twin lambs, each animal, mothered or unmothered, was placed in the visual cliff apparatus once each hour from birth until it exhibited the criterion response (to be

described later). In the second stage of the experiment, using matched pairs, each unmothered lamb was placed in the visual cliff apparatus once each hour from birth until it exhibited the criterion response, as in the first stage. Each mothered pair-mate of the second stage, however, was left goggled with the mother, as described above, until reaching an age equal to half the age of its unmothered pair-mate when that pair-mate had first exhibited the criterion response to the visual cliff apparatus. At reaching this critical age the goggles were removed, not to be replaced, and the mothered lamb was placed in the visual cliff apparatus once each hour until it exhibited the criterion response.

The Visual Cliff

A smaller version of the visual cliff (Gibson & Walk, 1960, 1961, Walk & Gibson, 1961) was constructed using an 18" x 36" pane of glass enclosed on all sides and top and bottom and lighted from beneath. The enclosed space below the glass was 48" deep and the enclosed space above the glass was 24" high. Instead of the traditional runway across the middle of the glass, a platform, 6" x 18" was placed at one end of the pane overlooking the apparent drop. After being placed on the platform through a flap in the top of the enclosure overlooking the platform, the lambs were observed through a peephole in the end opposite the platform.

Lambs were placed on schedule on the 6" x 18" platform. A simple Pass-Fail criterion was used with passing defined as staying on

the platform for a period of three minutes without placing any two feet simultaneously on the pane of glass over the vacant area. When such criterion response was exhibited on any hourly trial, two subsequent hourly trials were given to validate the first observation. The age at which the criterion response was first observed was recorded as the critical value, and thus results were stated as hours of age at criterion.

CHAPTER IV

RESULTS

In the first stage of the experiment, the hypothesis tested was that mothered (M) lambs will avoid the visual cliff at a significantly earlier age than will unmothered (U) lambs. M and U lambs were placed in a visual cliff apparatus hourly from birth until exhibiting the criterion avoidance response. In the first stage all M lambs achieved the criterion in the visual cliff situation before their unmothered twins. Ages at which the criterion responses were first exhibited are given in Table 1. A t-test of the differences in ages was significant. The observed t was 4.05, which is significant at the .005 level with 12 degrees of freedom. Thus, the first hypothesis was supported.

In the second stage of the experiment the hypothesis tested was that with the opportunity to learn visual patterns virtually eliminated up to the time of first testing, otherwise normally mothered lambs in a visual cliff situation will avoid the cliff at a significantly earlier age than will unmothered lambs whose vision has been unimpaired by any experimental means. The results of the second stage of the experiment supported this hypothesis, in that all goggled-mothered (G) lambs again

Table 1

Ages at Which Mothered (M) and Unmothered (U)

Twins Exhibited Criterion Response

Pair	Mothered	Unmothered
1	2 hours	3 hours
2	3	11
3	5	10
4	3	5
5	2	5
6	1	4
7	1	2
8	5	7
9	3	5
10	1	4
11	7	8
12	3	12
13	5	7
Means	3.15	6.38

achieved criterion performance before their U pair-mates. Ages at which criterion responses were first exhibited are given in Table 2. A t-test of the differences in ages was significant. The observed t was 4.34, which is significant at the .01 level with 4 degrees of freedom.

Thus, in all instances M lambs performed in a more efficient manner in the visual cliff situation. Furthermore, it may be noted in Table 2 that three of the G lambs avoided the cliff on their first trials, immediately after the goggles were removed with no previous experience on the visual cliff apparatus. For example, the U lamb of pair 15 did not avoid the cliff until its 6th trial at the age of 6 hours. The G lamb of pair 15 thus wore goggles for 3 hours. When the goggles were removed this G lamb successfully avoided the glass immediately. The G lambs of pairs 16 and 18 also avoided the cliff with no previous experience.

During the first trials, the M and U lambs which had experienced no visual deprivation were observed to behave in the manner described by Collias (1956); that is, they tended to orient themselves along the surface of the wall, or follow the intersection of the wall and ceiling with their muzzles, making upward-directed butting movements with the mouth and nose. On the early trials before avoidance responses were observed, the lambs seemed to be completely oblivious to the apparent drop beneath their feet. Vision was apparently developing normally; eyes were open in all cases, and even at less than an hour of age all of the ungoggled lambs could follow a moving ewe (in the case of mothered

Table 2

Ages at Which Goggled-Mothered (G) and Unmothered (U)

Pair-Mates Exhibited Criterion Response

Pair	Mothered	Unmothered
14	9.5 hours	13 hours
15	3	6
16	6	12
17	5.5	7
18	2.5	5
Means	5.30	8.60

animals) or a moving human (in the case of human-reared animals).

Development of avoidance behavior was usually sudden and dramatic. When an animal "noticed" its apparently precarious position, it would exhibit the typical startle response of sheep and goats, that is, extension and stiffening of the front legs and flexion of the rear parts and "back-pedalling" of the rear legs.

When placed in the visual cliff apparatus, the lambs which failed a trial characteristically did so while making butting movements along the intersection of the wall and ceiling. In most cases, the startle response was made in a manner which kept the lamb on the platform, thus qualifying as a criterion response. Occasionally, an animal exhibited the startle reaction but failed the trial because its forefeet had already reached the glass, or because it fell onto the glass or otherwise was unable to keep completely free of the glass surface.

For a four-footed animal living in an environment of steep inclines, such an innate mode of response to apparent depth is obviously highly adaptive. That this startle response itself is a visually mediated reaction was demonstrated by Gibson and Walk (1960) when they noted that simply moving a lamb or kid to a position where its head was above the runway (platform) and the vacant area out of view brought about the disappearance of the reflex. This same phenomena was observed in the present experiment. In later trials, this striking startle response was replaced by movements which simply avoided the vacant area of the glass. The

startle reflex could be elicited again, however, by placing a lamb on the glass instead of on the platform. Further regression to the early preoccupation with following the wall and ceiling was never observed again in the visual cliff apparatus, although such orientation continued intermittantly in normal "solid ground" situations until its final disappearance, after weaning.

One final observation may be reported which may be of interest to future investigators. In an early pilot study connected with the present experiment, four lambs were isolated after being removed from mother ewes and cleaned in the usual manner. They were bottle-fed through apertures in the walls of their isolation pens on a feeding schedule later found satisfactory for other lambs. 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.

CHAPTER V

DISCUSSION

In the first stage of the experiment every M lamb achieved the criterion avoidance response before its U lamb twin. In the second stage of the experiment every G lamb which remained with its mother and was denied the opportunity for visual learning also achieved the criterion avoidance response before its U lamb pair-mate.

An important observation was recorded in the previous chapter which was not reflected in the statistical results. This observation was the striking manner in which visual cues gained ascendance in the visual cliff situation. In the early trials, the M and U lambs which had not been goggled followed the overhead intersection of the ceiling and wall of the enclosure onto the vacant space. The vision of these animals was apparently unimpaired in other situations. On given trials, however, the visual perception of distance underfoot in a downward direction became a stimulus of greater importance and gave rise to the typical startle response. Later, this startle response was replaced by a more voluntary kind of behavior, that is, a wary regard of the vacant area and no movements toward it.

The results of the second stage of the experiment provide conclusive evidence that development of the avoidance behavior in the visual cliff situation in the experimental lambs was not dependent upon visual learning under the tutelage of the mother. We may also note that a feature which might be called regressive could be elicited by placing directly over the vacant area an animal whose avoidance behavior had attained a point beyond the startle response.

The major finding of the present study, then, was that a relationship exists between the development of a survival reaction to apparent depth and the experience of non-visual interaction with a same-species mother. A further finding was that this visually mediated survival reaction was not itself dependent upon visually mediated experience. We may attempt to relate these findings to certain pertinent theories of behavior.

Contact Need Gratification and Organismic Equilibrium

It may be noted that Erikson (1950) stressed the importance of attaining early organismic homeostasis or equilibrium at the physiological level and a sense of "basic trust" at the psychological level. Ribble's (1943, 1944) observations and theories suggest that the organismic homeostasis may be aided initially by adequate contact stimulation. She described the part played by contact stimulation in the transition from intrauterine oxygen assimilation to postnatal air breathing. In utero, she says, the diaphragm arches over the liver in such a way that its

movement draws in oxygenated blood from the placenta via the umbilical cord. She further theorizes that at birth the neonate must continue to live on whatever oxygen is stored in the liver while the disphragm reverses its movement to draw air in through the nose and mouth into the undeveloped lungs in the narrow chest cavity. The so-called "birth-cry," she says, is the prenatal action of the diaphragm simply forcing air out the mouth for the first time and certainly does not represent the successful changeover to extrauterine living.

All of Ribble's observations, of course, have been made in regard to human babies, but there is evidence in puppies (Scott, 1958) and also in rats (Bingham & Griffiths, 1952) that early contact stimulation is a necessary part of the early physiological life of these organisms. Ribble (1943, 1944) states that stroking, rocking, and other kinds of mothering are necessary in the accomplishment by the neonate of a number of extrauterine processes besides breathing. Pinneau (1950) delivered an extensive critique of Ribble's ideas, but applied studies continue to point to the importance of some as yet unspecified elements in the mothering of human infants.

That contact stimulation can be of therapeutic value in psychological treatment is illustrated by Waal's (1955) report of a special technique of psychotherapy with an autistic child. The first step is a general reduction of anxiety through soft massaging, rhythmical petting and gentle tickling and touching of the solar plexus, neck, spine, chest,

chin, hands, and palms. In the second step the therapist attacks the areas of bodily tension with a heavier touch and provocative movements. The tightly clenched jaws and masseters, the stiff chest, fixated shoulders, and the tense orbicularis palpebrarum and frontalis muscles are subjected to harsh pressure resulting in protests from the patient. Waal reports the disappearance of autistic symptoms in one child under such treatment.

Possible Mechanistic Explanations

In the present study we may presume that the M lambs found early adequate gratification of contact needs, and, therefore, it is tempting to theorize that the appearance of retinal sensitivity to motion parallax--according to Walk and Gibson (1961) the most important single cue to distance--depends for its expeditious appearance on the gratification of early contact needs. That such interaction may be endocrinal is suggested by Meier's (1964) findings regarding differences in behavior of infant monkeys related to mode of birth. Certainly the human-reared U lambs in the present study received some contact stimulation, and it may be that when the cumulative amount was adequate, retinal sensitivity to motion parallax became possible due to a release of some unspecified secretion. It would also be tempting to theorize that the appearance of retinal (or higher) sensitivity to motion parallax may mark the beginning of the critical period for imprinting in sheep, as well as in other species.

We may note that the mothered G lambs which were goggled presented several cases in which sensitivity to depth appeared on the first

trial, moments after the goggles were removed. This indicates that sensitivity to depth was developing without the experiencing of distance cues. If, indeed, sensitivity to depth develops without practice, then we might speculate that the cataract patients discussed by Hebb (1949) also perceived depth immediately, although form identification may have taken some time and conscious practice.

Holistic Description

The previous section reflects an attempt to analyse the experimental observations into several popular categories. Gratification or non-gratification of contact needs was selected as the obviously important difference between mothered and unmothered lambs, and the visual cliff situation was described as a depth perception situation involving motion parallax as a primary depth perception cue.

More important to the lamb, however, is the obvious seriousness of the survival aspect of the situation. In a critical sense, the experimental procedure created a situation not greatly different, as far as the animals were concerned, from the situations faced by their evolving ancestors on the slopes of mountain ranges. Apparent in its survival value is the first tendency of the lamb to orient to the safety of the mother's side or to the side of an embankment, thus avoiding some of the danger of falling. Slightly later, it is quite valuable to survival if edges of solid ground overlooking vacant space elicit the back-pedalling startle reaction, and, later still, it is further valuable if the lamb

simply stays away from situations which would elicit the back-pedalling startle reaction. At least the first two of these reactions seem to qualify for classification under a heading of species-specific behavior, since they are (1) characteristic of all or almost all members of a species at a given age (suggesting a close association if not relationship with elements of the genetic endowment); (2) they require certain classes of external stimuli for their appearance, and (3) their early or late appearance is significantly related to the care-receiving history of the organism. This last feature is the most relevant for the present research; if basic organismic equilibrium of extrauterine living is efficiently established by care-giving behavior applicable to the species, then it appears that the eliciting of potentially adjustive species-specific behavior follows smoothly, just as breathing, digestion, and locomotion adjust smoothly to the new form of living under the proper treatment. Nursing is another integrated system which must attain an effective level of proficiency even with inexperienced ewes and lambs.

The vast literature of child development indicates that first relationships are extremely important to human infants, and the present study provides evidence that they may be absolutely vital to sheep, particularly in view of the four lambs whose deaths were attributed to isolation. What Erikson (1950) discusses as the early stages of ego development in the human, then, may be closely linked to the survival concept of evolutionary thinking in regard to species survival. In other

words, animals whose basic equilibrium or basic trust is established efficiently seem to have a better chance to realize the potentialities of their genetic endowment, thus increasing the probability of their survival if, indeed, their genetic endowment is applicable to the given ecology.

As for contact need gratification, we may speculate holistically that sheep mothers, as well as mothers of other species, answer a number of needs besides those for contact, probably out of motivation unconnected with the needs themselves. In other words, the ewe may lick the lamb because of the olfactory attraction of the membrane. Furthermore, we may speculate that much of the need-answering is so subtle that human observers may be entirely oblivious to the care-soliciting behavior of the lamb or its closure in the care-giving behavior of the ewe. The possible variety in interacting variables challenges the imagination, but it is probably this kind of multiple need-closure, rather than simply gratification of specific needs that affects the establishment of the organismic equilibrium and renders even the most sensitive kind of human-rearing grossly inadequate from the lamb's point of view.

Synthesis of Findings

The first important finding of this research study was that mothered lambs developed avoidance reactions in a visual cliff situation earlier than did unmothered, human-reared lambs. This finding was interpreted as a feature resulting from the general fostering of ego

development by the early establishment of organismic equilibrium or basic trust, and, further, that this early maturation was the result of some elements which were maximized by own-species mothering.

In a second experiment it was determined that the mechanism which fostered the early maturation of survival functions was not affected by deprivation of the opportunity for visual learning. Therefore, it was concluded that other-than-visual interaction with the same-species mother in the complex mother-neonate relationship was the primary basis of early ego development.

Suggestions for Future Research

As indicated in a preceding section, the observations made in connection with the present research project can lead to the posing of a number of research questions. The present study has isolated a large block of the behavior of the mother-neonate relationship (that is, the care given by the same species mother) and found it related to the sequential appearance in the lamb's behavior of a particular adjustive reaction to apparent depth. The next step, logically, would seem to be to begin to specify more of the major features of what constitutes "good" mothering or "bad" mothering from the lamb's viewpoint. In this regard, the findings of Harlow (1961) and Seay, Alexander, and Harlow (1964) have been interpreted to mean that the mothering of infant rhesus does not have to be active on the part of the mother to be remarkably more adequate than no mothering at all. In sheep, the specification of active and

passive aspects of the mother-neonate relationship might be done through the use of narcotized ewes or various kinds of substitute mother objects.

Obvious also is the need for long and patient observation to reveal other species-specific behavior patterns which might be used as "dependent variables" in the sense that visual cliff performance was used in the present experiment.

It may also be hoped that some of the wild relatives of the domestic sheep and goat could be studied more precisely to uncover other parallels between evolutionary principles and "ego" functions.

CHAPTER VI

SUMMARY

Many authors in the field of animal behavior have been concerned with the effects of an animal's early experience upon its later behavior. There is ample evidence that interference in the formation of the mother-neonate relationship in sheep and goats produces remarkable effects in later social and other behavior. The effects have usually been attributed to a stress reaction. The present research was designed to demonstrate the holistic aspects of the effects of early experience upon "ego" development as a whole, evidenced in expeditious appearance in ontogony of species-specific survival reactions to the stimulus of perceived depth.

In the first part of the experiment, thirteen pairs of twin lambs were separated, half being left with their mothers and half being reared by humans. All were tested for the ability to react adaptively to the stimulus of depth using a variation of a visual cliff apparatus. Mothered lambs developed avoidance behavior before human-reared lambs. In a second part of the experiment, matched pairs of singly born lambs were tested in a similar manner. One lamb of each pair was reared by humans and the other lamb of each pair was fitted with translucent goggles

which prohibited patterned vision and left with the mother ewe. Again mothered lambs demonstrated the criterion avoidance behavior before their human reared pair-mates in every case.

The explanation was suggested that the early appearance of avoidance behavior in mothered lambs represents a primitive form of "ego" functioning operating through species-specific behavior, and that such "ego" functioning is of value to survival. A holistic concept of efficient establishment of a basic organismic equilibrium in the normal mother-neonate relationship was advanced to explain the differential results. Furthermore, it was concluded that the fostering of primitive "ego" functioning was not dependent upon visual learning, but was probably more closely related to gratification of contact needs.

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APPENDIX A

Table 3

Times of Day of Single and Twin Births

Hour	Single Births	Twin Births	Total
0000-0059	2	0	2
0100-0159	2	2	6
0200-0259	0	1	2
0300-0359	1	1	3
0400-0459	0	0	0
0500-0559	4	3	10
0600-0659	4	3	10
0700-0759	2	0	2
0800-0859	1	0	1
0900-0959	1	0	1
1000-1059	1	1	3
1100-1159	2	1	4
1200-1259	0	1	2
1300-1359	1	0	1
1400-1459	0	1	2
1500-1559	0	2	4
1600-1659	0	1	2
1700-1759	0	0	0
1800-1859	1	3	7
1900-1959	3	2	7
2000-2059	2	1	4
2100-2159	0	2	4
2200-2259	1	0	1
2300-2359	0	2	4