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The purpose of this study was to determine whether there was any difference in tactile discrimination of six nursery school children before and after a tactually depriving experience.

Each subject was asked to report verbally his discrimination of heat, pressure, and texture stimuli, applied by specially devised instruments, on a specific area of the volar surface of the right forearm. A plaster cast, which extended from below the elbow distally to above the wrist of the right arm, was worn for 48 hours to provide the tactually depriving experience. Tactile discrimination of heat, pressure, and texture stimuli was measured before application, immediately after removal, and again 96 hours after removal of the cast.

The Mann-Whitney U Test was used to test the significance of differences in tactile discrimination of each subject (1) before the cast was applied and immediately after its removal and (2) before the cast was applied and 96 hours after its removal. The only statistically significant difference was for discrimination of pressure before the cast was applied and immediately after cast removal.

TACTILE SENSE DISCRIMINATION OF SIX NURSERY SCHOOL CHILDREN

by

Marjorie Goff Anderson

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Approved by

Barbara E. James

Thesis Adviser

APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Thesis Adviser Barbara E. James

Oral Examination Committee Members Donald W. Grinnell

Elaine R. Lewis

Eunice M. Dumas

March 16, 1968
Date of Examination

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CHAPTER I

INTRODUCTION

This study attempts to examine the tactile sense of six nursery school children before and after a tactually depriving experience. Investigation of selected literature concerning sensory deprivation revealed that research interest has been centered around the auditory and visual senses rather than the tactile sense. It is, however, through all of the senses--visual, auditory, gustatory, olfactory, and tactile--that the human organism is made aware of his environment. The absence of, or the limitation of, any one of these senses automatically limits the environment of the organism and thus creates a handicap.

When one is deprived of the visual or of the auditory sense, he compensates for his lack by utilizing his remaining senses in varied and unaccustomed ways. This fact underlies the familiar folk belief that when one sense is lost, the other senses become more acute in order to compensate for the loss. The deprived organism is forced to become more aware of stimuli that have been present all the time.

Parents are aware of a child's response to a variety of stimuli. They are quick to note evidence that an

infant or a young child has reacted with pleasure or displeasure to stimuli of the visual, auditory, olfactory, and gustatory senses. The most common reference made to tactile sense stimuli by parents is one associated with the infliction of pain.

Authorities in the field of child development have found that infants are extremely aware of their tactile environment. They respond to patting, stroking, cuddling, and textural and pressure differences, as well as to the temperature of objects or atmosphere (Bowlby, 1952; Frank, 1957; Spitz, 1945).

Clinical practitioners in nursing have reported that patients complain of itching, burning, or crawling sensations of the skin under plaster casts. Older children and adults are able to verbalize concerning these sensations, whereas smaller children seem to indicate similar sensations of discomfort by their restless behavior. Similar responses and reactions have been reported also when large areas of the body have been covered by heavy ointments and bandages.

The basic questions that arise from these observations are (1) What is the effect upon children of the deprivation of normal tactile stimulation on the skin? and (2) What causes the unusual sensations? Answers to these questions will increase the clinical nurse practitioner's understandings as she deals with and cares for children in situations

where tactile sense deprivation occurs. Information of this nature would be of comparable interest and help to parents and to professional people in the fields of education and child development.

Purpose of the Study

The main purpose of this study was to determine whether there was any difference in tactile discrimination of nursery school children before and after tactile sense deprivation.

Objectives of the Study

The objectives of this study were:

1. To measure tactile discrimination of a specific body area (right forearm) in the normal healthy state.
2. To measure tactile discrimination of the same specific body area immediately after removal of a light plaster cast which had covered the area for 48 hours.
3. To measure tactile discrimination of the same specific body area 96 hours after the removal of the cast.

Definitions of Terms Used

The following terms have specific meanings for

use in this study:

1. Tactile discrimination refers to the verbally reportable differences in experiences mediated by the sense of touch.
2. Tactile sense deprivation refers to the limiting of the specific experiences of pressure, heat, and texture stimuli.
3. Texture refers to the degree of roughness or smoothness of a surface.
4. Mesh refers to the number of abrasive particles affixed to a square inch of sandpaper.

Hypotheses

Specifically, this study was designed to test the following hypotheses:

1. There are no significant differences between discrimination of pressure applied to the right forearm of nursery school children before application and after removal of a plaster cast covering that area.
2. There are no significant differences between discrimination of heat applied to the right forearm of nursery school children before application and after removal of a plaster cast covering that area.
3. There are no significant differences between

discrimination of texture applied to the right forearm of nursery school children before application and after removal of a plaster cast covering that area.

Basic Assumptions

Two important assumptions are basic to this study:

1. A 48-hour period of deprivation is sufficient in time to result in a difference in tactile discrimination.
2. Nursery school children can verbally report tactile discrimination.

Limitations of the Study

The study was limited by a small incidental sample which was composed of six nursery school children between the ages of 3 years 5 months and 5 years 7 months. The study was further limited by the small area of the body tested.

Organization of the Remainder of the Thesis

Four chapters remain in this study. Chapter II--Review of Related Literature--cites previous sensory discrimination studies conducted with animal and human subjects. Chapter III--Procedures--includes a description of the sample and how it was selected, the instruments

used, and the utilization of the instruments. Chapter IV--Results--includes findings reported from the tests, statistical treatment of the data, and an observational analysis of the data. Chapter V--Summary, Discussion, and Recommendations--summarizes the results and indicates conclusions drawn from the study. Recommendations for further study are also included in this final chapter.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The complicated process of growing up is profoundly influenced by experiences of the organism from conception to death. What are these all-important experiences? An experience might involve seeing a lovely view or an angry face, hearing a pleasant sound or a raucous noise, tasting a piece of candy or a sour lemon, smelling a rose or household ammonia, or feeling a sharp pin prick or a piece of velvet. An experience, then, implies the reaction of an organism to a stimulus that is perceived by a sensory receptor. This is a very elementary concept of experience for it is usually thought of as something far more complicated. The complicated concept is merely the inter-relation of the various stimuli and the interpretation given to them by the brain.

Researchers have long shown interest in studying the individual who is blind or deaf. Perhaps the obvious nature of these handicaps has stimulated the interest of researchers. The literature prior to World War II, however, yields no evidence of systematic research in the area of tactile sense deprivation.

Sensitivity to tactile stimuli seems to operate before the other sensory processes. Several investigators have reported that one of the first stimulations to which the fetus responds is tactile stimulation in the oral-nasal region (Carmichael, 1954; Gesell, 1945; Hooker, 1952; Windle, 1940). The early appearance of the tactile sensory process would indicate that it plays a significant role in the development of the child, beginning at the embryonic stage.

Review of Animal Research Pertinent to Sensory Deprivation

Research that has been done to test the effects of early experiences on the later behavior of animals demonstrates that such experiences exert a profound influence on intelligence, social behavior, responses to pain, and even such presumably genetically determined phenomena as weight and size.

In an investigation of the effects of early sensory and behavioral deprivation upon exploratory behavior, Montgomery and Zimbardo (1957) placed three groups of 21-day-old rats in different living conditions: a normal cage (20" x 10" x 8" wire-mesh cage), a behavioral deprivation cage (6" x 4" x 4" hardware-cloth cage with sheet-metal top), and a sensory and behavioral deprivation cage (6" x 4" x 4" sheet-metal cage with hardware-cloth

floor and placed in a light-proofed and sound-proofed cabinet). The only observed difference was in the gait of the two deprived groups. The deprived groups also showed more approach-avoidance behavior toward particular parts of the Y-maze.

Melzack and Scott (1957) raised ten dogs in isolation from puppyhood to maturity. Specially constructed cages drastically reduced the sensory experience of the dogs. Twelve control litter mates were raised as pets in private homes or in the laboratory. In two tests using strong electric shock, the restricted dogs required significantly more shocks before they learned to make the appropriate avoidance responses than their free-environment litter mates. In tests using nose-burning and pin-pricking, the behavior of the restricted dogs was found to be strikingly different in capacity to perceive pain and respond to it when compared to normal litter mates. Melzack and Scott concluded that early perceptual experience determines, at least in part, (1) the emergence of overt responses such as avoidance of noxious stimulation and (2) the actual capacity to perceive pain normally. The behavior of restricted dogs suggests that perceiving and responding to pain, which is so fundamental to normal adult behavior and presumably so important for the survival of an individual or a species, requires a background of early and prolonged perceptual experience.

A group of Scottish terriers raised in a blank isolated environment from age 4 weeks to 7 months were found to be more physically active and curious than the control group. The experimental group reacted to fear stimuli by wild agitation as opposed to simple avoidance. The restricted dogs showed less intelligent behavior and less social behavior. The investigators concluded that a rich, stimulating environment in early life is an important condition for normal development.

> But the experiments bring out clearly that any animal needs varied sensory stimulation in order to develop normally, just as it needs food and drink. . . . Organisms like to be disturbed (as by an exciting novel, climbing a mountain and so on). And indeed they cannot live normally and fully if they are not. Especially during the early, plastic period of life, they must have a good deal of stimulation in their environment. If they do not, they may remain forever immature. (Thompson & Melzack, 1956, p. 42)

Levine and Lewis (1959) studied the effects of infantile experience on the maturation of stress response. Seventy-six infant albino rats were assigned to one of four groups and handled once daily at different ages. Group 1 was handled from age 2 days through 5 days, Group 2 was handled from age 6 days through 9 days, Group 3 was handled from age 10 days through 13 days, and Group 4 was handled from age 2 days through 13 days. At age 14 days the rats were randomly assigned, one-half to a control situation and the other half to a stress situation in which

they were subjected to cold of 5°C. for 90 minutes. The adrenal glands were then removed to determine Adrenal Ascorbic Acid Level. In Groups 1 and 4, which had been handled during the period directly following birth, there was a significant depletion in adrenal ascorbic acid in response to cold stress. Significant adrenal ascorbic acid depletion was not noted in Groups 2 and 3, which had been handled later in infancy. The results of Levine and Lewis' study indicate that there is probably a critical period in the life of the infant rat when handling is of crucial importance.

In a study using 32 male albino rats, a relationship between gentling, rate of growth, and degree of damage to cardio-vascular and gastro-intestinal systems following stress was shown. The rats were placed either in an experimental group or in a control group immediately following weaning. At that time the mean weights of the two groups were the same. The experimental group was gentled for 10 minutes a day for 3 weeks; the control group was not gentled. Gentling consisted of holding the animal nestled in the palm of the experimenter's left hand and close to his chest. In this position the animal was stroked with the thumb and forefinger from the head to the base of the tail. At the end of the experimental period, the mean weight of the experimental group was significantly higher than that of the control group.

There was also less damage to the cardio-vascular and gastro-intestinal systems of the gentled group following a stressful experience. (Weininger, 1954)

To investigate perceptual and motor impairment as a result of immobilization by a total body cast, Draper and Bernstein (1963) placed five juvenile rhesus monkeys in total body casts for a period of 48 hours. They observed a temporary motor deficit immediately following release. This deficit was no longer noticeable after a period of 15 minutes. No evidence could be found of perceptual impairment at any time.

In research done with macaque monkeys and surrogate mothers, Harlow has produced strong evidence that love is related to tactual experience. "A baby monkey raised on a bare wire-mesh cage floor survives with difficulty, if at all, during the first five days of life" (Harlow, 1958, p. 675). Infant monkeys showed a definite preference for the soft, cloth-covered mother surrogate over the hard wire-mesh-covered surrogate in spite of the fact that food was received from both surrogates. Harlow's research isolated contact comfort as a variable of overwhelming importance and even suggested that the act of nursing is important not because of the nutrition received but because of the frequent and intimate body contact.

Review of Human Research Pertinent to Sensory Deprivation

Most motor activities are oriented by tactile stimulation, but it is often forgotten how much prolonged learning and especially tactile experience were required earlier to achieve these motor patterns.

> Patting the baby rhythmically not only soothes him, but apparently promotes well-being and metabolic efficiency. . . . Prolonged deprivation of such tactual contacts and soothings may establish in the baby persistent emotional or affective responses to the world, since his initial biological reactions to threats have not been allayed and hence may become chronic (Frank, 1957, p. 220).

Frank further implies that tactual sensitivity plays a leading role in the early development of the human from the fetus stage onward. In addition:

> Perhaps many of the personality disorders believed to stem from childhood are due to deprivation of essential tactile experiences and to the establishment of signs and symbols upon inadequate or distorted tactile experiences (Frank, p. 247).

The infant receives stimuli such as warm-cold, pain, and pressures through his tactile sensory process. There are, obviously, individual differences in thresholds which may vary from time to time as the infant's internal states are altered, especially when he is ill, fatigued, or emotionally disturbed.

> A person who is strongly reacting emotionally, as in acute fear or pain, or grief, may be able to recover his physiological equilibrium

> through close tactual contacts with another sympathetic person (Frank, p. 220).

Researchers in the field of maternal deprivation have established a strong relationship between mother-love and the act of cuddling or petting the child (Spitz, 1945, 1946; Spitz & Wolf, 1946; Bowlby, 1952). Bowlby (1952) has stated that maternal deprivation during the stage between 3 and 12 months of age particularly causes adverse effects. If maternal deprivation is at least partially tactual deprivation, then again the importance of tactual stimulation is illustrated.

The term "hospitalism" has been used to describe a vitiated condition of the body due to long confinement in a hospital. Spitz (1945) cites examples showing the extremely high mortality rate of institutionalized children. Of the institutionalized children studied, the surviving ones, practically without exception, developed subsequent psychiatric disturbances. They became asocial, delinquent, feeble-minded, psychotic, or problem children. These psychological injuries were attributed by Spitz to be the result of two factors: (1) lack of stimulation and (2) the presence or absence of the child's mother. "Stimulation by the mother will always be more intensive than even that of the best trained nursery personnel" (Spitz, 1945, p. 55).

In studying the emotional development of the child,

Spitz (1949) noted that the social environment of the normal infant was restricted almost entirely to one person, the infant's mother. The two distinct emotional responses differentiated in the course of the first 2 months of life appear to correspond to pleasure and displeasure and seem to appear in reaction to physical stimulation (Spitz, 1949). Since the mother is the one with the infant at all times, it seems apparent that it is she who supplies the physical stimulation.

A study was conducted by Ourth and Brown (1961) to determine the immediate effects of moderately different treatments of neonates during their brief hospital stay. In a nursery for the newborn, twenty neonates were divided into two groups. One group, the "mothered" group, was breast-fed, and the mothers were instructed in such mothering practices as holding, rocking, and positioning their babies. Approximately 30 to 60 minutes were spent for each feeding of the "mothered" babies. The other group, the "non-mothered" group, was bottle-fed; physical needs were met, but no added mothering was given. The babies in this group had from 15 to 20 minutes spent with them for each feeding. The "non-mothered" group cried significantly more than the "mothered" group. From the results of the Ourth and Brown study, there seems to be a strong relationship implied between mothering and tactual stimulation.

In a test designed to measure tactile discrimination in young children and to examine tactile discrimination in relation to sex and age, James (1965) used 204 children and 30 adults as subjects. These subjects were divided by sex and by age. Of the children, six age groups were used--ages 4, 5, 6, 7, 9, and 11 years--with each group consisting of 15 girls and 15 boys; six sets of twins and singletons who were matched according to age, sex, and intelligence were also used. The adult group was composed of 15 males and 15 females ranging in age from 21 to 30 years. The test used was a Touch Test designed by the investigator and consisted of 24 stimulus cards. Each card had two small squares of sandpaper affixed to it. The sandpaper ranged in texture from fine to very coarse. On one-third of the cards the square on the left was the coarser, on another third the square on the left was the finer, and on the remaining eight cards the two squares were of the same mesh. The subjects were blindfolded and asked to feel the sandpaper and then to indicate if the two samples felt the same or if one felt rougher. James found no statistically significant difference between sexes at age 4 years, but girls had a significantly better score than boys at age 6 years. Significantly lower scores were made by 6-year-old boys than by 11-year-old boys. No significant differences were observed between girls in the various age groups.

Heron, Bexton, and Hebb (1953) studied the effects of monotony of sensory environment upon attention and problem-solving ability of subjects. The subject lay on a couch in a quiet room most of the time for a day or more. He wore translucent goggles to eliminate varied visual stimulations and cardboard cuffs to decrease the range of tactual stimulation. Through a small loudspeaker system the subject was asked to solve problems such as anagrams or mental arithmetic. The subjects showed marked boredom, difficulty in concentration, and a statistically significant decrease in problem-solving efficiency.

It seems that all experiments involving sensory deprivation also restrict mobility. Mendelson, Solomon, and Lindemann (1958) observed eight poliomyelitis patients during treatment in a respirator and kept case records on their reactions, particularly hallucinatory. The observations made led Mendelson and his colleagues to conclude that restriction of mobility with its concomitant kinesthetic sensations may be as important in the production of mental disturbances in sensory deprivation as the restrictions of the other senses.

In a study designed to test the effects of decreased variation in the sensory environment, Bexton, Heron, and Scott (1954) used 22 male college students as subjects. The deprivation conditions were the same as those cited in the Heron, Bexton, and Hebb (1953) study. The subjects

experienced hallucinatory activity--visual, tactual, and auditory. One subject related an experience in which he saw a rocket ship discharging pellets which kept striking his arm. Another subject reported receiving an electric shock from an hallucinatory doorknob. Heron and his associates concluded that the results supported the hypothesis that the maintenance of normal, intelligent, adaptive behavior requires a continually varied sensory input.

To determine if tactile-kinesthetic activity reduction via immobilization would show impairment of intellectual and perceptual processes, 22 male university students were placed in "coffin-like" boxes for 1 week. The boxes were lined with rubber cut out in the shape of a human figure. The subjects were immobilized in the boxes except for being unstrapped for 15 minutes at each mealtime, 1 hour in the afternoon, and 9 hours at night. They could not sit up or stand up. Intellectual and perceptual-motor tests were used. Disturbance of both performance and electrical activity of the brain was produced. There were significant impairments in recall and verbal fluency tests. Color discrimination and reversible-figures tests showed significant impairment. Depth perception, pain sensitivity, and size constancy were not affected. (Zubek & Wilgosh, 1963)

In a similar study, 13 subjects were used. Here,

the subject lay in a comfortable bed in a lighted, semi-soundproof cubicle with an observation window. He wore translucent goggles that admitted diffuse light but prevented pattern vision. Cotton gloves and cardboard cuffs extending from below the elbows to beyond the finger tips were worn to limit tactual perception. Auditory perception was severely limited. Communication between the subject and the experimenter was made possible through a two-way speaker system. A tactual form-discrimination test was given, and measurement of the two-point threshold was made before the subject entered the cubicle, after 48 hours of isolation, and after 72 hours of isolation. The experimental subjects showed significant impairment of their tactual form-discrimination ability. A significant decrease of the two-point threshold measurement was shown for the experimental group in two of the four loci tested. One peculiar phenomenon was noticed while the experimental subjects were being tested--at times they were uncertain whether they were being touched or not, and they would respond frequently when no stimulus was being applied. (Doane, Mahatoo, Heron, & Scott, 1959)

Ormaston (1958) determined movement thresholds before and after periods of sensory deprivation, sensory bombardment, and waiting in a reception room. His results indicated that readiness for stimulation significantly

increased under sensory deprivation and waiting but decreased under bombardment.

A group of researchers who carried out a brief sensory isolation experiment with both normal and neurotic subjects made the following observation: "Personality disorganization may be produced by sensory isolation, with the severity of the symptoms related to the length and extent of the deprivation conditions" (Cohen, Rosenbaum, Dobie, & Gottlieb, 1959, p. 486).

In a perceptual isolation experiment carried out at New York University, 14 freshmen male students who met criteria of interest, intelligence, and apparent stability served as subjects. The deprivation conditions of this study consisted of the following: (1) the subject lay on a comfortable couch in a small room made partially soundproof, (2) a monotonous masking noise was fed into the subject's ears through earphones, (3) a light was on at all times, (4) the subject's eyes were covered with eye cups made from halved pingpong balls, (5) the subject's hands were covered with gloves, and (6) the subject's hands and forearms from the elbows to beyond the finger tips were enclosed in cardboard cuffs. The isolation experience was for an 8-hour period. The subjects performed significantly worse on complex reasoning tasks immediately after isolation. The experimenters concluded that (1) vividness and structure of imagery

are increased by perceptual isolation, (2) the degree to which contact with reality is interrupted is more important than the length of time of the isolation experience, and (3) increasing time spent in isolation and increasing monotony of stimuli seem to increase vividness, structure, and persistence of imagery and perhaps to decrease realism of imagery. (Goldberger & Holt, 1958)

A completely different method of producing sensory deprivation was devised in a study by Lilly (1956) in which he used two subjects. Each subject was suspended in a tank containing slowly flowing water kept at a constant temperature of 94.5°F. The subject was nude except for a blacked-out mask (enclosing the entire head) worn for breathing and supporting straps used under the arms to stabilize the subject's position in the tank. According to reports of both subjects, the experience was such that the supports and the mask were felt tactually but little else; even the usual pressures on the body caused by gravity were lacking. Immediately after exposure, each subject wrote personal notes on his experience. They had developed a "stimulus-action" hunger; hidden methods of self-stimulation developed, such as twitching muscles, making slow swimming movements, and stroking one finger with another. The attention of the subjects was powerfully drawn to any residual stimulus, such as the mask and the

suspension supports. These residual stimuli seemed to occupy completely the consciousness to an almost unbearable degree. Fantasies and imageries were perceived in the final stage of the isolation experience. The night following emersion from the tank, each subject in the study reported an awareness of sensations that his bed seemed to exert great pressure against his body.

In an experiment carried out at McGill Laboratories, two subjects had an area on the volar surface of the forearm covered with a 3 x 6 cm. plastic cup with perforated top to allow ventilation to the skin. The area was tested with Von Frey hairs before and after isolation to determine sensitivity. At the same time a homologous area on the other arm was tested. The subjects showed a trend to a lowered threshold after isolation. When touched on the isolated area with the hairs, the subjects frequently reported experiencing pain, warmth, or itch but not when touched on the non-isolated arm. When the isolated area was touched or stroked with a pencil, the subjects reported queer sensations that they were unable to describe with any precision. (Heron, 1961)

Aftanas and Zubek (1963) conducted a study designed to determine the effects of a prolonged period of no tactual stimulation of a circumscribed area on the forearm and the possible similarity of these effects to those resulting from the application of constant pressure to the same area.

Thirty-six male university students were assigned, 12 in each of three conditions. In Group 1--the absence of tactual stimulation--a perforated plastic cup was fastened to the volar surface of the forearm, 8 cm. below the elbow. In Group 2--the application of constant light pressure--a slightly curved perforated disc was applied to the same area with a pressure of 20 gm./cm. Group 3--the control group--had open plastic rings attached to the same area. The experimental conditions lasted 1 week. Measurements of tactual acuity and heat and pain sensitivity were taken before and immediately after the experiment, 1 day after the experiment, and 2 days after the experiment. Group 1--the no-stimulation condition--showed increased acuity. Group 2--the constant-stimulation condition--showed decreased acuity. The changes in acuity in Groups 1 and 2 were still evident when tested 2 days after the experiment. No change was noted in temperature and pain perception, and no hallucinatory experiences were reported.

With the exception of the study reported by Heron (1961) and the one carried out by Aftanas and Zubek (1963), the literature yielded no reference to studies in tactile sense deprivation per se. All other studies deprived more than one sense simultaneously. Patients in casts or patients in bandages are deprived only of normal tactile stimuli; thus it seems that further

study of the tactile sense under controlled deprivation conditions is warranted.

CHAPTER III

PROCEDURES

Identification of the Sample

The initial step in the preparation of the study was the identification of suitable and willing subjects in cooperation with the director of the nursery school. The cooperation of the recommended subjects was enlisted. A letter was sent to the parents of each recommended subject soliciting the parents' cooperation and requesting permission for their child to participate in the study (see Appendix A).

The sample consisted of three males and three females. These children were enrolled in the 1967 summer session of The University of North Carolina at Greensboro Nursery School. The ages of the subjects ranged from 3 years 5 months to 5 years 7 months. These white middle-class children were free from any known physical defects and were of average or above-average intelligence.

Determination of Body Area to Be Tested

The determination of the body area to be tested included several considerations. It was deemed desirable to choose an area that could be covered with a plaster

cast, cause minimum interference with the child's normal activities, and be easily accessible for testing. The area chosen for application of the cast was the right forearm. The cast was to extend from below the elbow distally to above the wrist. By so limiting the area, no joint movement would be inhibited by the cast application.

Development of the Instruments

Since no instruments were known which would test what the writer purported to test, suitable instruments had to be developed. The services of a professional engineer were obtained. The engineer designed instruments for testing pressure and texture and then arranged for having these instruments produced. In collaboration with the writer, a method for measuring heat was devised. A description of the instruments follows, and sketches of the devices used for testing pressure and texture appear in Appendix B.

Description of the Instruments

A search of the literature revealed a scarcity of techniques that could be utilized to assess tactile discrimination. A technique was developed for the assessment of sensitivity to heat. An Argus model #300 slide projector was used. The light emitted by a Westinghouse 300-watt bulb was projected through an

f3.5 lens onto the designated stimulus area. The distance between the light source and the stimulus area was 22½ inches.

The apparatus used for the assessment of pressure stimulation in this study consisted of a ¼-inch diameter steel spring loaded plunger so arranged that graduated markings became visible as the application of force was increased. A diagram of this apparatus is shown in Appendix B.

Texture discrimination was measured by movement of each of four 1-1/8-inch by 5/8-inch pieces of sandpaper across the stimulus area. The apparatus consisted of a steel rod, ¼ inch in diameter by 4 inches in length, with a drilled block sliding between two fixed points. The block, 5/8 inch square by 1-1/8 inches long, had its longitudinal surfaces curving toward the extremities. Affixed to each of the four curving surfaces was a piece of aluminum oxide abrasive glued to a treated cotton backing. The mesh numbers of the affixed abrasives were #400, #240, #100, and #50 respectively. The interval scale from mesh #400 to #50 was graded by the Minnesota Mining & Manufacturing Company in accordance with the commercial standard of grading of abrasive grain on coated abrasive products published by the United States Department of Commerce. A diagram of the apparatus is shown in Appendix B.

Testing of the Instruments

The instruments were pre-tested to ascertain whether they measured what the writer wished to measure. The pre-test also indicated needed revisions in instructions to be given the subjects.

Testing Procedure

Administration of the instruments. Each subject was asked to come into the testing room and sit in a chair. The assistant showed the child two samples of sandpaper, one coarse and one fine. The child was asked to feel and classify each as rough or smooth.

With the wrist and the elbow of the right arm in a flexed position, a cloth measuring tape was used to locate the half-way point on the ventral surface of the forearm between the wrist and the elbow. A dot was made at this point with a felt-tipped marking pen. With the dot as a reference point, another dot was placed 1 inch proximally and another dot 1 inch distally. This set apart a 2-inch area in the center of the forearm.

The child was asked to put his forearm through the door of a cardboard house-front. After the arm was comfortably placed on the table behind the house-front, the light source--placed 22½ inches from the center mark on the child's arm--was switched on. The experimenter

then asked the child to indicate with a verbal report when the marked spot on the arm began to feel warm. A stop watch was activated simultaneously with the light source. As soon as the child indicated the perception of warmth on the marked spot, the stop watch and the light source were deactivated. The time interval between the activation and the deactivation of the stop watch was the recorded response.

The pressure gauge was then placed on the center dot of the forearm. The experimenter slowly began to apply force to the pressure apparatus. The child was asked to report verbally as soon as he felt pressure. The reading of the pressure gauge marking was recorded by the experimenter.

The texture discrimination instrument was then placed in a position so that the textured surface came in contact with the arm at the dot proximal to the elbow. The textured surface was moved toward the wrist and then back to the starting position. The child was asked to indicate verbally if this surface was perceived as rough or smooth. This procedure was repeated for each of the four textured surfaces.

Each child was thanked for playing the game and told that he would have the opportunity to play the game again later.

Application of the cast. After the initial testing

of all the subjects, a plaster cast was applied to the right forearm of each subject. The cast was thicker on the ventral and dorsal surfaces and extended from below the elbow to above the wrist. The cast was applied by a Board-certified orthopedist.

Each of the mothers was given a specially prepared comment sheet with instructions to note any reference the child made to sensations of the skin area covered by the cast. These were to be returned when the child had the cast removed. A copy of the comment sheet appears in Appendix B.

Post-testing. The casts were left in place for 48 hours, at which time they were removed by the writer. Immediately after the removal of each cast and again after a lapse of 96 hours, the complete testing procedure was replicated.

Analysis of the Data

For testing the hypotheses that there are no significant differences in heat or pressure discrimination by nursery school children before application and after removal of a plaster cast, the Mann-Whitney U Test as described by Siegel (1956) was utilized. This is one of the most powerful of the nonparametric tests, suitable to an ordinal level of measurement. A nonparametric analysis was warranted since normalcy of population and equality of variance could not be assumed.

CHAPTER IV

RESULTS

The results of this study were evaluated in two different ways. First, the Mann-Whitney U Test, a nonparametric statistical test designed for ordinal level measurement, was utilized to test the first two hypotheses. Second, an observational analysis was done on the data from all the tests.

When Subject F's cast was removed, it was noted that the cast had been softened and the position of the cast changed so that the testing site was partially exposed. Since the tactile sense deprivation for this subject was not comparable to the other subjects', the data recorded for Subject F was excluded from the analysis. The Mann-Whitney U Test was used to analyze the data obtained from five subjects.

The responses of the subjects to the pressure stimulus are shown in Figure 1. The pressure scale reading denotes the point on the instrument where the subject verbally reported discrimination of pressure.

Hypothesis I states that there are no significant differences between discrimination of pressure applied to the right forearm of nursery school children before

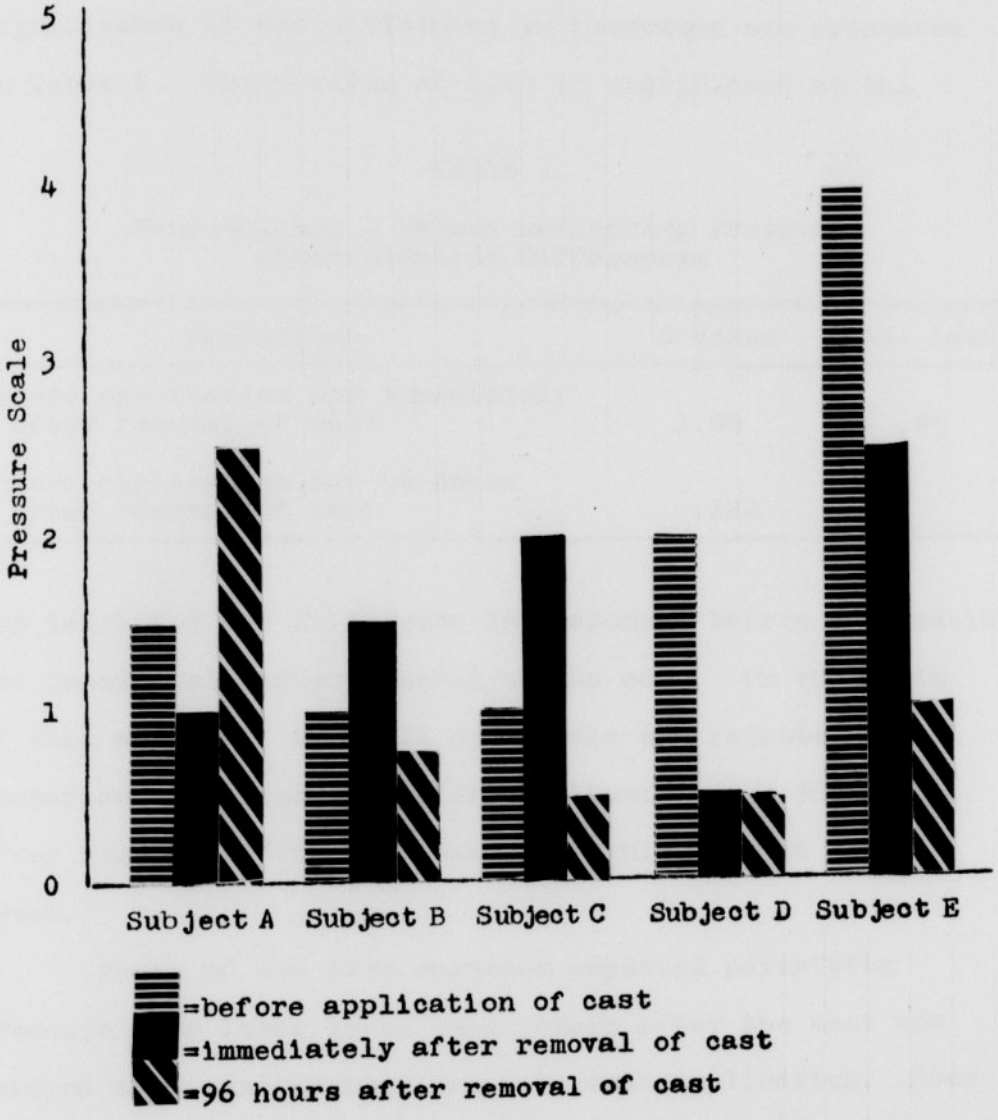

FIGURE 1

Responses to Pressure Stimulus

application and after removal of a plaster cast covering that area. The U values obtained which reflected the significance of the difference in responses are presented in Table 1. The U value of 1.00 is significant at the

TABLE 1

Mann-Whitney U Values Reflecting Pressure Discrimination Differences

Comparison	U Value	Sig. Level
Before application and immediately after removal of cast	1.00	.05
Before application and 96 hours after removal of cast	.222	

.05 level for the difference in responses before application and immediately after removal of the cast. On the basis of this analysis, the null hypothesis was rejected. A comparison of responses before application and 96 hours after removal of the cast was not significant at the .05 level.

Three of the five subjects reported perceiving pressure at a lower level immediately after the cast was removed than was reported prior to cast application. Four of the five subjects reported perceiving pressure at a lower level 96 hours after the cast was removed than they had reported prior to application of the cast.

The responses of the subjects to the heat stimulus are shown on Figure 2. The seconds scale denotes the time

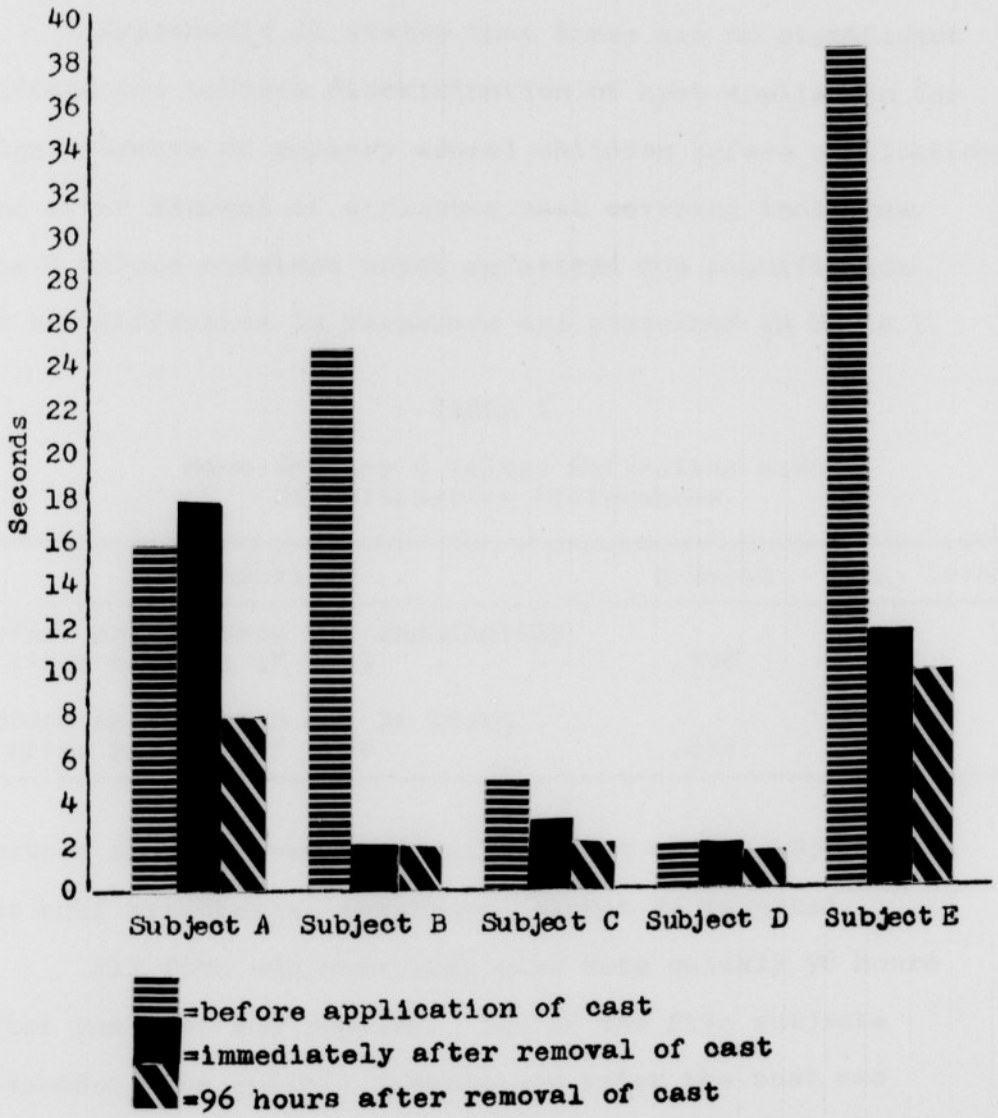

FIGURE 2

Responses to Heat Stimulus

lapse from exposure to the heat stimulus until the subject verbally reported discrimination of heat.

Hypothesis II states that there are no significant differences between discrimination of heat applied to the right forearm of nursery school children before application and after removal of a plaster cast covering that area. The U values obtained which reflected the significance of the difference in responses are presented in Table 2.

TABLE 2

Mann-Whitney U Values Reflecting Heat Discrimination Differences

Comparison	U Value	Sig. Level
Before application and immediately after removal of cast	.548	
Before application and 96 hours after removal of cast	.222	

Neither of the U values is significant at the .05 level; the null hypothesis, therefore, cannot be rejected.

All five subjects responded more quickly 96 hours after the cast was removed. Two of the five subjects responded less quickly immediately after the cast was removed. The response of one subject was the same before and immediately after. Two of the five subjects responded more quickly immediately after the cast was removed.

Hypothesis III states that there are no significant differences between discrimination of texture applied to

the right forearm of nursery school children before application and after removal of a plaster cast covering that area. The data from the texture discrimination test could not be analyzed statistically, but an observational analysis was made.

In examining the data from the texture discrimination test, the experimenter realized that the subjects had been asked to discriminate between degrees of roughness; there was no absolute for the smooth texture, and the experimenter felt that this was too subjective a type of response to expect from nursery school children. The data were then re-examined, comparing only the responses made to the two extremes in texture.

The experimenter kept a record of behavior of the subjects during the testing procedure. Subject B seemed unusually curious about the testing procedure. This subject did not appear to be giving the same degree of attention to the perceptual responses to texture as the other subjects. On the basis of this behavior, Subject B's responses to the texture discrimination test were excluded from further consideration.

Subject A was the youngest subject of the group, 3 years 5 months. The responses given in the texture discrimination test, rough for the smoothest texture and smooth for the roughest texture, cast doubt on the ability of this subject to verbalize responses accurately.

Subject A's responses were excluded from consideration in the texture discrimination test on the basis of inability to verbalize responses accurately.

The observational analysis of the texture discrimination test data was done for three subjects. The responses of these three subjects are shown in Table 3.

TABLE 3

Responses to Texture Discrimination Test

	#400 Sandpaper (smoothest)			#50 Sandpaper (coarsest)		
	1	2	3	1	2	3
Subject C	S	S	S	R	R	R
Subject D	S	S	S	R	R	R
Subject E	S	S	R	R	R	R

1=subject's response prior to application of cast
2-subject's response immediately after removal of cast
3=subject's response 96 hours after removal of cast

R=perceived as rough
S=perceived as smooth

The three remaining subjects, C. D, and E, were able to report verbally discrimination between degrees of roughness when the stimuli were the extremes in texture. With the exception of one response of the 18 responses, there were no variations. This variation was the response of Subject E in the test done 96 hours after removal of the cast. At this time Subject E perceived the smoothest sandpaper to be rough. From this sample of three, a

tentative conclusion was drawn that there was no change in texture perception following a tactually depriving experience.

An examination of the five comment sheets returned by the mothers revealed the following comments: (1) three subjects commented that there was itching of the skin under the cast; (2) three subjects commented that the cast hurt; and (3) two subjects commented that the area under the cast "felt funny." The experimenter concluded that the evidence lends some support to the premise that tactile sense deprivation causes tactile hallucinations.

The analysis of the data in this study gave some evidence to support the premise that there is a change in acuity of tactile discrimination following a tactually depriving experience. The results were significant in the comparison of responses to pressure before application and immediately after removal of the cast. The null hypothesis stating no difference in tactile discrimination of pressure applied to the right forearm of nursery school children before application and immediately after removal of a plaster cast covering that area was rejected. The other null hypotheses could not be rejected on the basis of data obtained in this study. Further testing is suggested.

CHAPTER V

SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Summary

The purpose of this investigation has been to determine whether there is any difference in tactile discrimination of nursery school children before and after tactile sense deprivation. Instruments were developed to assess tactile discrimination of pressure, heat, and texture. Six children, three males and three females, served as subjects in this investigation. The subjects ranged in age from 3 years 5 months to 5 years 7 months. All were enrolled in the 1967 summer session of the Nursery School of The University of North Carolina at Greensboro.

Each subject was tested for tactile discrimination of pressure, heat, and texture on a specified area of the right forearm. Tactual deprivation was accomplished by the application of a plaster cast to the right forearm of each subject. The cast extended from below the elbow to above the wrist. Each subject wore the cast for 48 hours. The testing procedure was repeated immediately after the removal of the cast and again 96 hours after the removal of the cast. The data collected depended upon the verbal responses made by the subjects to the heat, pressure,

and texture stimuli before the cast was applied, immediately after the cast was removed, and 96 hours after the cast was removed.

One subject exposed the testing site by softening and moving the cast. This subject's responses were not included in any of the analyses. The responses of two other subjects to the texture discrimination test were excluded from consideration on the basis of inattention and inability to verbalize responses accurately.

The Mann-Whitney U Test was used to test the hypotheses that there are no significant differences between discrimination of pressure and heat on the right forearm of nursery school children before application and after removal of a plaster cast covering that area.

The only statistically significant difference was in the response to pressure stimulus before application and immediately after removal of the plaster cast. The U value for this comparison was significant at the .05 level. Three of the five subjects were more discriminating of pressure immediately after the cast was removed.

The texture discrimination test responses were not of such type that they could be statistically analyzed. A limited observational analysis did not reveal any evidence that would indicate a change in the ability of the subjects to discriminate texture before application and after

removal of a plaster cast.

Discussion

The increased ability of the subjects to perceive pressure on an area which had been deprived of tactile stimulation found in this study was in agreement with the findings of Aftanas and Zubek (1963). The absence of any significant change in perception of heat following the tactually depriving experience was also the same as found by Aftanas and Zubek (1963). The subjects' sensations of itching or "feeling funny," which the mothers recorded on the comment sheets, showed some agreement with the hallucinatory responses reported by Bexton, Heron, and Scott (1954) and by Heron (1961).

Recommendations

It is recommended that:

1. This study be replicated using a larger sample,
2. The texture discrimination test be revised to require discrimination of two textural extremes only,
3. The subjects be allowed to experience textures on a homologous area of the body during the pre-test instruction period,
4. An older age group be used for subjects,

5. The tests be repeated at each testing session after a waiting period of from 5 to 10 minutes so that there are two sets of responses for each subject under each condition.

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APPENDIX A

LETTER TO SUBJECTS' PARENTS

COPY OF LETTER SENT TO SUBJECTS' PARENTS

Dear Mr. and Mrs. _____:

Dr. Barbara James, of the Department of Child Development faculty at The University of North Carolina at Greensboro, and Mrs. Marjorie Anderson, R.N., Master's Degree candidate in Child Development, are currently engaged in a research project which is designed to (1) assess the tactile discrimination level of young children and (2) determine the effects of limited stimulation on the tactile discrimination level.

We are at present asking young children in the age range of from 3 to 5 years to participate in this project. The procedure involves the assessment of the tactile discrimination level of each child. The child is asked to report what he feels when the right forearm is tactually stimulated. A light plaster bandage is then placed on the right forearm and left in place for 48 hours. This plaster bandage will be applied by Dr. Eulyss Troxler, a local orthopedist. Another assessment, using the same technique, is then made after the bandage is removed. The only restricting feature of this procedure is that the bandage must stay as dry as possible during the 48-hour period.

We would like to ask your cooperation in allowing _____ to take part in our research project. July 5 has been set as the day for the application of the plaster bandage. The bandage will be removed on July 7.

If you have any questions concerning this research, please feel free to contact me at 275-6806.

We do appreciate your cooperation. Please sign your name to the attached sheet and return it to the Nursery School Director.

Sincerely,

Marjorie Anderson, R.N.
Master's Degree Candidate, UNC-G

Helen Canaday, Director
Nursery School

APPENDIX B

TESTING MATERIALS AND PROCEDURES

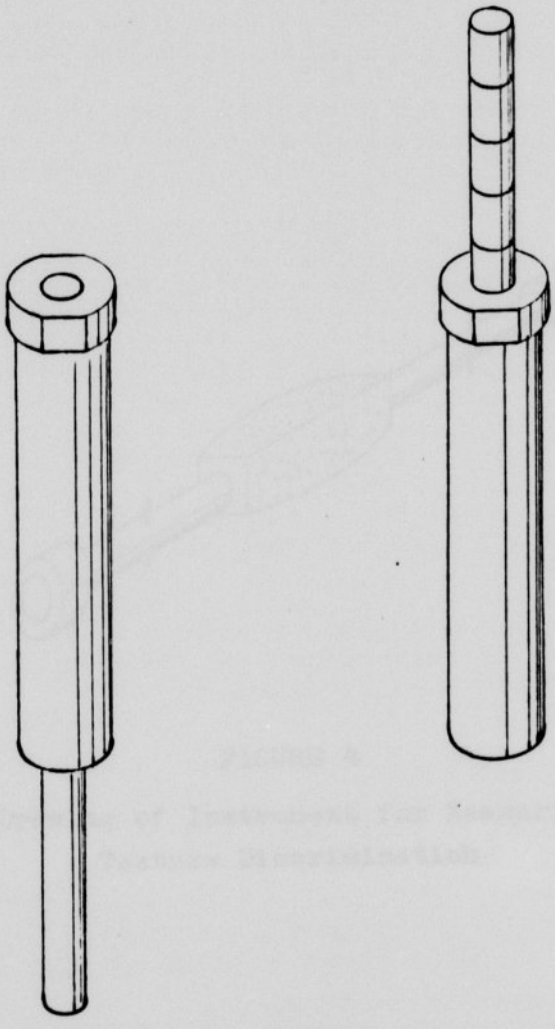

FIGURE 3

Drawing of Instrument for Measuring
Pressure Discrimination

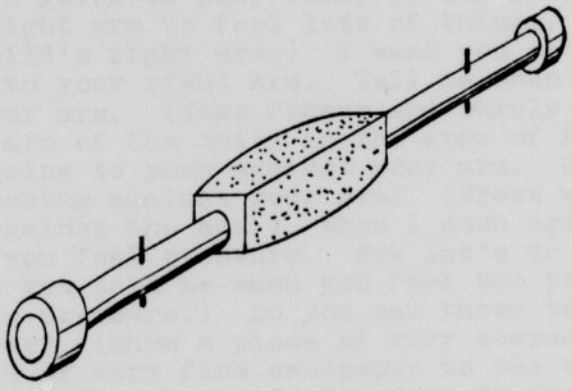

FIGURE 4

Drawing of Instrument for Measuring Texture Discrimination

DIRECTIONS FOR TACTILE DISCRIMINATION RESEARCH

1. Measure arm. Have child's palm up , with upper arm near his body; measure one-half the distance between the wrist and the elbow; with a felt-tipped marking pen, make dot and then measure 1 inch from dot toward elbow and mark, and 1 inch from dot toward wrist and mark. (Talk with child about anything except experiment during this time.)

2. Pre-test instructions to child. _____, the game we are going to play today is one in which you use your right arm to feel lots of things. (Point out the child's right arm.) I want you to watch what I do to your right arm. Tell me when my finger touches your arm. (Take finger and barely touch the right arm of the child in the area of the dot.) Now I am going to push against your arm. Do you feel me pushing against your arm? (Press with medium pressure against the arm.) When I push against your arm, you feel pressure. Now let's do that again, and you tell me when you feel the pressure. (Repeat the pressure.) Do you see these two pieces of sandpaper? (Show a piece of very coarse sandpaper and a piece of very fine sandpaper to the child.) Now tell me how each one feels--does it feel rough or smooth? (Allow the child to touch samples and make the judgment.)

3. Experiment. Now, _____, I want you to put your arm in the door of this house I have set up here. Mrs. Anderson is on the other side of this house, and she will be talking to you about what you feel on your arm.

   a. Your arm feels nice and cool, _____. I want you to tell me when it feels warm.

   b. Tell me, _____, do you feel something on your arm? Please say "now" when you feel me push against your arm. Say "now" when you feel the pressure.

   c. _____, do you feel something on your arm? When I move the toy back and forth across your arm, tell me if it feels rough or smooth.

      (1) Does it feel rough or smooth?
      (2) Does it feel rough or smooth?
      (3) Does it feel rough or smooth?
      (4) Does it feel rough or smooth?

COPY OF COMMENT SHEET

Please record any comments made by your child concerning feelings about the plaster bandage.

Date	Time	Comment