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Conditioned Sucking in Infants
With the Nonorganic Failure
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CONDITIONED SUCKING IN INFANTS WITH THE NONORGANIC FAILURE TO THRIVE SYNDROME

By

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ABSTRACT

CONDITIONED SUCKING IN INFANTS
WITH THE NONORGANIC FAILURE
TO THRIVE SYNDROME

By

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The nonorganic failure to thrive syndrome is a serious pediatric problem which is usually diagnosed when an infant is below the third percentile for weight and no organic reason for growth failure can be found. Typically the infant will show a marked decrease in weight or failure to gain weight, often accompanied by problematic feeding behaviors, including atrophy of effective sucking. Deficits in cognitive, affective, and physical functioning are usually present.

The etiology of this syndrome has usually been attributed to maladaptive mother-infant transaction. Mothers of these infants are often unable to appropriately meet their infants' needs, while the infant may introduce such factors as biobehavioral irregularity into the transactional situation. Maternal and infant behaviors influence each other and soon escalate, resulting in a frustrating feeding relationship.

Intervention has usually emphasized psychotherapy

and education for the mothers of these infants, with limited success. In contrast, based on previous studies which demonstrated that infant sucking can be modified through operant procedures, the present study focused on enhancing infant sucking through operant procedures. A computer-assisted instrumentation system was developed that analyzed the topography of infant sucking and delivered visual and/or auditory reinforcement. It was hypothesized that this operant intervention should increase sucking effectiveness and food intake. The long term objective was to break the escalating pattern of maladaptive transaction in the feeding situation.

Operant conditioning was only moderately successful in modifying certain indices of sucking for certain infants. It appears that the primary factors that influenced the success of conditioning were the infants' atypical biobehavioral states and certain procedural factors.

Future research needs to focus on modifying the conditioning procedure. It is also important to investigate the relationship between infant variables and response to conditioning. Finally, long term outcome studies need to be conducted to determine the critical environmental and psychosocial influences on nonorganic failure to thrive infants and determine the effects of this type of intervention.

To Andrew....who has taught me that
the greatest gift is a
loving heart

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CHAPTER 1

INTRODUCTION

The nonorganic failure to thrive syndrome has been noted in the pediatric and psychological literature since the early 1960's and is estimated to account for one to five percent of pediatric hospital admissions (Levine, 1978). Nonorganic failure to thrive usually is diagnosed when an infant is below the third percentile for weight, as related to height, and no organic factors such as cystic fibrosis or gastro-intestinal abnormalities can account for the weight loss (Hannaway, 1970; Garfunkle, 1977; English, 1978; Holmes, 1979). Typically, the infant will show a marked decrease in weight or failure to gain weight, often accompanied by excessive spitting up and/or diarrhea, as well as difficult feeding behaviors, such as lethargy or refusal of the nipple. Atrophy of effective sucking, in terms of amplitude and frequency, is usually prominent. For infants who do not die from malnutrition or secondary infection, there usually are serious physical, intellectual and emotional sequalae. Followup studies indicate later intellectual impairment, behavior disorders, and recurring medical problems (Glaser, Heagarty, Bullard, and Pivchik, 1968; Elmer, Gregg, and Ellison,

1969; Fitch, Cadol, Goldson, Wendell, Swartz, and Jackson, 1976; Pollitt and Eichler, 1976; Hufton and Oates, 1977). It is evident that nonorganic failure to thrive is a life-threatening disorder with serious implications for future functioning.

The etiology of the nonorganic failure to thrive syndrome has been linked to the psychosocial environment of the infant, in particular, the mother-infant relationship. Both mother and infant bring certain behaviors into the relationship that influence the success of feeding. The most common observation is that environmental stress and maternal personality characteristics result in maladaptive nurturing behaviors. Infants may introduce into the feeding situation factors such as biobehavioral irregularities or initially weak sucking. Maternal and infant behaviors influence each other and soon escalate, resulting in a frustrating, ineffective feeding relationship.

Intervention usually has emphasized psychotherapy and education for the mothers of nonorganic failure to thrive infants. The success of such mother-oriented interventions is related to the severity of her psychopathology. In contrast, the present study focused directly on the nonorganic failure to thrive infant. Specifically, this research involved the development of operant conditioning procedures designed to facilitate

sucking in the nonorganic failure to thrive infant. It was hypothesized that facilitating sucking would increase food intake, thus enhancing the infant's growth. It would also serve to interrupt the escalating cycle of maladaptive feeding by reducing the aversiveness of the feeding situation and implementing more adaptive feeding behaviors. Other possible benefits included a reduction in apathy and increased interest in the environment, which might enhance cognitive, social and affective development. Another objective would be to encourage more satisfactory mother-infant transaction.

An operant procedure also has certain advantages in terms of research and intervention. Most importantly, it can take into account individual differences among infants, thus allowing intervention to be tailored to the needs of each child. Such a model allows for a precise evaluation of the effectiveness of the intervention.

There were two primary goals for the present research program. One was the development of an intervention directed at the nonorganic failure to thrive infant. The second goal was the development of a data base of the behavior, learning, and development of infants with this syndrome. Such a data base is important in furthering understanding of the nonorganic failure to thrive syndrome and will thus facilitate future

research and intervention programs.

CHAPTER 2

REVIEW OF NONORGANIC FAILURE TO THRIVE LITERATURE

Etiology

Environmental factors

Many investigations of nonorganic failure to thrive, either in whole or in part, focus on the presence of environmental factors. Such factors as marital strife, lack of family intactness, erratic living patterns, financial stress, presence of an alcoholic in the family unit, many and closely spaced children, poor housing, and low socioeconomic status (SES) have been widely suggested (Elmer, 1960; Patton & Gardner, 1962; Bullard, Glaser, Heagarty and Pivchik, 1966; Barbero & Shaheen, 1967; Togut, Allen and Lelchuck, 1969; Koll, 1969; Kerr, Bogues, and Kerr, 1978).

Although these factors are well documented, there is surprisingly little empirical evidence to indicate that they differentiate between the environments of failure to thrive infants and other infants. Most studies draw their samples from urban, predominantly lower SES areas, where such environmental factors are common. Few studies have sampled higher SES groups, although failure to thrive is found in all SES groups

(Elmer, 1960; Patton & Gardner, 1962; Leonard, Rhynes, and Solinit, 1966). Family disruption and/or environmental stress accounts for only a small portion of the variance associated with factors contributing to nonorganic failure to thrive. For example, many families of nonorganic failure to thrive infants are not as environmentally stressed as has been assumed (English, 1978). Glaser et al. (1968) report that growth failure is not consistently associated with poverty, family disruption, or large families. Moreover, few studies of nonorganic failure to thrive infants have included both a reference and a comparison group. Among those that have, few report demographic differences (Pollitt, Eichler and Chan, 1975; Kerr et al., 1977, Vitze, Falsey, O'Connor, Sandler, Sherrod, and Altemier, 1980). Thus there is little evidence to support the contention that global environmental variables, such as stress, account for the occurrence of nonorganic failure to thrive. Nevertheless, it is necessary to take such factors into account when considering interventions designed to remediate the nonorganic failure to thrive situation. Environmental factors need to be viewed as working synergystically with other factors in the development of nonorganic failure to thrive.

Maternal history

Chronically disruptive histories of mothers of nonorganic failure to thrive infants are reported widely (Leonard et al., 1966; Fischoff, Whitten and Petit, 1971; Pollitt et al., 1975; Kerr et al., 1978; Vitze et al., 1980). Such stressful factors as alcoholism or psychiatric illness in their nuclear families, financial and emotional deprivation, and violence in the home during their upbringing are cited. Many mothers report that their childhoods were marked by loneliness and sadness. However, no specific events are regularly found in the histories of these mothers. Even in the few studies that used comparison groups, no specific historical variables consistently have differentiated mothers of nonorganic failure to thrive infants from mothers of normal infants. Although it appears that most mothers of nonorganic failure to thrive infants had chaotic childhoods, the fact that this might be confounded with low SES must be taken into account.

Maternal personality characteristics

The partial or primary focus of many studies has been to look for constancies in the personality characteristics of mothers with nonorganic failure to thrive infants. Elmer (1960) interviewed mothers of nonorganic failure to thrive infants and was not able to find

overall similarity in their personalities. However, almost all mothers were psychologically and environmentally stressed. They displayed a tendency to react to stress by either depression and despair or by ineffectual acting out. Overall, the mothers of nonorganic failure to thrive infants, while presenting a diverse assortment of personality characteristics, were ineffective in their ability to cope with stress. However, these mothers fared better with other siblings, suggesting a maladaptive interaction between mother and infant that was specific to that dyad. Mothers of nonorganic failure to thrive infants appear to be "unwilling mothers," who have an urgent need to be cared for themselves. For example, Leonard (1960) reported that mothers of nonorganic failure to thrive infants demonstrated a general inability to assess their infants' needs as well as their own. They easily became overwhelmed by stress, in particular pregnancy and child rearing, and despaired rather than coped. Togut (1969) stated that these mothers were particularly needy and deprived. They had a propensity for acting out that could only be controlled at the expense of encroaching on their intellectual functioning. The needs of these women severely hampered their interactions with others. Kerr et al. (1978) suggested two different maternal personality types involved in this syndrome,

"apathetic-futile" and "impulse-ridden." Mothers described as "apathetic-futile" seemed absent-minded, and at times, hostile, when interacting with their infant. "Impulse-ridden" mothers demonstrated behaviors ranging from rejection to overstimulation. Although these mothers may demonstrate dissimilar parenting behaviors, both types displace blame, cope poorly, and have difficulty seeing the results of their actions.

Bullard et al. (1966) and Fischoff et al. (1971) suggested the presence of a character disorder in the mothers of nonorganic failure to thrive infants. Fischoff et al., through intensive psychiatric interviews with mothers, concluded that a large percentage of the mothers of nonorganic failure to thrive infants (10 of 12 in the Fischoff et al. study) manifest a number of characteristics suggestive of a character disorder: 1) disturbed early childhood histories, 2) poor performance in current day-to-day activities, 3) behavior on initial contact indicative of fairly severe pathology, 4) desire for an anaclitic relationship with an intense need to be taken care of, 5) literal, concrete thinking patterns with a limited capacity for abstraction of planning for the future, 6) the use of denial, isolation, and projection as major mechanisms of defense, and 7) a predisposition to action or acting out as opposed to thought. Fischoff et al. suppose that

these personality features would not be conducive to adequate mothering. In particular, he cites the mothers' limited ability to accurately assess the environment, their own needs or the needs of their children or to adapt to changes in the environment.

However, Vitze et al. (1980) in a prospective study of nonorganic failure to thrive, found no differences in maternal attributes between a group of mothers whose infants later failed to thrive and a comparison group. This contradicts the literature relating deviant maternal behavior to nonorganic failure to thrive. Vitze et al. suggest that because measurements of maternal attributes were made before the infants were diagnosed, they were not subject to a "search for pathology." In addition, the inclusion of an appropriate comparison group drawn from the same population probably accounts for their conflicting results. Drotar, Malone, and Negray (1981) also indicate the need for appropriate comparison groups in studies of nonorganic failure to thrive etiology and suggest that the role of maternal personality characteristics receive more careful treatment.

In summary, while some studies have found that mothers of these infants have certain characteristics that may predispose them to poor mother-infant interaction, it is apparent that prospective studies with

comparison groups might more accurately assess the role of maternal personality characteristics.

Mother-infant transaction

The previously discussed studies suggest that mothers of nonorganic failure to thrive infants may have personality characteristics that predispose them to having poor interactions with their infants. There appears to be general support for the description of the mother-infant relationship in the nonorganic failure to thrive syndrome as unsatisfying and maladaptive. However, although many discussions focus on the mother's role, it is important to note that the mother-infant relationship is reciprocal and may be unique to each particular dyad. This is especially apparent when a nonorganic failure to thrive infant has several normally developing siblings. The complexity of the problem can be addressed by Sameroff and Chandler's (1976) transactional model, which stresses the reciprocity of the infant and environment, especially in terms of synchrony. Transactions may fail because of interferences stemming from either or both members of the dyad.

Leonard et al. (1966) draw attention to two theoretical assumptions related to the reciprocal nature

of the dyad in nonorganic failure to thrive. First,

> motherhood is a developmental phase which is activated by pregnancy and the birth of a child. The adequcy and resourcefulness of this developmental stage is multiply determined by the mother's previous experiences as well as by the way in which her resources are nurtured or depleted during the successive phases of motherhood. (Leonard et al., 1966, p. 608)

Second,

> mother and infant are reciprocally and progressively influenced by each other's actions and attitudes. It follows that the developmental characteristics of the infant which would lead to maternal-infant difficulties cannot readily be separated from those which may be caused by such difficulties. (Leonard et al., 1966, p. 608)

Leonard continues by stressing the importance of the feeding situation as a shared experience.

English (1978) also notes the importance of viewing nonorganic failure to thrive as a transactional problem. He states that nonorganic failure to thrive infants have difficult or disturbed feeding behavior, as do Glaser & Heagarty (1968), and Pollitt & Eicher (1976). Nonorganic failure to thrive infants may fight the feeder, spit, vomit, have poor appetites, and sleep through feedings. Even nurses and other professionals report that these infants are extraordinarily difficult to feed. An infant with initial feeding problems, or a tendency for them, when paired with an insecure mother with limited coping ability may cause a

"temperamental clash". Insecure mothers simply may not be able to sustain an involvement in the feeding of their infant. This especially is striking in families where other siblings are feeding and growing normally. However, in a prospective study, Vitze et al. (1980) found no neonatal differences between infants who were later to become nonorganic failure to thrive and a group of comparison infants. However, infants in the first group were lighter in weight at birth and had shorter gestational ages. While Vitze et al. looked at a range of neonatal behaviors, they did not focus on feeding or other biobehavioral measures related to feeding.

Other reports indicate that the mother may behave differently with the nonorganic failure to thrive infant than with previous children (e.g. Leonard et al., 1966). This may be due to the added stress an additional child produces, or the special emotional meaning that the nonorganic failure to thrive child has for the mother and family.

Other behavioral variables besides feeding may be involved in the development of a poor interaction. Ramey et al. (1972, 1975) note the importance of infant vocal response in synchronizing the mother-infant interaction and providing pleasurable feedback to the mother. Ramey et al. note that nonorganic failure to thrive

infants have poor vocal responsiveness. Regardless of the etiology (congenital, environmental), a vocally unresponsive child does not facilitate attention giving in the mother, and may exacerbate her feelings of low self-esteem and insecurity. Such feelings may hamper the development of a synchronized, satisfying relationship that would be conducive to adequate food intake on the part of the infant.

Additional evidence of overall problematic interactions comes from Pollitt et al. (1975) who report that mothers of nonorganic failure to thrive infants have more negative interactions with their infants. Scolding was more common than praise and verbal and physical interaction was less than in a comparison group. Overall, their interactions did not enhance enjoyment or synchrony. In their discussion of abused and neglected infants, Gaensbauer and Sands (1979) point to a variety of distorted affective communications that arise in the infant and lead to disengagement or negative responses in the mother. Two of these, withdrawal (such as inattention or lack of response to being held) or idiosyncratic responses (such as crying to stimulation or play) that are shown by many nonorganic failure to thrive infants, interfere with the interaction by hampering synchrony and causing negative reactions in the mother.

The feeding situation itself is the prototype

of future interactions and attachments. The mother, the infant, as well as the environment all contribute to the success or lack of success in the feeding process. Campbell (1973) suggests a number of factors that may influence the feeding process, including visual, auditory, olfactory, tactile and kinesthetic experiences during feeding, the flow and quality of the nutrient, qualities of the nipple, infant state variables such as hunger and wakefulness, and historical variables in the infant and mother, including the clinical history. Campbell's assumption is that intake is not necessarily lessened by nonattention of the mother, in terms of actual time spent in feeding, but in the often subtle qualities of the feeding process. He cites Thoman et al. (1970, 1971) who suggest that difficulty in feeding may result from mothers "carrying out more actions that do not have to do with feeding, breaking into their partner's sequence of acts, and missing clues necessary to planning their next actions." Campbell suggests that maternal anxiety level may play a prominent role in these behaviors. Skilled nurses, on the other hand, appear to ply the infant with stimulation to make him suck and watch for signs such as satiety, gas, flow of fluid, and state.

Campbell also supports the view that the mother's handling of the infant affects feeding. He found that

primiparous mothers, as compared to multiparous mothers, made more changes while feeding the infant (i.e., bottle in and out of mouth, burping) and their infants spent more time in more irregular sucking patterns. Overall, Campbell's data suggest that subtle changes in handling can produce alterations in food intake. Clinical reports suggest that mothers of nonorganic failure to thrive infants may engage in similar feeding behaviors (University of Delaware, College of Nursing Bulletin, 1978). Wirtz and Pollitt (1980) found that a maternal communication factor and a nutrition factor were both related to infant weight gain at one month.

Recent reports by Drotar (1975, 1981a, 1981b), Drotar, Malone and Negray (1979, 1980), and Drotar, Malone, Negray and Dennstedt (1981) focus on the interaction of familial and infant variables in the development and maintenance of nonorganic failure to thrive. According to the reports, infant growth problems often reflect a dysfunctional mother-infant relationship. Disturbance in mother-infant interaction may vary in degree of severity, ranging from interactional problems that affect feeding only to those affecting infant's emotional development as a whole. The way in which the family copes with life stress exerts a strong influence on the mother-infant relationship. Whereas the life histories of mothers influences their

ability to nurture an infant, problems in parenting must be studied in the framework of the present family structure and environmental factors. Mother-infant interaction is not viewed as inflexible, but as changing within the transactional context of the family. Stresses within the family unit may interfere with the mother's ability to respond appropriately to the needs of the infant, disrupting patterns of feeding and nurturing. Drotar (1981a) states:

> ...these early distress-filled parent-infant relationships lead to feeding conflict, the infants' spitting up and inconsistent food intake. As a consequence, mother and infant do not learn that pleasurable signals are forthcoming from one another, that their communications are needed, or that their partners' responses are contingent on what they do. As this vicious cycle continues, mutual arousal and excitement can become progressively dampened and interactions less frequent. In turn, this lowers the infants' goal directedness, and deprives both mother and infant of further opportunities for social interchange and mutual learning. Eventually, compromised nutrition contributes to this cycle. The mother and other family members become more helpless and eventually 'turn off' their response to their infant. (Drotar, 1981a, p. 11)

Intervention Strategies

Primarily directed to the caregiver

The nonorganic failure to thrive literature contains little mention of intervention strategies directed toward either the mother or infant. Most reports suggest focusing the intervention solely on the mother and her behavior, relying on changes in her behavior to positively affect the infant. However, recent reports by Drotar (1979, 1980, 1981) focus on intervention in a family context. He stresses that an effective care plan must take into account dysfunctional behaviors within the family that interfere with adaptive mother-infant transactions. While the focus of hospitalization in nonorganic failure to thrive may be on the treatment of physical disease, psychosocial treatment must be integrated with medical care. Drotar's discussion of the role of the psychologist in pediatric settings suggests ways in which an interdisciplinary approach can be developed. In brief, his treatment plan for families of nonorganic failure to thrive infants stresses decentering the focus of intervention from the mother, focusing on future behavior change rather than past errors, using family members as resources to enhance infant functioning, and strengthening the family with outside resources when needed.

Several authors suggest strategies for working with mothers and families of nonorganic failure to thrive infants. Multi-level intervention is important: the mother, infant, and family should be involved with several community services, such as visiting nurses, parent aides, and general financial services. These multiple interventions both increase the support for the family as well as act as moderators of the infant's progress after discharge from the hospital. In addition, the approach of hospital staff and outside interventionists must be supportive and nonaccusatory. In brief, professionals must seek an alliance with the mother and family. The goal of all intervention should be to bolster maternal esteem and confidence and alleviate maternal guilt. Lastly, intervention should have an educational focus. It is important to teach about child development and parenting skills, as mothers and families are often lacking in this knowledge. This can be included as part of hospitalization as well as on an outpatient basis (Corcoran, 1978, University of Delaware, College of Nursing Bulletin).

Primarily directed at the nonorganic failure to thrive infant

Ramey, Starr, Pallas, Whitten, and Reed (1975) were particularly interested in the relationship of

response-contingency to the nonorganic failure to thrive syndrome. They hypothesized that failure to thrive infants may be exposed to inadequate amounts of response-contingent stimulation (stimulation which the infant controls through his own response) in the home environment. They suggest that mothers of failure to thrive infants may be understimulating, or may not be able to provide experiences for the child in which he learns that he can affect the surroundings. The lack of response-contingent stimulation may result in apathy and feeding problems (i.e., withdrawal, inability to establish reciprocal processes with the mother).

Ramey and his associates implemented an intervention program consisting of three parts. The first part was an operant conditioning procedure (response-contingent) designed to increase the rate of non-crying vocalization. The ability of an infant to control the onset and duration of a visual stimulus through the production of non-crying vocalization was an indication of the infant's mastery of a contingency. This ability was tested at specific points over the course of the intervention program. It was designed also to increase positive behaviors in the infant, facilitating mother-infant interaction. Ramey, Heiger, and Klisz (1972) previously had developed this procedure and demonstrated that failure to thrive infants could increase their

rate of non-crying vocalizations, though at a slower rate than normal infants, using an operant procedure. Second, an in-home feeding program was designed in which nutritionally adequate food was delivered to the infant's home three times a day. Third, a one-hour per day, in-home tutoring program by a "child development specialist," was conducted. This program provided a curriculum that focused on promoting experiences in which the child could control external stimulation. There were specific tasks in four areas; language, gross motor activity, exploratory behavior, and social development. Only the experimental group received the response-contingent training through the in-home program.

Ramey et al. found that "both the quality of nutrition and the opportunity to receive response-contingent stimulation in a social context contribute significantly to the remediation of developmental retardation." It was found that infants who were exposed to the response-contingent program, in addition to the nutrition program, were more able to master the contingencies in the operant learning situation. All infants (experimental and control) gained weight well exceeding the expected gain for their age. Developmental indices (Bayley Scales) showed that all children were significantly and positively affected by the program, with the experimental group making greater advances in psychomotor

performance.

In summary, this study indicates that failure to thrive infants can respond to developmental and nutritional intervention. Under appropriate conditions, they also can change their behavior in an operant learning situation. The study by Ramey et al. (1975) demonstrates that it is possible to develop a successful intervention program with a primary focus on the failure to thrive infant.

Lipsitt (1978) reports a case study in which feeding was encouraged in a fifteen-month-old girl. Due to a history of medical problems, feeding had become aversive. She refused food completely, and had a feeding tube placed in her abdomen at seven months of age. Using social and auditory reinforcement (praise and a music box), Lipsitt and his colleagues were able to wean the child away from the tube in the span of a few weeks. This suggests great potential for intervention at the level of the infant and the effectiveness of operant conditioning with this type of problem.

CHAPTER 3

A RESEARCH PROGRAM FOR NONORGANIC FAILURE TO THRIVE INFANTS

Overview of the Program

This research/intervention program is based on a number of findings concerning the nonorganic failure to thrive syndrome, which are reviewed in the previous sections. These findings suggest the focus of intervention with this population. First, nonorganic failure to thrive stems from transactional difficulties between mother and infant that are escalating in nature. Thus, intervention must break this maladaptive pattern. Second, nonorganic failure to thrive interferes with the biological mechanisms of feeding in the infant. Intervention must then help regulate and strengthen feeding, and remove the aversive nature of the feeding situation. Third, among nonorganic failure to thrive infants there are a variety of maladaptive behaviors and levels of functioning. Thus, an intervention program must be able to account for individual differences in infant behavior and functioning. Fourth, the most successful intervention has been directed toward the infant, suggesting that this is an effective approach for

intervention. Fifth, most reported interventions have not been subjected to experimental control. Intervention must be designed to evaluate the effectiveness of the intervention employed. Sixth, nonorganic failure to thrive is a life-threatening condition which usually requires hospitalization of the infant. Ideally, then intervention should be implemented in the hospital.

This research involved the behavioral modification of the failure to thrive infant's feeding behavior. Using operant conditioning, in which the infant is rewarded for producing a desired behavior, this research focused on the infant's sucking behavior, a primary component of the feeding process. A detailed description of the operant procedure is presented in the research methodology section.

The major goal of this research was to strengthen the sucking responses of the failure to thrive infant and thereby decrease the frustration and aversiveness associated with feeding. Facilitating sucking should increase food intake, and allow the infant to grow and thrive. With a stronger infant, who is more adept at sucking, the mother can now better learn appropriate methods of helping proper feeding behavior to continue. Although successful feeding should decrease apathy in the infant and promote cognitive development, the initial goal was to bring the infant out of a life-threatening

situation.

In brief, an operant learning intervention, with a focus on sucking, satisfies the assumptions of what a successful intervention program should include. It would help break the cycle of maladaptive transaction between mother and infant; it would focus directly on the failure to thrive infant, it could easily be made to conform to the needs and behavior of an individual infant; and it is amenable to stringent experimental control. It also can be implemented in a hospital setting and is initially directed at removing the infant from a life-threatening situation.

The goals of the present research were twofold: First, to develop and implement an intervention program directed at the nonorganic failure to thrive infant; and second, to develop a data base of behavior, learning, and development in these infants. Such a data base is important in increasing understanding of this syndrome and developing future research and intervention programs.

Review of Operant Conditioning of Sucking Literature

Overview

There is a general consensus that sucking can be altered by reinforcement as early as the newborn period (Fitzgerald and Porges, 1971). Studies of operant

conditioning of infant sucking can be roughly divided into two categories: studies of non-nutritive sucking and studies of nutritive sucking.

Non-nutritive and nutritive sucking are characterized by two distinct patterns in normal infants. In general, non-nutritive sucking is characterized by the presence of bursts and pauses with rapid sucking within each burst, whereas in nutritive sucking the infant sucks at a slower rate but in a continuous pattern.

There is considerable controversy as to whether non-nutritive and nutritive sucking are controlled by the same factors. There has been some question, although not well supported, that different neurological mechanisms may be involved (Wolff, 1966), but the evidence seems to support the idea that the different patterns are shaped by different environmental factors. Dubignon, Campbell, Curtis, and Partington (1969) found no relationship between non-nutritive sucking and the infant's intake of milk. This supports the previous conclusion (Dubignon & Campbell, 1969) that generalization from non-nutritive sucking studies to actual infant feeding behavior is unwarranted. As Dubignon and Campbell suggest, nutritive sucking may be controlled by stimuli provided by the nutritive fluid itself. There is considerable evidence that particular variables of the nutrient such as type and quantity, affect the sucking

of the infant. For example, Kron, Stein, Goddard, and Phoenix (1967), Engen, Lipsitt, and Peck (1974), and Crook (1976) suggest that it may not be valid to create a strict dichotomy of sucking into nutritive and non-nutritive categories. Crook found that by varying the quantity of nutrient delivered, it was possible to change infant's sucking rhythm to conform to either sucking pattern. Burke (1977) suggests that sucking is controlled by swallowing, and that the differences in response when fluid is available are due to the mechanism of swallowing.

Non-nutritive sucking

Operant control of non-nutritive sucking in infants has been demonstrated with both visual and auditory reinforcement. Siqueland and DeLucia (1969) found that both 4-and 12-month-old infants will change the amplitude of their sucking when exposed to a visual reinforcement. Infants rapidly increased the amplitude of sucking when such responses resulted in the presentation of attractive stimuli. In addition, 12-month-old infants demonstrated that operant procedures could be successfully used to re-establish sucking in infants in whom non-nutritive sucking was a weak or non-existent response. In an earlier study, Siqueland and DeLucia (1969) found that 3-week-old infants controlled their

non-nutritive sucking rates when that intensity of a visual stimulus varied directly with the sucking rates. The fact that infants can strengthen their sucking behavior, and can re-establish atrophied sucking behavior, points to the potential usefulness of this procedure with nonorganic failure to thrive infants.

Butterfield (1968) and Siperstein (1973) studied the effects of contingent auditory stimulation on non-nutritive sucking in neonates. Both response amplitude and response rate were found to be affected by contingent auditory stimulation, in the form of melodic music.

Patterns of non-nutritive sucking have been explored as possible diagnostic indicators of mild neurological abnormalities in infants. On the basis of Prechtl's observations of irregular temporal organization of rhythmical motor patterns in neurologically abnormal infants, Wolff (1966) compared the non-nutritive sucking patterns of normal neonates with neonates who had a history of perinatal distress. He found that the distressed neonates had slower and more irregular sucking patterns. In a further elaboration of this theme, Dreier and Wolff (1972) showed that the non-nutritive sucking of normal neonates differed with biobehavioral state. Prechtl, Weinmann, and Akiyama (1969) found similar results in their observations of respiratory and cardiac rates in normal and distressed neonates. These studies

demonstrate that distressed neonates may exhibit irregular patterns of non-nutritive sucking even when there are no outstanding signs of neurological impairment. Infants who usually would not be labeled "high risk," may actually fall into this category because of irregular sucking patterns, as well as other possible behavioral deficits. The differences in temporal organization of these so-called normal infants may strain the infant-caregiver relationship. Dreier and Wolff suggest that non-nutritive sucking may be a useful tool for diagnosis of minimal CNS dysfunction. It is also a useful tool in warning of possible interactional problems between infant and caregiver. In terms of the present research, it is clear that infants, from birth, display distinct and often maladaptive sucking patterns.

Nutritive sucking

The infant's nutritive sucking has also been manipulated within an operant framework. The majority of studies have used the nutrient itself as the reinforcer. Kron (1970) studied nutritive sucking as an indicator of neurological dysfunction, in a manner similar to that used by Dreier and Wolff for non-nutritive sucking. He related individual differences in neonate's ability to adapt to intermittent schedules of nutritive reinforcement to possible minimal neurological dysfunction.

In a similar vein, Dubignon and Campbell (1969) found differences in newborn feeding as measured by intake to be related to a variety of historical and perinatal factors such as length of labor, sedation of mother, birth weight, gestational age, Apgar rating, and maternal parity.

Kron (1967) also studied the role of arousal and learning in the development of environmental control of early feeding behavior. He instituted four types of reinforcement schedules: individualized, arbitrary, variable, and graduated fixed-ratio. The individualized schedule took into account the infant's typical pattern of sucking. Although not all infants adjusted successfully to this schedule, many adjusted rapidly. This individualized schedule can be compared to the "perceptive mother who recognizes the infant's patterns of behavior, accommodates to them, and is rewarded by the infant's vigorous feeding behavior and absence of crying." The other three schedules were much less effective. The arbitrary and variable schedules appeared to be comparable to situations where there is dissonance between the nurturing environment and the infant's feeding behavior. Kron suggests that this tends to thwart development of environmental control and results in unsatisfactory mothering experiences. Infants exposed to these schedules were much less able to adapt their

sucking adequately. The graduated fixed-ratio schedule can be compared to a highly stimulating but ungratifying mother. Infants exposed to this schedule responded by either increasing sucking to a tiring level, or withdrawing. Overall, Kron concludes that successful early mothering involves a

> mutual adaptation in which the nurturing environment approximates and then retrains the infant's feeding behavior by a perceptive manipulation of the infant's state of arousal. Coordination between the infant and its environment sets the stage for associative learning which develops in concert with the development of the infant's discriminative and response capacities. The process of behavioral acquisition begins with unconditioned feeding responses, which are transformed into complex, learned behavior through the mediation of an appropriately reinforcing environment. (Kron, 1967, p. 312)

Kron's individualized schedule approximated this ideal environment-infant interaction. It is interesting to note that there were individual differences in the infant's ability to respond to environmental control and master frustration. Thus, not only are environmental (mothering) variables important, but infant variables are also involved in this mutual, synchronous process.

Hypotheses

The goals of this research were to strengthen the sucking response in nonorganic failure to thrive

infants and to lessen the aversiveness of the feeding experience. The long-term objective of this research is to have the caregiver learn to provide adequate, response-contingent care, once the infant is again feeding and sucking. In the present study, the emphasis was on the development and implementation of an operant conditioning program directed at the nonorganic failure to thrive infant. Although the role of the parent is taken into consideration, the present research focused specifically on infant variables and behavior, with the primary objective of encouraging the infant to suck. The study assessed the effectiveness of conditioning on sucking, as well as other behavioral and cognitive areas.

The following hypotheses were evaluated:

1. Contingent visual/auditory reinforcement will produce significant increases in sucking amplitude and/or frequency.

2. There will be significantly greater food intake in experimental infants than comparison group infants.

3. There will be significantly greater weight gain in experimental infants than comparison group infants.

4. Infants exposed to operant conditioning will score higher on the Bayley Scales, upon discharge, than

comparison group infants.

CHAPTER 4

RESEARCH METHODOLOGY

Subjects

Subjects were infants who were hospitalized at Hurley Medical Center, Flint, Michigan. All infants had a primary diagnosis of nonorganic failure to thrive, which included the following:

1. Weight below the 5th percentile for age, or judged by the attending physician to have a severe deficit in weight gain.

2. Upon full work-up by the medical staff, no organic cause for the infant's failure to gain weight was found.

3. No evidence of severe neurological abnormalities, as judged by the attending physician. In most instances, the pediatricians performed a neurological screening on infants, to further investigate their neurological functioning.

However, the infant did not have to meet a criterion of normal intellectual and motor development, as this would not be expected with a nonorganic failure to thrive infant. Only gross abnormalities, such as indications of cerebral palsy, deafness, or blindness

excluded an infant from the study.

Fourteen infants were involved in the study. Nine of these infants were involved in the phase of instrumentation development. Their responses to the procedures and instrumentation system aided in refining many aspects of the research. Five infants were exposed to standard experimental procedures, as detailed below.

Experimental and Comparison Infants

Infants were selected as either experimental or comparison infants. Both groups of infants received the standard medical and psychological treatment that is a regular part of nonorganic failure to thrive intervention at this hospital. This includes whatever medical procedures are necessary to improve the infant's medical condition and intervention by the pediatric social worker with the family. The pediatric social worker is typically in regular contact with the infant's family, in both a therapeutic and community referral role.

In addition, all infants were assessed for cognitive functioning at certain times during their hospital stay. These procedures are described in detail below.

Only the infants selected for the experimental condition were exposed to the operant conditioning procedure. Comparison infants had measurements made of their nutritive sucking during their hospitalization

and served as an arousal effects comparison group. For these infants measurements of sucking were made on a twice daily basis. In addition, they were exposed to noncontingent stimulation at two points during their hospitalization. Detailed conditioning procedures will be discussed in a later section. Thus, sucking was monitored regularly for all infants.

Apparatus

System components

The instrumentation system (Figure 1) consisted of two primary components. The nutrient delivery system, which consists of the burette, tubing and nipple, provided nourishment in response to the infant's creation of a negative pressure on the nipple. This component of the system followed the general model of the system developed by Kron and Litt (1971).

The second component of the system was the computerized waveform analysis and reinforcement controller assembly, which provided automatic real time analysis of the infant's sucking waveform topography and which also controlled the type and quantity of visual and/or auditory reinforcement.

A strain gauge pressure transducer in conjunction with an associated amplifier and display scope converted the infant's sucking waveforms into electrical signals

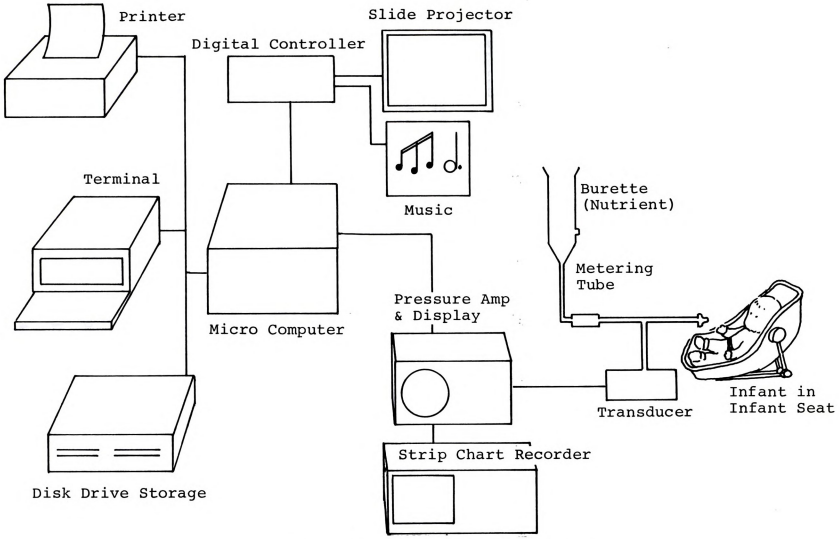

Figure 1: Instrumentation System

which were subsequently digitized and processed by the computer. Topographical characteristics, such as amplitude and frequency were determined and used by the computer in producing the digital signals controlling the reinforcement delivery devices.

The system also functioned as a data base and report generator, providing a summary of an infant's response during a feeding session. Data from previous feeding sessions could easily be reviewed and copied on the system's printer.

User operations

Since the investigator had to devote full attention to the infant's participation and behavior, it was necessary to keep the operation of the instrumentation system simple and non-technical. There were three steps in conducting an experimental phase: (1) assembling the nutrient delivery components, (2) start-up and initialization of the computer system and (3) the actual collection of data.

Using sterile technique, the tubing, burette and nipple were assembled. System start-up and all subsequent interactions were accomplished using the computer terminal. After the identifying and control information, such as infant number, phase and reinforcement types were entered, the operator simply manipulated a 'start/

stop' button to initiate data collection.

All operator interactions were prompted by the computer using a 'question/answer' format, asking the operator for a response to a list of options generated by the computer. A menu was displayed on the terminal screen allowing the operator to choose the next action to be taken. When a conditioning phase was underway, the computer analyzed the sucking waveforms, determined whether or not a criterion amplitude existed, delivered the appropriate reinforcement, determined the sucking wave peak amplitude, and maintained an accurate count of the total number that had occurred. Unless the phase was stopped by the operator, a five minute timer terminated the phase and the data were immediately displayed.

Software

In order to allow for future changes, the computer programs were written in modular format. Each software "module" executed in computer memory as a stand-alone program that communicated with other modules using supportive calls. All software interactions were transparent to the user, thus making the system easy to use and operate. All software modules were written in Fortran and Assembly level languages.

During initial program development stages it was realized that the most critical part of the system would

entail the ability of the computer to analyze sucking waveform data in "real-time", that is, as they occur. As shown in Figure 2, it was required that the computer recognize when an individual sucking wave value reached amplitude criteria so that the proper reinforcement could be delivered almost instantaneously. The process of (1) recognizing the attainment of amplitude criteria, (2) delivery of reinforcement and (3) the updating of the reinforcement counter (number of reinforcements given) had to occur fast enough so that the computer could continue to search for an amplitude peak. The process of identifying a suck peak was simplified using a three point detection scheme, as shown in Figure 3. A simplified explanation involves the following protocol. As sampled waveform data entered the computer, its amplitude value CS was numerically compared to the two previous data values, PS1 and PS2. Note that while the sucking waveform increased, PS2 was always less than PS1, and PS1 was always less than CS. When PS2 was greater than PS1 and PS1 was greater than CS, the slope of the sucking waveform was decreasing; therefore, PS2 was defined as the wave peak.

The success of using this peak amplitude detector was based upon the premise that all sucking waveforms were well-defined, smooth and free of artifact and baseline fluctuations. Use of a hard silicone nipple as

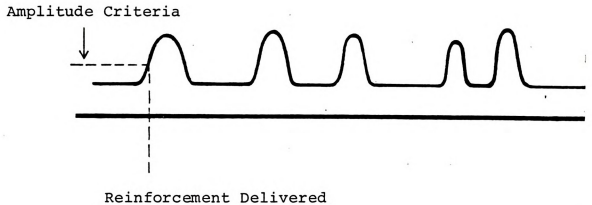

Figure 2: Relationship between sucking topography, amplitude criteria, and reinforcement delivery

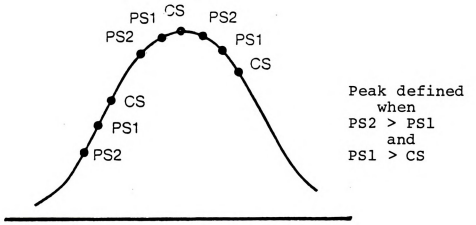

Figure 3: Three-point detection scheme used to identify peak sucking values

described by Kron and Litt resulted in waveforms as exemplified by Figure 4. Analysis of this waveform using the 3 point slope detection scheme worked sufficiently well because of the smooth and consistent nature of the sucking pattern produced. Single peaks existed for each suck and were easily identified. Mouthing, biting and other nipple manipulations by the infant produced no waveform artifacts.

However, use of such a nipple was observed to be stressful to the infants which would make peak identification using this scheme inappropriate for the majority of infants in that they would "fight" or "refuse" to feed from the nipple. It was decided that continual use or attempts to force this nipple on the infants was not desirable when considering the health of these patients.

A means of using a standard, pliable "soft" nipple was developed for use in the nutrient delivery system. The infants willingly accepted this nipple as it closely resembled all previous nipples routinely used in feeding. However, the effects on the resulting waveforms were dramatic in that the sucking patterns no longer resembled the well-defined, smooth patterns previously observed. There was considerable artifact, baseline shifting and varying wave form topographies attributable to use of the soft nipple. Wandering baselines and small fluctuations sometimes occurred during the "plateau" phase of

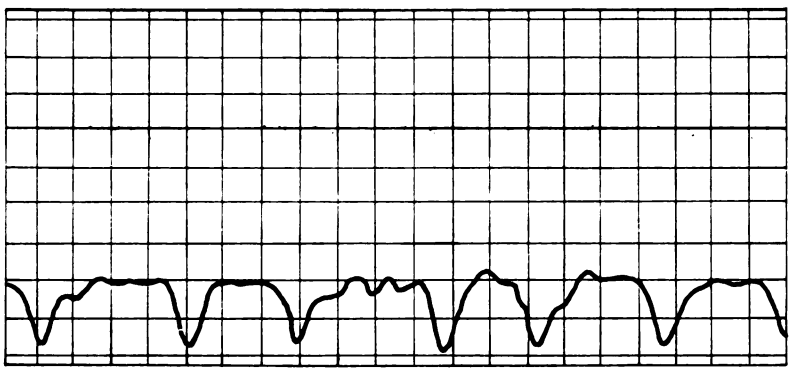

Figure 4: "Hard nipple" waveform

each individual suck. The software analysis technique previously used was unable to properly analyze these observed waveforms.

When the waveforms from the use of the two nipples were compared, a significant observation was made. Waveforms of short duration and varying amplitudes were replaced by sucks of longer duration, but constant amplitudes.

In developing a computer software algorithm for analyzing these patterns, two significant changes were made. The signal waveform filtering characteristics of the pressure amplifier were changed from an upper frequency cutoff of 12 hz down to 4 hz. This reduced the majority of high frequency artifacts previously observed. The three point slope detector was enhanced into a five point slope detection scheme, thus reducing the chances of misinterpretation of proper peaks. Waveform sampling time was increased to 20 mili-second intervals. Baseline differences between individual sucks was compensated for by determining minimum values as well. As shown in Figure 5, subtraction of the previous minimum value from incoming current values allowed for the effects of baseline wander to be minimized. Other criteria, as shown in Figure 6, resulted in an increased ability of the computer to properly analyze sucks for peak values.

Refinements in the software analysis programs

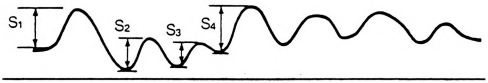

Figure 5: Five-point detection scheme used to identify peak sucking values

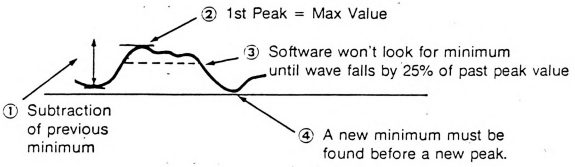

Figure 6: Additional criteria for identifying peak sucking values

allowed for the accurate qualification of peak sucking pressures, using a standard, pliable nipple. The combined hardware and software system now could effectively generate and analyze sucking topography and deliver appropriate reinforcement.

Variables of Interest in Conditioning

The most impressive characteristic of an operant procedure is the potential for evaluating the effectiveness of various procedural factors. The following is a discussion of factors that were evaluated.

Type of Reinforcement

As previously reviewed, both auditory and visual stimuli have been used to reinforce sucking in neonates and older infants. Whereas Ramey et al. (1972) found visual stimuli to be effective in modifying the vocal behavior of nonorganic failure to thrive infants, the apathy and withdrawal of these infants is widely noted. Nonorganic failure to thrive infants commonly tend to scan their surroundings, but may not focus on or similarly engage the visual environment. Therefore, auditory stimuli may be more effective reinforcers for use with a nonorganic failure to thrive infant in that such stimuli may enhance obligatory attention.

In the present study, auditory and visual

reinforcement were presented alternately in an effort to maintain the infant's interest in reinforcement. Auditory reinforcement followed the example of Butterfield (1968) who used melodic "bluegrass" music successfully with neonates. Thus, infants received 2 seconds of music played at decibel levels of approximately 70 db after each desired sucking response. Visual reinforcement consisted of a bright geometric figure, as in Ramey et al. (1972) and Siqueland and DeLucia (1969). Figures consisting of 3-4 colors in either the shape of a circle, triangle, square, or star were used. The figure was changed when habituation was indicated as judged by the experimenter. When an infant showed a decrease in looking at the viewing screen when reinforcement was presented, it was assumed that habituation was occurring. Experimenters were trained to recognize habituation through experience with the nine infants involved in the development of procedures and instrumentation. The basic criteria for habituation was a change in the infant's frequency of visual fixation over a period greater than one minute.

Presence or absence of nutrient

As previously reviewed, infant sucking changes with the availability of a nutrient. Thus, it seemed ideal to reinforce nutritive sucking, which is similar to the "real life" feeding situation and differs significantly from

non-nutritive sucking. However, for certain nonorganic failure to thrive infants, the presence of a nutrient might be so aversive as to impede conditioning. For example, the infant may not suck at all if a nutrient is delivered, or may be so disrupted by the presence of a nutrient that he does not attend to the reinforcement. For such infants, special manipulations of availability of nutrient may be necessary. One alternative may be introduction of a nutrient after acquisition of strong non-nutritive sucking. However, most infants tolerated the presence of nutrient.

Type of nutrient

Two types of nutrients have been favored for infant feeding; sugar solutions and milk formulas. Sugar solutions have an intrinsic reinforcement value for most infants, but the presence of a sugar solution slows the sucking rate. In addition, the use of sugar solution in conditioning may interfere with transfer of sucking to regular feeding, due to "negative contrast effect" (Krobe and Lipsitt, 1972) where milk becomes aversive after experience with sucrose. Because of the importance of transfer between conditioning and "real life" feeding, the goal of increasing rather than slowing sucking, and the severe nutritional needs of the nonorganic failure to thrive infant, milk or

formulas were used as the primary nutrient. Although the option of using sugar solution to prime the unresponsive infant for the conditioning procedure was available, the option was not exercised for any infant in the present study.

Operant Conditioning Procedure

The flexibility of an operant conditioning model and its capacity for adaptation to individual infants was of great significance to the present research. It was expected that every infant would demonstrate unique behaviors and have individual needs that must be considered (Ingram and Fitzgerald, 1974; Fitzgerald and Brackbill, 1976). The research staff followed the general guidelines for conditioning described in previous sections, but relied on clinical judgement to make innovations in the programs of individual infants. These judgements stemmed from the empirical data derived from the infant's response to conditioning as well as clinical observation. However, in most cases it was possible to adhere to the guidelines previously discussed.

Infant sucking in the nonorganic failure to thrive syndrome atrophies in both amplitude and frequency. The overall objective was to increase sucking effectiveness and comfort and interest in feeding. To this end, it appeared that increasing amplitude would have the largest

effect. Thus, the primary objective of the operant procedures was to increase sucking amplitude. The prototypical operant conditioning was as follows.

1. To facilitate description, the term "conditioning session" refers to the experimental feeding which preceded two regular feedings each day. The term "phase" refers to different parts of the conditioning procedure, such as the A and B phases, described below.

2. In terms of nutrient, all infants received the appropriate infant formula, in the amounts generated by the strength of the suck, as in normal infant feeding. The amount varied across conditioning sessions and was recorded throughout the experiment.

3. Because the computer was capable of making very shortly spaced measurements of the waveform of the infant's suck, reinforcement was delivered immediately upon demonstration of a criterion response. This method is superior to taking a measurement of highest amplitude reached during a suck, comparing that with criterion sucking, and then delivering reinforcement. Thus, reinforcement directly followed the demonstration of a suck greater than or equal to criterion level.

4. Reinforcement consisted of a two second presentation of either auditory or visual stimulation, but not both simultaneously as described previously. In the conditioning phases of the experiment, the

specific reinforcer varied from reinforcement to reinforcement. In the noncontingent phases of the experiment, reinforcement was randomly distributed throughout the session.

5. Each conditioning session lasted 10 minutes. During this time period, two 5-minute phases were presented. These were either similar or different phases. If an infant had not mastered a criterion response, that phase was repeated at the next conditioning session. However, only one noncontingent phase was presented between appropriate conditioning phases.

Summary of phases

Baseline

Phase A: Contingent Reinforcement (Frequency Criteria)

Phase B: Noncontingent Reinforcement

Phase C: Contingent Reinforcement (Frequency Criteria)

Phase D: Contingent Reinforcement (Amplitude and Frequency Criteria)

Phase E: Noncontingent Reinforcement

Phase F: Contingent Reinforcement (Amplitude and Frequency Criteria)

Phase G: Contingent Reinforcement (Amplitude and Frequency Criteria)

Experimental infants

The conditioning phases were as follows:

1. Baseline: Infants were placed in the

experimental crib, where measurements of their sucking were made over four 5-minute periods, in two, 10-minute episodes conducted at least 4 hours apart.

2. Phase A: Contingent Reinforcement (Frequency Criteria): Infants were reinforced for sucks that equaled or exceeded the average of their median suck during Baseline. Infants remained in Phase A until they were able to produce this level of sucking at a frequency 50% greater than during Baseline, over a 5-minute period.

3. Phase B, Noncontingent Reinforcement: Infants received the same number and type of reinforcements, presented randomly, as during Phase A, over a 5-minute period.

4. Phase C, Contingent Reinforcement (Frequency Criteria: Infants were exposed to similar conditions as in Phase A. No infant in this study mastered this criterion.

5. Phase D, Contingent Reinforcement (Amplitude and Frequency Criteria): Infants would be reinforced for sucks at an amplitude 10% greater than the criterion response during Phases A & C. An infant would remain in Phase D until criterion response rate was 50% greater than the rate in Phase C. Thus, both amplitude and frequency would be increased.

6. Phase E, Noncontingent Reinforcement: Infants

would receive the same number and type of reinforcements, presented randomly, as during Phase D. However, no infant progressed to Phase E.

7. Phase F, Contingent Reinforcement (Amplitude and Frequency Criteria): This is a repeat of Phase D.

8. Phase G, Contingent Reinforcement (Amplitude and Frequency Criteria): Infants would be reinforced for sucks at an amplitude 10% greater than the criterion in Phase D and F and would remain in Phase G until they are able to produce sucks of this amplitude at a rate 50% greater than the criterion response rate produced in Phase F. Again, both amplitude and frequency are being increased. However, the criterion levels were determined somewhat differently in Phase A and Phase G.

After this phase, noncontingent phases would not occur, but reinforcement would continue until the infant leaves the hospital.

Comparison group infants

The following procedures applied to infants in the comparison group.

1) Baseline. Infants were placed in the experimental crib for 10 minutes prior to the two appropriate feedings each day, throughout their hospital stay. These infants received nutrient as in a normal bottle feeding.

2) Arousal effects baseline: After the initial feeding period, these infants were exposed to noncontingent stimulation during the next feeding period and on the third day of hospitalization. The level of noncontingent stimulation was equivalent to the median level of noncontingent stimulation received by the first three experimental infants during Phase B. This provided a measure of the effects of stimulation per se on infant sucking rates.

Of course, many variations on the conditioning procedure are available. Type of reinforcement, length of presentation, criterion levels, and length of phases, as well as other factors may be manipulated. Nevertheless, such parametric manipulations were not attempted in the present study.

Measures of Facilitation of Infant Development

As previously reviewed, apathy and retardation are characteristic of many nonorganic failure to thrive infants. Many factors may account for this, especially lack of nutrition and weakened physical condition, which interferes with interaction with the environment, especially in terms of motor abilities. Lack of nutrition also inhibits neurological development. In addition, the literature also suggests that lack of

response-contingent stimulation may contribute to apathy and retardation characteristic of the nonorganic failure to thrive infant. The following measures assessed changes in the physical, cognitive, and affective areas and were given to all infants at the onset and termination of their participation in the research program.

Bayley Scales of Infant Development

This is a well-documented measure of infant development (Bayley, 1969; Osofsky, 1979) and is capable of measuring developmental changes, especially in the motor area, in infants as young as two months.

Measures of behavior related to actual feeding

The transfer of the strengthening of sucking during conditioning to actual feeding was a goal of this intervention. This was assessed for all infants. In a hospital setting, this can be best measured by the following:

Amount of intake. This was obtained from the nurse's notes in the infant's chart. Amount of intake was recorded for all feedings for both experimental and control infants, and for all experimental sessions.

Weight of infant: Infants in Hurley Medical Center routinely are weighed daily, and thus weights were recorded for both groups of infants.

Collection of infant biobehavioral and historical data

Collection of detailed infant biobehavioral and historical data was important for several reasons. First, it seemed important to have knowledge of the infant's course in the hospital both to determine if any particular factor might have influenced sucking at any particular time, and to chart the course of behavior change throughout hospitalization. Second, routine, continuous observations of infant behavior are lacking in the nonorganic failure to thrive literature. Historical data will allow a better understanding between past and present functioning.

Data were derived from two sources: daily biobehavioral records and a historical summary, including a measure of maternal perceptions of the infant derived from Broussard. These data records are described in the Appendix.

Data Analysis

The data base included the recorded topography of infants sucking over time as well as measurements of historical, physical, and developmental variables. Data can be analyzed using a variety of descriptive and inferential statistics but the number of subjects in the present study was not adequate for statistical

analysis. However, it is expected that an adequate number of subjects will be obtained in the next 18 months.

Thus, data in the present study were analyzed on a single case basis. Sucking data were examined for changes over time and the relationship between historical and behavioral factors was explored. When an adequate number of subjects are included (approximately 10 experimental and 10 comparison infants) then comparisons between comparison and experimental groups for sucking topography, will be made through the use of difference scores, using an analysis of variance technique.

In addition, group comparisons of physical and developmental outcome measures can be assessed using T-tests when enough data are generated. After data on a large group of infants are collected (N=50), correlational analyses of infant variables with progress in operant conditioning and outcome measures will determine which variables are useful in predicting outcome as well as determining their usefulness in selecting an effective course of operant conditioning.

Human Subjects

The present research stems from a large number of studies which clearly indicate that infant sucking

can be effectively and safely enhanced. Both the operant procedure and the overall design of the apparatus have been shown to be safe and effective in both this study and related research. Because the operant procedure calls for using the infant's interests and capacities to enhance sucking, the possibility of weakening sucking or feeding is virtually ruled out, as demonstrated in the infant's responses to the conditioning procedures. In addition, the infants in the present research were carefully monitored in terms of both physical and developmental progress.

The physician's or parent/guardian's option of removing the infant from the research was an additional safety control.

In contrast to the minimal risks, there were important benefits for participating infants. Experimental infants were involved in an operant conditioning intervention that was especially tailored to each infant's behavior and needs. Because the overall goal of this research was to determine the most effective operant procedures, experimental infants almost were assured a program that would facilitate sucking and development if these infants were capable of learning through operant procedures.

All infants, experimental and control, derived important benefits from participation that would

otherwise not be readily available. Perhaps most significant was the comprehensive developmental assessment, which was very useful in planning other interventions, and helping the physicians, nurses, mental health workers, and parents better understand the child's functioning. In addition, because the infants were carefully monitored in terms of behavior and growth, many subtle, yet significant, observations were made in terms of behavior and growth, which were a good source of information for all parties involved.

The consent form is attached in the Appendix. Also included is the explanation of the study and procedures. In addition to receiving these forms, parents met with one of the research staff to discuss the program and the specific details of the infant's participation. A member of the research staff had daily contact with the parent/guardian to help ensure good communication.

Confidentiality was protected through careful data collection and storage. All infant data were stored using the computer system in the Biomedical Engineering Department. Access to the contents was strictly limited to the principal investigators, through a turnkey system. In addition, all infant names were coded in information storage.

The instrumentation system as shown in Figure 1 was

designed to facilitate the gathering of infant sucking waveform parameters and for the precise control of delivery of reinforcement stimuli without risking patient safety. All components of the apparatus were tested for mechanical and electrical safety throughout the research study.

Facilities Available

Hurley Medical Center is the largest hospital in Genesee County. It is located in Flint, Michigan, an industrial city with a population of approximately 200,000.

Hurley Medical Center has recently opened the Arthur L. Tuuri Pediatric Center, an inpatient pediatric unit. The center has 60 pediatric beds, including a pediatric intensive care unit. During calendar year 1979, there were over 3500 admissions to the pediatric units, covering almost 18,000 patient days. Approximately 2% or over 70 admissions had the primary diagnosis of failure to thrive. Hurley Medical Center is a training hospital for both physicians and nurses, and presently trains 11 pediatric residents.

The Department of Biomedical Engineering has extensive involvement in the Pediatric Unit. Most significant for the present research is the department's expertise in infant monitoring systems, computer

programming and data analysis.

Both the Department of Pediatrics and the Department of Biomedical Engineering have adequate research space, which has facilitated this research. The size of patient rooms, and the availability of conference and consultation rooms on the unit ensured necessary space for data collection and parent contact. The Biomedical Engineering Department has a comprehensive laboratory for equipment construction and maintenance and a specially designed computer center that is climate controlled.

CHAPTER 5

RESULTS

The primary goal of this research program has been the development of an operant intervention to modify sucking and feeding behavior in nonorganic failure to thrive infants. The instrumentation system which is the basis for the operant procedures was described previously. As noted, instrumentation development required the use of numerous nonorganic failure to thrive infants. Developing the instrumentation system in this manner has resulted in a system that conforms to the needs and behaviors of these infants and effectively analyzes sucking topography and delivers reinforcement. Work with these pilot infants also has indicated the diversity of nonorganic failure to thrive infants in the areas of history, development, and behavior. This data base is very useful in beginning to delineate subgroups of nonorganic failure to thrive infants in terms of variables that may affect their responses to the operant procedure. Lastly, but most important, five nonorganic failure to thrive infants have been involved in the conditioning program over their hospital stay. Their response to the operant procedure suggests that such procedures directed at infant feeding may be effective

if certain procedural changes are made.

Certain difficulties were encountered in the use of the maternal perception scale, ("Know Your Baby Scale") derived from Broussard. While the scale items were useful interview questions, the majority of mothers were unable to provide numerical scores in rating their infant's behaviors. As illustrated in the following sections, many parents were poorly educated and often illiterate. Information obtained from this scale as an interview measure is incorporated into the historical and behavioral descriptions of each infant, but numerical scores are not provided. There also were certain difficulties in the administration of the Bayley Scales of Infant Development. As noted in the following sections, age-related Developmental Indexes could not be computed for infants younger than 2 months, who comprised a significant portion of the sample. In some instances, complete Bayley Scales could not be administered, or optimal performances could not be obtained, due to the infant's biobehavioral state, medical state (particularly if the infant was receiving intravenous medication), or lack of parental cooperation. These problems will be noted where appropriate.

First, the types of infants encountered during the past months will be described in Table 1. Then historical, developmental and behavioral information

and conditioning data will be described in a case report format for the five infants mentioned previously.

Descriptive Data - Pilot Infants

Table 1 illustrates the types of nonorganic failure to thrive infants encountered during instrumentation development. As can be seen, there is considerable variability in history, family and environmental variables, and infant behavior. These data suggest that the operant procedures need to be tested on a range of infants, to determine the effectiveness of the intervention on different types of infants. The data also suggest that the manner in which these factors influence the syndrome needs to be determined.

Table 1

Description of Nonorganic Failure to Thrive Infants Involved in Instrumentation Development

T.S.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
3 week old, White female. Incestual relationship with father resulted in this pregnancy. Mother - 16 years old, unmarried, has 34 year old boyfriend who is seriously ill. Mother is also chronically ill. 8th grade education, but appears to have greater potential. T. lives with mother, grandmother, close to other relatives.	Mother preoccupied with boyfriend. Feels T. does not love or respond to her. Eventually removed T. from study because "it was making T. not like me."	3 weeks premature, sleeps through feedings - mother does not wake T. Has grandmother feed T.	Sleepy, nonresponsive, very difficult to arouse. Sucks of low amplitude and frequency. Does not open mouth for nipple.	Mental and psychomotor functioning on neonatal level. Too young to obtain numerical Developmental Indexes.

Table 1 -- Continued

J.B.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
23 day old, Black male. Common-law marriage, 2 year old sibling with same father. On welfare, but mother wants to return to work. Father is in California looking for employment. Appears to be steady, supportive relationship. Parents in early twenties.	Mother knowledgeable about child care and J.'s history. Understands seriousness of J.'s condition.	Normal pregnancy, good prenatal care. Planned pregnancy.	Sucks well, but becomes very agitated if feeding interrupted. Responsive, cuddly.	Mental and psychomotor functioning. age appropriate. Too young to obtain numerical Developmental Indexes.

Table 1 - Continued

M.S.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
3 month, 28 day old White female. Parents married, late teens. M. lives with parents, 10 other relatives, mostly retarded. 2 year old sister. Mother - borderline retarded with speech impediment. Father illiterate. Both unemployed.	Both parents concerned about M. and attentive to her. Father assumes most parental responsibility. He is concerned about influence of retarded relatives on the children.	Normal birth. M., sister and parents moved to Texas after M. born. Mother eventually returned to Flint. M. left in care of relatives in Texas - neglected and underfed. Hospitalized in Texas, eventually M. and father returned to Flint.	Irritable, cries frequently, spits up.	Mental and psychomotor - average. Not all items were administered, due to infant bio-behavioral state and sudden discharge from hospital. However, consistently passed most items at age level.

Table 1 - Continued

J.E.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
4 month, 6 day old White male. 2 year old ½ brother. Father - construction worker.	Unaware of problem until physician and friends noted. Mother depressed. Parents do not accept seriousness of J.'s condition.	Breast-fed, but not enough milk. Mother feels this is due to stress. She is preoccupied with personal concerns. She also had problems breast feeding J.'s brother.	Ate ravenously, gulped air. Pulled bottle to mouth, irritable if removed.	Mental and psychomotor - average. MDI = 111 PDI = 90

Table 1 - Continued

L.I.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
6 month old, White female. Parents married, late teens. 2 preschool siblings. Parents borderline retarded.	Father extremely inappropriate, overstimulating to infant. Indications of abuse in siblings. Parents do not hold L. during feeding.	Traumatic birth. Fetal distress. Parents noted L. became ill during previous month, at that time L. stopped babbling, responding. Cries a lot now.	Spits up. Cries frequently, does not quiet, very irritable.	Mental and psychomotor - far below average. MDI = 60 PDI = 60

Table 1 - Continued

P.M.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
7 week old White male. Mother - 19 father - 30, married. Father employed, low-level management for fast-food restaurant. 2 year old sister. Stable relationship.	Both parents very concerned. Sacrifice for their children. Mother depressed borderline anerexia, tired, overstressed Father tired, overstressed.	Normal birth, not a planned pregnancy. Father works 65 hrs/ week. Severe financial stress. Mother reports that she kept eating less and becoming more tired. P. lost interest in feeding. Sleepy all the time.	Sleepy, sucks with very low frequency and amplitude. Difficult to arouse.	Mental and psychomotor - below average. Too young to obtain numerical Developmental Indexes.

Table 1 - Continued

T.W.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
14 month old Black female. Mother - 30, unmarried, unemployed. Alcoholic, appears to have serous emotional problems.	Mother angry at T. for not eating. Does not provide sustained attention, easily angered by T. Mother drank beer during interview.	T. refused most food for several months. Mother does not try to control, attributes T.'s behavior as "badness."	Screams, hides face when approached. Strikes out if touched.	Not available, unable to test with Bayley scales. Social and verbal behavior appears below age level.

Table 1 - Continued

M.H.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
1 month, 4 day old, Black male. Mother in late teens, lives with steady boy-friend - M.'s father. Unemployed. 15 month old brother.	Mother is concerned, displays appropriate loving behavior to her children. Father supportive.	Mother does not wake M. to feed. He then spits up when fed. Food intake very in-adequate.	Sleepy, spits up frequently. Falls asleep during feeding.	Nonattentive, but psychomotor at age level. Too young to obtain numerical Developmental Indexes.

Table 1 - Continued

M.P.

Identifying Data	Parental Characteristics	History	Infant Characteristics	Developmental Level
1 month, 11 day Black male. Mother, late teens, unmarried. Lives with mother. Family disorganized, no stable home.	Mother stressed, not knowledgable of child development. Spent time with M., but not comfortable in interacting with him.	Infant sleeps through feedings, spits up when fed. Occurring since birth.	Sleepy or irritable.	Mental and psychomotor - below average. Too young to obtain numerical Developmental Indexes.

Case Studies

Case #1

Clinical Observations and Historical Information

Adam G., a 9 month old White male, was admitted to the pediatric unit with a primary diagnosis of "lack of normal physiological development," a common term for failure to thrive. His weight upon admission was 13 lbs., 10 oz., below the third percentile. Medical evaluation conducted during his hospitalization disclosed no organic reason for his lack of weight gain.

Adam lives with his parents and two siblings, a 6 year old brother and 2 year old sister. His father is a secondary school math teacher who spent considerable time in the hospital and kept a concerned watch over Adams' progress. He appeared much more comfortable in this supervising role than in playful interactions with Adam. Mrs. G. is a housewife with some college education. She is soft spoken and somewhat shy. Her interactions with Adam were loving and appropriate. She relates that her pregnancy was planned. Both parents appeared to do their best to attend to the children at home while Adam was hospitalized.

Adam's birth weight was 7 lbs., 15 oz. He weighed 13 lbs. at 6 months, and 14 lbs., 3 oz. a few weeks

prior to hospitalization. Medical records indicated that his birth was not marked by any problems. Adam's mother reports that he had mild colic during his early months. Her description of his food intake up to age 6 months seems appropriate in both quality and quantity. Mrs. G. feels that Adam was always a "temperamental" infant, and not easily consolable. He was placed on infant formula and later cereals and other infant foods were added gradually. However, at 6 months of age, the family doctor suggested that Adam begin drinking whole milk instead of formula. He became congested, and soon afterwards would cough and vomit when fed. Another physician attributed these problems to a milk allergy, and replaced milk with formula. However, although the vomiting lessened, Adam still tended to spit up and became an "irritable" feeder. His food intake decreased.

Although Adam was a "low weight for age" infant throughout his postnatal development, it was not a concern to his parents until Adam's more recent visit to a physician. This is surprising, in light of the fact that his parents are educated and intelligent and have raised two other children. They report that although they noticed that Adam was thin, they felt that he looked thin because he was long. They were surprised to learn that he was of average length and markedly underweight.

Though markedly thin and pale, Adam was usually happy and responsive. It was apparent that he had opportunities for cognitive stimulation, as he demonstrated comfort and facility with age-appropriate toys and was socially adept. However, his gross motor functioning was inadequate. These observations were supported by his Bayley Scale scores upon admission which placed his mental functioning somewhat below age level (MDI 83) and his psychomotor functioning very much below age level (PDI 58). It appeared that his motor deficits were related to an overall physical weakness, which made his gross motor functioning generally unstable. However, his fine motor functioning was at age level.

Observation of Adam's feeding behavior revealed that while Adam appeared hungry, as demonstrated by reaching for the bottle and sucking eagerly, his sucking was ineffective in that he expended a great deal of energy with relatively little food intake. He swallowed a lot of air, and would burp and spit up much more than would be expected of a 9 month old infant. After spitting up, he would tend to become irritable and lose interest in feeding.

Upon discharge, Adam demonstrated marked improvement in his feeding behavior, and cognitive and motor functioning. His weight upon discharge was 13 lbs., 13 oz.,

a gain of 3 oz. in five days. He rarely spit up and was less irritable. His mental Bayley Scale score was now at age level (MDI = 103) and his motor scale had increased (PDI = 80). The physician felt that Adam would continue to make progress at home, now that the feeding problems had been eliminated.

Conditioning data

Adam's sucking was reinforced using the procedures and instrumentation described in the methods section, with two changes that need to be noted. First, only visual reinforcement was delivered, due to problems with the audio system. Second reinforcement was generated for sucks slighly lower than the median suck during baseline, due to computer problems.

As illustrated in Figures 7 and 8, sucking frequency per conditioning session and intake per conditioning session both increased over the five days that Adam was involved in the operant program. Increasing trends also were noted in percentage of sucks reinforced, as illustrated in Figure 9. These increases suggest that the operant procedure was effective in facilitating sucking behavior for this infant. However, several factors constrain interpretation of this data as evidence of conditioning. First, a noncontingent phase could not be conducted due to computer problems. Second,

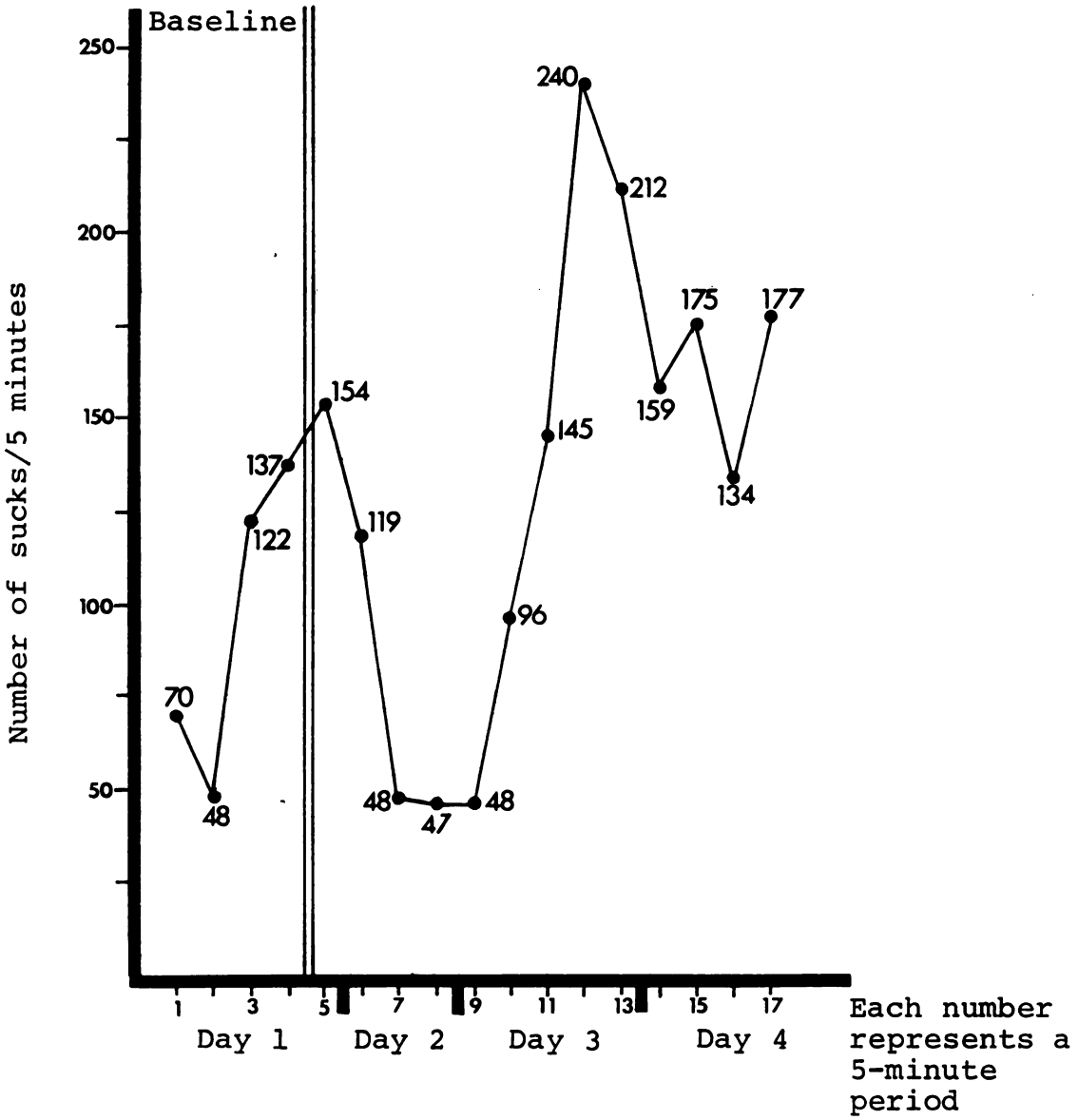

Figure 7: Changes in sucking frequency: case number 1 (Adam)

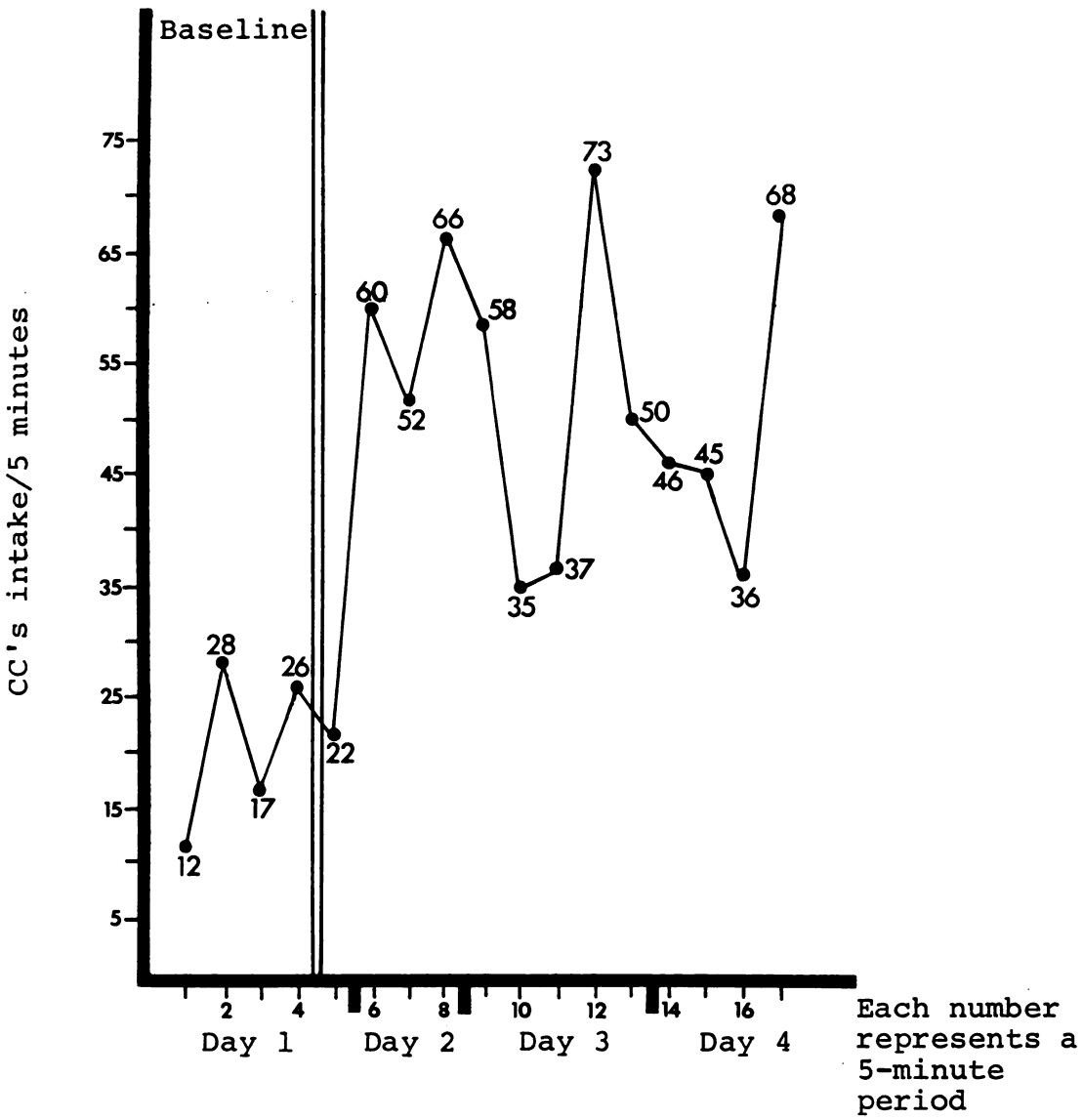

Figure 8: Changes in intake: case number 1 (Adam)

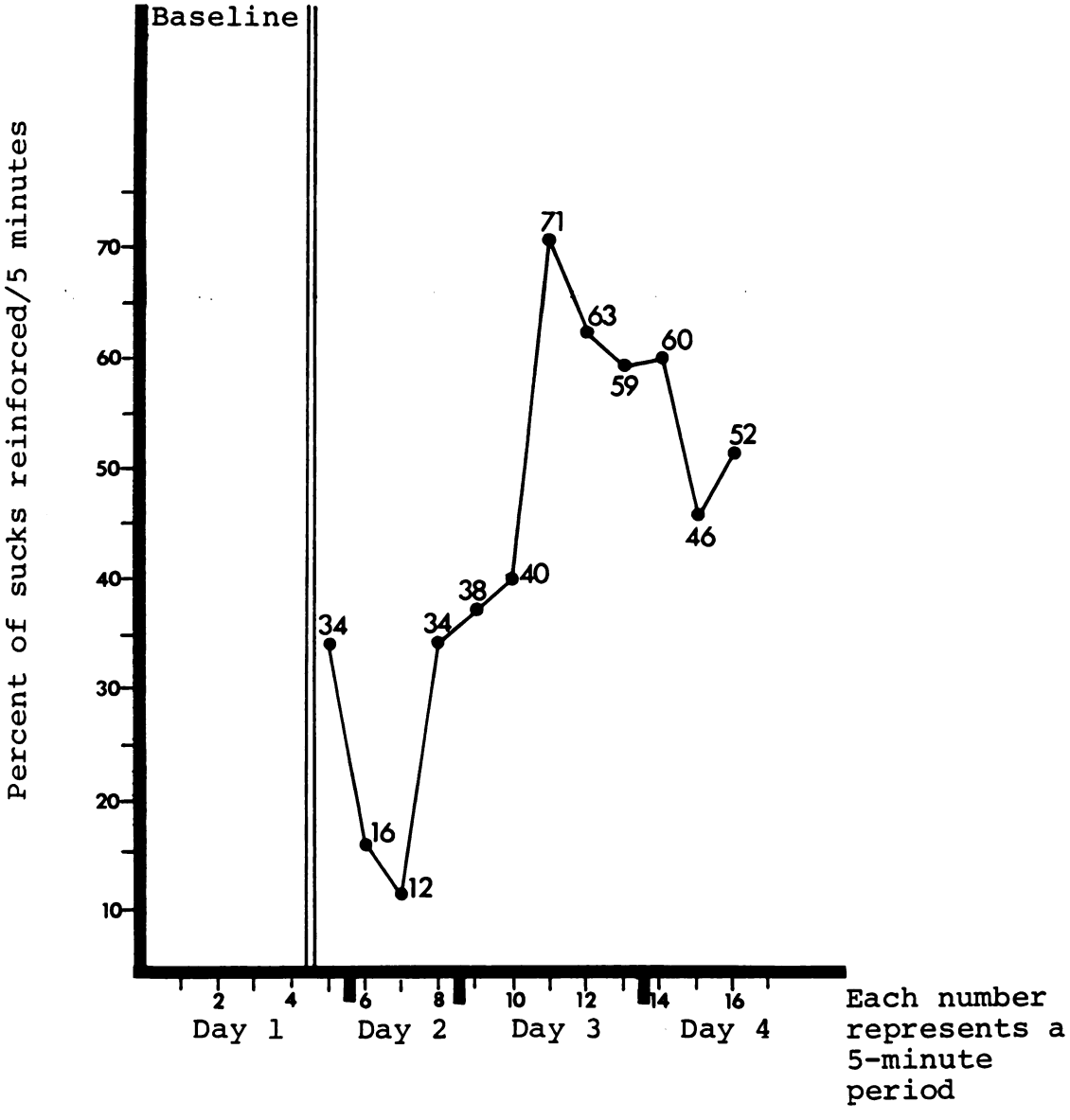

Figure 9: Changes in percent of sucks reinforced: case number 1 (Adam)

amplitude data are not of the quality desired and thus cannot be illustrated graphically. However, increasing trends were generally noted over time.

During the conditioning sessions Adam attended to the reinforcement and visually searched the display screen when placed in the experimental crib. He often smiled and kicked his legs when he was able to generate reinforcement. After about 10 conditioning sessions, he learned that he could obtain reinforcement without sucking, by pulling on the tube that connects the burrette to the bottle. This instrumentation problem soon was corrected. Over time, Adam became more interested in feeding. He eventually would reach for the bottle when placed in the infant seat, and regularly held his own bottle.

Conclusions

Adam's response to the conditioning procedure, the noted increases in sucking frequency and amplitude, as well as food intake, are all preliminary indicators of the effectiveness of this intervention. Although somewhat developmentally slow by formal measures of infant development, Adam appeared to be a happy and responsive infant. Because he was functioning well, especially socially, the seriousness of his physical problem may have been masked to the physician and Adam's parents. It appears that Adam was originally an

irritable and colicy infant whose feeding problems were compounded by a milk allergy. The subsequent vomiting and congestion created problems in his food intake and his approach to the feeding situation. In short, Adam resembles the type of nonorganic failure to thrive infant whose problems lie primarily in the realm of feeding. Operant conditioning, combined with a non-allergenic diet, may have removed the aversive nature of feeding and strengthened his sucking. It seems very likely that he will be able to sustain these positive feeding behaviors at home.

Case #2

Clinical observations and historical information

Chris W., an 8 month, 6 day old, White male, was admitted to the pediatric unit with a primary diagnosis of "lack of normal physiological development," a common term for failure to thrive. In addition, child abuse was strongly suspected.

Chris' weight upon admission was 14 lbs. 1 oz., below the third percentile for height. He was a pale, emaciated infant, with sparse, patchy hair and glazed-over eyes. He was physically dirty and had diaper rash. Physical exam revealed a number of cuts and bruises covering his body. Most prominent were numerous facial bruises. Other marks were on his legs, abdominal area, and buttocks. In addition, a specialist in children's

dentistry determined that Chris' upper front teeth had been pushed back up into the gums by trauma.

Chris is the only child of parents in their early twenties. His father is an unemployed construction worker, his mother works 12 hours per day in a convenience store. Chris is often left in the care of his father's brother and sister-in-law, at least for part of the day. Both these persons are in their early twenties and unemployed.

Chris was brought to the hospital by a Protective Services worker, who visited the family home after a neighbor complained about Chris' condition. Chris was finally found at the in-law's house. Mrs. W. was contacted at work and agreed to accompany the Protective Services worker to the hospital. Both parents spent a great deal of time in the hospital with Chris. However, their role in his care was generally passive. They would sit him on their lap for long periods, but rarely played with him. They participated in feeding Chris, but easily became frustrated or disinterested. Overall, their parenting skills and interest appeared limited.

Parental accounts of the multiple bruises found on Chris could not account for the injuries he sustained. While the details of their account changed over time, they generally attributed his injuries to "clumsiness"

or unusual accidents. They felt that he bruised easily, but medical evaluation did not confirm this suggestion. They report that his facial bruises occurred when he fell out of a wagon onto a stone. Chris' physicians felt that this was highly unlikely, judging from the location of his bruises.

In addition to probable physical abuse, it was readily apparent that Chris was a neglected infant, especially in terms of meeting physical needs. His feeding history indicates that Chris was not provided appropriate types or quantities of food, and that these deficits appeared to cause problems in his feeding behavior. Mrs. W. reports that he was on infant formula until 2 months ago. She was not able to report the quantity of formula he drank, but she stated that it was expensive and that they often would run out of it. She states that Chris used to "eat too much" and vomit extensively. At no time did she make an effort to enroll Chris in a local feeding program that provides formulas and other foods to infants, although she was aware of the program. Discussion with Mrs. W. strongly suggested that she was not aware of the importance of an adequate infant diet. Approximately 2 months ago, Mrs. W. switched from using formula to whole milk, or mixed cereal with milk, due to the cost of formula. She states that she also introduced some fruits and vegetables. Chris seemed

to stop gaining weight, although he seemed to eat more. He also began having chronic diarrhea. Approximately 2 weeks prior to hospitalization, he began spending more time at the in-law's house. There he was fed only iced-tea, water, juices, and spaghetti. His parents revealed no concern or anxiety when reporting this feeding regimen. They report that Chris has always been a difficult infant to feed and greatly prefers a bottle to being spoon fed. He often refuses food by not opening his mouth, spitting up food or choking. This was regularly observed when the W.'s fed Chris, and to a lesser extent when he was fed by nurses. Neither parent could state how they tried to overcome this problem.

Upon admission, Chris was a lethargic infant who spent much time staring blankly at the ceiling or television. He would respond to social contact by moving his eyes or head slowly to the person initiating the contact. His facial expression never reflected pleasure. Chris would startle when a hand or object was quickly moved toward him, and he would turn his face away.

Assessment with the Bayley Scales was difficult, due to his lethargy. His optimal performance on the day following admission indicated that he was functioning below age level in both mental and motor areas, although his cognitive deficits were more severe. He did not vocalize or smile, and showed very little interest in

the test materials. Motorically, he was surprisingly agile for being so emaciated. He performed more poorly on fine motor tasks, probably due to his lack of interest in the test materials.

Upon discharge, Chris demonstrated little change in his Bayley performance. He was somewhat more socially responsive and smiled occasionally. He occasionally vocalized when stimulated. However, his interest in toys and the test materials was still minimal. Due to an illness during hospitalization, his discharge weight was the same as his weight upon admission. However, the physician felt that he was able to leave the hospital as his food intake and feeding behavior had improved. He still would often refuse solids, but accepted a bottle more consistently. No organic cause for his failure to gain weight was found. Chris was released in the care of a foster parent. His placement will be decided at a later date. At the time of discharge, it was not yet ascertained where the physical abuse occured, but it was obvious that his parents were respnsible for his physical neglect.

Conditioning data

Due to a brief illness and some medical testing, Chris was involved in the operant procedure for three of his nine days of hospitalization. The first two days of conditioning were consecutive. It should be

noted that due to problems with the audio system, only visual reinforcement was presented.

As illustrated in Figures 10 and 11, there were increases in median sucking amplitude per conditioning session, and percent of sucks reinforced per conditioning session also increased during the first two days of conditioning. These indices were more irregular on the last days of conditioning. A decrease in these indices is noted for the period of noncontingent reinforcement. Food intake per conditioning session was variable throughout conditioning as noted in Figure 12. Frequency of sucks also was variable throughout conditioning, as noted in Figure 13. Overall, these data suggest that the operant procedure was effective in modifying certain parameters of sucking over consecutive sessions.

Behavioral observations during conditioning coincide with the operant data. Although initially lethargic, Chris was soon attending to the visual reinforcement. During the second conditioning session, he found that he could turn his head while biting the nipple to receive reinforcement. This instrumentation problem was soon corrected. Chris appeared much more attentive to feeding during the first three days of conditioning than during his regular feedings. His sucking became more regular, and he was alert and attentive. His

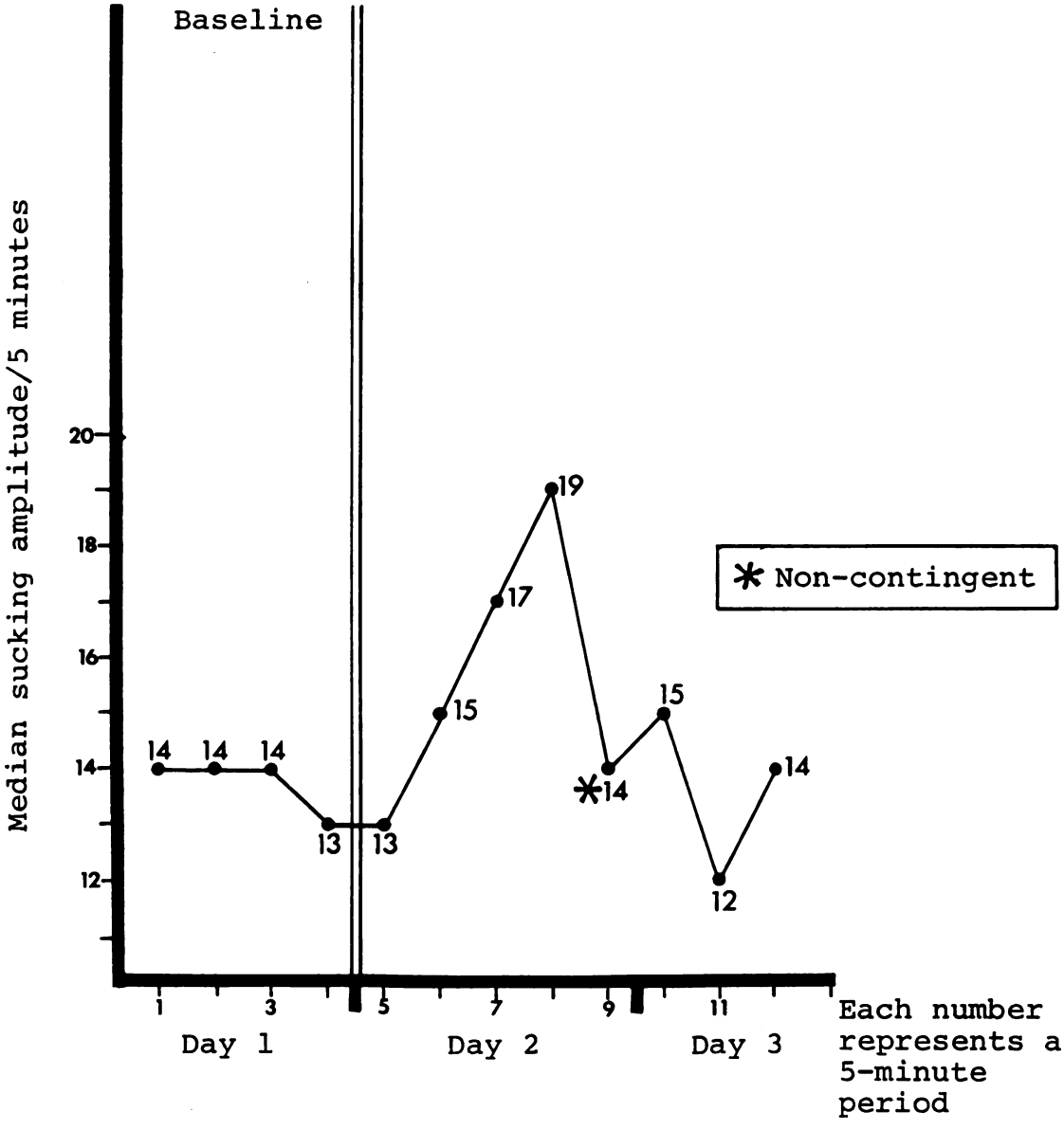

Figure 10: Changes in median sucking amplitude: case number 2 (Chris)

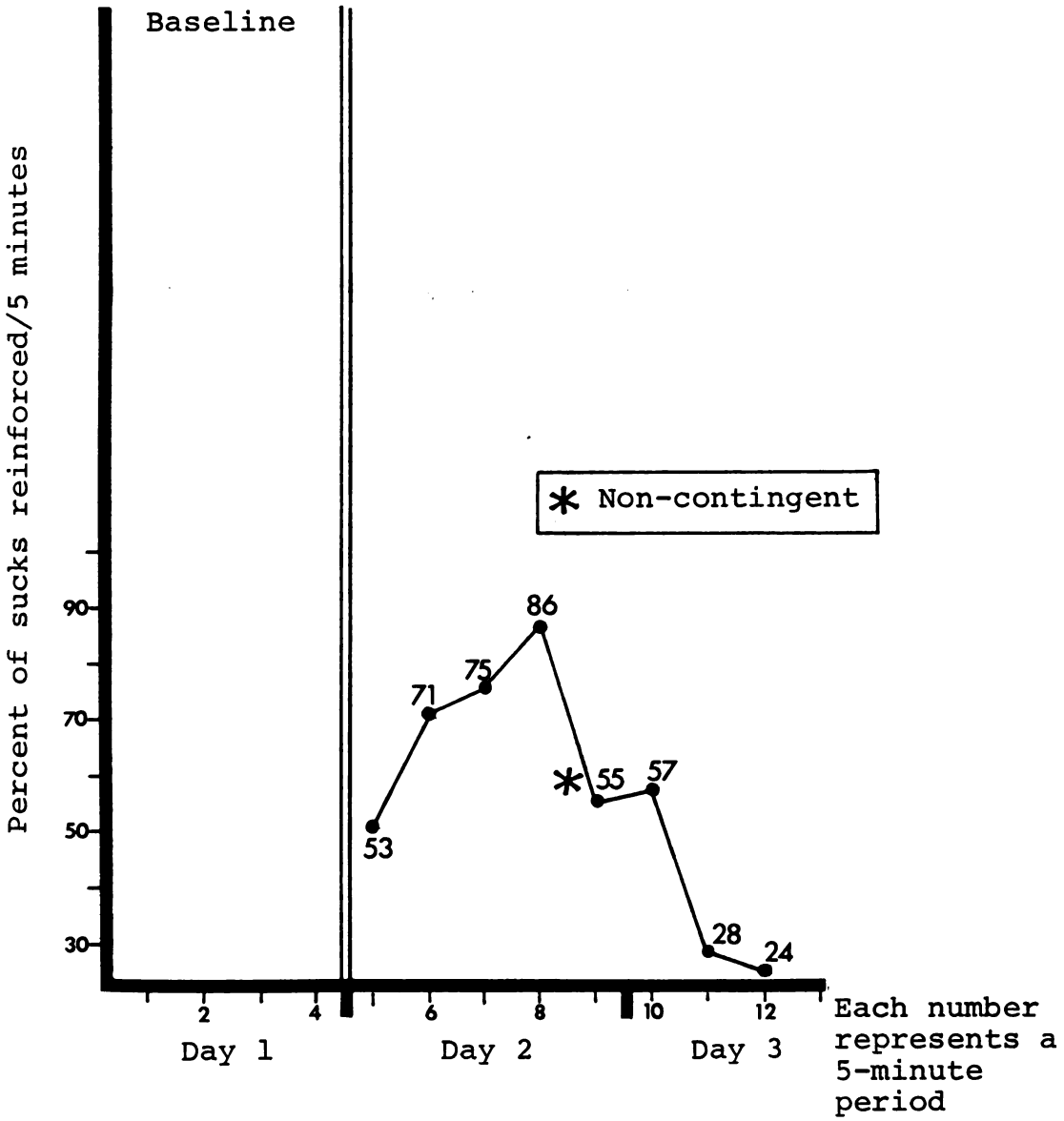

Figure 11: Changes in percent of sucks reinforced: case number 2 (Chris)

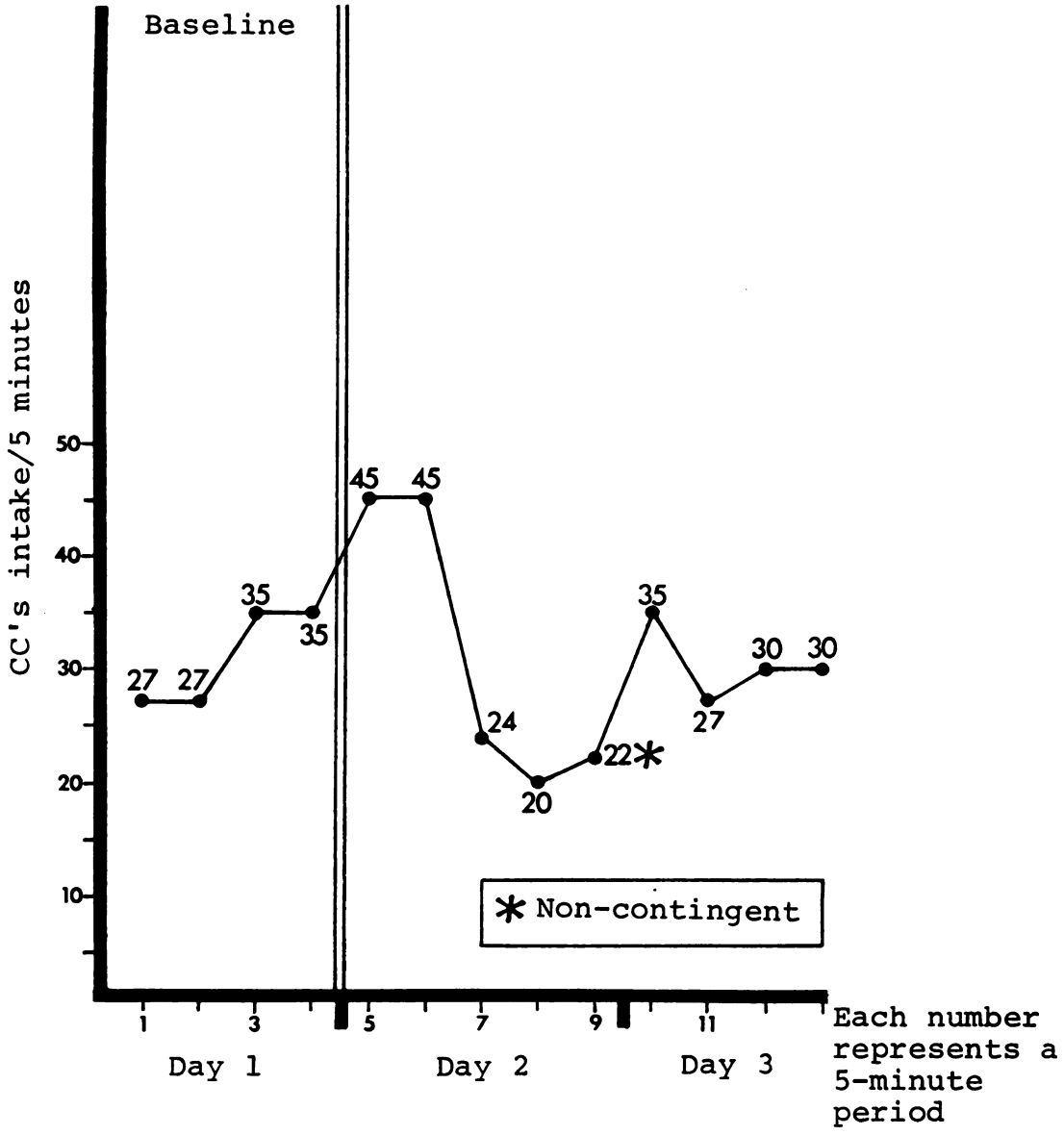

Figure 12: Changes in intake: case number 2 (Chris)

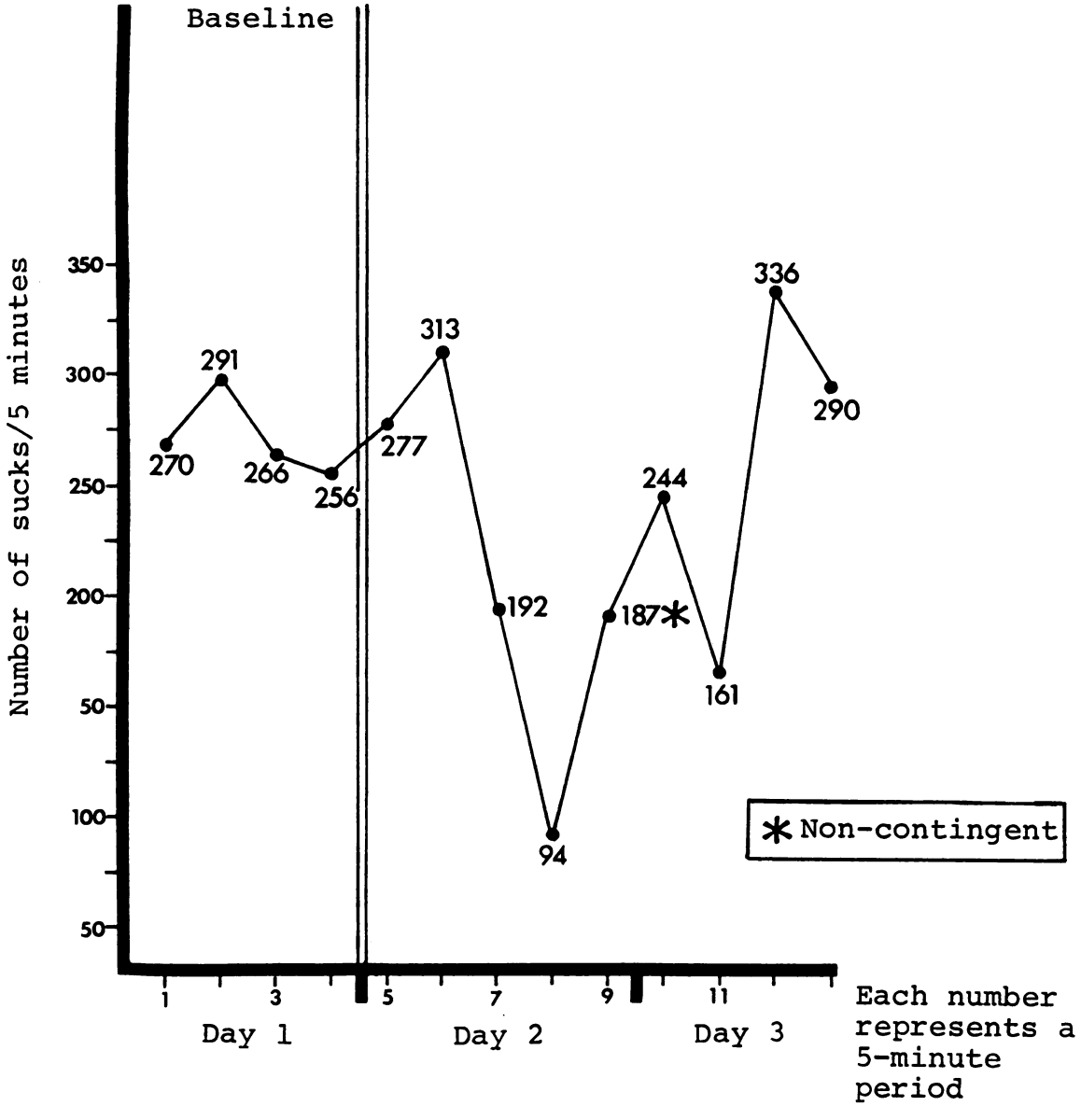

Figure 13: Changes in sucking frequency: case number 2(Chris)

behavior was different on the final day of conditioning. While alert, he was irritable and nonattentive to the reinforcement. However, his overall feeding behavior had improved throughout hospitalization. It is likely that his irritable behavior on the last day may be related to invasive tests and procedures conducted the previous day and his recent illness. Chris' response to the noncontingent session was very different than his previous behavior. His sucking became irregular and he seemed to search for reinforcement if it did not appear in response to sucking. He eventually began pushing the bottle out of his mouth.

Conclusions

Chris' history and behavior are characteristic of the "typical" nonorganic failure to thrive infant described in the literature. He was lethargic, physically and emotionally neglected, and fed inappropriately. His parents were deficient in parenting skills and interest, and were not aware of his needs. He refused food and had chronic spitting up and diarrhea. Considering the seriousness of his condition, and his relatively brief exposure to conditioning, the increase in certain feeding and sucking indices is particularly interesting. Chris' responses provide suggestive evidence that operant conditioning may be an effective intervention for

seriously distressed nonorganic failure to thrive infants.

Case #3

Clinical observations and historical information

Kurt W., a 3-week-old-White male, was admitted to the pediatric unit with a diagnosis of "emaciation/rule out failure to thrive." He was reported to vomit extensively after feeding, and had watery stools. No organic cause for these problems was found through medical evaluation.

Kurt weighed 7 lbs., 2 oz. upon admission and his birth weight was 6 lbs., 11½ oz. His admission weight was at the 5th percentile. Kurt was in neonatal intensive care for several days after birth with a collapsed lung and had a chest tube inserted temporarily. However, he recovered well and has had no further pulmonary difficulties. No other birth related problems were reported.

Kurt lives in a large extended family. His parents are married and both are unemployed. Mrs. W. is in her late teens; she is quiet, not very self-assured and often appears uncomfortable in the mothering role. She was quite distressed at Kurt's condition. Mr. W. is in his early twenties; he, like his wife, is quiet and reserved in his interactions with the research and medical staff. He paid attention to Kurt, and often

initiated interactions with him, but was not adept at caring for Kurt or comforting his wife. The W.'s live with Mr. W.'s mother in a partitioned section of what appears to be very small living quarters. Kurt's grandmother is unemployed, and although she is home frequently, she rarely provides support to Kurt or his parents. Mr. W. has 9 siblings, and 26 nieces and nephews that all "see grandma's house as their own." As a result, there are constantly children and adults in the living quarters. Kurt's crib, while in the parent's partitioned space, is not free from disruption. There is no place for quiet or privacy in this living arrangement.

The most pervasive description of Kurt's behavior, from both his parents and the medical staff, is irritability. Kurt's mother reports that he is fussy almost all of the time. She responds to questions about his crying with a sigh, and feels that he cries much more than most infants. Judging from Kurt's hospital behavior this is a realistic description. Kurt's mother also reports that he has no sleeping schedule. She says he is "jumpy" and may sleep for only a few minutes before waking up crying. Kurt will only fall asleep if he is being held and Mrs. W. often stays up nights with him.

Kurt's mother reports that his food intake is about 4 oz. of formula every 4 hours, which is a

reasonable amount. However, he was a very difficult infant to feed and it often took the nurses over an hour to feed him. He whimpered and often refused the nipple, both at home and in the hospital. His tendency to vomit was an additional problem, often necessitating beginning feeding again, to ensure adequate caloric intake. Kurt seemed to swallow air during feedings and would then vomit extensively rather than burp.

Due to Kurt's young age, Bayley developmental index scores could not be computed. However, his response to the Bayley items points to an overall irritability and limited range of responsiveness. Item by item comparisons reveal little difference between his performance upon admission and on discharge 9 days later. He rarely engaged objects visually and his response to auditory stimulation was weak and diffuse. This lack of alertness, and inability to respond to stimulation in an organized manner, would make Kurt a difficult infant to care for. The most promising result of testing is that his motor functioning is well within normal limits, although it took time to obtain his optimal performance.

Kurt demonstrated no marked behavior changes over the course of hospitalization. He was irritable throughout his stay. His vomiting lessened to some degree, but it was still in the range of ½ oz. to 1 oz., 2-3

times a day. His discharge weight was 7 lbs. 9 oz., a gain of 7 oz. This is a sizeable weight gain and is especially remarkable considering that he was on clear liquids and intravenous fluid feedings for 2 days of hospitalization. This weight gain appears to be the result of a very dedicated nursing staff who spent a large amount of time feeding Kurt.

Conditioning data

Operant data do not indicate positive changes in sucking frequency (Figure 14) or food intake (Figure 15) per conditioning session over 4 days of operant conditioning. Kurt's sucking frequency and food intake during conditioning sessions were variable over this time period. There was an indication of an overall decrease in these indices over time. Unfortunately, indices of sucking amplitude are not as accurate as would be desired, due to computer problems. Thus, these data are not graphically displayed. However, amplitude data suggests variability over the course of conditioning.

Clinical observations of Kurt's behavior during conditioning substantiates the lack of evidence for conditioning noted in the operant data. Kurt was either irritable or sleepy during the conditioning sessions and efforts to calm or arouse him usually were

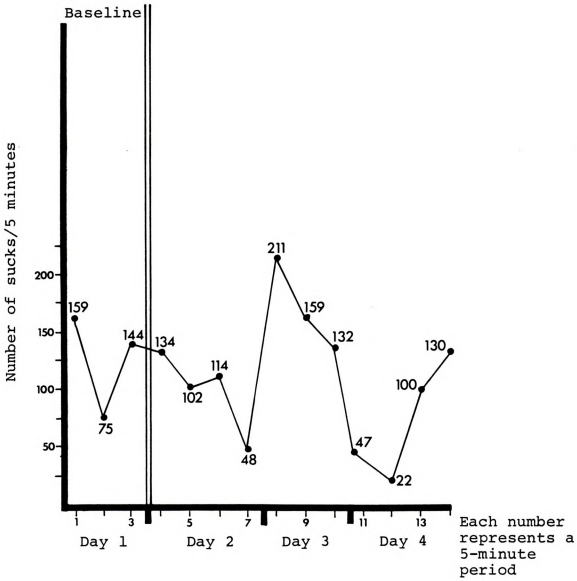

Figure 14: Changes in sucking frequency: case number 3 (Kurt)

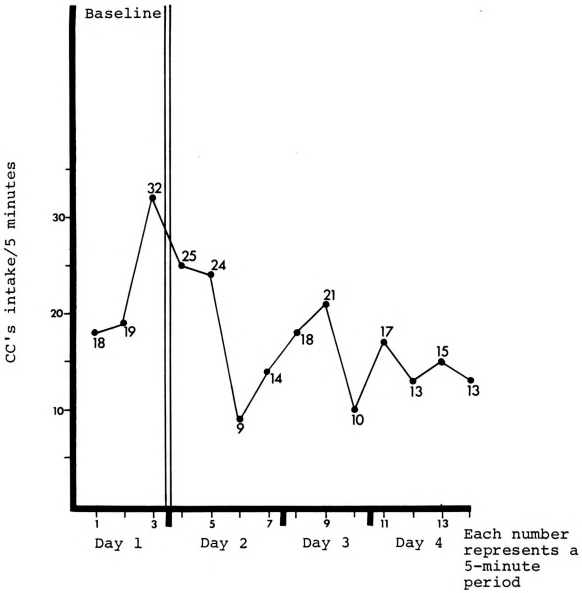

Figure 15: Changes in intake: case number 3 (Kurt)

unsuccessful. He rarely attended to the visual reinforcement (no auditory reinforcement was available) and did not appear to suck to generate reinforcement.

It is difficult to ascertain if the conditioning procedure itself was related to the general decrease in sucking indices. The experimental procedure - removal from his crib, feeding in an infant seat, exposure to reinforcement - may have been disruptive to this immature infant. However, it is possible that factors unrelated to the conditioning procedure, such as his lengthy stay in a hospital environment, may have influenced his feeding behavior.

Conclusions

Kurt's feeding problems appear to stem from two primary factors. First, Kurt obviously is an extremely irritable infant, whose range of responsiveness to the environment is very narrow. Kurt finds it very difficult to adjust to internal and external demands, and does not respond in predictable patterns. While it is not possible to definitively assess the etiology of his problems in responsivity, it seems likely that judging from his young age, his neonatal problems and parental reports, that his behavioral difficulties are congenital at least to a degree. They do not appear to be solely the result of poor maternal behaviors,

although Kurt's behavior certainly affects the interaction between himself and his mother. Second, Kurt and his parents live in a highly disruptive psychosocial environment. Their living space is noisy and unpredictable and their relationships with the extended family are not supportive. It would be difficult for any parents, especially young, significantly stressed parents, to help Kurt develop and maintain appropriate feeding and sleeping behaviors and schedules in this environment. While the W.'s are trying to give Kurt the attention and care that he demands, their physical and psychological resources rapidly are being depleted. Kurt's initially irritable temperament is probably worsened by this environmental stress.

The combination of Kurt's behavior and the significant environmental stress does not allow for optimistic predictions in terms of Kurt's development and the parental-infant relationship. Kurt's poor response to the conditioning procedure suggests that intervention directed primarily toward Kurt may not be effective at this time. Perhaps the only effective intervention may be significant environmental change; having Kurt and his parents move from their living situation and providing them with some relief from caregiving.

Kurt's lack of positive response to the operant procedure may point to certain limitations in the use

of this type of intervention. Although this procedure has resulted in positive changes in sucking indices for lethargic and withdrawn infants, and operant procedures have produced behavior change in young infants in other studies, this type of intervention may not be effective if the infant's ability to attend to and organize the environment is extremely limited. There are even some indications that this experience may have been somewhat disruptive for Kurt. However, Kurt's response does not rule out the use of this procedure for young and/or biobehaviorally immature infants. More infants like Kurt will have to be tested to make definite conclusions in this area.

Case #4

Clinical observations and historical information

Latisha P., a 2 month, 7 day old Black female, was admitted to the Pediatric Unit with a diagnosis of failure to thrive. Her weight at admission was 8 lbs., 4 oz; below the 5th percentile. Her birth weight was 6 lbs., 15 oz., and she was 3 weeks premature.

In addition to prematurity, Latisha's birth and medical history has been marked by medical problems. She suffered from respiratory distress and hypoglycemia at birth and was in neonatal intensive care. Latisha's

mother, Ms. C., is diabetic and was also hypertensive throughout the pregnancy. She had a serious kidney infection during the last weeks of the pregnancy. There is also indication that she had venereal disease that was untreated during the pregnancy. Latisha was again hospitalized at 1 month of age because of feeding problems, including frequent vomiting and refusal to nipple. No reason for these difficulties were found at this time. Speech therapists used oral stimulation exercises to facilitate her sucking, and she seemed to respond to these procedures.

Latisha was readmitted to the hospital after her physician found that she had only gained 1 oz. in the prior 3 weeks. She also had severe conjunctivitis. Latisha's mother reported several problematic feeding behaviors that may have been related to her poor weight gain. Specifically, Latisha is very sleepy during feeding, or cries even when being fed. She also vomits frequently. These behaviors were also observed by the nursing staff. Ms. C. reports that she fed Latisha approximately 4 oz. of formula, 6-8 times per day and cereal 3 times per day. However, the physician doubts that this report is accurate, as Latisha should be gaining rapidly with this caloric intake. This also is a large amount for a 2-month-old infant.

Latisha lives with her mother, an unskilled

laborer who works a 12-hour night shift in a factory. She is divorced from Latisha's father. Latisha also has an 8 year old half-sister living at home. Ms. C's mother and sister live nearby and take considerable responsibility in caring for Latisha. They were also the primary caregivers for Latisha's half-sister when she was an infant. As a result, Ms. C. has little experience in caring for infants and admits that this is a problem. While her mother and sister care for Latisha some of the time, Ms. C. has Latisha in her care when she is not working, so her deficits in parenting skills are a significant factor in Latisha's care. Ms. C. states that she does not know what to expect in Latisha's development and behavior, or how to encourage adaptive feeding and sleeping habits. She views Latisha as an infant who is difficult to play with and who would prefer to be left alone. She feels that her daughter is very difficult to feed. Ms. C. often appeared to be hostile to anyone who had contact with her infant and it soon became apparent that this hostility stemmed from her own insecurity. She spent almost every night in the hospital room with Latisha, stating that this was causing problems because she was missing work. Her reason for staying was not because she wanted to be with Latisha, but that Latisha would be hurt or neglected if left alone. Her attitude often reflected

that mothering was a chore rather than a pleasurable experience, yet beneath her anger was depression. At times, she came close to crying. It was evident that Ms. C. was stressed in her life situation and conflicted over her role of mother. However, she was also an intelligent woman who could likely benefit from a supportive or therapeutic relationship.

Bayley Scales administered on the second day of hospitalization indicated that Latisha's mental and motor functioning were both substantially below age level (MDI = 56, PDI = 72). Due to her young age, it was not possible to compute developmental indexes that reflected her prematurity. Several attempts were needed to obtain her optimal performance as she was generally sleepy or irritable. Regardless of the index scores, Latisha's response to Bayley items suggested that she was not very responsive to social or other environmental stimulation. She startled easily, but then reverted to a sleepy state. It was difficult to gradually arouse her to a comfortable level of awareness. This type of responsiveness was also noted in feeding. She would fall asleep while feeding, and often needed stimulation to keep sucking. She was hungry at times, but rarely opened her eyes when feeding. Vomiting was a consistent problem, if she was not burped every one-half to one ounce.

Latisha weighed 8 lbs., 8 oz. at discharge, a gain of 4 oz. Her Bayley performance was improved (MDI = 62, PDI = 96), primarily due to her somewhat greater responsivity and alertness. While she was still a generally unresponsive infant, she was more alert than at the time of admission.

Conditioning data

Latisha was involved in the operant procedure for 5 of her 6 days of hospitalization. Data suggest that the conditioning procedure was not effective. As seen in Figures 16, 17 and 18, her response to conditioning was variable over time, as measured by indices of sucking frequency, intake, and sucking amplitude. Percentage of sucks reinforced will not be displayed, as the quality of these data is not of the quality desired, due to computer problems. Clinical observations coincide with the operant data, for the first 4 days of conditioning. During the first 4 days of conditioning, Latisha was sleepy and not attentive to the visual stimulation, nor did she seem to respond to auditory reinforcement. However, toward the end of her hospital stay, she was more responsive during conditioning. She opened her eyes, attended to the reinforcement, and began to suck more actively. Unfortunately, a noncontingent phase could not be conducted.

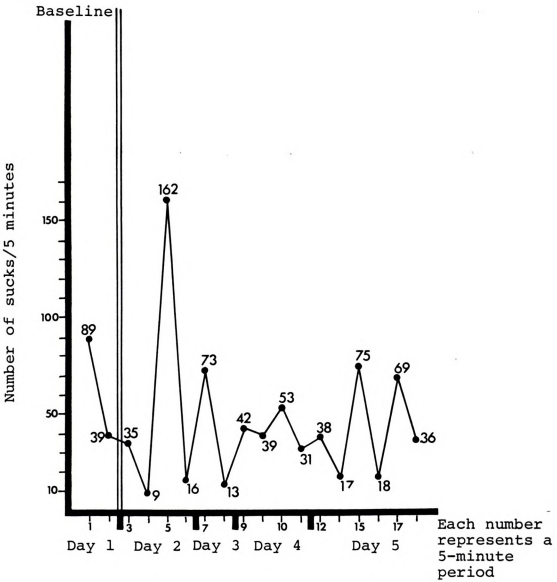

Figure 16: Changes in sucking frequency: case number 4 (Latisha)

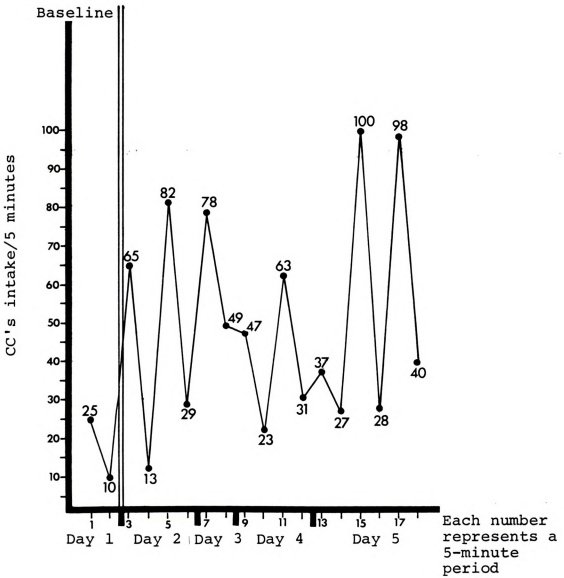

Figure 17: Changes in intake: case number 4 (Latisha)

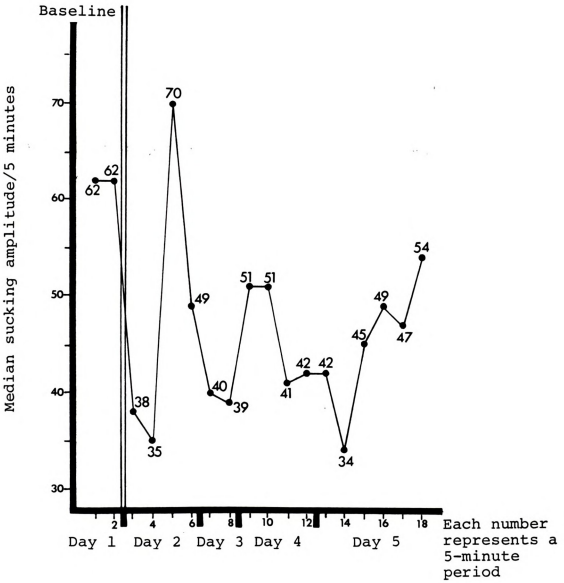

Figure 18: Changes in median sucking amplitude: case number 4 (Latisha)

Conclusions

Latisha's feeding problems and lack of weight gain stem from two sources. One is her generally unresponsive biobehavioral state and irritable digestive system. This makes her a difficult infant to feed. The other source is the quality of caregiving that she receives. It is doubtful that Latisha's overly stressed and conflicted mother provides the patient attention to feeding that Latisha needs. It also appears that Ms. C. does not provide adequate stimulation for Latisha. She interprets her lack of responsiveness as rejection, rather than as a signal to give Latisha cognitive and emotional stimulation to help her respond more adaptively to her environment. Latisha's eventual response to the operant procedure and her improvement in general suggests that she can change her behavior if given appropriate stimulation. It is very probable that her greater caloric intake was also an important factor in her more alert behavior.

Case #5

Clinical observations and historical information

Jesse W., a 4 month, 28 day old, White male, was admitted to the pediatric unit with a diagnosis of lack of normal physiological development, malnutrition, rule out nonorganic failure to thrive. Jesse's weight upon

admission was 11 lbs., 8 oz., below the third percentile. His birth weight was 8 lbs., 13 oz. No organic cause for his failure to gain weight was found during his hospitalization.

Jesse lives with his unmarried mother and 2 year old sister. Ms. W. is in her early twenties and unemployed. She was usually pleasant and appeared intelligent. However, she seemed to know little about parenting, especially in terms of feeding. She said that she is "into health foods" and fed Jesse a rather atypical diet of soy formula from powder (that does not contain salt or other additives in bottled formula that are essential to nutrition), strawberry juice, banana juice, and vitamin supplements. She stated that Jesse drinks 10, 8 oz. bottles of formula per day, but told the physician that he drank 5, 8 oz. bottles per day. Overall, her reports of Jesse's food intake do not seem accurate. Ms. W. did not feel that Jesse was underweight and was not supportive of his hospitalization. She feels that he is a normal, responsive infant with feeding problems, especially spitting up or ruminating. Jesse's birth was normal. He was hospitalized at 2 weeks of age with a temperature that soon subsided. He has not yet settled down to predictable sleeping and eating patterns.

Jesse was a pale, emaciated infant, who performed

surprisingly well on the Bayley psychomotor items, considering his physical condition. His MDI was 65, his PDI was 95. Overall, Jesse was passive in his interactions with the environment, although his mother feels that he is responsive.

Jesse was in the hospital for 4 days before his mother removed him from the hospital against medical advice. She had been bringing "health food" soy formula into the hospital and did not agree with the hospital diet or the reason for his hospitalization. Because he left so quickly, another Bayley could not be administered prior to discharge. The medical staff contacted Protective Services regarding Jesse.

Conditioning Data

Jesse was included as a comparison group subject. Indices of sucking and food intake were variable throughout hospitalization and did not appear to be affected by the presence of the reinforcement stimuli, presented during arousal effects baseline. For example, Figures 19, 20 and 21, depicting sucking amplitude, intake, and frequency illustrate this data. While a slight increasing trend is noted in Figure 20, the range of response is too narrow to be labeled as a significant increase. Measurement of intake has an error range of 1-2 cc's.

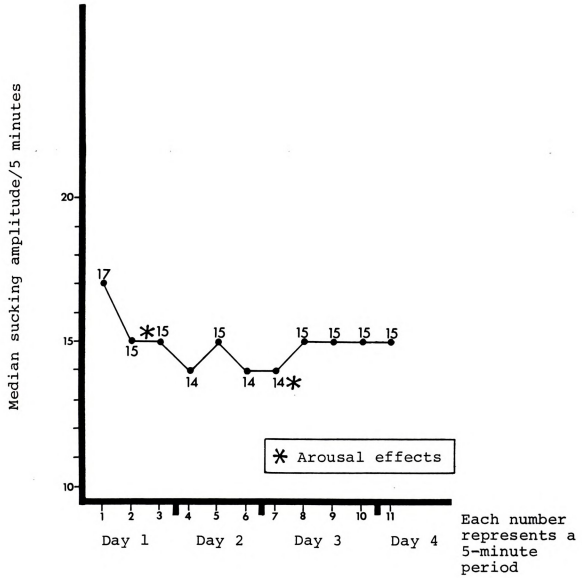

Figure 19: Changes in median sucking amplitude: case number 5 (Jesse)

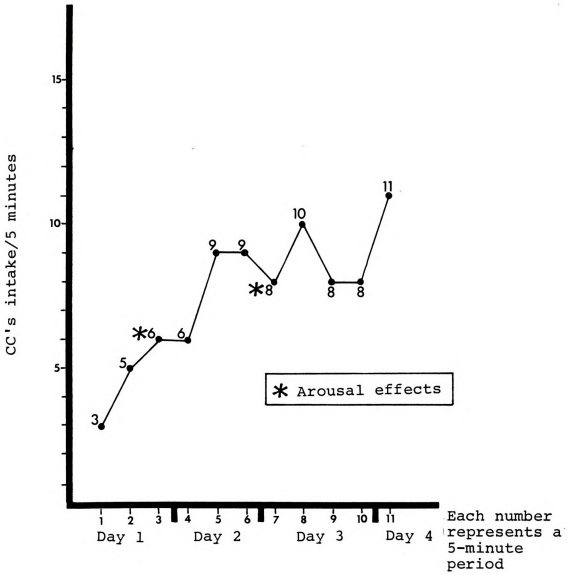

Figure 20: Changes in intake: case number 5 (Jesse)

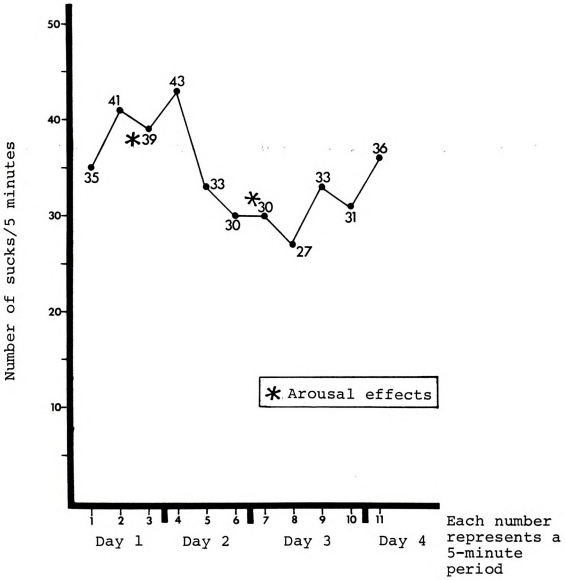

Figure 21: Changes in sucking frequency: case number 5 (Jesse)

Jesse was not a cooperative feeder. It is possible that this was compounded by a monilia infection, which might have made his mouth sore. He often refused the nipple by turning his head or pushing it out of his mouth. When he sucked, he had very little intake. No behavioral changes were noted over time.

Conclusions

Like many infants included in this research, it appears that Jesse's feeding problems stem from a number of factors. Most significant are his diet, which likely caused him to be malnourished and irritable, and problems in parenting.

While there was some increase in total food intake during his hospitalization, sucking data indicates that his actual behaviors did not change. Most likely, he began to eat more because the nursing staff was spending time feeding him.

CHAPTER 6

DISCUSSION

Descriptive and Historical Data

Infants involved in the present study presented diverse histories and demonstrated a variety of behavioral characteristics. In addition, there was diversity in the infants' responses to the conditioning procedure, both behaviorally and in terms of actual conditioning data. Other investigators have drawn attention to the behavioral diversity among nonorganic failure to thrive infants. Moreover, some attempts have been made to classify nonorganic failure to thrive infants according to behavioral topology (for example Barbero and Shaheen, 1967; Holmes, 1979; Drotar et al., 1981).

With respect to the question of behavioral topology, experience with the nonorganic failure to thrive infants in the present study suggests two general conclusions. First, although there are great differences in the histories of these infants, all histories are marked by the mothers' inabilities to recognize their infants' needs and/or respond appropriately to these needs. This was especially apparent in the area of feeding. Second, the behaviors and primary biobehavioral states of all

infants were generally atypical compared to normal infants of similar ages. While, at times, all infants deviate from alert, responsive biobehavioral states, it appears that the infants in this study were rarely able to maintain an alert, responsive state.

These general conclusions point to two important issues with respect to the present study. First, it seems apparent that a significant problem in the histories of these infants is the inability of their mothers to provide consistent response-contingent stimulation. Thus, an operant paradigm, as exists in the present study, seems an appropriate intervention. Second, diversity in infant behavior and primary biobehavioral states suggests that it is important to explore the relationship between infant characteristics and response to conditioning. As discussed in the research methodology section, correlational analyses of infant variables with progress in conditioning will help determine whether operant conditioning will be more effective with some subgroups of nonorganic failure to thrive infants than with other subgroups. These analyses will be made when data are generated from a larger number of infants than were included in the present study.

Conditioning Data

Conditioning data from the five infants previously discussed indicate that the operant procedure was not uniformly successful in modifying the sucking behaviors of these infants. This contrasts sharply with results of previous investigations of operant conditioning of sucking in normal infants (Sinqueland and DeLucia, 1969; Butterfield, 1972; Ramey et al., 1972, 1975). The following is an exploration of issues that may have constrained conditionability in the present study. Many of these issues have been addressed in past reviews of infant operant conditioning (see Fitzgerald and Porges, 1971; Lancioni, 1980).

Conditioning procedure

Certain aspects of the conditioning procedure do not appear to be well suited to facilitating sucking in these infants. Phase A required that infants produce sucks that equaled or exceeded the average of their median sucking amplitudes during Baseline at a rate 50% greater than Baseline frequency. This criterion may have been too stringent for the initial phase of conditioning. An alternative approach may be to shape sucking amplitude requiring only small increases in the criteria levels. A possible procedure may be as follows:

1. Baseline: Require two, 5-minute measurements of infant sucking rather than the four baseline measurements made in the current study. This would reduce the number of noncontingent sessions prior to conditioning.

2. Phase A (Contingent Reinforcement): Reinforce infants for sucks that equal or exceed the average of the two median sucking amplitudes attained during Baseline. This criterion would be maintained until 50% or more of the infant's sucks equal or exceed criterion for one, 5-minute phase. When this level of responding occurs, the amplitude criterion level could be raised by 10%. The amplitude criterion would be maintained until 50% or more of the infant's sucks equal to or exceed criterion for one, 5-minute phase. Thus, the amplitude criterion could be raised by intervals of 10% until the median amplitude of one, 5-minute phase is 25% greater than the highest median amplitude demonstrated during Baseline.

3. Phase B (Noncontingent Reinforcement): Expose infants to one, 5-minute phase of noncontingent reinforcement. The number of reinforcements presented during Phase B would equal the number presented in the previous 5-minute phase.

4. Phase A (Contingent Reinforcement): Conditioning procedures follow those described in Phase A. The

initial amplitude criteria would be the median sucking amplitude during Phase B.

As noted above, only two phases of baseline would be used in the new conditioning procedure, in contrast to four phases conducted in the present study. Feeding in the infant seat for an extended period without reinforcement might interfere with later conditioning, due to associations made to the nonreinforcing experimental situation. Infants may turn off their responses in the experimental situation if it has been nonreinforcing in the past. While a reduction in the number of baseline sessions might hamper data interpretation, in some cases, reducing the number of baseline sessions may facilitate conditioning.

Temporal relationship between reinforcement delivery and emission of response

Many researchers suggest that to be effective reinforcement has to be delivered immediately after the emission of the response. Ramey and Ourth (1971) suggest that this is particularly important with atypical infants. Millar (1972) as well as Bijou and Baer (1961) suggest a linear relationship between level of responding and delay of reinforcement, with highest level of responding present with immediate reinforcement. The importance of the immediacy of reinforcement delivery

has been a central focus of the present operant procedures. As discussed in detail in the methodology section, computer software was developed that could continuously analyze sucking waveform topography and deliver immediate reinforcement. However, there were periodic problems in reinforcement delivery, whereby reinforcement was generated for sucks of a lesser amplitude than the criterion level. This may have interfered with the infant's acquisition of high amplitude responses. This problem has been corrected and should not be a factor in future research.

Characteristics of the reinforcement

The type of reinforcements used are a factor in the effectiveness of an operant conditioning procedure. The types of visual and auditory reinforcements used in the present study have been shown to be effective in other studies of infant conditioning, as described previously (Butterfield, 1968; Sinqueland and DeLucia, 1969; Ramey et al., 1972, 1975; Siperstein, 1973). In addition, most infants, both those involved in instrumentation development and those involved in conditioning, demonstrated interest in the reinforcements presented. This was especially apparent for the visual reinforcement. It is doubtful that the characteristics of the reinforcements presented constrained conditionability.

However, the duration of reinforcement presentation may have influenced the effectiveness of conditioning. Manipulations of the duration of reinforcement presentation may need to be made to find the most optimal duration. A shorter reinforcement presentation might facilitate conditioning by encouraging the infant to suck more frequently to maintain reinforcement presentation. A one-second presentation, in contrast to the two-second presentation used in the present study, may be a more effective procedure with these infants. On the other hand, it is possible that a longer reinforcement presentation may be more effective. Longer durations may allow more processing time for these infants, i.e. more time to learn the response-contingent relationship.

Number of conditioning sessions per day

Increasing the number of conditioning sessions per day might facilitate conditioning in these infants. For many infants in the present study, clinical observation suggests that it took several sessions to become comfortable in the experimental situation. Conditioning data also suggest that changes in sucking indices might only occur after extended exposure to conditioning procedures. Ramey (1981) suggests that nonorganic failure to thrive infants, as compared to normal

infants of similar ages, may require a greater amount of exposure to conditioning procedures for behavioral change to occur. While the researcher cannot increase the length of the hospital stay, the number of sessions per day can be increased. Two, 10-minute conditioning sessions per day were used in the present study. Ramey (1981) suggests that increasing the number of sessions to three per day might increase the effectiveness of conditioning.

Habituation as a factor in responding

Overall, it has been noted that the administration of the same reinforcer produces habituation and that some change in the reinforcement event results in higher levels of responding. In terms of auditory reinforcement, Butterfield (1978) and Siperstein (1973) found that variations in auditory reinforcement are crucial in maintaining the infant's interest in the reinforcement. Studies by Caron, Caron and Caldwell (1971) and Hopkins, Zelazo, and Kagan (1973) illustrate the importance of variation in terms of visual reinforcement. While in the present study, there was continual variation in auditory reinforcement, there was less variation in visual reinforcement. The conditioning protocol required a change in visual reinforcement only if habituation was indicated. It is possible that the

clinical judgment of the experimenters was not an adequate measurement of habituation and that visual reinforcement will need to be changed on a more regular basis to facilitate conditioning.

Location of visual reinforcement and presence of distraction

It has been demonstrated that when presenting visual reinforcement, the location of that reinforcement in reference to the infant's visual field is important. Specifically, Millar and Schaffer (1972, 1973) demonstrated that visual reinforcement should be delivered in the center of visual field. This was taken into consideration in the design of the instrumentation system. In addition, to enhance attention to the reinforcements, as many external distractions as possible were eliminated. The experimental room was equipped with lighting that could be adjusted for intensity. Lighting in the room was dimmed to enhance the presentation of reinforcement and to eliminate distractions. However, some possible sources of distraction are unavoidable. For example, it is necessary that an experimenter be present during conditioning to hold the feeding bottle and attend to the infant while he is in the infant seat. Although the experimenter makes every attempt to stay out of the infant's line of vision, it is possible that the presence of

the experimenter is a distraction that interferes with conditioning. On the other hand, there is no reason to believe that adults are especially salient social stimuli for non-organic failure to thrive infants. One would only expect interference with conditioning from effective competing stimulation. In any event, the question of experimenter effects will need to be further considered in this ongoing study. Lastly, while the railing on the crib in which the infant sits is lowered approximately 18 inches below the projection screen, it is possible that the metal bars may be distracting. These can be covered with plain material to reduce any possibility for distraction.

Situational factors

Koch (1967) discusses the impact of the unnatural experimental situation on the effectiveness of operant conditioning. In general, the reinforcement value of a stimulus might not only depend on its physical characteristics but on the situation in which it is delivered. While previous studies have successfully conditioned a variety of target behaviors in a laboratory situation, feeding in an unfamiliar situation may be especially troublesome for nonorganic failure to thrive infants. As noted in the case histories, many of these infants were easily disrupted by environmental changes.

Modifications may have to be made in the experimental situation to facilitate the effectiveness of the conditioning procedure.

Biobehavioral state

Biobehavioral state often has been noted as a factor related to conditionability in infants, although as Lancioni (1980) suggests there has been little systematic study of this issue as it relates to operant conditioning. Fitzgerald and Brackbill (1976), discussing classical conditioning, report that biobehavioral state has been shown to affect a variety of parameters of unconditioned responding. They suggest that it is important to consider state as a variable. As discussed in the results section, there are indications that biobehavioral state may have interfered with conditioning. Nonorganic failure to thrive infants deviated significantly from the optimal biobehavioral state of alertness. They were frequently either irritable or lethargic. Lanciano suggests that conditioning should be conducted during alert biobehavioral states. He notes that wake-up or soothing procedures need to be prolonged beyond the immediate appearance of an alert state, to ensure stability of that state. This was a significant problem for the present research, as infants did not maintain alert states for long periods. Whereas some

infants became more alert during conditioning, manipulating these infants into an alert state prior to conditioning is a problem that needs further investigation. It is possible that the time schedule of conditioning may have to be changed to provide a better match between the infant's hunger state and time of conditioning. Many infants were quite irritable prior to a feed, while others appeared to "turn off" their hunger response and become withdrawn or sleepy. Conditioning between feedings, while hunger may be at more moderate levels, may be a solution to the problem of non-optimal biobehavioral state. However, such variations in conditioning will have to be monitored carefully so that they do not lead to non-effective conditioning of the sucking response. For example, the intent of this research is to enhance sucking when the infant is hungry so that the feeding experience becomes pleasant and effective for producing weight gain. To strengthen sucking independent of hunger would be counter-productive for intervention.

Conclusions

Failure to demonstrate consistent positive results does not indicate that non-organic failure to thrive infants cannot modify their sucking through operant conditioning procedures. The two most prevalent

findings in this study were the lack of response-contingent stimulation in the histories of these infants and their atypical biobehavioral states. These two factors may have been severely constrained conditionability among these infants. Ramey (1981) and Ramey and Finkelstein (1978) suggest that previous experience with response-contingent stimulation affects later response-contingent learning. Thus, given the lack of response-contingent stimulation in the histories of these infants, it is not surprising that conditioning was not demonstrated easily. Increases in the number of daily conditioning sessions may enhance conditionability. As respect to biobehavioral state, the types of procedural modifications previously discussed may increase the infant's alertness prior to conditioning, thereby enhancing conditionability. Overall, a variety of parametric and situational modifications must be investigated before operant conditioning is ruled out as a possible intervention for nonorganic failure to thrive infants.

The individual differences reported in the present study suggest that continued modification of conditioning procedures may be a worthwhile undertaking. Operant conditioning procedures are able to take individual differences into account so that intervention can be tailored to individual infants. In addition,

an intervention that focuses on response-contingent stimulation seems especially important for nonorganic failure to thrive infants, who generally present histories lacking in these types of experiences.

Future Research

The following are areas for future research:

Modification of conditioning procedures

Future investigation of the effectiveness of conditioning procedures must take into account the procedural issues discussed above. Changes need to be made in the number of baseline sessions, the conditioning criteria, the number of sessions per day, the times during which sessions occur, and the length of reinforcement presentation. In addition, changes in the experimental situation may need to be made to reduce distractions. Manipulation of such parametric and situational factors might result in a more effective conditioning procedure for individual infants.

Lasting effects of behavioral change

If conditioning of sucking can be demonstrated consistently in nonorganic failure to thrive infants, the question arises whether changes in sucking behavior can be maintained over time. The main emphasis of the

present study was on assessing the response of non-organic failure to thrive infants to an operant conditioning procedure. A more comprehensive question is whether this procedure creates lasting effects. While few studies have examined this issue, except for a limited number of target behaviors with older infants (for example see Azrin and Foxx, 1974; Inglis, 1977) the operant literature as a whole suggests that behavioral changes over time can be maintained, given appropriate conditions.

One assumption of the present study was that changes in the sucking and feeding behavior of nonorganic failure to thrive infants could help to break the escalating cycle of this syndrome by providing mothers with a more responsive infant. Mothers would then be better able to learn to respond to infant cues in feeding as well as in other areas. Thus, it makes sense to investigate methods by which mothers of nonorganic failure to thrive infants can learn to provide contingent, intermittent reinforcement of their infants' sucking and feeding behaviors. As described in the review of the literature, intervention in the areas of mother education and psychotherapy are not highly successful, at least in the short run. Perhaps a more successful approach would be to teach mothers to recognize certain parameters of infant behavior and respond to these in ways that

would facilitate these behaviors. In terms of feeding, it may be possible to teach mothers to provide response-contingent stimulation during a feed. One possibility presently being investigated is the development of a hand-held infant feeding bottle that can signal the amplitude and frequency of infant sucking. This could be used to help mothers become more aware of infant feeding behavior so that they could learn to provide reinforcement and encouragement to their infants.

Outcome studies

Long term outcome studies of nonorganic failure to thrive are an important area for future research for two primary reasons. First, given the previously reviewed chronic intellectual, socioemotional, and physical deficits that often accompany the nonorganic failure to thrive syndrome, and the general failure of past intervention programs to prevent these deficits, it is important to investigate the long term effects of the operant intervention on the development of non-organic failure to thrive infants. Second, while numerous studies have explored and documented the potent influences of various aspects of the home environment (for example, Wachs, Uzgiris, and Hunt, 1971; Bradley and Caldwell, 1976a, 1976b), infant attributes (for example Bell, 1971; Lewis and Rosenblum, 1974), and

socio-familial influences (for example, Beckwith, Cohen, Kopp, Parmalee, and Marcy, 1976) on development in normal infants, this type of research has not been conducted with a nonorganic failure to thrive sample. In order to gain a comprehensive understanding of the nonorganic failure to thrive syndrome, it is necessary to identify the critical influences on cognitive, socio-emotional and physical development over time for these infants. This understanding should facilitate the development of more comprehensive and effective intervention programs. An outcome study currently is being developed using infants involved in the operant intervention as well as other nonorganic failure to thrive infants. The overall goal of this study is to explore the synergystic effects of treatment and environmental, psychosocial and infant variables in nonorganic failure to thrive outcome.

Changes in response measures

As previously discussed, changes in the operant conditioning procedure may have to be made to facilitate conditioning. In addition, more sophisticated techniques for data analysis are being considered. While the present research focused on sucking amplitude and frequency, and food intake, future research may focus on parameters of sucking regularity, such as sucking bursts and pauses.

It is important to measure the effect of the operant conditioning procedure on these parameters, which are an integral part of the feeding interaction (Kron, 1967). It also may be important to modify these parameters in nonorganic failure to thrive infants. For this type of analysis, computer hardware will need to be obtained that can store sucking topography as produced in real time, instead of only sucking amplitudes and frequencies.

APPENDIX I

Consent Forms

Infant Feeding Study
Department of Pediatrics

Dear Parent or Guardian:

As you know, the Department of Pediatrics at Hurley Medical Center is conducting a study of infants who have feeding problems, like those of your infant.

One way to help us better understand these types of problems is to get a clearer understanding of how these infants feed. This can be done by measuring the sucking behavior of infants with these problems.

We have developed a special technique that we hope will help infants learn how to feed better. Specifically, your infant will be placed in a special crib for 10 minutes before 2 feedings a day. He or she will feed from a special nipple that is attached to a small computer. The computer measures the sucking. When your baby sucks well, he or she is rewarded, by either hearing music or seeing a picture. Although we can't guarantee that infants will improve with this procedure, we are hopeful that our technique will enable them to learn to suck more strongly.

In addition, your infant will have special physical and developmental testing at the beginning and end of the program, which will last as long as your infant is in the hospital. This testing is very helpful in understanding the development of infants with feeding problems.

Your infant's participation is voluntary. Your infant does not have to participate in this program. In addition, you may decide to remove your baby from the research at any time. However, we hope that you will talk to us about your concerns first. Call either Jolie Brams or Dave Dickey at 766-0460.

Most importantly, whatever you decide, it will not affect the care of your infant. Your infant will receive the same medical care whether he or she is involved in the research or not.

All information that we collect about your infant is confidential. As we obsreve your infant's feeding, we will talk to you and your doctor. But no one, uncluding relatives, will receive any information unless you allow it.

If you want your infant to participate in this important research, please fill out the attached form.

We truly appreciate your time in reading this.

Jolie Brams, M.A.
Child-Clinical Psychologist

David Dickey, M.S.
Director of Biomedical Engineering

Infant Feeding Study

Department of Pediatrics

Dear Parent or Guardian:

As you know, the Department of Pediatrics at Hurley Medical Center is conducting a research study of infants who have feeding problems, like those of your own infant.

One way to help us better understand these types of problems is to get a clearer understanding of how these infants feed. This can be done by measuring the sucking behavior of infants with these problems.

It would be helpful if your infant could participate in this study. To do so, he or she wil be placed in a specially designed crib for 10 minutes before 2 feedings a day. During that time, your infant will feed from a special nipple that measures the infant's sucking.

In addition, your infant will have special physical and developmental testing at the beginning of his or her involvement in the research and again at the end, before he or she goes home. The testing is very helpful in understanding the development of infants with feeding problems.

Your infant's participation is voluntary. Your infant does not have to participate in this program. In addition, you may decide to remove your baby from the research at any time. However, we hope that you will talk to us about your concerns first. Call either Jolie Brams or Dave Dickey at 766-0460.

Most importantly, whatever you decide, it will not affect the care of your infant. Your infant will receive the same medical care whether he or she is involved in the research or not.

All information that we collect about your infant is confidential. As we observe your infant's feeding, we will talk to you and your doctor. But no one, including relatives, will receive any information unless you allow it.

If you want your infant to participate in this important research, please fill out the attached form.

We truly appreciate your time in reading this.

Jolie Brams, M.A.
Child-Clinical Psychologist

David Dickey, M.S.
Director of Biomedical Engineering

Hurley Medical Center
Dept. of Pediatrics
Dept. of Biomedical Engineering

Infant Feeding Project

1. I have freely consented for both my infant and myself to take part in a scientific study being conducted by John W. Tauscher, M.D., Jolie Brams, M.A., and David Dickey, M.S.

2. The study has been explained to me and I understand the explanation that has been given and what my participation and my infant's participation will involve.

3. I understand that I am free to discontinue my participation and my infant's participation in the study at any time without penalty.

4. I understand that the results of the study will be treated in strict confidence and that both myself and my infant will remain anonymous. Within these restrictions, the general results of the study will be made available to me upon my request. I also understand that the investigators will present the general results of their research at professional meetings and in scientific publications.

5. I understand that participation in the study does not guarantee any beneficial results to me or my infant.

6. I understand, that at my request, I can receive additional explanation of the study after my participation is completed.

7. I understand that in the unlikely event of physical injury resulting from research procedures, Hurley Medical Center, its agents, and employees, will assume that responsibility as required by law. Emergency medical treatment for injuries or illness is available where the injury or illnss is incurred in the course of an experiment. I have been advised that I should look toward my own health insurance program for payment of said expenses.

Signatures:

_____
(mother)

Infant name _____ _____
(father)

Date _____ _____
(guardian)

_____
(witness)

APPENDIX II

Data Records

Know Your Baby Scale

I am going to ask you several questions about your baby and I would like you to compare your baby to the average baby. For each of the questions I ask, let's say the average baby scores 20 units. I want you to give me a number that shows how your baby reacts compared to the average baby. For instance, if your baby does something twice as often as the average baby, you would say 40. If your baby does something three times as much as the average baby, you would say 60. If half as much as the average baby, you would say 10; if your baby does not do something at all, you would say zero. You may use any number you wish that shows how your baby compares to the average baby. Any questions?

	If the average baby is 20?
How often is your baby hungry?	_____
How much illness has your baby experienced?	_____
How much does your baby sleep?	_____
How much milk does your baby take during a feeding?	_____
How much does your baby respond to strangers?	_____

ID _____
DATE _____

If the average baby is 20?

How much crying has your baby done? _____

How often does your baby smile? _____

How much trouble has your baby had feeding? _____

How often does your baby coo, babble, make plesant sounds? _____

How much spitting up or vomiting has your baby done? _____

How well does your baby play with you? _____

How much difficulty has your baby had in sleeping? _____

How much does your baby enjoy his/her feedings? _____

How much difficulty has your baby had with bowel movements? _____

How much does your baby enjoy it when you play with him/her? _____

How much trouble has your baby had in settling down to a predictable pattern of eating and sleeping? _____

How often does your baby sleep through the night? _____

How much does your baby "cuddle"? _____

Respondent:
1. mother
2. spouse
3. father of child/not spouse
4. boyfirend/not father
5. her mother
6. her father
7. his mother
8. his father
9. other _____

Historical Data

Infant number _____ Birthdate _____
Condition (E or C) _____ Sex (M or F) _____
Race (A, B, C, D) _____
Weight at admission (lbs) _____
Weight at admission (oz) _____
Length at admission (inches) _____
Admitting diagnosis (coded) _____

Medical history:
Please answer the following with Y or N

Seizures ____	Asthma ____
Chronic respiratory infections ____	Frequent constipation ____
Frequent diarrhea ____	Colic ____
Frequent vomiting ____	Frequent spitting up ____
Trouble sleeping ____	
Enter pre mental raw score ____	post mental raw score ____
Enter pre mental MDI score ____	post mental MDI score ____
Enter pre motor raw score ____	post motor raw score ____
Enter pre motor PDI score ____	post motor PDI score ____

Enter # of previous hospitalizations _____
Is the child breast (1) or bottle (2) fed? _____

How much does infant eat per day? _____

milk ____	formula ____
meat ____	fruits ____
vegetables ____	juice ____
water ____	
other ____ type _____	

What is the most infant eats per day?

milk ____	formula ____
meat ____	fruits ____
vegetables ____	juice ____
water ____	
other ____ type _____	

What is the least infant eats per day?

milk ____	formula ____
meat ____	fruits ____
vegetables ____	juice ____
water ____	
other ____ type _____	

Daily Record

Medications:

Medication? _____

Visits:
Person? _____

Vomiting:
Amount? _____

Number of hours of sleep (last 24 hrs)? _____
# of runny stools (last 24 hrs.?) _____
List medical symptoms (last 24 hrs.):
Symptom _____
Infant Weight (lbs) _____
Infant Weight (ozs) _____
List behavioral observations _____

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