An Efficacy Study of Occupational Therapy With High-Risk Neonates

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This single-subject research study with replication evaluated the effect of daily occupational therapy on the nutritive and nonnutritive sucking behaviors of three high-risk, premature infants. At the time of entrance into the study, the infants were 34 to 35 weeks old and were documented poor feeders. Treatment consisted of individual, multimodal sensory stimulation, with emphasis on proprioceptive and vestibular input, graded to the sensory needs of the infants. Movement components of the jaw and tongue during nutritive and nonnutritive sucking were measured during baseline and intervention phases to assess the infants' sucking ability. A comparison of testing results revealed that during intervention the total sucking scores improved significantly for two of the three infants and that rapid changes occurred in the oral-motor function of all three infants. The results of the study suggest that occupational therapy can improve the rate of development of sucking in the premature neonate. However, future research needs to be done to isolate the specific techniques of treatment that produce positive changes.

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One of the primary concerns of the interdisciplinary team caring for the infant in the neonatal intensive care unit (NICU) is the infant's ability to feed (Casaer, Daniels, Devlieger, & DeCock, 1982; Trykowski, Kirkpatrick, & Leonard, 1981). The neonate's oral-motor function and ability to consume adequate nutrition orally is often one of the factors that determine the length of stay within the NICU and the types of follow-up services recommended at discharge (Braun & Palmer, 1986). A number of factors relate to the neonate's ability to feed efficiently; among these are sucking ability, gestational age, muscle tone, heart rate, respiratory status, and level of arousal (Kron, Ipsen, & Goddard, 1973; Trykowski et al., 1981).

The occupational therapist must consider both physiological and neurobehavioral characteristics when intervening to improve feeding function in the neonate. Of particular concern are the infant's regulation of behavioral states, tolerance of sensory input, response to sensory input, muscle tone, and motor organization. The underlying problems are identified, and then treatment plans and procedures are developed that address those components. Intervention methods involve the use of tactile, vestibular, and proprioceptive input. Objectives are to facilitate movement, improve self-regulation of behavioral states, improve muscle tone, and assist in motor organization (Als, 1986; Cornell & Gottfried, 1976; Field et al., 1986; Scarr-Salapatek & Williams, 1973; White & Labarba, 1976). Occupational therapists are generally familiar with these sensory systems and with methods for facilitating adapted, organized responses through multimodal sensory stimulation (Ayres, 1972; Farber, 1982; Pelletier & Palmeri, 1985).

Treatment of the neonate involves an interactive approach that uses specific handling techniques in a highly individualized manner (Anderson, 1986; Pelletier & Palmeri, 1985). The therapist carefully considers structural alignment, muscle tone, muscle function, and sensory systems and is guided by the infant's responses to handling (Forsyth, 1986). The effect of treatment designed to meet the individual sensory needs of infants may best be studied by conducting single-subject design research in which the individual progress of the infant is recorded and analyzed. Single-subject research allows the method of treatment and the rate of functional change to be objectively compared within infants. Variables are controlled by the infant serving as his or her own control (Ottenbacher, 1986).

Literature Review

Oral-Motor Skills in Neonates

The feeding behaviors of premature and at-risk neonates have been described in the literature (Casaer et
Various intervention strategies have been implemented to improve the oral-motor skills of neonates with feeding difficulties. Bernbaum, Pereira, Watkins, and Peckham (1983) researched the effects of nonnutritive sucking on a pacifier had on nutritive sucking during gavage feeding in 30 premature infants whose birth weight was <1,500 g. The addition of nonnutritive sucking accelerated the maturation of the sucking reflex, facilitated a more rapid transition from gavage to oral feeding, decreased intestinal transit time, and caused more rapid weight gain, resulting in a shortened hospital stay.

The efficacy of oral-motor stimulation for increasing nutritive sucking was investigated by Trykowski et al. (1981). These researchers examined the effect of perioral stimulation on nutritive sucking in high-risk neonates. The treatment consisted of light-touch-pressure stimuli to the oral musculature. Infants who received this treatment prior to feeding demonstrated a significantly higher rate of sucks per minute and ingested more formula. Trykowski et al. concluded that perioral cutaneous stimulation applied during the feeding of premature infants with known sucking problems appeared to enhance the rate of sucking.

**Intervention With High-Risk Neonates**

In general, intervention methods involving sensory stimulation have resulted in improved outcomes for the high-risk neonate (Field et al., 1986; Leib, Benfield, & Guidubaldi, 1980; Masi, 1979; Neal, 1968). Optimal amounts of sensory stimulation appear to improve arousal time, activity level, and visual attention. In studies by Field et al. (1986) and White and Labarba (1976), premature infants who received tactile and kinesthetic stimulation gained significantly more weight than those who did not. In other studies in which vestibular-proprioceptive stimulation was administered through oscillation on a waterbed, the infants who received the stimulation demonstrated better weight gain, decreases in the incidence of respiratory pauses, and improved maturity and modulation of movement (Korner, Guilleminault, & Vanden Hoed, 1978; Korner, Schneider, & Forest, 1983).

Excessive stimulation may be detrimental to the neonate. It has been demonstrated that premature babies in neonatal intensive care units are overstimulated and that sensory input may be overstressing them, causing excessive caloric loss that ultimately affects their growth (Long, Philips, & Lucey, 1980).

In the present study, the occupational therapy intervention methods made use of handling techniques and graded sensory input to facilitate postural alignment and reciprocal movements appropriate to developmental age. The vestibular, tactile, and proprioceptive inputs were carefully applied to promote arousal and attention and to heighten or reduce muscle tone (Anderson, 1986). The sensory stimulation followed an open-spiral approach in which attention was given to each response of the infant and guidance was based on his or her response. As was recommended by Forsyth (1986), the goals of the intervention were to develop a sensorimotor acceptance of movement, organization of tone and movement from the central axis of the body, and an active use of
righting reactions upon which motor skills could be developed. The effectiveness of this method in promoting organization of sucking patterns and oral-motor skill in high-risk neonates was evaluated in the present study. Given evidence from other studies of general benefits from appropriate sensory stimulation, this study investigated the specific effects of treatment on the quality of oral-motor function.

**Method**

A single-subject research design with replication was used to evaluate the effect of daily occupational therapy on the nutritive and nonnutritive sucking behaviors of three high-risk premature infants.

**Sample**

The three infants of the NICU selected for this study were documented problem feeders (e.g., the infants required nasal gastric feeding; oral feeding required excessive time or excessive assistance by caretakers). The infants were 34 or 35 weeks’ estimated gestational age at the time of the first evaluation and were at risk for sensorimotor dysfunction due to documented hypoxia, respiratory distress syndrome, intraventricular hemorrhage, asphyxia, cyanosis, or other medical problems.

Infant 1 was born at 28 weeks’ estimated gestational age (established on the basis of the Dubowitz and Dubowitz Clinical Assessment of Gestational Age [Dubowitz & Dubowitz, 1977]). His Apgar scores were 3 at 1 minute and 3 at 5 minutes. His medical history included respiratory distress syndrome, Grade 4 intraventricular bleed, hyperbilirubinemia, and pneumonia of the right lower lobe. At the time of entrance into the study he was 34 weeks’ gestational age, and on 51/2 oxygen per nasal cannula. He weighed 1140 g and was gavage fed more than 50% of his formula intake.

Infant 2 was born at 31 weeks’ gestational age. Her Apgar scores were 4 at 1 minute and 6 at 5 minutes, and her birth weight was 1280 g. Her medical problems included respiratory distress syndrome, bradycardia, and Grade 4 intraventricular hemorrhage. At the time of entrance into the study she was 35 weeks old, weighed 1430 g, and was fed partially by nasal gastric tube (less than 30% of feeding).

Infant 3 was born at 27 weeks’ gestational age and had Apgar scores of 1 at 1 minute and 6 at 5 minutes. Her birth weight was 1070 g, and her medical history included respiratory distress syndrome and patent ductus arteriosus with ligation several weeks after birth. At the time of entrance into the study she was 35 weeks old, weighed 1515 g, and was fed orally 30 cc every 3 hours.

**Instrumentation**

The infants were evaluated by one of two clinicians or by the principal investigator, all of whom had experience in administering the instrument and in treating high-risk neonates. A revised version of the Neonatal Oral Motor Assessment Scale (NOMAS) (Braun & Palmer, 1986) was repeatedly administered to assess the sucking behaviors of the three infants during baseline and intervention phases.

The NOMAS identifies and quantifies neonatal oral-motor behaviors. The assessment enables the therapist to analyze individual tongue and jaw motor responses during nonnutritive and nutritive sucking. After conducting a pilot study with premature neonates, we revised the scale to improve specificity of the items and to increase sensitivity by rating frequency of the oral-motor behaviors. We evaluated the test–retest reliability of the revised NOMAS by testing it on 26 premature infants (34–38 weeks’ gestational age) who were identified as problem feeders. In repeated testing in a 24-hour interval, test–retest reliability ranged from .67 to .83. Interrater reliability, calculated by using another sample of 15 premature, “poor feeder” neonates, ranged from .93 to .97 on the scale’s subsections.

In a discrimination analysis, scores on the revised scale accurately classified 13 of the 16 dysfunctional feeders (“required nasal gastric feeding supplements”), 17 of the 21 inefficient feeders (“slow or difficult to feed”), and all 18 normal, full-term neonates (“without feeding problems”) (Case-Smith & Bauer, 1987).

**Instrument Administration**

A standard procedure was used to administer the NOMAS. The infants were gently aroused to an awake state, in which their eyes were open and motor activity was present (Behavioral State 3, 4, or 5 on the Brazelton scale [1973]). The assessments were initiated 20 to 30 minutes prior to the infants’ regular feeding times. Tests were not performed immediately after stressful procedures or excessively fatiguing events. The author and two clinicians trained in use of the NOMAS alternately administered the assessment.

Sucking was evaluated with the infant in the examiner’s lap with the neck and head held in neutral alignment or in slight flexion. Nonnutritive sucking was rated by observing the infant sucking or mouthing on the examiner’s fifth finger for 1 minute. Nutritive sucking was then rated by having the infant suck on a premature infant nipple while ingesting the formula specified in the infant’s medical orders. The infant’s oral-motor responses were observed for a 5-minute interval during feeding with removal and reentry of the nipple two to three times.
The normal characteristics for nutritive and non-nutritive sucking were rated according to their frequency of occurrence. Responses were scored 2 for characteristics occurring consistently or greater than 50% of the time, 1 for inconsistently or less than 50% of the time, and 0 for not at all. Abnormal characteristics were scored as present or absent, and were considered present if seen one or more times.

Design
An A-B single-subject design with replication was used (Ottenbacher, 1986). The A-B design was selected because of ethical considerations and limitations in the amount of time that the infants were in the NICU. Baseline measures were collected approximately every other day for a 1- to 2-week period so that a minimum of five evaluations were completed. During the intervention phase, each infant received therapy 5 days per week and evaluation data were collected every 2 to 4 days. Data collection was discontinued when the infant was discharged from the NICU.

Procedures
Treatment principles fundamental to occupational therapy were followed in intervention. These included open-ended interaction with the neonates, individualized multimodal sensory stimulation, and consideration for preterm sensory system development. All these principles form the basis of early treatment, which is preventative, that is, designed to enhance normal responses, motor organization, control of state, and automatic reactions (Als, 1986; Pelletier & Palmeri, 1985).

Occupational therapy was divided into seven activities, which the therapist implemented while holding the infant in her lap. The therapist did the following:

1. She handled the infant proximally to protract and depress the shoulders and elongate the neck extensors, and practiced subtle weight shifts on the upper thorax. With her hands at the pelvis, she rolled the infant from a supine to a sidelying position.

2. With the infant well supported in correct spinal alignment and chin tuck, the therapist applied joint approximation through the head and shoulders. Precautions were observed on hand placement to avoid pressure over the anterior fontanelle.
3. With the infant supported at the shoulders and upper thorax, she facilitated head righting during subtle weight shifts of the infant in prone and semi-sitting positions.

4. With the infant in a prone or upright position, she provided linear vestibular stimulation in the anterior-posterior or lateral plane. The vestibular stimulation and concomitant proprioceptive input were graded according to the responses of the infant.

5. She applied perioral stimulation, then rhythmic pressure to the infant's tongue. While the infant was sucking, she assisted in jaw and tongue stability through gentle and constant pressure to the base of the infant's tongue (under the mandible).

6. She positioned the infant in slight flexion during feeding.

7. She taught the infant's parents feeding, handling, and positioning methods.

Treatment sessions were 20 to 30 minutes long if feeding was not included and up to 45 minutes long if feeding followed the handling and sensory input.

**Results**

Data were collected in a 3- to 6-week period when the infants were between 34 and 40 weeks old. Subscores for nutritive and nonnutritive sucking and total scores were graphed for baseline and intervention phases. All the infants demonstrated increasing scores throughout the baseline and intervention phases, as might be expected in a rapidly maturing neonate.
Profiles

The profiles for the infants at the end of the baseline and intervention phases were notably similar. All three infants were characterized by the following observations with minimal deviation between infants. Throughout the baseline phase, sucking was characterized by a lack of consistency in rate and rhythm of jaw movement. Jaw movements were minimal excursions or poorly graded, inconsistent excursions. The tongue appeared flattened and was inactive during sucking. Mouth closure and spontaneous initiation of jaw movement were consistently present by the end of the baseline phase.

Assessments at the end of the intervention phase documented a consistent sucking rate and rhythm across infants. The tongue movement had increased to the point of efficiently expressing liquid from the nipple. The tongue was cupped at times, but tended to remain flattened with disorganized extension-retraction movements. The remaining deficits were instances of lack of rhythm, clenching on the nipple, and inconsistent jaw excursion.

Visual Analysis

Celeration lines were drawn through the baseline data to facilitate visual inspection of assessment results. Nonnutritive sucking for Infant 1 during intervention followed the celeration line established during baseline, which indicates that for this infant there was no change in the trend of nonnutritive sucking development (see Figure 1). In Infants 2 and 3, however, a slight improvement in nonnutritive sucking occurred, as more than half the scores during intervention were above the celeration line (see Figures 2 and 3).

Changes in nutritive sucking were also modest. Although scores during intervention for Infants 1 and 2 were above the celeration line, nutritive sucking scores for Infant 3 fell below the sharply rising celeration line established during baseline (see Figures 4, 5, and 6).

When total scores for sucking are examined in Figures 7, 8, and 9, it is apparent that intervention scores are definitely above the baseline trend for Infants 1 and 2. Using the binomial test of statistical significance (Kazdin, 1982; Ottenbacher, 1986), we found that the total sucking scores for Infants 1 and 2 indicated a significant change between phases ($p < .05$). Total sucking scores for Infant 3 are evenly distributed above and below the celeration line, which suggests that no change in the development of sucking occurred with intervention.

Discussion

Interpretation of these results is limited for several reasons. Because premature infants tend to mature rapidly, baseline data were characterized by an ascending trend line rather than by a level trend line at a fixed point. Significant autocorrelation of sucking scores and the existence of relatively few data points prohibit the use of traditional statistical analysis of these data. Given that rapid changes in behavior are the norm for these infants, differences due to intervention are difficult to document and interpret. The relatively short periods of baseline and intervention were necessary since the behaviors measured are specific to neonates and are not observed in older infants. The results of early intervention with the neonate need to be assessed over a longer period of time; however, instruments appropriate for measuring neo-
nental behaviors are not appropriate for measuring the behaviors of older infants. The instrument used in this study is applicable only to infants less than 44 weeks old; thus, its use in single-subject research over an extended period of time is limited.

Despite significant changes in the sucking behaviors of two of the infants during occupational therapy intervention, informal impressions were that sucking responses depend on a set of complex variables that the therapist needs to consider when correlating sucking behaviors with occupational therapy. Nutritive sucking, in particular, seemed to be affected by a number of factors, including the infant's metabolic and respiratory status. Nutritive and nonnutritive sucking are also affected by the hunger, heart rate, and breathing patterns of the child, as well as by behavioral state, energy level, and other physiological factors (Kron et al., 1973). For these reasons, sucking behaviors may not be accurate or reliable outcome measures of occupational therapy intervention. At the same time, oral feeding represents a functional outcome and is often a goal of occupational therapy treatment.

The results of this study suggest that occupational therapy can improve the rate of development of sucking in the premature neonate; however, it is unclear from the data which treatment variables produced the positive changes. To clarify the effect of specific techniques, additional studies should examine the effect of different types of sensory input, such as vestibular-proprioceptive or perioral tactile stimulation. An alternating treatment single-subject design (Ottenbacher, 1986) could be applied to evaluate the different methods. It is also recommended that baseline and intervention phases be initiated at different gestational ages to investigate whether the changes in developmental rate occur as a consequence of age or of intervention. Measurements of multiple parameters in the neonate, for example, speed and amount of feeding intake or weight gain, would further clarify the effect of intervention. Studies incorporating group experimental design with well-defined intervention methods and multiple measurements of neonatal behaviors would improve the external validity of further investigations of occupational therapy efficacy with neonates.

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References


