Oral Sensorimotor Therapy in the Developmentally Disabled: A Multiple Baseline Study

(mental retardation, single subject research)

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The efficacy of a program of sensorimotor facilitation procedures to improve oral motor function and feeding behaviors in students with severe developmental delay was explored. Four severely handicapped students were administered the oral habilitation program using a multiple baseline across-subjects design with staggered introduction of the treatment. Graphic analysis and the split-middle method of trend estimation revealed that one subject evidenced an increase in weight and improved oral motor evaluation as a result of the intervention. Two other subjects displayed partial improvement. The correlates of treatment effectiveness are briefly discussed and the need for continued investigation is emphasized.

The feeding process is often taken for granted by parents and educators. It represents, however, a developmental sequence that may be modified or facilitated through therapeutic intervention. Palmer (11) was one of the original investigators to delineate the necessary components of feeding. Bosley (22) a student of Palmer's, completed a detailed analysis of the development of sucking and swallowing. More recently, Shepherd (3) conducted an in-depth analysis of the maturation patterns of oral motor reflexes and emerging oral motor skills. Shepherd's study involved filming various oral activities followed by a frame-by-frame analysis of the oral function involved. Morris (4) and Wilson (5) have provided therapists with a detailed analysis of oral-motor development and common oral motor dysfunctions. Mysake (6), Bosma (7), and Ingram (8) also explored and elaborated on the importance of oral reflex development and integration in establishing normal feeding patterns. Recently, Campbell (9) reviewed the neural circuits involved in the control of basic oral reflexes and activity. She presented a theoretical model for understanding rhythmic oral patterns. The model posits a central pattern generator that produces the sequence of movements common to many functional oral activities. According to this model, sensory stimulation can influence oral motor activity; however, the specific effect will vary depending on the state of the musculature and central nervous system.

The effect of abnormal oral development has been studied by various investigators. For example, Bosma (10) studied the rate and rhythm of sucking bursts in normal and "clinically suspect" subgroups of premature infants. He found that low sucking rates and "disorganized" sucking were associated with infants categorized as "high risk." In a similar study, Wolf (11) investigated the serial organization of sucking patterns in 40 healthy newborns. He noted little variation in the sucking patterns of normal infants after the 4th day of life; however, he found that premature infants tended to suck in a disorganized manner during the first week of life.

The persistence of any "normal" oral reflex beyond the time of its expected integration may be an indication of oral-motor delay or disorder. For instance, a persistent suckle pattern results in the tongue moving backwards in the oral cavity. This precludes the tongue tip elevation necessary for a more developed swallow pattern. As more sophisticated movements are required of the musculature, it may become evident that the child is unable to adequately bite, chew, or swallow foods. This may be accompanied by a hyper- or hypo-sensitivity of the oral region and oral cavity. The alignment of the oral musculature may also be subject to changes in postural tone and position. This in turn interferes with general oral function. The child gradually establishes abnormal movement patterns in conjunction with feeding.

Techniques that employ sensorimotor facilitation procedures to
normalize tone and reduce abnormal reflex activity are available, and they are extensively employed by occupational therapists serving the developmentally disabled (12-14). Despite this fact there is little empirical evidence that these procedures are effective in normalizing feeding patterns dysfunctional because of neuromotor or oral reflex pathology. Indeed, Snell noted that almost no experimental tests of intervention procedures recommended for use with oral motor dysfunction exist (15).

Previous research revealed that severely handicapped persons tend to be underweight (16). Berg (17) found that developmentally delayed children who manifested eating problems had abnormally low body weight and a reduced percentage of body fat compared to "normal" children of the same age. The normalization of the feeding pattern should lead to both an improvement in oral motor behaviors and an increase in body weight in severely and profoundly handicapped individuals with feeding disorders because of oral motor dysfunction. Recent studies suggest that the efficacy of a program of oral motor therapy to achieve the above goals was investigated (18). This feeding program was based on principles outlined by Mueller (19) and Rood (20) and presented by Galland (21, 22). A pre-test post-test control group design was employed involving 20 severely and profoundly retarded individuals with feeding disorders. Analysis revealed no statistically significant difference in body weight gain or development of specific feeding behaviors over the 9-week treatment period. However, two subjects in the treatment group did appear to evidence relatively large weight gains when compared to the other subjects. The authors speculate that the gains made by these two subjects were "masked" by the data pooling statistics used in the group analysis. They recommended that future research in this area employ alternate design and analysis procedures that do not rely on data pooling techniques that may obscure clinically significant differences (18).

Table 1
Descriptive Information for Each Subject (N = 4)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age (years, months)</th>
<th>Functional Range</th>
<th>Diagnosis</th>
<th>Number of weeks</th>
<th>Initial wt. (lb)</th>
<th>Initial oral evaluation score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.7</td>
<td>Severe MR</td>
<td>46XX with translocation of 22 chrom</td>
<td>2</td>
<td>10</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>6.9</td>
<td>Profound MR</td>
<td>Multiple congenital anomalies</td>
<td>4</td>
<td>6</td>
<td>98</td>
</tr>
<tr>
<td>3</td>
<td>24.6</td>
<td>Profound MR</td>
<td>Brain damage at birth-Seizure Hx</td>
<td>6</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>4</td>
<td>10.11</td>
<td>Profound MR</td>
<td>Sturge-Weber Syndrome</td>
<td>8</td>
<td>4</td>
<td>58</td>
</tr>
</tbody>
</table>

Methods

Subjects. Subjects were four students identified by a habilitation team, including a state-licensed psychologist, as severely or profoundly retarded. All resided in a state-supported facility for the mentally retarded and evidenced some degree of neuromotor disorder. The specific diagnosis, age, and other identifying information for each subject appear in Table 1.

All the subjects were partially dependent in most areas of self-care and were identified by the residential staff as problem feeders; that is, they required some assistance in feeding and evidenced some degree of oral motor pathology.

Apparatus. To determine the degree of oral-motor dysfunction and plan an individual program of therapy, each subject was administered an evaluation of oral-motor and feeding function adapted from the Vineland Assessment Battery (13). The evaluation consisted of two parts. Part I measured, on a 4-point ordinal scale, four oral reflexes, the position of the tongue at rest, and the degree of drooling present. These items were not part of the Vineland Assessment Battery. Part II was a more direct assessment of feeding skills that were also rated on a 4-point ordinal scale. The 21 items were taken from the 75 total feeding behavior items included in the Vineland Assessment Battery. These particular items were chosen because they covered lower-level feeding behaviors more appropriate for the population under investigation. For items in both parts of the evaluation, a score of 4 indicated the most normal, independent, performance. A total score of 21 was possible on the reflex portion of the evaluation, and a maximum of 84 was possible on the feeding assessment portion of the evaluation.

The evaluations were administered by two occupational therapists experienced in oral-motor assessment and therapy. Inter-rater reliability was previously obtained for six subjects and resulted in a coefficient of 81 (18).

Procedure. The treatment em-
ployed in this study included three major components: the inhibition of abnormal oral and postural reflexes, the facilitation of normal muscle tone, and the desensitization of the oral region.

Inhibition of Abnormal Oral and Postural Reflexes. Because oral reflexes disrupt the normal feeding pattern (3), they were inhibited by several techniques. The most obvious procedure is manual intervention with the musculature as the reflex occurs. For example, abnormalities in sucking resulting from the presence of a suckle reflex were reduced by jaw control manipulations that prevented excursions during the ingestion of liquid or pureed food. This was accomplished by exerting upward pressure on the mandible as it depressed. Similar inhibition procedures were used with other oral reflexes, such as the rooting and bare reflex (3, 21).

Facilitation of Normal Muscle Tone. The individual may be unable to perform normal movements once abnormal reflex patterns have been inhibited. Normal movement was facilitated by a variety of procedures, including direct manual guidance of the musculature through the desired movement, the use of quick stretch and the tonic vibration reflex to produce a contraction or counteract spasticity, or the use of pressure to the muscle or tendon to inhibit abnormal contractions (21, 22, 24).

Desensitization of the Oral Region. The threshold of tactile stimulation in the oral region may be abnormally low in some individuals with severe developmental disabilities (29). This increased oral sensitivity may make contact in the oral area unpleasant and may interfere with feeding. Oral desensitization procedures included gradually increased tactile stimulation in the oral region and eventually in the oral cavity itself until tolerance was developed for the degree of contact necessary for feeding therapy.

The exact treatment program for each subject was based on the initial oral-motor evaluation and an observation of the individual subject's feeding pattern. Specific treatment techniques were drawn from those proposed by Gallen et al. (21, 22), who provides detailed guidelines and instructions for more than 200 treatment techniques for oral motor and feeding problems in the following areas: sucking, swallowing, jaw movement and stability, lip closure, breathing patterns, chewing, tongue mobility, drinking patterns, and the control of abnormal reflexes. All therapy was administered on an individual basis by two occupational therapists experienced in pediatric treatment. During the intervention period each subject received approximately 30 minutes of therapy a day, 5 days a week. Some subjects received therapy just before or in conjunction with their meals, and others were scheduled
for therapy at various times during the day. Which children received therapy during or just before meal times was determined by the therapist administering the treatment and based on the nature of the oral motor or feeding problem exhibited by the student.

Subjects were randomly assigned to treatment order and a multiple baseline design across subjects with staggered intervention was employed. In this design the treatment is applied to succeeding subjects in a staggered manner so that the baseline for each subject increases in length (25). The staggered baselines provide added control to the design.

If the behavior exposed to staggered treatments changes, then the efficacy of the intervention is strengthened. This is because it becomes increasingly implausible that rival hypotheses would simultaneously influence each target behavior at the same time that the staggered intervention was introduced. In this particular design the intervention was introduced at 2-week intervals throughout the 12 weeks of the study.

All four students received the same type and amount of food from the Center's central kitchen. Food consistency ranged from pureed to normal depending on the feeding skills of the particular individual. Each student was assisted in feeding as needed by an aide assigned to that unit. The aides were aware that the student was in a study but were unaware of the hypotheses under investigation or whether the subject was in the baseline or intervention period of the study.

The subjects' weights were recorded on a weekly basis by aides who were also unaware of the specific hypotheses under study or the status of the students in the program, that is, whether they were in the baseline or intervention phase. An attempt was made to record weights on the same day of each week and at approximately the same time.

Finally, the oral motor evaluation described previously was also administered to each student on a weekly basis by a registered occupational therapist. The oral evaluation was administered on the same day each week and at approximately the same time.

Results

Figures 1 through 3 graphically
Figure 8
Graph of oral evaluation scores for Subject 2

Figure 7
Graph of oral evaluation scores for Subject 3

Figure 8
Graph of oral evaluation scores for Subject 4

Visual interpretation of the
graphs for each of the four
subjects is difficult. Subjects 2 and 3
displayed increases in weight during
the intervention phase, whereas Subjects 1 and 4 evidenced
decreases in weight. Subjects 1 and 4 exhibited gains in their oral motor evalu-
ation scores during the intervention phase, whereas the oral evaluation scores for Subjects 2 and 3 remained relatively stable or declined slightly during treatment.

To further clarify and quantify the
graphic analysis, the split middle
method of trend estimation was
computed for responses from each
subject (26). This technique provides
a method of describing the rate of change over time for a single
individual. First, data points are
plotted as shown in the Figures.
Then the split middle technique
estimates the slope or "line of progress." The line of progress runs in
the direction of behavior change
and indicates the rate of change.
This line is also referred to as the
"celeration line," a term derived
from the notion of acceleration (if
the line of progress is ascending) or
deceleration (if the line of progress
is descending). The works of White
(27) and Kezin (26) contain
details for calculating celeration lines.
In the calculation of the celeration
lines in this study, the mean was
used instead of the median, since
the mean was believed to be more
representative of the total number
data points. The remainder of the
calculations followed the
procedures outlined by White (27).

The celeration lines for each
phase of the study are included in
the figures corresponding to that
subject's response pattern. The
slope of the individual celeration
lines indicates the rate of change for
a particular phase. The change
across phases can then be evaluated
by comparing the levels and slopes
of the celeration lines for the base-
line and intervention phases. The
slopes for weight versus oral eval-
uation measures do not correspond
visually because of the fact that the
intervals on the ordinate for the two
measures are not equal.
Table 2
Results of Binomial Tests for Each Subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>Direction of Change</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>Decrease</td>
<td>.001*</td>
</tr>
<tr>
<td>Subject 2</td>
<td>Increase</td>
<td>.004</td>
</tr>
<tr>
<td>Subject 3</td>
<td>Decrease</td>
<td>.02</td>
</tr>
<tr>
<td>Subject 4</td>
<td>Increase</td>
<td>.05</td>
</tr>
</tbody>
</table>

* p-level computed by using additional weight measures from medical records to provide more baseline data.

To determine whether a statistically significant change in behavior across phases was present, a simple statistical test was employed (25). To compute the test, the slope of the baseline is extended through the intervention phase (see Figures). The probability of a data point during the intervention phase falling above the projected slope of the baseline is 50 percent (p = .50), given the null hypothesis that there is no change in performance or rate across the phases. The binomial test was applied to the data for the four subjects. The results appear in Table 2.

Celeration lines were not computed for the baseline period for Subject 1 because of the small number of responses recorded during this phase (N = 2). An approximate celeration line for the weight measure for Subject 1 was calculated by using values that existed in the student's records. These weight measures were recorded on a monthly rather than on a weekly basis. The values for the 2 months previous to the study (which do not appear on the graph) were used to calculate the estimated celeration line for the baseline in Figure 1.

Discussion
The analysis of the data from the four subjects revealed mixed results. During the intervention phase only Subject 1 exhibited significant changes in both weight and oral evaluation scores. One subject demonstrated a significant increase in weight (p = .004), and two subjects showed a decreasing trend in weight. The subject also displayed decreasing trends in oral evaluation scores during the intervention phase. The celeration line for Subject 1 indicated an increasing trend in oral evaluation scores, but the significance of this trend is not readily apparent.

Particularly enigmatic are the changes in direction of celeration for some measures. For example, both the baselines for Subject 3 indicated a slightly increasing trend. However, after 6 weeks of intervention, the trend for both measures was in the opposite direction. The reasons for these changes are not readily apparent.

The treatment appeared to produce unequivocal beneficial effects for Subject 1 (see Figures 4 and 8) but proved to be ineffective for Subject 3 (see Figures 5 and 7). The other two subjects appeared to experience some partial benefits (see Figures 2 and 5). The subject for whom the intervention was least effective was also one of the youngest (10 years, 11 months). He had a very low initial weight (45.6 lbs) and the lowest baseline oral evaluation scores. His body weight was obviously significantly below the norm for male children of comparable ages. On the other hand, the subject for whom the treatment was least effective was the oldest student (24 years, 6 months) and the heaviest (188 lbs). This student's weight was not unusually low and it may have been unrealistic to expect weight gain in this particular case. It should also be noted that Subject 3's initial oral motor evaluation scores were low, and no improvement was noted in this area during intervention. Obviously, improvement was expected in the area of oral motor function for this subject in spite of his relatively "normal" weight.

Three of the subjects (1, 2, and 4) evidenced initial body weights considerably below the norm, not an unusual finding for members of this population. Two of the three subjects with low body weights displayed increases in weight during the intervention phase (see Figures 2 and 5). In spite of the weight gains made by two of the subjects, it may be that the dependent measure of weight gain lacked sufficient sensitivity to changes in feeding patterns and an alternate dependent measure such as amount of food consumed or time spent in feeding may be more sensitive. Also, the fact that many severely handicapped persons are underweight does not in itself justify its use as a dependent measure. It should first be established that increasing weight gain in this population correlates with improved health. Increasing weight gain in severely handicapped nonambulatory students may have a negative impact on the ability of aides, parents, and others who must lift and position these students.

One of the obvious limitations of this investigation is the lack of
homogeneity among the subjects in terms of age and weight (see Table 1). For the design employed to be maximally effective, it would have required subjects closely matched on several variables of interest. Unfortunately, students in this study had to be selected who had not previously been involved in a comprehensive feeding program and for whom parental or guardian consent could be obtained.

Finally, although the results of this investigation are mixed, the intensive design procedures employed did reveal individual improvements or partial improvements in three of the four students. The study also demonstrated the usefulness of single-subject multiple baseline designs in evaluating the clinical progress of students receiving a program of oral-motor rehabilitation. The procedures employed in this study can be readily adapted to any clinical setting to provide a systematic method of gathering data and measuring change on an individual basis. The importance of being able to quantitatively document change or the lack of change, as a function of therapy is obvious. As additional cases demonstrating similar changes are reported, clinicians will be able to apply therapeutic procedures with an increased degree of confidence. As Hacker notes, "When the causal relationship between a therapeutic technique and the improvement of individuals with a particular dysfunction can be documented across the variables of individual differences, settings, and therapists, the potential of that approach becomes well substantiated." (28, p 105)

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A copy of the evaluation protocol may be obtained from the senior author.

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