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. Graphical 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 (1) was one of the original investigators to delineate the necessary components of feeding. Bowlby (2), 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. Myske (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 circuitry 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 11 healthy newborns. He noted little variation in the sucking patterns of normal infants after the 4th day of life; however, he (11) found that premature infants tended to suck in a disorganized pattern 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 attempts to evaluate the effects of a program of oral motor therapy to achieve the above goals was investigated (18). This feeding program was based on principles outlined by Muller (19) and Rood (20) and presented by Gallender (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).

The purpose of this study was to investigate the efficacy of a program of oral motor habilitation using an intensive (single-subject) design to emphasize the individual effects of the intervention program. It was hypothesized that functional improvement in an individual's feeding patterns would lead to improved oral motor skills and also to an increase in body weight, and that these improvements would be more evident using a single-subject design.

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 function adapted from the Velpe Assessment Battery (23). 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 a part of the Velpe Assessment Battery. Part II was a more direct assessment of 21 feeding skills that were also rated on a 4-point ordinal scale. The 21 items were taken from the 37 total feeding behavior items included in the Velpe 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, or independent, performance. A total score of 24 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 (5, 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 (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
therapies during or just before mealtimes
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 em-
ployed. 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 effi-
cacy of the intervention is strength-
ened. 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
teaching 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 re-
corded on a weekly basis by aides
who were also unaware of the specific
hypotheses under study or the
status of the students in the pro-
gram, 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 evalua-
tion described previously was also
administered to each student on a
weekly basis by a registered occupa-
tional therapist. The oral evalua-
tion was administered on the same
day each week and at approxi-
mately the same time.

Results

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

Figure 7
Graph of changes in oral evaluation scores for Subject 3

Figure 8
Graph of changes in oral evaluation scores for Subject 4

portray the changes in weight for each of the four subjects during the baseline and intervention periods, whereas Figures 5 through 8 contain information related to changes in oral motor performance revealed by the administration of the oral motor evaluation.

Visual interpretation of the graph results 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 evaluation 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 “celebration 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 Kedem (26) contain specifics for calculating the lines. In the calculation of the celebration 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 of data points. The remainder of the calculations followed the procedures outlined by White (27).

The celebration lines for each phase of the study are included in the figures corresponding to that subject’s response pattern. The slope of the individual celebration 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 celebration lines for the baseline and intervention phases. The slopes for weight versus oral evaluation measures do not correlate 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>Weight Decrease</td>
<td>.001*</td>
</tr>
<tr>
<td></td>
<td>Oral Evaluation Increase</td>
<td>-1</td>
</tr>
<tr>
<td>Subject 2</td>
<td>Weight Increase</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Oral Evaluation Decrease</td>
<td>.004</td>
</tr>
<tr>
<td>Subject 3</td>
<td>Weight Decrease</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Oral Evaluation Decrease</td>
<td>.02</td>
</tr>
<tr>
<td>Subject 4</td>
<td>Weight Increase</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>Oral Evaluation Increase</td>
<td>.06</td>
</tr>
</tbody>
</table>

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

No binomial test was computed because of the lack of a celeration line during the baseline (too little baseline data).

To determine whether a statistically significant change in behaviors across phases was present, a simple statistical test was employed (28). 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 (celeration line) 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 demonstrated increases in both weight and oral evaluation scores, one exhibited a significant increase in weight (p = .004), and two subjects showed a decreasing trend in weight. Two of the subjects 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 unclear because of the lack of baseline data.

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 benefits for Subject 1 (see Figures 1 and 8) but proved to be ineffective for Subject 3 (see Figures 3 and 7). The other two subjects appeared to experience some partial benefits (see Figures 2 and 5). The subject for whom the intervention was most 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 (158 lbs). This student's weight was not unusually low and it may have been unrealistic to expect weight gain in his 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 aids, 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 habilitation. 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.

REFERENCES