Effects of Adaptive Seating Devices on the Eating and Drinking of Children With Multiple Handicaps

Janet Bower Hulme, Jay Shaver, Sandra Acher, Leslie Mullette, Connie Eggert

Key Words: cerebral palsy • feeding behavior • positioning

The purpose of this study was to explore the effects of adaptive seating on oral-motor functioning as it relates to eating and drinking in 11 children with multiple handicaps between the ages of 1 and 4 years. An assessment instrument with a behavioral base was used for the seven direct observations of each child's motor behavior. During the first and last visit the parent or guardian filled out a pre- and post-equipment questionnaire. Evaluations were conducted every 6 weeks beginning 3 months before and ending 6 months after the receipt of the seating devices. An analysis of variance was used to analyze rating scale score data. A nonparametric sign test was used for the analysis of yes/no data. Other data were analyzed for frequencies and central tendencies. Sitting posture and head alignment during eating and drinking improved significantly. A significant increase in the frequency with which liquid and food was retained in the mouth was noted. A significant number of children progressed from bottle to cup drinking and from eating blended to chopped or cut-up food. The present research extends beyond case study and retrospective study reports to support the efficacy of the use of adaptive seating devices by children with multiple handicaps.

Positioning to normalize muscle tone and minimize the influence of abnormal postural reflex mechanisms has become an accepted standard of practice in evaluating and treating oral-motor dysfunction in persons with multiple handicaps. Stratton (1981) suggested that overall muscle tone and reflex patterns are directly reflected in the oral area and that "the client's position should be closely documented...with specific concern focused on head and shoulder alignment" (p. 719). Ottenbacher, Hicks, Roark, and Swiney (1983) stated, "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" (p. 541). According to Ogg (1975), the most important motor function related to feeding is control of the head and neck.

The use of Adaptive Seating Devices (ASDs) has been described in several studies where control of the head and trunk and maintenance of symmetrical alignment were considered important precursors to oral-motor intervention and feeding (Dunkel & Treffler, 1977; Hulme, Poor, Schulein, & Pezzino, 1983; Moore, Berman, Edwards, Cowsar, Echols, & Forbes, 1982; Ray, Bundy, & Nelson, 1983; Roberts, 1982). Gendreau (1980) proposed that positioning is the most important consideration in preparing the client for a meal and that special adaptations are usually needed for optimum results. Larsen (1980) suggested that adaptive behavioral changes result from the use...
of seating devices that stabilize the individual in an optimum position. Banerdt and Brecker (1978) reported that positioning a child in an adaptive high-chair improved the child's ability to move his hand to his mouth and thus to begin self-feeding with minimal assistance. Hulme et al. (1983) concluded from caretakers' retrospective perceptions that self-feeding behavior improved after ASDs were introduced.

The literature describes only general beneficial effects of positioning in ASDs. No studies were found that evaluated the specific behavioral effect of positioning in ASDs on oral-motor components and functional feeding skills. Nor were there studies that considered the use of ASDs as a variable in evaluating the effectiveness of various oral-motor treatment techniques. The purpose of the present study is to evaluate the effectiveness of positioning in ASDs in relation to (a) maintenance of head alignment during eating, (b) retention of food in the mouth during eating, (c) change in consistency of food eaten, (d) maintenance of head alignment during drinking, (e) retention of liquid in the mouth during drinking, (f) change in method of drinking, (g) change in time spent eating, (h) change in self-feeding behavior, (i) frequency of tongue protrusion behavior, and (j) frequency of lip closure behavior.

This study was part of an ongoing research effort to evaluate the impact and effectiveness of ASDs used by persons with multiple handicaps. It extended previous studies through a longitudinal design with di-

**Figure 1**
Assessment Instrument for Evaluating Eating and Drinking Activities

<table>
<thead>
<tr>
<th>CHILD:</th>
<th>DATE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE OF BIRTH:</td>
<td>HEALTH:</td>
</tr>
<tr>
<td>DAYS OF PREMATURITY:</td>
<td>MEDICATION:</td>
</tr>
<tr>
<td>EVALUATOR:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ATC R P TESTS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>x or %</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. a. Drink - lip closure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fluid Consumed:</td>
<td></td>
</tr>
<tr>
<td>b. Drink - tongue inside</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Drink - head in extension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Drink - no lost liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. a. Food - lip closure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Food Eaten:</td>
<td></td>
</tr>
<tr>
<td>b. Food - tongue inside</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Food - head not in extension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Food - no lost food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Alertness (A,E,C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DEMOGRAPHICS**

**%**

Drinking: The Client Uses
- Bottle
- Straw
- Cup/Glass
- Other

Eating: The Client
- Uses Spoon
- Finger Feeds
- Is Fed

The Client Eats
- Pureed Food
- Chopped Food
- Cut Up Food
- Independent
- Physical Prompt
- Jaw Control
- Other Control: Where?
rect observation of behavioral skill changes seen in conjunction with ASD use.

**Method**

**Subjects**

The accessible population for this research consisted of all persons with multiple handicaps in Montana between the ages of 0 to 18 years who were scheduled to receive adaptive seating devices (ASDs) for the first time and whose performance was not at criterion level on eating and drinking activities as measured by the observation tool (see Figure 1). Community contacts such as Easter Seal and the developmental disability division of regional care providers referred clients to the study. Permission for the subjects’ participation in the research was obtained from parents or guardians after the study was explained to them. The protocol of securing informed consent was reviewed and accepted by the University of Montana Human Subjects Committee.

Sixteen persons were referred to this study. Two subjects were independent in eating and drinking behaviors when referred, 2 subjects did not use the ASDs when they received them, and 1 subject died before the visits were completed. Thus, 11 subjects participated in this study, 8 girls and 3 boys.

The subjects ranged in age from 1 year and 6 months to 3 years and 9 months, with a mean age of 2 years and 6 months. Six subjects had spastic tone, 2 were hypotonic, 1 had mixed tone, and 2 had severe mental retardation or a genetic disorder without a specified change in tone. Four had seizure disorders. All 11 subjects lived in their natural or adoptive homes. Each served as his or her own control in the sense that the subject’s behaviors observed before equipment receipt were compared to the subject’s behaviors observed with equipment use.

**Adaptive Seating Devices**

Subjects received custom-made seating devices while participating in the study. Six of the ASDs were designed for transportation and positioning. Five were designed for positioning only. Head support was provided for subjects not having independent head control. All subjects had trunk support, hip stabilization, thigh support, foot support, and a tray. Other components of the ASD varied with the needs of each subject. The ASDs were fabricated from lexan, foam, and/or wood. Optimum positioning was based on sitting position principles described in *Positioning the Client with Central Nervous System Deficits: The Wheelchair and Other Adapted Equipment* by Bergen and Colangelo (1985). The head was maintained in the vertical plane, the trunk was upright, hips were flexed to a greater than 90° angle to neutralize a posterior tilt or prevent pelvic thrust, knees were flexed to a 90° angle, ankles were in neutral or slight dorsiflexion, and feet were supported.

**Assessment Methods**

An assessment instrument and coding system, using both a behavioral base and direct observation, was used to evaluate motor activities, including sitting, head control, eating, and drinking. Table 1 gives, in detailed form, directions for each activity, measurement techniques for each activity, and criteria for each activity. Subjects were seen in their homes seven times with 6-week intervals between each visit. They received the ASDs between the third and fourth visit and were tested in the ASDs the last four visits.

Each subject was seen in her or his home starting approximately 3 months before and concluding approximately 6 months after receipt of the ASDs. The time of day for the visits varied because of the varied schedules of the subjects. Visits were scheduled during periods of the day when the subject was in an alert, nonfussy state according to the criterion established by the assessment instrument. Visits were scheduled when the subject would be hungry by the end of the observation period. The duration of the observation period for each visit ranged from 60 to 90 minutes.

The subject’s behavior, such as lip closure or head position, was observed by the examiner using the assessment instrument while the care giver simulated regular daily activities and procedures typically used in intervention programs. During each visit, ten trials of each activity were observed and the results recorded except when the subject lost interest (i.e., refused food or drink, or fussed) or when visual attention to the stimulus (i.e., food, drink, a picture, or a toy) could not be obtained.

Five examiners assessed the performance during the home visits. The same examiner saw a given subject through all visits except when sickness intervened. Interrater reliability was established among the examiners with an 80% accordance being considered reliable. Reliability was established by the following procedures: (a) viewing videotapes of nonhandicapped children performing the required skills, (b) viewing videotapes of children with handicaps, and (c) observing children with handicaps on site. Reliability checks were made every 2 months and additional training was initiated until all examiners were at 80% accordance at one rating.

During the first and last visit, the parent guardian completed a pre- and postquestionnaire, which included questions on sitting posture, head control, eating, and drinking. On each visit, data were collected from interviews with parents, home trainers, and/or therapists about the training programs and eating habits of the subject.
<table>
<thead>
<tr>
<th>Behavior</th>
<th>Directions</th>
<th>Criterion for Positive Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Controlled Sitting Position (CSP)</strong></td>
<td>At the beginning and after units of 5 trials of other activities, observe S for 60 seconds. Record - If S does not maintain a controlled sitting position for 60 seconds. + If S maintains a controlled sitting position for 60 seconds. Record 10 trials.</td>
<td>S is in a &quot;controlled sitting position&quot; for the 60-second observation. Can be out of CSP for maximum of 10 continuous seconds before the 60-second observation is recorded. Note. Controlled sitting position is defined as follows: Head aligned over shoulders in anterior-posterior plane, trunk in midline aligned over hips. Arms symmetrical, shoulder width or less apart. Hips, knees and ankles flexed at least 90° and feet on stable surface.</td>
</tr>
<tr>
<td><strong>2. Head Control</strong></td>
<td>Instruct P to place S in the best supported sitting possible without P providing support. P places S's head in midline. P stays in front of S and if possible presents toys at eye level or talks to S to encourage S to keep head in midline. E observes head alignment from the side with regard to anterior-posterior position. Record duration the head is held in midline. Record 10 trials of 30 seconds each.</td>
<td>S maintains head in midline with the body with less than 10° deviation anterior or posterior for 30 seconds. S may deviate more than 10° anterior or posterior if S brings it back to midline within 5 seconds.</td>
</tr>
<tr>
<td><strong>3. Drinking</strong></td>
<td>Instruct P to place S in typical position for drinking. P presents glass of liquid (milk, juice) to S's mouth in manner used typically and says, &quot;Drink, (name).&quot; Use clear glass. Record + if positive - if negative L Lip (both) closure in swallowing fluids. T Tongue inside mouth when swallowing (observe from side) H Head not extended during swallowing (observe from side) S Does not lose liquid with each drink/swallow</td>
<td>S closes both lips on glass. S swallows with tongue inside mouth. S maintains head in midline to 20° flexion. Liquid remains in mouth, does not drip off chin with each drink/swallow.</td>
</tr>
<tr>
<td><strong>4. Eating</strong></td>
<td>Ask P how S eats most of his or her meal. Record under demographics. Instruct P to place S in typical position for eating. P presents food to S in typical manner. Record + if positive - if negative L Lip closure in swallowing food T Tongue inside mouth behind teeth when removing food from spoon and swallowing H Head not extended during swallowing (observe from side) S Does not lose food or saliva while chewing</td>
<td>S swallows food with head in midline and does not lose food or saliva while swallowing. S closes both lips around spoon to remove food. S removes food from spoon and swallows food keeping tongue inside lips. S maintains head in midline to 20° flexion while eating. Food remains in mouth, does not go from lips onto chin while S is chewing and swallowing each bite.</td>
</tr>
<tr>
<td><strong>5. Alertness</strong></td>
<td>Record A Alert state focuses attention on source of stimulation, motor activity is at a minimum E Eyes open, considerable motor activity, reactive to external stimuli with increased motor activity C Crying, intense crying, difficult to break through</td>
<td>A—S attends to P, the food, drink, toy or picture. E—S reacts to P, food, drink, toy, or picture with attending behavior and motor activity. C—S cries for more than one minute and cannot be consoled. The evaluation is terminated until a later time.</td>
</tr>
</tbody>
</table>

*Note.* E = examiner; P = parent; S = subject.
Data Analysis

To test the hypothesis that the use of ASDs would significantly change motor patterns, an analysis of variance was used to analyze rating scale score data for sitting posture, eating, and drinking behavior. A nonparametric sign test was used for analyzing questionnaire data that could be responded to with yes or no. Other data, such as data on training programs, sex, and disability, were analyzed descriptively for frequencies and central tendencies. When rating scale score data were analyzed descriptively, 80% of the total trials during a visit were considered as successful target behavior criteria. Averages were determined by using the target behavior criteria from the three “before ASD” visits or from the four “after ASD” visits.

Results

Training Programs

Throughout the period of this study, all 11 subjects were involved in professionally supervised training programs. Programs included training in eating, drinking, reach and grasp, sitting balance, head control, tracking, sensory stimulation, and communication. Eating, drinking, and sitting balance programs were part of a regular regimen for 6 (55%) subjects throughout the study. Two (25%) subjects had eating and drinking or sitting balance programs only after the ASDs were received. Three subjects did not have a sitting balance program throughout the study. Three subjects did not have eating and drinking programs throughout the study. Therefore, the study data were analyzed both with and without training programs as a factor. The results indicated that the areas of significant change remained the same. The authors suggest caution in generalizing these results to other populations because of the small number of subjects and the fact that there was no control group in the usual sense.

Sitting Posture

Sitting posture improved with the use of ASDs. None of the subjects met correct sitting criteria before the ASDs arrived. With the use of the ASDs, 9 met the sitting criteria. Observation data indicated that sitting posture improved significantly during 10 one-minute observations spaced over a 1- to 2-hour period \( F(1,20) = 48.2, p < .01 \) (see Figure 2). The head was maintained in the vertical plane, the trunk was upright, hips were flexed at a greater than 90° angle to neutralize a posterior tilt or prevent pelvic thrust, knees were flexed to a 90° angle, ankles were in neutral or slight dorsiflexion, and feet were supported significantly more with the use of the ASDs \( F(1,20) = \) variable, \( p < .01 \) (see Table 2). Arm position did not change significantly.

Eating

Observation data indicated significant improvement in subjects’ ability to maintain their heads in alignment during eating \( F(1,20) = 10.6, p < .01 \) (see Figure 3). Four subjects held their heads in alignment during eating before ASD use. An average of 6 subjects are with their heads in alignment with the use of ASDs.

The frequency with which food was retained in the mouth during eating significantly increased \( F(1,20) = 17.0, p < .01 \) (see Figure 4). An average of 6 subjects retained most spoonfuls of food in their mouths before receiving the ASDs; an average of 6 subjects retained most spoonfuls of food after using the ASDs.

Tongue protrusion and lip closure around the spoon during eating did not improve significantly.

A significant number of subjects were able to change from eating pureed or blended foods to eating
chopped or cut-up foods \( F(1,20) = 9.7, p = .01 \) (see Figure 5). An average of 7 subjects were eating pureed foods whereas 4 were eating chopped foods prior to receiving the ASDs. Three subjects were still eating pureed foods and 8 were eating chopped or cut-up foods after receiving and using the ASDs.

The questionnaire data indicated a significant increase in the time spent eating dinner (from 25 to 35 minutes) with the use of the ASDs \( (p = .05) \). Nine of the 11 subjects spent more time eating dinner after using the ASDs than before.

**Self-Feeding**

The subjects' ability to self-feed with their fingers or with a spoon did not show significant improvement.

Six were fed throughout the observation period, and 2 were offered finger foods but were primarily fed by the care giver. After receipt and use of an ASD, 1 subject, who occasionally finger-fed, began to self-feed with a spoon, and 1 subject, who was fed with jaw control, began to self-feed with a spoon and assistance from a care giver.

**Drinking**

Significant improvement in maintaining the head in alignment during drinking was observed \( F(1,29) = 6.8, p = .03 \) (see Figure 6). Six subjects demonstrated the skill throughout the observation period. An average of 9 subjects maintained head alignment during drinking after receiving and using the ASDs.
A significant increase in the frequency with which liquid was retained in the mouth during drinking was also observed \(F(1,2) = 13.0, p = .01\) (see Figure 7). A comparison of the first visit with the last visit indicates that 9 subjects showed improvement. Significance was attained based on individual findings indicating a greater intervisit rate of change with the use of the ASDs than without their use.

A significant number of subjects progressed from primarily bottle feeding to cup drinking \(p = .01\). An average of 2 subjects were drinking from a cup prior to receiving the ASDs, whereas an average of 5 subjects were drinking from a cup during the four visits using the ASDs.

Tongue protrusion and lip closure behavior during drinking did not improve significantly.

No significant improvement in independent drinking was observed in this study.

Discussion
The results of this study support the premise that the use of custom-fit ASDs stabilizes the subject in an improved sitting posture for function. With ASD use, the positioning of feet, knees, hips, trunk, and head significantly improved. With the use of ASD support, the hips and arms of 91% of the subjects, the knees and feet of 82%, and heads of 55% were correctly aligned. Head alignment over time and during activities appears to be the most difficult to maintain when ASDs are used.

The results generally support the premise that the use of ASDs that stabilize individuals in an optimum position promotes adaptive behavioral changes in functional feeding skills. It is interesting to note that changes in the functional feeding skills did not correspond with changes in several oral-motor components considered important in this process. It is suggested that compensatory oral-motor patterns may have been used more efficiently with the use of the ASDs and that the oral-motor components investigated may not have been the most sensitive to change relative to adaptive positioning. According to Morris (1975), simple tongue protrusion during swallowing may normally be evident up to the age of 36 months. Wilson (1978) describes studies that indicate the majority of children protrude the tongue until 7 years of age. Since the average age of the subjects in this study was 2 years and 6 months, the normal variation and range of diminution of tongue protrusion may have limited the effectiveness of this component as a variable in the study.

According to the normal developmental progression described by Morris (1975), the successive ability to isolate and control fine movements of the tongue and lips is based on increasing postural jaw stability. Limited postural or internal jaw stability is a common problem among clients with neuromotor impairment. Just as ASDs are used to provide external stability to the client's head, trunk, and hips to enhance more isolated movements of other body parts, the technique of manually stabilizing or controlling the jaw is frequently used by therapists to enhance the development of independent tongue and lip movements. It is proposed that components of jaw stability, as precursors to independent lip and tongue control, be investigated in further studies as indicators of change with use of ASDs.

This study found that a significant increase in eating time corresponded with the use of ASDs. This may not initially be viewed as positive by caregivers, especially not by those in school or institutional settings. However, it is suggested that the increase in eating time may have been the result of two important incidental events with positive developmental implications. One, in some cases the subject was included in the family dining routine with feeding interspersed with the caregiver's own eating and with communication among family members. This situation would provide enhanced social and language stimulation. Two, more time may be required initially to accommodate and assimilate the improved ability to drink from a cup and adapt to a greater variety of food textures. A significant number of subjects in this study demonstrated these two skills when positioned in ASDs. Schwaab, Niman, and Gisel (1986), in a study of normal children's chewing cycles found that puréed food (applesauce) was swallowed in the shortest amount of time and with the least number of chewing cycles compared with solid food (a raisin or graham cracker). Gisel, Lange, and Niman (1984) suggested that time is the parameter that changes with eating.
Summary

This research substantiates previous research that found ASDs position subjects in more optimal sitting positions than is otherwise possible. This research also supports the hypothesis that custom-fit ASDs are effective in improving some components of eating and drinking behavior. Maintaining the head in alignment during eating and drinking improved with the use of the ASDs. Liquid and food were lost from the mouth less frequently. The consistency of food changed from pureed/blended to chopped and cut up. A significant number of subjects changed from bottle to cup drinking.

A more in-depth study of the interaction of training programs and ASDs as they affect components of eating and drinking is recommended. A larger subject pool and a time series analysis using videotaped sessions with multiple observer scoring is recommended to provide additional information.

Acknowledgment

This research was funded in part by the Foundation for Physical Therapy.

References


