Adaptive seating devices (ASDs) are used in the treatment of children with multiple handicaps. This longitudinal study evaluated, through direct observation and parent-guardian assessment, the behavioral changes seen with the use of ASDs and programming. Nineteen individuals with multiple handicaps and developmental disabilities, aged 1 to 6 years, participated as subjects. Data were collected by a trained observer from eight on-site evaluations and from parent-guardian responses to a preequipment and postequipment questionnaire. Evaluations were made every six weeks, starting about three months before and ending about six months after receiving the seating devices. The activities observed were head control, controlled sitting posture, visual tracking, reach, and grasp. Rating scale data were analyzed using an analysis of variance and a Friedman's test. Other data were analyzed descriptively for frequencies and central tendencies. Sitting posture, head control, and grasp improved significantly. Parent perceptions of the equipment indicated that the chairs freed parents from the need to provide support for their children's activities of daily living, which enabled them to participate in other activities with the children and around the home.

Key Words: Equipment design, Handicapped, Pediatrics, Physical therapy, Posture.

Adaptive seating devices (ASDs) often are recommended for nonambulatory individuals with developmental disabilities. Children with multiple handicaps, especially those with moderately to severely disabling cerebral palsy, have difficulty maintaining head and trunk stability. Movements of arms and hands disturb a precarious balance. Movement of the head frequently results in abnormal upper extremity movement, which interferes with hand movement. Abnormal upper extremity and head movements "are serious problems for a child in play, educational, or later vocational settings." Finnin stated that the basis for head control during activities of daily living is adequate control of the whole body. Good total body positioning becomes the basis for attending behaviors and visually directed reach and grasp.

Physical therapists working with individuals with multiple handicaps are asked frequently to recommend a suitable chair to accomplish one or more of the following goals: 1) maintain a functional position, 2) increase comfort in sitting, 3) improve head and trunk control, 4) decrease abnormal muscle tone and reflex patterns, 5) improve capability to participate in an educational or a community setting, and 6) improve manipulation skills. Since the late 1960s, several types of ASDs have been developed. The use of wood, metal, Lexan, or polyethylene foam to construct ASDs is described by many authors. Hobson and colleagues developed a process of vacuum forming plastic around a plaster mold of the client. A plastic shell was developed by Chailey Heritage Hospital in England. Vacuum packing of Styrofoam beads into a seat mold was described by Roberts and Moore and associates.

Studies reporting evaluation results of ASDs are sparse. Moore et al evaluated 1) client maintenance of functional positioning, 2) client comfort, 3) ease in moving the client in and out of the seat, 4) ease in handling and carrying the seat, 5) whether the client preferred the device, and 6) whether the seat was being used and for what activities. The results indicated that the seats were being used for toileting, school activities, feeding, transportation, camping, and positioning. Teachers and therapists stated that their clients were able to sit more comfortably using the ASDs than when using other chairs.

In a group of 25 patients with cerebral palsy using molded ASDs for periods of up to three years in England, the data indicated that management, comfort, and functional capability improved for almost all individuals. Trefer et al, in a study of seating and positioning supports, concluded that students' ability to hold their head in alignment with their trunk increased significantly with use of ASDs. The mean sitting time while maintaining trunk control also improved significantly. The mean daily sitting time with ASDs was seven hours, as compared with about six minutes without the
The authors concluded that with positioning equipment students with multiple handicaps could sit for longer periods of time and therefore be more attentive and participate more in the classroom.

O'Brien and Tsurumi compared the effect of sitting in an ASD to being positioned prone over a bolster on the student's ability to align the head. They concluded that "head righting of severely handicapped individuals with cerebral palsy is no different while positioned in semiprone from head righting while seated in a wheelchair." Hulme et al used questionnaires to assess the caregivers' retrospective perceptions of the clients' behavioral changes after use of ASDs in conjunction with training programs. The behaviors of sitting upright, visual tracking, and grasping improved significantly according to the caregivers. They reported that the clients spent more time with others and visited more new places in the community after receipt of the equipment.

The purpose of this longitudinal study was to evaluate with direct observation and with parent-guardian questionnaire the effectiveness of ASDs. We hypothesized that use of ASDs would 1) improve positioning and increase the time spent in functional positions; 2) produce positive behavioral changes in the motor skill activities of head control, visual tracking, reach, and grasp; 3) improve the client's social interaction within the community; and 4) provide increased freedom and support for the caregiver.

METHOD

Subjects

The accessible population for this study included all individuals with multiple handicaps in Montana between the ages of 0 to 18 years who were scheduled to receive ASDs and whose performance was not at criterion level in head control, sitting posture, visual tracking, reach, and grasp as measured by observation. Community health care providers, such as regional Easter Seal and Developmental Disability Division agencies, referred clients to the study. When a client was referred to the Easter Seal Adaptive Equipment Program or became a client in the Developmental Disability Division regional program, the senior author (J.B. Hulme) contacted the client's family to explain the project and to schedule an initial visitation date. The clients' parents or guardians indicated their willingness to participate in the study by signing a consent form. The protocol of securing informed consent was approved by the University of Montana Human Subjects Committee.

Twenty-seven clients were referred to the study. Two clients' performances of the skills measured by observation were at criterion level, 3 clients did not use the ASDs when the equipment was received, 1 client moved, 1 client had surgery, and 1 client died before completion of the visits. Thus, 19 clients participated in this research.

These 19 clients (13 girls, 6 boys) ranged in age from 16 months to 3 years 9 months, with a mean age of 2.4 years. Eight of the clients had spasticity, 3 had hypotonicity, 4 had mixed tone, and 4 had severe mental retardation or a genetic disorder without specific abnormal tone. Five of the 19 clients also had seizure disorders. All clients were nonambulatory and nonverbal at the initiation of the study. All clients lived in their natural, adopted, or group homes. The clients served as their own controls with behaviors observed before receipt of the equipment being compared with behaviors observed with use of the equipment.

Adaptive Seating Devices

Clients received ASDs while participating in the study. Ten of the ASDs were designed for transportation and positioning. Nine were designed for positioning only. Head support was provided for those clients not having independent head control. All clients had trunk support, hip stabilization, thigh support, foot support, and a tray. The ASDs were fabricated from Lexan, polyethylene foam, or wood. Optimal positioning was based on sitting position principles discussed by Bergen and Colangelo.

An assessment instrument and coding system based on a behavioral approach were designed (J. B. Hulme, K. Gallagher, P. Lambert, and A. McKinnon; unpublished data; 1981) and used to evaluate, through direct observation, the clients' motor activities, including sitting, head control, visual tracking, reach, and grasp (Appendix 1). The clients were observed in their homes every six weeks starting about three months before and concluding about six months after receipt of the ASDs. Time of day for the visits varied because of the varied schedules of the clients. Visits were scheduled during periods of the day when the client was in an alert, cooperative state. After the optimum observation time for each client was identified, it was maintained consistently throughout the remaining observations. The duration of the observations varied from 60 to 90 minutes. The client's behavior was observed by the examiner using the assessment instrument while the parent or guardian simulated regular daily activities and procedures typically used in intervention programs. During each visit, 10 trials of each skill were observed and the results recorded, except when the client lost interest, that is, refused food or drink, became uncooperative, or did not concentrate visually on the test stimulus.

Five examiners assessed performance during the home visits. The same examiner saw a given client throughout all visits except when examiner sickness intervened. Interrater reliability was established among the examiners using an 80% level of accordance as the criterion measure. Reliability was established by the following procedures: 1) viewing videotapes of children without handicaps performing the required skills, 2) viewing videotapes of children with handicaps, and 3) observing children with handicaps during on-site visits. Reliability checks were made every two months, and additional training was initiated if examiners fell below the 80% level of accordance.

During the first and last visits, the client's parent or guardian completed a preobservation and postobservation questionnaire, which included questions on sitting posture, head control, visual tracking, reach, and grasp (Appendix 2). On each visit, data were collected from interviews with parents or guardians, home trainers, or therapists about the training programs in which each client was involved.

Initially, eight clients (Group 1) were observed in their homes four times between January 29, 1982, and December 28, 1982, with three-month intervals between visits. These clients received the equipment after the second visit and were observed using the ASDs during the last two visits.

After analyzing the data from the four visits, we decided that more complete conclusions could be formulated if more visits were made during the same time span. The study, therefore, was extended to include 11 additional clients who were observed in their homes seven times with six-week
Differences before versus after the use of ASDs, was the OVA) and a Friedman's test were used to analyze rating scale data for head control, sitting posture, visual tracking, reach, and grasp. The ANOVA, which would indicate significant differences before versus after the use of ASDs, was the primary analytical measure. Because of our concerns about the normal distribution of the patient population, however, the Friedman's test also was performed for confirmation. Only ANOVA results that were confirmed by the Friedman's test are reported. The rating scale data referred to descriptively for frequencies and central tendencies. A non-parametric sign test was used for analysis of the questionnaire data that could be responded to with either yes or no.

Rating scale data from Group 2 clients with seven home visits were analyzed. Data from the Group 2 clients were collapsed for the four visits that coincided with the three-month visit intervals of the Group 1 clients. The combined data of Groups 1 and 2 formed Group 3 data with a total of 19 clients. These combined data were analyzed separately using the same methods.

RESULTS—GROUP 2
Training Programs

All 11 clients in Group 2 participated in professionally supervised training programs. These training programs included sitting balance, head control, visual tracking, reach, and grasp (Table). The study data, therefore, were analyzed both with and without training programs as a factor where it was appropriate. The results indicated that the areas of significant change remained the same. We suggest caution in generalizing these results to other patient populations because of the small sample size and because the study did not involve a control group that participated in the training programs without ASDs.

Sitting posture. Sitting posture improved with use of ASDs. Observation data indicated that sitting posture improved significantly during 10 one-minute observations spaced over a one- to two-hour period (F = 48.2; df = 1,20; p ≤ .01). The head was maintained in the vertical plane (F = 49.0; df = 1,20; p ≤ .01); the trunk was upright (F = 22.9; df = 1,20; p ≤ .01); the hips were flexed to about 90 degrees (F = 20.2; df = 1,20; p ≤ .01); the knees were flexed to 90 degrees (F = 19.4; df = 1,20; p ≤ .01); and the ankles were in neutral or slight dorsiflexion, and the feet were supported (F = 39.5; df = 1,20; p ≤ .01). Arm position did not change significantly. None of the clients met the predetermined sitting criteria before using the ASDs; after use of the ASDs, 9 clients met the sitting criteria. On the first visit, 2 of the 11 clients' feet were in a functional position; on the last visit, 9 clients' feet were in position. On the first visit, 2 clients' knees were in a functional position; on the last visit, 9 clients' knees were in position. On the first visit, 5 clients' hips were in a functional position; on the last visit, 10 clients' hips were in position. On the first visit, 4 clients' heads were in alignment; on the last visit, 6 clients' heads were aligned. On the first visit, 8 clients' arms were in a functional position; on the last visit, 10 were. Ninety-one percent of the caretakers reported that the clients' ability to sit upright improved with use of the ASDs.

Head control. Head control was observed while the client focused visually on an interesting object, picture, or face. Head control in the anterior-posterior direction for 30 seconds improved significantly (F = 48.3; df = 1,20; p < .01). Two clients maintained head control on the first visit; 10 did on the last visit.

Visual tracking. Visual tracking horizontally and vertically did not demonstrate significant improvement with direct observation. Forty-three percent of the parents or guardians perceived that the clients' ability to turn their head to follow a moving object improved.

Reach. Direct observation indicated that complete reach (eg, reaching to touch a toy) did not improve significantly. Three clients did not exhibit complete reach during any of the observations. Three clients exhibited complete reach on the first visit, and seven exhibited complete reach on the last visit. Their improvement, however, was not significantly greater with the use of the ASDs. The lack of significant change in reach was supported by parents' or guardians' reports that their child's reach did not improve after use of the ASDs.

Grasp. Direct observation indicated that radial and digital grasp improved significantly (F = 8.4; df = 1,20; p ≤ .02). When analyzed separately, neither radial nor digital grasp improved significantly. One client exhibited radial and digital grasp on the first visit, and five clients exhibited radial and digital grasp on the last visit. Parental perceptions supported the significance in grasp improvement, although not specifically differentiating between types of grasp.

Social Interaction

Descriptive data from the parent-guardian questionnaires indicated that parents and guardians could feed and play with their children more easily when they were using the ASDs. The clients could be in an upright position in the family room or living room without being supported directly by a family member. Family members found that shopping and going out to eat were easier when their children used the ASDs. Two families took long plane trips for the first time after receiving the ASDs.

Positioning

The data indicated that time spent sitting increased significantly (F = 59.1; df = 1,20; p < .01) and that the time spent
lying down decreased \((F = 8.9; \ df = 1.20; p \leq .02)\). On the first visit after receipt of the ASDs, 73% of the clients were using them four or more hours a day for sitting. On the last visit six months later, 60% of the clients were using the ASDs four or more hours a day.

**RESULTS—GROUP 3**

The data from the 19 clients who were observed four times supported the significance of the Group 2 results. Sitting posture improved significantly \((F = 34.7; \ df = 1.20; p \leq .01)\). Head control also showed significant improvement in the Group 3 data \((F = 9.7; \ df = 1.20; p \leq .01)\). The significance of radial and digital grasp improvement also was substantiated by the Group 3 data \((F = 8.4; \ df = 1.20; p = .01)\). Neither reach nor visual tracking changed significantly.

**DISCUSSION**

The results of this study reflect changes in positioning, motor behavior, and social interaction with use of ASDs by children with multiple handicaps. All clients used the ASDs a minimum of two hours a day, and 60% were using them four or more hours a day six months after receiving them. This finding indicated acceptance of the chair into part of the daily routine. Interestingly, we found a decrease in the percentage of clients (from 73% to 60%) using ASDs four or more hours a day over the six months observed. The equipment may have lost some of its uniqueness, or the client may have gained more independence in other positions such as prone standing. Although the clients outgrew the chairs periodically, the adaptive equipment specialist redesigned the chairs so that this was not a factor affecting the amount of time the clients spent in the ASDs. Observational data indicated that more independence in sitting did not occur; therefore, the decrease in the amount of time using the ASDs could not be attributed to the clients sitting without use of the ASDs.

All components of sitting posture except arm position improved with use of the ASDs. Sitting posture before the ASDs were controlled by the caretaker while the client sat on the caretaker’s lap or in a high chair. Even though the caretaker actively attempted to control posture, only 45% of the clients’ hips were in a functional position, 36% of the clients’ heads were aligned, and 18% of the clients’ arms were positioned functionally. The caretakers apparently were unable to maintain an optimal sitting position for the children’s functional activities while simultaneously implementing the intervention programs. With use of the ASDs for support, 91% of the clients’ hips and arms, 82% of their knees and feet, and 55% of their heads were aligned correctly. Head alignment over time and during activities appeared to be the most difficult to maintain in the ASDs.

Individuals who are handicapped severely by cerebral palsy often have difficulty maintaining a vertical position of the head. In some individuals with cerebral palsy, the head is in almost constant movement. In others, it falls into the plane of gravity and cannot be raised because of inadequate muscle control. In still others, spastic muscle groups or uninhibited reflexes maintain the head in an abnormal posture that restricts function.\(^1\) One study involving head control training of clients with cerebral palsy using audiobiofeedback found that when feedback was removed after nine weeks of training, the head control performance decreased.\(^1\) This study indicated that postural awareness remained under volitional control rather than progressing to an automatic state. The authors concluded that the biofeedback-stimulated head control required that the children divide their attention between postural stability and any eye-hand activity they were attempting. The ASDs in our study provided external control and stability that maintained improved head and trunk alignment to enable the clients to give their full attention to activities involving distal movements, such as grasp.

The concept that clients can be "trained" to achieve head control automatically has not been documented. We suggest that until this concept is substantiated, clients with multiple handicaps who have deficient head control need external head and trunk stabilization to perform prehension activities, instead of expecting them to control their head in space volitionally while simultaneously attempting to develop control and precision in eye-hand activities.

Some of the results of this study simply confirmed what other studies have suggested (ie, that head control and sitting posture would improve with the use of ASDs). Some of the results, however, were unexpected. We hypothesized that ASDs would significantly improve visual tracking, reach, and grasp because we thought that providing proximal stability and head support would facilitate these skills. Instead, we found that visual tracking, or visual pursuit of a moving object, and reaching to touch a toy were not areas of significant improvement. Forty-five percent of the clients could perform horizontal visual tracking on the first visit; 27% of the clients demonstrated complete reach on the first visit. On the last visit, 45% of the clients still could track visually throughout the range of 135 to 180 degrees, and 64% of the clients demonstrated complete reach. The artificial stability of the head made possible by the ASDs did not appear to facilitate visual tracking; the clients could track visually throughout the range using eye movement as much or more than head movement without the ASDs.

Improvement in reach occurred consistently throughout the study, but was not associated significantly with use of the ASDs. Abortive reaching (ie, slapping at an object with the hand) occurs in healthy infants at 2 to 3 months of age.\(^16\) Well-coordinated projected movement of the limb in space occurs only after development of the instinctive grasp reaction and its integration with visual mechanisms. This instinctive grasp reaction progresses from orienting to groping to grasping when a moving object comes into contact with any part of the hand. Of the four clients exhibiting reach improvement, all demonstrated an improved instinctive grasp reaction (eg, orienting to a 1-in* cube more frequently and grasping it), whereas only one client showed improvement in visual tracking. Three clients who exhibited no reach during any visit also showed no visual tracking or grasp progression. This observation supports the premise that instinctive grasp development stimulates reach improvement and that without it reach improvement may not be seen.

Much of the literature regarding the development of prehension in the upper extremity also emphasizes the role of vision in the development of grasp. Twitchell states that development of "voluntary" use of the hand is related directly to the evolution of the automatic grasping reactions.\(^16\) In our study, three of the six clients who had improved grasp also demonstrated improved visual tracking. Three of the five clients who failed to exhibit a grasp reaction on any visit also exhibited no horizontal visual tracking. Hohlstein describes three developmental phases of grasp.\(^17\) In Phase 1, the infant

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\(\text{1 in} = 2.54 \text{ cm.}\)
is unstable in the upright position and uses the whole hand in a gross, unspecialized manner. In Phase 2, the infant has developed stability in the shoulder and elbow joints, and the grasp is in a transitional stage moving from gross, total hand movements to precise, isolated movements. By Phase 3, stability is present at the shoulder, elbow, wrist, and carpometacarpal joints, and grasp is with the pads of the distal phalanges in a precise, highly specialized manner. The results of our study indicate that clients, when using ASDs, were provided with adequate stability at the trunk, shoulders, and elbows to facilitate significant improvement in prehension, progressing from ulnar and palmar grasp (Phase 2) to radial and digital grasp (Phase 3).

In the client with cerebral palsy, the traction response and the avoiding reactions generally are exaggerated, resulting in an increase of upper extremity flexion and a decrease in the ability to project the hand in space. Positioning to decrease the effects of these reflexes and recruiting the aid of the visual system for guidance may result in more successful prehension. Intervention for clients who have difficulty grasping must focus on appropriate application of sensory stimulation or positioning to bring about joint stability or cocontraction, rather than on developing a specific grasp. Before being able to use the hand in a precise manner for grasping, for example, the infant must have developed stability at the more proximal joints. The ASDs provided this stability and positioned the client for sitting for longer periods of time, which enriched the sensory input. The ASDs enabled the caregiver to interact with the clients without also directly providing sitting support and stability. The result was a natural developmental progression in prehension.

White, in a study of environmentally deprived infants reared in an orphanage-type nursery, discovered that purposive prehension may be retarded by environmental deprivation and that development of “voluntary” use of the hand could be accelerated by enriching the visual surroundings, providing periods of tactile stimulation, and positioning the infants prone instead of supine during the day. Similarly, we hypothesized that because the ASDs positioned the clients in a supported sitting posture for longer periods during the day, they provided enriched opportunities for sensory and tactile experiences. In addition, because radial and digital grasp of the children improved significantly after use of the ASDs, grasp was accelerated by the improved sitting position.

Kuypers has proposed a concept of motor control that departs from the classical concepts of pyramidal and extrapyramidal systems. He postulates a medial system that exerts control over axial and proximal limb musculature and a lateral system that is responsible for distal limb movements. Results of a study by Loria of 30-week-old infants support the theory of a dual motor control mechanism operating during development, a proximal system guiding visually directed reach, and a distal system controlling tactile directed prehensile skill. We found no statistically significant relationship between proximal (reach) and distal (prehension) motor function. Even the most advanced infants used tactile stimulation to orient the thumb for grasp. In our study, reach did not improve significantly with ASD use, but grasp did improve. If these activities indeed are modulated by two separate systems, we propose that the lateral system modulating distal movements with tactile input was affected more by use of the ASDs than the medial system modulating proximal movements with visual input because grasp improved significantly, but reach did not.

This study, although limited by a small sample size, supports our hypothesis that ASD use would significantly improve motoric progress in grasping. The results, however, do not support our hypothesis that ASD use would improve visual tracking or reach. Neither ASDs nor training programs significantly improved independent sitting, but ASD use did improve supported sitting posture.

CONCLUSION

This research suggests that ASDs used in treatment protocols will improve sitting posture components and head stability. Functional improvement was seen in grasp, but not in visual tracking or reach. Caregivers stated that they could feed, play, and travel with the family member more easily with than without the use of the ASDs.

REFERENCES

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20. White BL: The Development of Perception During the First Six Months of Life. Read at the American Association for the Advancement of Science meeting, Cleveland, OH, December 30, 1963
## APPENDIX 1
### Assessment Instrument

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Directions</th>
<th>Criteria for Testing</th>
</tr>
</thead>
</table>
| **1. Controlled Sitting Position (CSP)** | At the beginning and after units of five trials of other activities, observe S* for 60 seconds. Record:  
- if S does not maintain a CSP for 60 seconds.  
+ if S maintains a CSP for 60 seconds. Record 10 trials. | S maintains a CSP 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—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. |
| **2. Head Control** | Instruct parent to place S in the best supported sitting position possible without providing support. Parent places S's head in midline. Parent 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. Examiner observes head alignment from the side with regard to anterior-posterior position. Record duration of time the head is held in midline. Record 10 trials of 30 seconds each. | S maintains head in midline with the body with less than 10° anterior-posterior deviation for 30 seconds. S may deviate more than 10° anterior or posterior if S returns head to midline within 5 seconds.  
0-0 = 0 sec  
1-5 = 5 sec  
6-10 = 10 sec  
11-15 = 15 sec  
16-20 = 20 sec  
21-25 = 25 sec  
26-30 = 30 sec |
| **3. Reach** | Instruct parent to place S in typical sitting position at elbow-height table. Present toy or food on table at S's midline and at maximum reach of S's extended arm. Attract S's visual attention to toy or food. Tell S to "get the toy (food)." Observe reach activity for 15 seconds after end of parent's first command. Observe how far S reaches to toy or food. Record: -,A,P,C. Record 10 trials. | S reaches to toy or food within 15 seconds.  
- S makes no attempt to reach toy or food.  
A S initiates reach to toy or food.  
P S reaches half the distance to toy.  
C S reaches to touch toy or food. |
| **4a. Grasp I** | Instruct parent to place S in typical sitting position at elbow-height table. S's forearm and hand rest on table. Present toy or food. Attract S's visual attention. While S is looking, contact little finger side of dominant hand with toy or food and set toy or food next to hand. Observe how S grasps toy or food within 15 seconds. Record: --,O,T,F. Record 10 trials. | S grasps the object within 15 seconds.  
- S makes no attempt to grasp toy or food.  
O S orients to toy or food with arm and hand movements.  
T S grasps toy or food to palm, wrist, or forearm on table.  
F S grasps toy or food to palm, wrist, or forearm off table. |
- if S does not grasp.  
U if pronated hand presses cube into palm.  
P if pronated hand presses cube into palm using ring, middle, and index fingers only; no thumb.  
R if hand presses cube into palm using thumb and index and middle fingers.  
D if cube is held with the thumb opposed to the ends of the index and middle fingers and not touching the palm. |
### APPENDIX 1

**Assessment Instrument**

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Directions</th>
<th>Criteria for Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a. Tracking: Horizontal</td>
<td>Instruct parent to place S in typical sitting position facing away from parent. Parent places S’s head in midline. Parent directs S’s attention to handing toy or light. Parent presents a small penlight or toy to left at eye level and about 12 in(^b) from S’s face. If S orient to the left, move light in 180° arc in front of S in S’s line of vision. If S does not orient to left, turn S’s head to left to orient to light and note in comments section whether head turning elicits assymetrical tonic neck reflex. Observe number of degrees S tracks light from left. Record: 0°,45°,90°,135°,180°. Record maximum 10 trials.</td>
<td>S follows penlight or tracks continuously with eyes at toy level from left to right 180° or less. 0° if S does not track at all. 45° if S tracks 1°–45°. 90° if S tracks 46°–90°. 135° if S tracks 91°–135°. 180° if S tracks 136°–180°.</td>
</tr>
<tr>
<td>5b. Tracking: Up</td>
<td>With S in typical sitting position, head in midline, parent presents penlight 12 in from S’s face at eye level in midline. Move penlight (or dangling toy) vertically in midline above S’s head. Observe number of degrees S tracks. Record: 0°,45°. Record maximum 10 trials.</td>
<td>S follows penlight or toy continuously with eyes from midline upward 45° or less. 0° if S does not track at all. 45° if S tracks 1°–45°.</td>
</tr>
<tr>
<td>5c. Tracking: Down</td>
<td>Same as above, but move penlight or toy from midline vertically down to shoulder height. Record maximum 10 trials.</td>
<td>S follows penlight or toy continuously with eyes from midline downward 45° or less.</td>
</tr>
<tr>
<td>6. Sitting Support</td>
<td>Instruct parent to place S in most independent position possible without support from parent. Observe amount and type of support needed. Record: -,E,T,H,S,I. Record one trial.</td>
<td>S sits for 30 seconds. – if S cannot sit. E if supported from head downward. T if supported from shoulders or trunk downward. H if supported from hips. S if sits independently, arms or hands braced on legs or knees. I if sits independently, no support for a minimum of 30 seconds.</td>
</tr>
<tr>
<td>7. Alertness</td>
<td>Record: A Alert state—focuses attention on source of stimulation. Motor activity minimal. E Eyes open, considerable motor activity, reactive to external stimuli with increased motor activity. C Crying, intense crying, difficult to break through. Record one trial.</td>
<td>A S focuses attention on parent, food, drink, toy, or picture. E S reacts to parent, 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>

* S = subject.  
*b 1 in = 2.54 cm.
### Sample Parent-Guardian Survey Questions

#### Behavioral Activity

<table>
<thead>
<tr>
<th>Sample Survey Questions</th>
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<tbody>
<tr>
<td>a. How often does the client go out of the home?</td>
</tr>
<tr>
<td>every 3 months</td>
</tr>
<tr>
<td>b. In your opinion, has the ease of transportation into the community changed since using the adaptive equipment?</td>
</tr>
<tr>
<td>more difficult</td>
</tr>
<tr>
<td>2. Positioning</td>
</tr>
<tr>
<td>a. In your opinion, has the client's ability to sit upright changed with use of the adaptive equipment?</td>
</tr>
<tr>
<td>much worse,</td>
</tr>
<tr>
<td>more leaning</td>
</tr>
<tr>
<td>b. Before using the equipment, what position was the client in when awake?</td>
</tr>
<tr>
<td>Lying:</td>
</tr>
<tr>
<td>0-2 hours</td>
</tr>
<tr>
<td>more than 12 hours</td>
</tr>
<tr>
<td>Sitting:</td>
</tr>
<tr>
<td>0-1 hours</td>
</tr>
<tr>
<td>more than 6 hours</td>
</tr>
<tr>
<td>3. Eye-Hand Activities</td>
</tr>
<tr>
<td>a. Since using the adaptive equipment, the client can grasp an object.</td>
</tr>
<tr>
<td>does not try</td>
</tr>
<tr>
<td>b. In your opinion, has the client's ability to turn his head to track a moving object visually changed with use of the adaptive equipment?</td>
</tr>
<tr>
<td>much movement, no head turning</td>
</tr>
</tbody>
</table>