Effect of Seated Position on Upper-Extremity Access to Augmentative Communication for Children With Cerebral Palsy: Preliminary Investigation

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KEY WORDS
- cerebral palsy
- communication aids for disabled
- patient positioning
- posture

OBJECTIVE. Our goal in this study was to determine the effect of seated position on upper-extremity access to augmentative communication for a child with cerebral palsy.

METHOD. A single-subject ABAB design was used with one 5-yr-old participant. We compared accuracy and speed of selection of targets on a speech-generating device in the participant's typical position and in an intervention position. The intervention position conformed to current clinical conventions and research on promoting upper-extremity movement. The intervention position was achieved through simple modifications to the participant's typical seating.

RESULTS. Accuracy of target selection was moderately improved in the intervention position compared with the typical position.

CONCLUSION. Results provide preliminary empirical evidence of the positive effects of functional seating on access to augmentative communication for children with cerebral palsy. Further research is required to confirm the positive effect of the intervention position across other people who use augmentative communication.

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Children with cerebral palsy (CP) often have difficulty speaking and may thus require augmentative and alternative communication (AAC; Treviranus & Roberts, 2003). *AAC* is defined as strategies, devices, and techniques that supplement or replace vocal or written communication (Beukelman & Mirenda, 2005). Examples of AAC include communication boards, picture exchange systems, and speech-generating devices. AAC can assist children with CP in achieving communicative goals (e.g., expressing needs and wants, exchanging information with and developing social closeness to others, fulfilling social etiquette routines; Light, 1989). When these goals are not met, children with CP may face challenges with social interaction, participation in education, and maintenance of quality of life (Falkman, Dahlgren Sandberg, & Hjelmquist, 2002). As a result, occupational therapists often facilitate spoken and written communication through AAC for children with CP (McCormack, 1990).

Compromised motor skills may make physical access to AAC a distinct challenge for children with CP (Light, 1989; Treviranus & Roberts, 2003). Frequently, the upper extremity is used to access AAC (Stowers, Altheide, & Shea, 1987; Treviranus & Roberts, 2003). For example, a finger or fist may be used to select letters directly from a touch screen or to strike a switch to stop a cursor that scans through a word list on a laptop. Thus, difficulties with accurate and efficient movement of the upper extremity can affect a child's ability to use AAC. Seated posture is thought to influence motor skills,

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specifically upper-extremity use for functional tasks (McNamara & Casey, 2007; Stavness, 2006). Children with CP frequently lack postural control and require specialized intervention to support seated posture (Stavness, 2006). Thus, it stands to reason that upper-extremity access to AAC may be significantly influenced by the seated position of children with CP (Mac Neela, 1987; McEwen & Lloyd, 1990).

The literature contains conventions for seating aimed at improving functional upper-extremity movement (Gregorio-Torres, 2006; Morress, 2006). These conventions (hereinafter referred to as *conventions of functional seating*) include (1) a neutral or anteriorly tilted pelvis with a neutral hip-flexion angle, (2) weight-bearing surfaces that support the feet and thighs, and (3) vertical alignment of the upper body (Creel, Adler, Tipton-Burton, & Lillie, 2001; Perr, 1998; Taylor, 1987). Theoretically, conventions of functional seating are thought to improve upper-extremity range of motion and control by (1) establishing a sound base of support to accommodate body weight such that balance is easily achieved and maintained, (2) establishing a relationship with gravity that facilitates a stable core (i.e., trunk and pelvis) to act as the base for upper-extremity movement, (3) enabling supported pelvic movement that complements and extends upper-extremity range of motion, and (4) positioning the individual to best view the actions of the upper extremities such that optimal hand–eye coordination results for precision tasks (Kangas, 2000; Stavness, 2006). To date, only sparse experimental evidence supports the efficacy of these conventions in enabling upper-extremity movement in children with CP. Myhr and von Wendt (1991) and Myhr, von Wendt, Norrlin, and Radell (1995) found that children with CP demonstrated improved arm and hand use in functional tasks and reaching in a functional seated position, characterized by mandatory anterior pelvic tilt and support of the feet and lumbar curvature, compared with a typical seated position that often precluded anterior or neutral pelvic tilt through the use of a reclined seat back and antithrust cushions. Reid (1996) found that a saddle seat improved alignment and postural control of the upper body and reduced the reaching path of children with CP compared with a flat bench.

Clinical guidelines for seating people who use AAC often refer to conventions of functional seating (Beukelman & Mirenda, 2005; McEwen & Lloyd, 1990). However, existing studies have provided only preliminary support for the effectiveness of conventions of functional seating in improving upper-extremity access to AAC for children with CP (Mac Neela, 1987; McEwen & Lloyd, 1990). Nwaobi (1987) found that efficiency of switch activation was maximized in 13 children with CP when the seat back was vertical, the seat was parallel to the floor, hip-flexion angle was 90 , and feet were supported on a platform. Pope, Bowes, and Booth (1994) monitored children with CP who used the Seating and Mobility system, which provided foot support and induced a 90 hip-flexion angle; they found finding that 6 of 9 children developed improved power wheelchair operation over 3 yr. By contrast, McCormack (1990) found no difference in the typing speed and accuracy of a boy with CP when positioned in neutral (i.e., 90 hip flexion) and posterior-tilted (i.e., 65 –70 hip flexion) pelvic positions. Similarly, Seeger, Caudrey, and O'Mara (1984) concluded that joystick use was not influenced by increasing seat angle above the horizontal and corresponding changes in hip angle in 9 children with CP. Existing studies that investigated the influence of seating on access to AAC involve few participants, and the results have not yet been replicated. Some studies have used specialized seating equipment for measurement purposes, thereby limiting ecological validity. Studies comparing different types of seating equipment have offered little insight into the biomechanical impact of the devices on the participants themselves and fail to link biomechanical impact to resulting performance. Moreover, studies have often focused on manipulating one aspect of seating, such as hip-flexion angle, and commented little on other elements. Whether people in these studies would be classified by the literature and clinical practice as having functional seating for upper-extremity use is, consequently, not clear.

In summary, empirical evidence to support implementation of conventions of functional seating for children with CP is distinctly lacking, despite their widespread inclusion in the clinical AAC literature. Our purpose in this study was to investigate the effect of seated position on the accuracy and efficiency of upper-extremity access to AAC for a child with CP. The specific research question was "Does a seated position characterized by the conventions of functional seating increase the frequency of accurate selection and speed of accurate target selection on a computer-based AAC device compared with the child's typical seating?"

Method

Design

We used a single-subject ABAB design with 1 participant (Kazdin, 1982). The dependent variable was accuracy of target selection on a computer-based AAC device. We also collected response time to accurate target selection. The independent variable was seated position: either

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baseline position (typical seating) or intervention position (characterized by the conventions of functional seating). The study consisted of four phases: baseline (A1), Intervention 1 (B1), withdrawal (A2), and Intervention 2 (B2). During the A phases, the participant's typical seated position was measured but not manipulated. During the B phases, the participant's typical seating was modified to place the participant in the intervention position.

Participant

One child with CP voluntarily participated in this study. The specific inclusion criteria and screening procedures, along with participant characteristics, are described in the sections that follow.

Inclusion Criteria and Screening Procedures. The inclusion criteria were (1) diagnosis of CP; (2) age 1–17; (3) use of a wheelchair for mobility; (4) use of AAC or potential to benefit from AAC; (5) ability to follow one-step instructions given in English; (6) ability to directly select targets from an AAC device using the hands; and (7) presence of motor skill limitations likely to affect accuracy, speed of target selection, or both in direct selection. Parents of potential participants, teachers, and other professionals were consulted to determine adherence to Criteria 1–4. The participant was then screened for adherence to Criteria 5–7 using a target selection task on a communication board that was the same size as the AAC device used in the study (i.e., 12 in. × 9 in.). The first author (Costigan) prompted the participant to touch colored square targets placed in each corner of the communication board using a spoken instruction (e.g., "Touch red") and a visual cue (i.e., point to the target, then remove finger). Each target was prompted twice for a total of eight selection attempts. A score of at least six of eight accurate selections (i.e., physical contact between the hand and the prompted target) indicated adherence to Criteria 5 and 6. The target selection task also determined appropriate positioning of the AAC device (i.e., orientation angle and horizontal distance from the participant that allowed comfortable extension of the elbow between 90 and 140).

The Manual Ability Classification System, a reliable and valid observational tool that classifies the ability of children with CP to use their hands (Eliasson et al., 2006), was used during the target selection task to assess adherence to Criterion 7. A rating of 3 or 4 as determined by the researcher (Costigan) signified adherence to Criterion 7; these ratings indicated limited ability to handle objects.

The participant's parents provided written consent, and the participant provided verbal assent using his consistent yes response (i.e., raising his right hand).

Participant Profile. The participant was a 5-yr-old boy with quadriplegia named Cole (pseudonym). Cole did not have an AAC device of his own but had tried several computer-based devices in the past. According to caregiver report, Cole used both his right and his left hands in selection activities. Cole was seated in a Jazz EASyS push chair (Thomashilfen, Bremervörde, Germany). School personnel from Cole's kindergarten classroom reported that this chair was used for all seated classroom activities. The seat of the chair was rigid and covered by a 1-in. foam cushion. The back and seat of the chair were both angle adjustable. A single footplate was height and angle adjustable. A pommel was also present.

Materials

The DynaVox DV 4 (DV 4; Dynavox Technologies, Pittsburgh, PA) communication device was used in all data collection sessions. The display contained six square targets of different colors. Targets were arranged in a 2-row × 3-column grid layout. Targets were square, measured 2 in. × 2 in., and were spaced approximately 1.25 in. apart. Each target was programmed to produce speech output of the corresponding color name immediately after physical contact between the fingers or hands and the target. A Sony video camera and tripod were used to record all data collection sessions. The video camera was positioned to capture speech output from the DV 4 and spoken instructions from the researcher and to visually capture both the participant and the researcher. A standard tape measure and goniometer were used in the analyses of seated position.

Procedures

The researcher (Costigan) conducted all sessions. Sessions took place in a quiet room in the participant's school, occurred 2 to 4 times per week, and lasted approximately 30 min. Transitions between phases occurred once the accuracy data were stable and showed no evidence of an increasing or decreasing trend. *Stability* was defined as fluctuation of <1.5 accurate selections about the mean for each phase (Kazdin, 1982). The DV 4 was positioned consistently at the table's edge in line with Cole's midline at a 40 angle to the horizontal during all data collection sessions. Cole was seated in his push chair throughout study phases. The push chair was consistently positioned so that the centers of the front wheels were a horizontal distance of 6 in. from the table's edge and wheels were perpendicular to the table's edge. Each session was videotaped to allow reliability checks to occur off site. All study phases included seating analyses and a selection task.

Seating Analyses. During all study phases, the researcher (Costigan) analyzed the following features of

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Cole's seated position before the first, fifth, and ninth selection attempts: pelvic position, weight-bearing surfaces, and upper-body orientation. During the A phases, the researcher analyzed and recorded Cole's baseline seated position but did not manipulate it. In the baseline position, the seat back of Cole's push chair was reclined to 135 relative to the horizontal seat base, and the footplate was elevated such that Cole's knee angle was extended beyond 90 . During the B phases, simple modifications were made to Cole's baseline position to place him in the intervention position, defined by (1) a neutral or slight anterior pelvic tilt; (2) the presence of appropriate weight-bearing surfaces for the thighs and feet that fully support the segment without impinging on circulation or limiting joint range of motion at the hips, knees, or ankles; and (3) vertical alignment of the upper body. Modifications made to achieve the intervention position included provision of a custom back cushion and soft lateral supports, adjustment of the seat back angle to 90 relative to the seat base, adjustment of the foot plate angle and height such that knee angle approached 90 , and physical readjustment of the participant's position in the push chair. Table 1 specifically defines the features of seated position, measurement techniques (Pedretti, 2001), and the conventions of functional seating.

Selection Task. During the A and B phases, the participant was prompted to select each colored target from the DV 4 twice for a total of 12 selection trials per session. Before the first data collection session, the researcher modeled an accurate target selection. In each session, the researcher instructed Cole to touch a target by providing (1) a spoken instruction (i.e., "Ready, touch [target color]") and (2) a visual cue (i.e., pointing briefly to the target color with the index finger). The visual cue was timed to correspond with the spoken instruction and thus eliminated the need for color recognition. After each instruction, the researcher waited until the participant made an accurate selection (i.e., the DV 4 spoke the name of the target color), until he made an inaccurate selection (i.e., the DV 4 spoke the name of a color other than the target color), or until 20 s had elapsed. The sequence of targets prompted was determined using a 6×6 Latin square to ensure that each target occurred in each sequence of six trials and that each target was prompted in the same serial position approximately the same number of times.

Target colors on the DV 4 corresponded to colored tabs that concealed a mystery picture. The mystery picture served as a motivator for the study task. Three mystery pictures, each covered by four colored tabs, were presented during each data collection session. When Cole made

Table 1. Seating Features, Measurement Techniques, and Characteristics of the Intervention Position

Feature and Definition	Measurement Technique	Pursued Convention in Intervention Position
Pelvic position		
Hip-flexion angle	Goniometer measurement of angle between middle lateral aspect of pelvis and long axis of femur[a]	Hip-flexion angle between 85 and 95 (Beukelman & Mirenda, 2005; Kangas, 2000; McEwen & Lloyd, 1990)
Weight-bearing surfaces		
Contact between seat surface and participant's thighs	Visual inspection, palpation, tape measurement of PG	Continuous contact between seat surface and the participant's thighs from buttocks to 1–2 in. proximal to knee (McClenaghan, Thombs, & Milner, 1992; McEwen & Lloyd, 1990; Ekblom & Myhr, 2002)
Contact between support surface and foot	Visual inspection, palpation	Contact between heel and ball of foot and support surface (Beukelman & Mirenda, 2005; Kangas, 2000; McEwen & Lloyd, 1990; Myhr & von Wendt, 1991; Nwaobi, 1987)
Upper-body orientation		
Alignment of spine in sagittal plane	Visual inspection of alignment of chin, nose, and navel	Vertical alignment such that 85 –95 angle exists between seat and line drawn between chin, nose, and navel (Beukelman & Mirenda, 2005; Nwaobi, 1987; Reid, 1996; Seeger et al., 1984)
Alignment of spine in frontal plane	Visual inspection of alignment of shoulders and hips	Vertical alignment such that 85 –95 angle exists between seat and line drawn between shoulders and hips (Beukelman & Mirenda, 2005; Kangas, 2000; Nwaobi, 1987; Reid, 1996; Seeger et al., 1984)
Lumbar support	Visual inspection, palpation about spine	Presence of symmetrical contact about spine between seat back and lower quarter of back (Beukelman & Mirenda, 2005; McEwen & Lloyd, 1990; Myhr & von Wendt, 1991; Myhr et al., 1995)

Note. PG = popliteal gap (i.e., space between frontal edge of seat and popliteal fossa).
[a]Implementing measurement technique on horizontal seat ensures that hip angle reflects pelvic position.

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an accurate selection, the researcher removed the tab corresponding to the target color to reveal a section of the mystery picture. If Cole made an inaccurate selection, Cole did not attempt selection, or the 20-s selection trial period expired, the researcher moved on to the next selection trial without removing the colored tab. If the mystery picture was completely revealed after four selection trials (i.e., all four color tabs removed), the researcher showed the mystery picture to Cole. Mystery pictures that remained partially or completely covered were revealed and shown to Cole at the end of the session to allow him to experience completion of the study task.

Procedural Reliability. Videotapes of 20% of all data collection sessions, selected randomly and stratified across study phase, were analyzed by a trained graduate student in the Department of Communication Sciences and Disorders at The Pennsylvania State University using a procedural standard. Procedural integrity was calculated as follows: number of steps implemented correctly/(number of steps correctly implemented + number of steps incorrectly implemented + number of steps omitted) × 100. Procedural integrity was found to be 97% (range = 94%–98%).

Measures

The main measure was frequency of accurate selection. Response time to accurate selection was also collected. These measures are specifically defined in the sections that follow.

Frequency of Accurate Selection. An *accurate selection* was defined as activation of the target resulting in speech output from the DV 4 that labeled the target color presented by the researcher within 20 s. An *inaccurate selection* was defined as activation of a target resulting in speech output from the DV 4 that labeled a color other than that of the target presented by the researcher. Lack of response from the participant or failure to make an accurate selection within 20 s was also considered inaccurate. We adopted these definitions because accurate initial selection minimizes communication errors and misinterpretation of thoughts and ideas (Light, 1988). Accurate selections were scored online by the researcher (Costigan). Frequency of accurate selection was calculated per session as the number of accurate selections made per session.

Response Time to Accurate Selection. We defined *response time to accurate selection* as the time from completion of the spoken instruction "Ready, touch [target color]" to the initiation of speech output from the DV 4 that named the target color. Response time was recorded only for accurate responses. The definition of *response time* included the time to initiate a movement response, time to execute a movement response, and time of the delay between target activation and speech output. This definition thus represented real-life response time to the task and was considered ecologically valid for communicative exchanges. Using a stopwatch, the researcher (Costigan) recorded response time to accurate selection for each accurate selection trial from session videotapes.

Data Reliability and Analysis. Twenty percent of selection trials, chosen randomly but stratified across study phases, were examined from session videotapes by a trained doctoral student in Communication Sciences and Disorders at The Pennsylvania State University to ensure reliable coding of accurate selections. Percentage of agreement for frequency of accurate selection data was calculated using point-by-point agreement (Kazdin, 1982) by means of the following formula: number of agreements/total number of trials analyzed × 100. The percentage of agreement was 95% for accuracy data, indicating that data were collected reliably (Kazdin, 1982).

The frequency of accurate selection for each session was graphed and analyzed via visual inspection (Kazdin, 1982). Data were analyzed for (1) changes in mean accurate selections between phases, (2) changes in the level of the dependent variable between phases (i.e., difference in performance between the end of one phase and the beginning of the next phase), (3) the trend of the data (i.e., the direction of the data for the dependent variable in each phase), and (4) the strength of the trend (i.e., the slope of the line connecting data points). Percentage of nonoverlapping data (i.e., the percentage of data points in the intervention phase that were greater than the highest data point in the baseline phase) was also calculated (Kazdin, 1982).

Results

Seated Position

Table 2 summarizes the results of seating analyses for all study phases. Figure 1 contains line drawings of Cole in the baseline and intervention positions. In general, Cole's baseline position did not adhere to conventions of functional seating. Baseline position was characterized by a distinct posterior pelvic tilt and a hip-flexion angle that was consistently >95 . Hip-flexion angle was variable within and between sessions, but ranges were similar in the A1 and A2 phases. The popliteal gap rarely measured between 1 and 2 in., consistently measuring <1 in. in the A1 phase and varying greatly during the A2 phase. Cole's feet were not consistently supported in any session in the A phases, stemming from variable contact between the

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Table 2. Results of Seating Analyses

Feature and Convention	Baseline		Intervention	
	A1	A2	B1	B2
Pelvic position				
Hip flexion angle between 85 and 95	0/9	0/9	13/15	7/9
Mean	130	137	95	94
Range	123 –137	129 –139	92 –97	92 –97
Weight-bearing surfaces				
Continuous contact between seat surface and the participant's thighs from buttocks to 1–2 in. proximal to knee	0/9	5/9	15/15	9/9
Mean PG (in.)	0.63	2.1	1.3	1.6
Range of PG (in.)	0–1	0–4	1–1.5	1–1.5
Presence of contact between heel of foot and support surface	2/9	4/9	15/15	9/9
Presence of contact between ball of foot and support surface	7/9	5/9	15/15	9/9
Upper-body orientation				
Vertical alignment in sagittal plane	0/9	0/9	15/15	9/9
Vertical alignment in frontal plane	0/9	0/9	15/15	9/9
Presence of lumbar support	0/9	0/9	15/15	9/9

Note. All fractions represent the number of seating analyses in which a characteristic was observed over the total number of seating analyses conducted in the phase; A1 = baseline; A2 = Withdrawal; B1 = Intervention 1; B2 = Intervention 2; PG = popliteal gap (i.e., space between frontal edge of seat and popliteal fossa).

footplate and the heels and balls of the feet within and between sessions. Cole's baseline position was also characterized by a consistent lack of both lumbar support and vertical alignment in the sagittal and frontal planes. The intervention position differed from the baseline position and adhered to the conventions of functional seating. Cole's position was also considerably less variable within and between sessions in the B phases. During the B phases, Cole's hip angle consistently reflected more neutral pelvic positioning (i.e., measured between 85 and 97), the popliteal gap consistently measured between 1 and 2 in., both the heels and the balls of the feet were in consistent contact with the foot plate, and the upper body was vertically aligned in the sagittal and frontal planes with consistent lumbar support.

Frequency of Accurate Selection

Figure 2 displays the frequency of Cole's accurate selections across phases. The mean frequency of accurate selection was higher in the B phases when Cole was in the intervention position (i.e., B1: mean = 6.4, range = 5–7; B2: mean = 6.7, range = 6–7) than in the A phases when he was in the baseline position (i.e., A1: mean = 3.3, range = 3–4; A2: mean = 4, range = 4). The data were stable in each phase, suggesting that changes could be attributed to the effect of seated position. Transitions between phases were consistently marked by a distinct change in the level of the data, with frequency of accurate selection clearly and immediately higher on initiation of B phases, during which the intervention position was implemented. The distinct and immediate changes in frequency of accurate target selection at phase transition, along with evidence of decreased performance in the A2 phase, suggest that a learning effect was not responsible for observed changes. Data were 100% nonoverlapping between A phases and B phases, indicating a clear distinction in frequency of accurate selections between the baseline and intervention positions. To determine the specific effects of seated position on access, post hoc analyses of the accuracy data were conducted by target position. This visual inspection of the data suggested that changes in accuracy between the A phases and the B phases were largely because of increases in the frequency of accurate selection of the upper right-hand target in the intervention position compared with the baseline. Cole was 100% accurate in selecting the upper right target during intervention (i.e., a mean of 2 of 2 accurate selections per session), but he was only 25% accurate in this location at baseline (i.e., mean of 0.67 of 2 accurate selections per session in the A1 phase and mean of 0.33 of two accurate selections per session in the A2 phase).

Response Time to Accurate Selection

Response time was recorded on only three to four selections during the A phases and five to seven selections during the B phases because of Cole's low frequency of accurate selection. Recorded response times to accurate selection were highly variable within phases (i.e., A1: mean = 8.28 s, range = 1.36–15.56 s; B1: mean = 8.14 s, range = 1.31–19.80 s; A2: mean = 6.10 s, range = 1.27–14.27 s; B2: mean = 7.00 s, range = 1.45–19.80 s). Given the small number of measures collected and the

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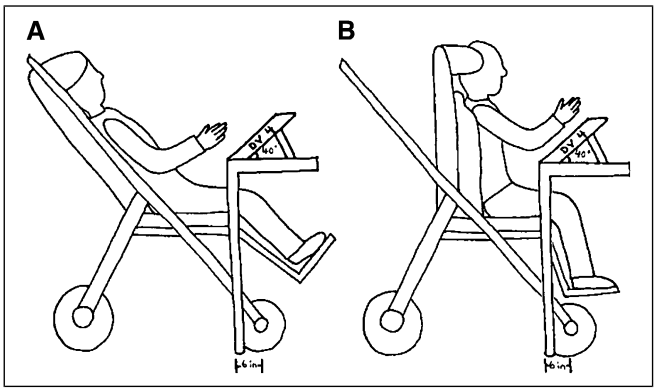


Figure 1. Line drawings of Cole in baseline position (A) and intervention position (B).

high variability observed, further analyses were not conducted on these data.

Discussion

The intervention position was efficacious in improving accuracy of target selection from a computer-based AAC device with the upper extremity for a single child with CP. Two main hypotheses may account for the observed improvement. First, the intervention position was different from the baseline position in body measurements and may have provided a biomechanical advantage to enable upper-extremity movement. The neutral pelvic position, consistent weight-bearing surfaces, and vertical alignment of the upper body achieved in the intervention position may have placed the participant's center of mass over a more appropriate base of support formed by the seat and footplate (Westcott & Burtner, 2004). Improved balance and postural stability may have resulted, forming a supported starting point from which to execute and control upper-extremity movement. The intervention position may also have enabled greater range of upper-extremity movement. The neutral pelvic position and maintenance of a space between the seat surface and the popliteal gap may have increased range of motion at the hips and knees (Perr, 1998) while the appropriate weight-bearing surfaces and supported vertical alignment of the upper body improved control of movement within those ranges. Improved range and control of motion at these joints may have coupled with upper-extremity movement to increase functional distance of reach and level of control within that reach, thereby enabling more accurate selection of targets, particularly those in distant locations.

Second, the intervention position may have altered the participant's position relative to the AAC device. This position may have reduced the task's level of difficulty in the intervention phases. Because the location of the push chair, table, and DV 4 were constant across phases,

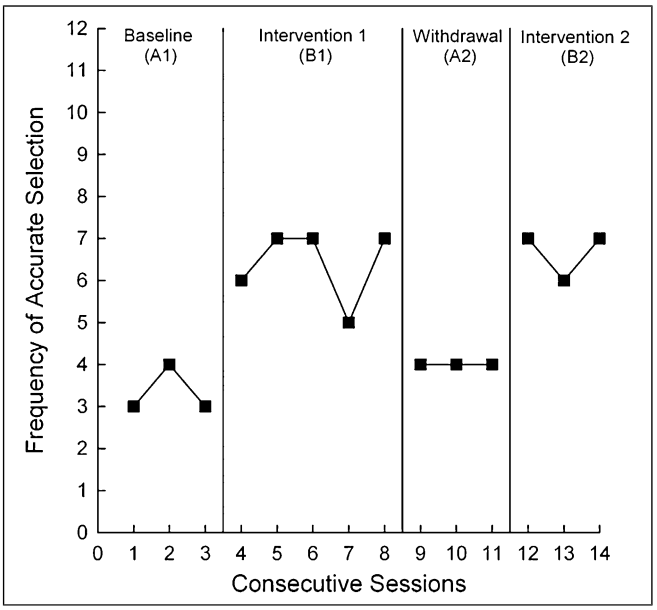


Figure 2. Cole's frequency of accurate selection, by session, out of 12 selection trials.

changes in body position and adjustment of the seat back angle decreased the horizontal distance between the participant and the DV 4 and increased the angle between the arm and the body during target selection. The intervention position also placed the head in midline such that the DV 4 was directly in front of the eyes, potentially improving the hand–eye coordination required to accurately select targets (Kangas, 2000; Stavness, 2006). These changes in position relative to the DV 4 may have made accurate selection of targets, particularly those in more distant locations, easier to achieve.

Although the intervention position improved the participant's accuracy in selecting targets in the intervention phase, the data do not lead to a definitive conclusion as to the mechanism of improvement. Informal qualitative observation of movement during target selection completed online by the researcher (Costigan) suggests that range and quality of upper-extremity movement was improved in the intervention position. Yet, we noted accuracy effects for only a single target location. A relative positioning advantage for the upper right-hand target may explain the absence of similar changes in accuracy of target selection between A and B phases for other target locations. It is therefore possible that body position changes resulting from implemented conventions of functional seating, positioning changes relative to the DV 4, or an interaction between the two was the mechanism for improved upper-extremity access to AAC.

Nonetheless, this study provides much-needed preliminary empirical evidence of the effect of seated position on upper-extremity access to AAC and suggests that improved physical access to AAC may be achieved through

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simple, low-cost seating modifications. Consideration of seating is likely an integral component of AAC service provision aimed at promoting functional communication and, ultimately, occupational performance (Beukelman & Mirenda, 2005; Mac Neela, 1987; McEwen & Lloyd, 1990). Thus, the AAC team for people with motor disabilities such as CP should always include a professional with seating expertise, such as an occupational therapist (Beukelman & Mirenda, 2005; Mac Neela, 1987; McEwen & Lloyd, 1990). Moreover, other professional members of the AAC team (e.g., speech–language pathologists) require basic knowledge of seating to address simple issues for people with mild motor impairments and to identify the need for expert involvement for those with greater impairments (McEwen & Lloyd, 1990). Vigilance in ensuring a functional seated position for physical access to AAC across and within all communicative exchanges—accomplished through regular seating analyses and modifications as demonstrated in this study and education of the individual, his or her family, and caregivers—may be a key step toward functional communication (Mac Neela, 1987; McEwen & Lloyd, 1990).

Limitations and Future Research Directions

This study has several limitations. First, although accuracy of target selection was improved in the intervention position, the participant did not achieve an adequate level of accuracy for functional communication (i.e., 80%; Beukelman & Mirenda, 2005). Seated positions other than the intervention position may better support accuracy of target selection. Studies comparing the intervention position as defined in this study with other plausibly functional positions (e.g., anteriorly tilted seat, reduction of hip angle to <90) would isolate the necessary components of truly functional seating. Functional seating is likely highly individualized such that a gold-standard seated position does not exist (Kangas, 2000). Thus, studies should investigate the principles that underlie the conventions of functional seating (e.g., postural stability) rather than strict implementation of a specific seated position. In addition, physical access to AAC is influenced by factors other than seated position, including access technique (e.g., direct selection vs. scanning) and training (Treviranus & Roberts, 2003). A different access technique, instruction in direct selection, or both may have enabled the participant to achieve accuracy levels that would support functional communication. Thus, appropriate seating is likely necessary, but not sufficient, for achieving physical access to AAC. Studies that include appropriate seated position as part of an overall access intervention may illuminate best practices for enabling functional communication through optimal physical access to AAC.

Second, replication is required to ensure generality of results. Considerable variability exists in the presentation of CP across and within diagnosed people (Treviranus & Roberts, 2003). Therefore, it is possible that the intervention position in this study was well suited to the participant and may not necessarily apply to other children with CP. Replication of results with a larger group of children with CP would support the efficacy of the conventions of functional seating in improving access to AAC. Moreover, replication of results with adult participants, with participants with other diagnoses, and using other effectors would allow more general conclusions regarding the effectiveness of the intervention position in improving access to AAC. Generality of results would also increase with investigation of the effect of the intervention position on upper-extremity access to other assistive technologies (e.g., power wheelchairs). Also, this study did not definitively isolate the mechanism through which the intervention position improved target selection. Studies that incorporate in-depth error analyses and include conditions that maintain participant positioning relative to the AAC device may help to verify theoretical arguments relating seating to physical access to AAC.

Last, this study demonstrates the influence of seated position on only one facet of physical access to AAC, specifically accuracy of target selection. The effect of seated position on efficiency of target selection for the participant was less clear; limited and variable response time data prevented strong conclusions. Research with participants of varied motor ability or with a modified definition of accurate target selection (e.g., 25-s selection trials) may illuminate the relationship between efficiency of access and seated position.

Conclusion

A seated position that ensured a neutral pelvic position, appropriate weight-bearing surfaces, and vertical alignment of the upper body was successful in improving access to a computer-based AAC device for a child with CP. Thus, this study provides important preliminary empirical evidence of the influence of seated position on access to AAC. Future research should strive to confirm the positive effect of the intervention position across other participants, dependent measures, and assistive technologies. ▲

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