Positioning for Head Control to Access an Augmentative Communication Machine

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The purpose of this paper was to study the effect of therapeutic positioning on the functional use of augmentative communication equipment. Recent literature on therapeutic positioning as it affects muscle tone and functional activities is reviewed. The effect of positioning intervention on rate and accuracy of head-controlled typing on an augmentative communication machine was measured. The rate of typing was found to increase significantly and the percentage of accuracy was found to decrease significantly with positioning intervention. A third measure combining rate and accuracy (accuracy rate) also increased enough to reach statistical significance. These results suggest that positioning changes do affect head control in the functional use of a communication machine.

Because of the combined areas of expertise needed to adequately address positioning, head control, communication, and overall function, a team approach to clients with these concerns is advocated.

Electronic equipment has become an increasingly important means of communication for many people with severe disabilities resulting from cerebral palsy or brain trauma. Occupational therapists, as members of the treatment team in a hospital or residential facility or as therapists in a school system, in home health care, or through independent living programs, may become involved in augmentative communication. Together with speech pathologists, physical therapists, physicians, and other health professionals, occupational therapists work with clients in assessing the most efficient mode of access to a communication device, in the fitting of the device itself, and in training the client in its functional use (Attermeyer, 1987; Stowers, Altheide, & Shea, 1987).

For occupational and physical therapists involved in augmentative communication, therapeutic positioning is a prerequisite that allows clients to make effective use of the advanced technologies that communication devices have to offer (Taylor, 1987; Vanderheiden, 1987). Positioning provides support for the trunk and extremities, reflex inhibition, and control of abnormal movement, thus allowing the client to focus on the voluntary motor control needed to operate communication equipment or participate in other functional activities (Christopher, 1984; Mac Neela, 1987; Taylor & Trefler, 1984).

Literature Review

Several authors and clinicians have provided general guidelines for wheelchair positioning (Hundertmark, 1985; Taylor, 1987; Taylor & Trefler, 1984). In most cases, positioning begins with the pelvis, which should be in neutral rotation or at a slight anterior tilt (Hundertmark, 1985; Taylor, 1987). According to Hundertmark, an anterior tilt of the pelvis facilitates “head and trunk extension and hip and knee flexion” (p. 210), which is the movement pattern needed for upright sitting. Conversely, a posterior pelvic tilt tends to promote trunk and neck flexion with hip extension and weight bearing on the sacrum. The hips should be flexed to at least 90° and slightly abducted (Taylor & Trefler, 1984). The seat-back orientation should be vertical when possible and the trunk should be in midline; side supports can be used if needed for stability. The knees and ankles should be flexed to 90° (Hundertmark, 1985; Taylor & Trefler, 1984).

Studies on wheelchair positioning have documented the effects of different positioning variables on muscle tone, hand function, and head righting. Nwaobi, Brubaker, Cusick, and Sussman (1983) used electromyography (EMG) to measure muscle tone in the back extensors of children with cerebral palsy when the seat and back surfaces were placed in various positions. They found the least amount of extensor activity when the seat was set at 0° (horizontal) to 15° of incline and the back
was set at 90° (vertical) and the greatest amount of extensor activity when the back was set at 75° or 120°. Nwaobi (1986) studied how orientation in space affects tone in back extensors, hip adductors, and plantar flexors. Significantly greater EMG activity was found in all three muscle groups when the chair was reclined to 120° than when it was set to 90° (vertical).

Some of the effects of positioning on hand function have been studied. Seeger, Caudrey, and O’Mara (1984) varied the seat angle from 0° (horizontal) to 30° of seat incline and measured performance on a computer task with the use of a joystick. The subjects were children and adolescents with cerebral palsy. The researchers found that increasing the angle of seat incline (i.e., flexing the hips to a more acute angle) made no significant difference in the subjects’ ability to do the hand function task. Nwaobi (1987) measured the time needed to activate a switch with the right upper extremity for 13 children and adolescents with cerebral palsy while they were positioned in four different orientations in space. Significantly better performance times were reported when the seating system was set at 0° (vertical orientation) than in the other orientations (15° and 30° of posterior inclination and 15° of anterior inclination). In another study (Noronha, Bundy, & Groll, 1989), the Jebsen–Taylor Hand Function Test (Jebsen, Taylor, Treischmann, Trotter, & Howard, 1969) was used to measure the hand function of boys with spastic diplegic cerebral palsy in a seated position versus in a standing table with trunk support. The subjects scored significantly better on the Simulated Feeding subtest while in the prone stander, but better on the Small Objects subtest while seated.

McCormack (1990) studied the effect of positioning the pelvis in neutral versus posterior pelvic rotation on typing speed and accuracy on a personal computer. The subject was an 8-year-old boy with spastic and athetoid cerebral palsy who typed with his left hand. No difference was found in speed and accuracy of typing in either position. The use of a key guard, however, was found to increase typing accuracy and decrease typing speed.

The following studies investigated the effect of positioning on head righting and alignment. Hulme, Shaver, Acher, Mullette, and Eggert (1987) observed oral motor function, including head alignment, in 11 children aged 1 to 4 years before and after they were provided with custom-made adaptive seating devices. Improvements were found in sitting posture, head alignment during eating and drinking, retention of food and liquid, and development of more adaptive eating skills. O’Brien and Tsuurnui (1983) compared frequency and duration of head righting in a semiprone position and in a seated position for subjects with cerebral palsy in an intermediate care facility. No significant difference in head righting was found between the two positions.

The research studies cited above and the experience of clinicians document the effect of therapeutic positioning on muscle tone, hand function, and head righting. Although clinicians who work with persons with physical disabilities generally accept the importance of therapeutic positioning for the use of communication equipment, more research is needed to further document the effect of positioning on the functional use of such equipment (Mac Neela, 1987).

Persons with cerebral palsy who are candidates for electronic augmentative communication equipment cannot physically meet their own needs because of their disability. For such persons, communication with others is necessary not only for social, vocational, and psychological needs, but also for their own daily living and health care needs. An inability to communicate their decisions and preferences to others may limit their control over their own lives, thus compromising what they define as independence. Augmentative communication equipment is a key to more efficient communication with caregivers, friends, relatives, and people in the community. If therapeutic positioning makes a difference in someone’s ability to access a communication system, that difference needs to be studied and documented so that users, clinicians, and third-party payers can jointly select the most appropriate adaptive equipment.

The present study addressed the following question: Does a change in seating position affect head control for rate and accuracy of typing on an augmentative communication machine in a subject with cerebral palsy?

**Method**

This single-subject study compared rate and accuracy on a Prentke Romich Light Talker1 in two different seating positions. The subject was a 37-year-old woman with spastic quadriplegia and choreoathetosis. At the time of this study, she lived in a residential facility for adults with cerebral palsy. For mobility around the facility, she used an electric wheelchair, which she controlled using a foot pedal (a modified joystick) on her right footrest. For mobility in the community and as a backup when her electric wheelchair was not working, she used a standard manual wheelchair, which she propelled by pushing with the toes of her shoes. She was able to vocalize but had no functional verbal communication. To meet her communication needs, she used the Light Talker with Express software, which she accessed by pointing to an electronic keyboard with a light sensor attached to a bicycle helmet on her head. At the time of this study, she had been using her Light Talker for 3 years.

During the baseline period (i.e., the first eight sessions of data collection), a facility staff member positioned the subject in her manual wheelchair with her communication device mounted on it. Her positioning

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1Available from Prentke Romich Company, 1022 Heyl Road, Wooster, OH 44691.
words were also counted as correct when they were made word given was when the subject began typing until she hit the speak spelling and the delete character key. Spaces between the intervention sessions were taken in a period of 9 enough word lists to get a minimum sample of 10 min of list that was not recorded. The subject then completed typing, each selection or hit on the communicator was words to let me know she was done. The time from display key on the overlay when she finished each set of 3 space between words. She was instructed to hit the speak intervention period (i.e., the second eight sessions of data collection), the subject was seated in her electric wheelchair, which has a firm back and side supports. She was positioned at the beginning of each session so that the back of her hips touched the back of the wheelchair and the seat belt was tightened as firmly as possible without discomfort. In this position, her hip flexion ranged from 80° to 85°. The top of the seat in the electric wheelchair measured 22 in. (56 cm) from the floor. The footrests were swung to the side, and a 7-in. (17.8-cm) stool was added to position the subject's knees and hips in 90° of flexion. The subject was also given verbal reminders to try to keep her hands in her lap. The height of the Light Talker was adjusted to the same height in relation to the electric wheelchair as it was in relation to the manual wheelchair during the baseline measurement.

The following procedure was used to measure the rate and accuracy of communicator use. The subject was given a list of 3 words at a time, chosen at random from a list of 150 common five-letter words that included as wide a sample of the alphabet as possible. After being allowed 10 to 15 sec to look over the words, the subject was asked to type the list of words on her communicator, leaving a space between words. She was instructed to hit the speak display key on the overlay when she finished each set of 3 words to let me know she was done. The time from when the subject began typing until she hit the speak display key was recorded with a stopwatch. During the typing, each selection or hit on the communicator was tallied as either correct or incorrect. For example, if the word given was music and the subject typed the keys M, U, A, delete character, S, I, C, then I would record one error for the A key and six correct hits for the correct spelling and the delete character key. Spaces between words were also counted as correct when they were made intentionally. Each session began with one practice word list that was not recorded. The subject then completed enough word lists to get a minimum sample of 10 min of typing.

Measurements for each of the eight baseline and eight intervention sessions were taken over a period of 9 weeks. After each session, the total number of hits and the total number of correct hits were each divided by the total time recorded on the stopwatch to calculate the number of hits per min and the number of correct hits per min of typing. I calculated the percentage of accuracy by dividing the number of correct hits by the total number of hits.

Results

Data for the measures of rate are shown in Figure 1. The mean rate during the baseline phase was 12.3 hits per min (SD = 1.18). During the intervention phase, all data points except the first were above the baseline mean, and three data points were more than two standard deviations above the baseline mean.

Data for percentage of accuracy are shown in Figure 2. The baseline mean for percentage of accuracy was 86.71% (SD = 2.52%). The percentage of accuracy during the intervention phase showed a greater variability than in the baseline phase, with two data points more than two standard deviations above the baseline mean and two data points more than two standard deviations below baseline mean.

Data for the accuracy rate (i.e., correct hits per min) are shown in Figure 3. The mean baseline rate was 10.66 correct hits per min (SD = 0.76). All data points in the intervention phase were above the baseline mean, and three data points were more than two standard deviations above the baseline mean.

Discussion

According to the two-standard-deviation-band method of data analysis (Ottenbacher, 1986), single-subject inter-
The results of this study suggest that positioning changes do affect head control in the functional use of a communication machine. Concerns about seating systems or head control are more often addressed by a physical or occupational therapist, whereas concerns about augmentative communication are more often addressed by a communication disorder specialist. Attemeier (1987) stated, "The 'fit' of a system to a particular child in his or her particular family/community environment requires much more expertise than anyone person can have" (p. 7). For a client to function at his or her highest potential, all of the people involved must work together in planning treatment or fitting equipment.

Two important considerations in therapeutic positioning are the client's comfort level and expectation of better function (B. Dudgeon, personal communication, October 2, 1989). In the present study, because of the subject's communication limitations, I found it difficult to obtain a clear statement of her thoughts and feelings about the two positions. When asked early in the baseline phase of the study what she thought or felt about her positioning, the subject selected no and spelled out bad on her communicator. During the intervention phase, when asked about how her position felt, the subject responded yes. When asked if the new position felt awkward, the subject replied yes but she was unable to describe anything specific that felt awkward.

Several limitations should be considered when evaluating the results of this study. One limitation inherent in single-subject research is that a difference demonstrated with one subject may or may not be generalizable to other persons. For this reason, the replication of these findings with other users of augmentative communication equipment is important to further validate these results. A second limitation of the study is that several changes in position were made for the intervention phase, including a more stable seating surface with side support, a change in the angle of hip flexion, and the addition of a foot intervention. These measures suggest that positioning played an important role in the subject's head control for augmentative communication. On the measure for percentage of accuracy, the results were less definitive. The first and last intervention data points were more than two standard deviations above the baseline mean. The sixth and seventh intervention data points, however, were more than two standard deviations below the baseline mean, thus meeting the criterion for statistical significance in the direction of lower accuracy with positioning intervention. Possible explanations for the low accuracy scores are the subject's increased level of frustration after making several mistakes in a row, increased level of stress, or increased rate of typing speed. Even on these measures, however, the accuracy never dropped below 80%, and the increased rate for those data points was sufficient to bring the measure combining rate and accuracy (accuracy rate) above the baseline mean.
support to control the angles of knee and ankle flexion. The subject was also verbally encouraged to keep her hands in her lap. Some or all of these modifications led to a significant change in head control for accessing the communication device. Further research would be necessary, however, to determine which changes were most helpful. A third important consideration is that both the subject and I were aware of the purpose of the study; thus, we both may have had expectations that have affected the results. Respect for the need and right of the subject to know the purpose of the study, the amount of time necessary for the data collection, financial considerations, and the nature of the study itself made it necessary that the research be conducted in this manner. Another problem that may have affected the results of the study in either direction was the arrangement of the squares on the overlay (referred to in this paper as keys). The four keys for yes, delete character, delete word, and base level (which changes the level to preprogrammed words and phrases) were adjacent on the communicator. A common error pattern was that the subject would type an incorrect letter, then go to the delete key to correct the error but miss again and hit the yes or base level keys, both of which required several consecutive correct moves to erase.

Further research in the area of positioning might include replication of this study with other users of Light Talkers to see if the results found here can be generalized. The positioning adaptations used in this study might be analyzed separately to find out which changes or combinations of changes were most helpful. Other modes of access to an augmentative communication machine, such as hand or foot typing, scanning, or the use of multiple switches, might also be affected when the client's position is adapted. The position of the communication device itself (i.e., height or position in space) may also be a factor in how efficiently it is used. A subject's positioning might be observed in relation to other functional activities, such as operating a wheelchair, writing or typing, reading or engaging in other cognitive tasks, or performing various activities of daily living.

Summary

This single-subject study addressed the question of whether a change in seating position affected the functional use of a Light Talker in rate and accuracy of typing. The results showed that, for one subject, an intervention in therapeutic positioning led to an increased rate in head-controlled typing. Although accuracy was found to decrease statistically after the position change, the increased rate was sufficient to compensate for the lower accuracy so that the measure combining rate and accuracy (i.e., accuracy rate) also increased. The implications of these results in clinical settings emphasize the need for interdisciplinary involvement in the assessment for, fitting for, and training on both seating systems and augmentative communication equipment. Further research is necessary to establish how the results described here may be generalized for other users of communication equipment and seating systems and how positioning affects other functional activities.

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References

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