Powered Mobility and Preschoolers With Complex Developmental Delays

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• child developmental disorders
• child, preschool
• motivation

OBJECTIVE. The purpose of this study was to explore the effects of a powered mobility riding toy on the participation behaviors of young children with complex developmental delays.

METHOD. A single-subject withdrawal design was used to study the effects of powered mobility on child-initiated movement occurrences, initiation of contact with others, and affect. The participants were two young children with complex developmental delays, including spastic quadriplegia. The intervention consisted of having the children use a powered mobility riding toy in their school settings during gym class and outdoor recess.

RESULTS. Primary findings were that use of the powered mobility riding toy (a) increased the number of self-initiated movement occurrences; (b) appeared to have some effect on initiation of contacts with adults and, for one child, negative adult initiations and positive peer initiations; and (c) did not have a clear impact on the amount of positive affect.

CONCLUSION. For some young children with severe motor impairments and developmental delay, use of a powered mobility device may increase self-initiated movement occurrences during free play.


Often, children with disabilities have physical limitations that prevent them from independently interacting with their environments. This lack of independence relates to three interconnected concepts: learned helplessness (Abramson, Seligman, & Teasdale, 1978; Maier & Seligman, 1976), contingency learning (Sullivan & Lewis, 1993), and self-efficacy (Hildebrand, 1988). Maier and Seligman’s (1976) learned helplessness hypothesis is that “when events are uncontrollable the organism learns that its behavior and outcomes are independent, and that this learning produces the motivational, cognitive, and emotional effects of uncontrollability” (p. 3). These theorists further stated that belief in uncontrollability undermines incentive to initiate responses. This belief relates to what Sullivan and Lewis (1993) referred to as contingency learning, or the process of becoming aware of “response–outcome relations and actively controlling or exploring them” (p. 59). According to Sullivan and Lewis, contingency learning promotes motivational, attentional, and cognitive development and has implications for infants with disabilities because they have reduced probability of experiencing a clear relationship between self-generated actions and environmental consequences. Drawing on the work of Bandura (1977), Hildebrand (1988) described self-efficacy as the individual’s belief in his or her ability to perform a behavior and suggested that success with one task tends to generalize to other tasks.

Because disabilities compromise some children’s abilities to interact with and control their environments, it is hypothesized that these children have an increased tendency to develop learned helplessness, to have fewer opportunities for contingency learning, and to have a lower sense of self-efficacy. Therefore, methods of...
providing these children with options for controlling their environments merit exploration.

One way that children who are typically developing learn the effects of their actions on their environment is through self-initiated locomotor activities (e.g., creeping, walking, riding tricycles). Through participation in these activities, children are able to experience consistent relationships between their behavior and environmental consequences and, thus, learn that their world is controllable (Brinker & Lewis, 1982). These experiences may foster further attempts to control environmental events (Brinker & Lewis, 1982). In addition to the potential to help overcome learned helplessness and deficits in motivation, independent mobility also may affect children's cognitive and social-emotional development (Campos, Kermoian, & Zumbahlen, 1992; Kermoian, 1998).

Independent mobility seems to increase children's sensitivity to objects and events beyond arm's reach and changes their goal orientation (Kermoian, 1998). Further, both research studies and theoretical articles suggest that independent mobility may affect children's spatial understanding (Butler, 1986; Kermoian, 1997, 1998; Telzrow, Campos, Shepherd, Bertenthal, & Atwater, 1987).

The development of independent locomotion also contributes to socialization, transformations in child–adult interactions, and the sense of independence and competence (Campos et al., 1992; Kermoian, 1997). Children with disabilities who gained independent mobility by using powered mobility devices demonstrated better social-emotional skills than when they did not have independent mobility (Butler, 1986, 1997; Douglas & Ryan, 1987; Paulsson & Christofferson, 1984). Further, parents of children who use powered mobility reported that independence in mobility stimulated their children's social and emotional skills and intellectual behaviors (Butler, Okamoto, & McKay, 1983; Paulsson & Christofferson, 1984). For some children with disabilities, the use of powered mobility devices improved self-initiated behaviors (Butler, 1986).

The question of when young children with mobility impairments should be introduced to powered mobility is not new. Both the theoretical and the research literature have supported the use of powered mobility for young children with disabilities (Butler, 1986, 1997; Chiulli, Corradi-Scalise, & Donatelli-Schultheiss, 1988; Kermoian, 1997; Paulsson & Christofferson, 1984; Tefft, Furumasu, & Guerette, 1997; Wright-Ott, 1997). Some literature indicates that preschool-age children have learned to use powered mobility devices (Butler, 1986; Butler et al., 1983; Paulsson & Christofferson, 1984). Further, devices specific to very young children have been designed, developed, and clinically implemented. Two examples are (a) the Transitional Power Mobility Aid for children as young as 18 months of age (Wright-Ott, 1997) and (b) an electric cart for an 11-month-old with multiple limb deficiencies (Zazula & Foulds, 1983).

In summary, the literature supports the use of powered mobility with young children with disabilities as well as its usefulness related to motivational, cognitive, and social-emotional gains. As described by Snell and Balfour (1997), "Mobility is no longer seen as a luxury for the person with a disability, but as an important contributor to lifestyle and self-development" (p. 23).

In most of the existing literature and research on powered mobility, the children studied were either developing typically or had disabilities that primarily affected their mobility (e.g., spina bifida, arthrogryposis, spinal cord injuries, limb deficiencies). The usefulness of powered mobility has not been adequately examined for children who have complex developmental delays that affect not only their mobility, but also other functional skills, speech, and cognitive development. Because the assumption often is made that such children cannot benefit from powered mobility, therapists and families need information regarding its use to make informed decisions.

**Purpose**

This study extended existing research on powered mobility for young children to children with complex developmental delays who are facing the challenges of severe neuromotor impairments, speech impairments, substantial limitations in functional skills, and cognitive skills assessed to be below chronological age. Specifically, the purpose of this study, which focused on two young children with complex developmental delays, was to explore the effects of a powered mobility riding toy during free play (recess or gym class) on three dependent variables: (a) self-initiated movement; (b) initiation of contact with others (target child initiations directed to adults, target child initiations directed to peers, peer initiations directed to target child, adult initiations directed to target child), and (c) affect. We hoped that powered mobility use would increase self-initiated movement and contacts initiated by other children as well as by the target children. Further, we expected that if target child-initiated behavior increased, a decrease would be observed in adult-initiated contacts with the target children. Finally, we anticipated that the intervention would lead to increases in the target children's positive affect.

**Method**

**Participants**

By contacting community occupational therapists, two children were recruited for this study, and informed consent
was obtained from their parents. Both children had spastic quadriplegia and no previous experience with powered mobility. Both had sufficient cognitive ability to play simple cause-and-effect games; both were able to follow one-step commands; and neither had been identified as having uncorrected visual deficits. The two children attended different public schools and were in classes for children with disabilities. Before this study, neither child had been considered for powered mobility use, with limiting factors being the complexity of their disabilities and the costs of powered mobility.

Diane (pseudonym), a 5-year-old girl, had spastic quadriplegia and developmental delay. According to school records, Diane scored at the 1-month level on the Fine Motor scale of the Peabody Developmental Motor Scales (Folio & Fewell, 1983) when she was 43 months old. Her school records contained no other standardized testing information. She could indicate yes and no with gestures but had no oral language. She used her left fist to touch or point at a picture icon for most of her communication. In conversation, Diane was persistent in pursuing her topic and ensuring that her communication partner understood her. She was dependent in all self-care skills, wore diapers, and had mobility skills that were limited to rolling from prone to supine and supine to prone and pivoting when positioned in either prone or supine. She often was positioned in a wheelchair with a custom foam seat. Diane's assets included her ability to focus on a task and her effective use of nonverbal communication, such as facial expressions and gross hand movements. Diane's peers appeared to like her as evidenced by comments they made to her and the frequency with which they spontaneously brought her objects. She frequently was excluded from an activity during free time if it was not specifically set up for her to be involved. Diane had ankle-foot orthoses, but often came to school without them. For trunk support, she wore a short-sleeved neoprene suit that extended to mid-thigh. As part of her educational program, Diane received occupational therapy, physical therapy, and speech therapy.

John (pseudonym), a boy with spastic quadriplegia and developmental delay, reached 5 years of age during the study. According to school records, his scores at age 4 on the Battelle Developmental Inventory (Newborg, Stock, Wnek, Guidubaldi, & Svinicki, 1984) were more than 2 standard deviations below the mean for receptive language and 3 standard deviations below the mean for expressive language and (Hedrick, Prather, & Tobin, 1984) were reported as 2 standard deviations below the mean for expressive language. Functionally, John was able to move from sitting to sidelying, could roll from supine to prone and prone to supine, and could sit independently. He was not able to crawl or creep. When engaged in activities, he tended to use his left hand almost exclusively, with his right hand often in a fisted position. Relative to self-care skills, John drank from a two-handled cup with assistance, self-fed finger foods, used a spoon with some spilling, and wore diapers. He effectively used gestures, facial expressions, some signing, and two-word and three-word combinations to communicate. His primary assets were his sunny personality and parents who were supportive and committed to him. John often wore a neoprene vest to assist with trunk support, a neoprene sleeve splint over the right elbow to limit flexion, and ankle-foot orthoses. Though he used bifocal glasses and had undergone surgery for strabismus, his therapist believed that his visual problems had been corrected and would not compromise his use of powered mobility. The staff in John's preschool program included one teacher, aides, an occupational therapist, a physical therapist, and a speech–language pathologist. In addition, parents volunteered in the classroom and student helpers and an adapted physical education teacher aided regular classroom staff in the physical education setting. At the beginning of the study, John was learning to ride an adapted tricycle. He had difficulty initiating peddling movement, but once started, he could sustain a maximum of three to four consecutive rotations.

**Procedure and Research Design**

The first two authors collected data at the children's schools either during gym class or at recess during playground activities. All sessions in baseline and intervention phases were videotaped with a Panasonic VHS Professional/Industrial Camera.\(^1\) The camera operator, either a research assistant or one of the researchers, started each 10-min taping session after the child was positioned appropriately (e.g., on a mat or swing during phases when the powered mobility device was not used or in the powered mobility device in phases where it was used). The camera operator stayed approximately 10 ft to 20 ft from the side or front of the child. Neither child appeared to attend to the camera.

Our original plan was to use an ABAB single-subject withdrawal design to examine the effects of powered mobility on several dependent variables. However, an extended training period, vacations, and illnesses required that we drop the last B phase for John. Baselines (A phases) reflected typical gym class and outdoor recess routines. The intervention (B phases) consisted of using the powered mobility riding toy (a car) during these times. For each child, training in using the riding toy followed the initial baseline phase.

Training was individualized and occurred within each

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child’s school environment. No other children were present during training, which provided the study children with the ability to start and stop the car, turn the car on command, and move 5 ft or more in one direction spontaneously or on request. The children’s occupational therapists and a researcher were directly involved in the training. For John, his mother and teacher also were involved. After one training session, Diane met all training criteria. During the initial training sessions, John spent much of his time turning in circles and laughing. After five training sessions, ranging in length from approximately 15 min to 30 min, the car was introduced into John’s school routine. Even though his performance was inconsistent, he appeared to have adequate control to operate the car with supervision.

Independent Variable
The powered mobility riding toy was a Boss battery-operated ride-on car (see Figure 1). Controls were (a) digital electronic controls for less jerking when the car was started and (b) adjustable-speed controls for slower maximum speeds for training purposes and indoor environments and faster speeds for outdoor environments. A remote-control device with an override switch enabled the supervising adult to control the car if necessary for safety.

The first two authors, working collaboratively with each child’s therapist, adapted the seating and controls. Using individualized inserts made from medium-density foam, the children were positioned in long-leg sitting with the knees abducted and slightly flexed. The inserts provided support laterally to slightly above waist height for Diane and behind the back to above shoulder height for both Diane and John. Lap belts provided further stabilization for both children. Diane used the Slik Stik joystick, whereas John used the Proportional Joystick because he was unsuccessful with the Slik Stik. For both children, the joystick was positioned slightly less than 4 in. above its normal midline position.

Dependent Variables
The dependent variables were measured during baseline and intervention. They were divided into three categories: child-initiated movement, initiation of contacts with others, and affect.

Child-initiated movement. Movement occurrences were defined as any displacement of the body in one direction (e.g., rolling, pivoting 90° or more, riding a toy) with no physical assistance given by another person. A series of movements of one type and in one direction were considered a single occurrence if they occurred with no greater than a 3-sec pause between movements. For example, if the car moved for 10 sec with a 2-sec pause and then moved again in the same direction for 6 sec, it was recorded as one movement occurrence. Alternatively, if the child changed the type or direction of movement (e.g., rolling to pivoting; going straight, then turning right), each type or direction of movement was counted as one movement occurrence (e.g., rolling to pivoting was counted as two occurrences).

During baseline, frequency counts of movement occurrences were determined by viewing videos of the sessions. For Diane’s intervention condition, a counter attached to the car and configured to count movement occurrences was used. Either the research assistant or one of the researchers started the counter at the beginning and stopped the counter at the end of each 10-min taping session. The intent was to use the counter for both children. However, though it was reliable for Diane, it provided inconsistent data on the outdoor playground at John’s school. Consequently, videotapes were used to collect frequency data during John’s intervention phase.

Initiation of contact with others. Target child-initiated contacts with others were counted whenever two conditions were met: (a) the target child (Diane or John) initiated the contact with another individual without any observable...
prompting or initiating behavior on the part of another person and (2) the target child independently vocalized (with either comprehensible words or other vocalizations, including shouting, laughing, grunting, etc.) or physically pointed to, touched, or indicated that he or she wanted something from another individual. Target child–initiated contacts and vocalizations were divided into two categories—peer-directed and adult-directed—and further categorized as positive or negative. Examples of positive contacts included saying comprehensible words, laughing, and using gestures to indicate desires. Examples of negative contacts were crying and screaming.

Other-initiated contacts with the target child also were divided into two categories: contacts by peers and contacts by adults. Peer-initiated contacts were defined as any child initiating any type of contact with the target child (e.g., talking to the child, touching the child or a mobility device the child was using, giving a toy or item to the child, taking a toy or item away from the child). Playing in proximity of the target child was not included unless contact occurred between the children. Adult-initiated contacts with the target child were (a) carrying, moving, or otherwise touching the child or the device in which the child was seated (e.g., swing, wheelchair, toy car); (b) talking to the child or giving him or her a toy or item; or (c) taking a toy or item away from the child. Contact with the target child by another individual was coded as positive if it appeared positive or neutral (e.g., asking a question, sharing a toy). The contact was coded as negative if it involved something that could be judged as potentially aversive, such as name-calling or commands such as, “Stop that!”

Affect. Affect was coded as positive, negative, or neutral. Positive affect was defined as clearly smiling, laughing, or squalling happily, whereas negative affect was defined as crying, throwing a tantrum, frowning, abruptly turning away from another person, or pouting. Neutral affect was defined as anything between those two extremes. Note that just because affect or a contact was coded as negative, it was not necessarily a negative outcome for the child.

Data Collection

For each baseline session for Diane and each baseline and intervention session for John, the raters counted the number of movement occurrences while watching the 10-min videotape of the session. For Diane’s intervention sessions, the person videotaping recorded the number of movement occurrences indicated on the counter at the end of each session. Sessions were timed with a stopwatch.

For all initiation of contact variables, partial interval recording was used whereby a rater viewed videotapes of the 10-min sessions and recorded every 15 sec whether a targeted behavior occurred at any time during that 15-sec period. For example, in the middle of a 15-sec interval, if an adult initiated a 3-sec contact with the child, the rater recorded it as adult-initiated contact, even though the contact did not extend throughout the interval. For affect, momentary time sampling was used whereby every 15 sec, at the moment of a beep, the rater rated affect as positive, negative, or neutral. For each initiation of contact and affect variable within the 10-min data collection session, it was possible to record a maximum of 40 occurrences. In instances when a child was obstructed from view, the rater indicated that obstruction on the recording form, and data from that interval were not included in the analyses. Obstructed view only occurred for affect.

One physical therapy graduate student served as the primary rater for all variables for Diane. Five senior occupational therapy students served as primary raters for John. All were blind to the purpose of the study. Five additional occupational therapy students and the first two authors conducted agreement checks on dependent variable evaluation both before and during data collection. For Diane, interrater agreement was determined for 7 of the 18 sessions; for John, interrater agreement was examined for all sessions. For movement occurrences, the percentage of agreement for overall behavior counts was used. For all other variables, point-by-point percent agreement across observation intervals was calculated (Ortenbacher, 1986). For both children, average interrater agreement was 98% or above for all variables except affect, where it was 91% for Diane and 94% for John.

Results

Movement Occurrences

In the A phases (no care), Diane either did not initiate movement or did so only one to three times during a given session (see Figure 2[1]). Each movement consisted of one laborious roll from either prone to supine or supine to prone. After only minimal training, Diane’s movement in the B phases (car) increased to between 44 and 87 movement occurrences per 10-min session. John’s frequency of self-initiated independent movement occurrences also increased, going from 0 to 19 during the two A phases to 28 to 65 movement occurrences during the B phase (see Figure 2[2]).

Initiation of Contact With Others

Diane demonstrated no negative initiations of contact with adults or other children. Though her rates of positive initiations were very low, she did have some positive initiations with others during 3 of the 6 intervention sessions across two phases. By contrast, Diane initiated contact with others
during only 1 of the 12 sessions in the two baseline phases (see Figure 3[1]). Conversely, John had more positive initiations with adults during the two baseline phases as opposed to the intervention phase (see Figure 3[2]).

Adults initiated numerous positive contacts and no negative contacts with Diane, regardless of the experimental condition (see Figure 3[3]). Of the 40 possible recording intervals per session, the number of intervals per session reflecting positive contacts by an adult ranged from 1 to 38 (median = 7) during baseline and from 7 to 33 (median = 22) during intervention.

Though adults initiated positive contacts with John during all phases, they generally initiated more negative contacts with him during the intervention phase than during the baseline phases (see Figure 3[4]). The median number of intervals in which positive contacts were recorded by an adult ranged from 1 to 38 (median = 7) during baseline and from 7 to 33 (median = 22) during intervention.

Other children initiated interactions with both target children during all conditions (see Figures 3[3]–3[4]). For Diane, the number of intervals reflecting positive contact initiated by another child ranged from 1 to 34 (median = 4.5) during baseline and from 0 to 11 (median = 3) during intervention. Children made positive contact with John during more intervention sessions (4 out of 5) than during baseline sessions (1 out of 10). The only negative contact by another child occurred during John's third intervention session.

**Affect**

Affect data are presented in percentages because the number of moments in which affect could be coded reliably varied from one day to the next. This variation occurred because the child's face sometimes could not be seen when the child moved quickly or when other children blocked the view. For Diane, the percentages of moments for which positive affect was recorded in baseline were highly variable, ranging from 6 to 50 (see Figure 4[1]). Less variability occurred during the intervention phases, with percentages ranging from 15 to 36. The percentage of moments reflecting John's positive affect also were highly variable (see Figure 4[2]). Negative affect occurred on 2 days: (a) the 2nd day of intervention during 3 (11%) of the 27 moments in which affect could be observed
Figure 3. Initiation of contact involving target children and others.
and (b) the 3rd day of the second baseline phase during 2 (13%) of the 16 moments in which affect could be observed. The latter was when he was playing on an adapted tricycle.

Findings From Interviews and Experiences Associated With the Study

Interviews with school staff and the parent of one child and a record of the researchers’ experiences associated with the use of the powered mobility riding toy in the school environment provided additional information. First, several positive characteristics of the intervention were identified. Therapists mentioned that the powered mobility device used in this study looks like a toy, was a source of interest to other children, and could be used to enable mobility play for children who because of their disabilities cannot otherwise independently participate in playground and gym activities. Further, therapists found that the car was easy to adapt with foam inserts to support sitting and to meet the unique needs of the individual children. Coupled with its low cost compared with most powered mobility devices, adaptability makes the device a useful evaluation and early training tool when therapists and the child’s family are trying to determine whether the child can benefit from powered mobility. Therapists also identified the adjustable-speed setting as helpful during this process because the lower speeds could be used when the child was first learning to control the device and when the child needed to maneuver in congested areas.

Negative characteristics of the intervention also were identified. First, the car was loud. Teachers and other staff members commented about the noise, and the first author attempted to minimize it by greasing the bearings and putting rubber tubing on the wheels. Despite the modifications, staff reported that the car was disruptive when used indoors. Second, the car was challenged by rough surfaces, and the children sometimes became stuck in small potholes, on the grass, or up inclines on the playground. Third, therapists noted that the large turning radius made the car impractical for use in most classrooms and other small or crowded spaces. Fourth, frequent, but solvable, breakdowns were encountered.

Discussion

This study demonstrated that two young children with complex developmental delays, including severe neuromotor impairments, could learn to drive a powered mobility riding toy and use it during adaptive physical education or recess successfully. The primary finding for both children was that use of the riding toy had a reliable and clinically

Figure 4. Momentary time-sampling data for positive and negative affect.
important impact on initiation of movement occurrences. After introducing the intervention, both children had immediate and substantial changes in movement occurrence data, with immediate returns to baseline levels when the intervention was withdrawn. Further, use of the riding toy appeared to have some effect on initiation of contacts with others, but did not have a clear impact on amount of positive effect.

The type and magnitude of changes observed in both children are impressive considering the short duration of the intervention and the fact that neither child typically would be considered a candidate for powered mobility. Combined total training and intervention time was slightly less than 3 hr divided over 7 sessions (1 training, 6 intervention) for Diane and less than 4 hr divided over 10 sessions (5 training, 5 intervention) for John. Having only intermittent use of the power mobility riding toy, each child was successful in learning to use the device and demonstrated some changes in other developmentally appropriate behavior. These results suggest that even if it is not possible to obtain powered mobility for a child for full-time use, a child with complex developmental delays may benefit from using a device part time during his or her school program. However, if one device is purchased for use by multiple children, we suggest using a proportional joystick and having an alternative switch-access control system to try with children who are unsuccessful with joystick control.

Consistent with the work of Sullivan and Lewis (1993) and the importance of a clear relationship between self-generated actions and environmental consequences, both children had substantially higher frequencies of self-initiated movement occurrences when using the powered mobility riding toy. However, the data related to the dependent measure of movement occurrences communicate only part of the story. Both children seemed to value the ability to direct their own movement in their respective environments. John often headed out a door or toward distant parts of the playground away from his classmates, resisting teacher and parental efforts to direct him back to the group. He was persistent about pursuing his own goals, many of which involved vestibular and proprioceptive stimulation, including (a) repeatedly turning in circles over a playground drainage grate, resulting in both circular movement and up and down bumping; (b) going over holes and other irregularities in the pavement; and (c) bumping into walls. The latter often appeared to be purposeful in that John would stop 1 ft to 2 ft from the wall, look at the adults, smile, and then push the joystick forward. He seemed to enjoy the crash. Thus, for John, the riding toy seemed to become the primary object of play, rather than a mobility device for reaching other persons or play objects in the environment.

John's occupational therapist also commented that after using the car John did better with the adapted tricycle and seemed to have a clearer understanding of movement. This change is consistent with the data in that his maximum number of baseline movement occurrences happened during the second baseline when he was using the adapted tricycle. Possibly, his increased success with the adapted tricycle reflects Hildebrand's (1988) suggestion that success with one task tends to generalize to other tasks or to Kermoian's (1998) contention that independent mobility changes the children's goal orientation.

Diane's patterns of movement provide further support for the importance of a clear relationship between self-generated behavior and environmental consequences (Sullivan & Lewis, 1993). Though she was able to roll over, she seldom used this skill to move from one place to another, possibly because it was labor intensive and provided little in terms of environmental consequences. By contrast, when in the riding toy, she was almost always in motion, intent on planning her next movement, or positioning the car so she could observe her peers' activities. Unlike John, she rarely bumped into things. Often it appeared that if Diane believed she might bump another person or an object, she would not move at all. For example, she was told that another child was in a blind spot behind her, so she did not move for 2 to 3 min. She started moving only after she was told that the other child was no longer there. This level of caution was typical of Diane's performance.

The findings related to initiation of contact with others were more variable. Though little difference was observed in the numbers of intervals in baseline versus intervention reflecting peer initiations with Diane, qualitative differences existed. Diane's play during the intervention phases appeared more mature than during the baseline phases. For example, when she was on the mat in the gym, her peers often placed an object near her or in her hand in much the same way children play with infants. The initiation of this type of interaction appeared to be consistent with the overt behaviors Diane exhibited because she did not speak and could not move efficiently. The placement of an object did encourage some arm movement toward the object, but her ability to manipulate the object was limited, and no developmentally appropriate play was observed. This situation is contrasted by two situations of her play in the car. First, a common activity observed during preschool gym class and recess when riding toys were available was that the children drove in circles or lines, following each other. As Diane appeared to become comfortable with the powered mobility riding toy, she began to join in this activity. Second, on one occasion in the car (the last session), one child in a group of several had a caterpillar. She put it on the car with-
in Diane's visual field, and the children giggled and made eye contact with Diane. Then Diane took the caterpillar for a ride with the other children chasing after her. These occurrences were the only clear examples of developmentally appropriate interactive play, and it appeared that the use of the car increased Diane's opportunities to participate meaningfully. Because these occurrences were toward the end of the intervention, we might have seen more of this type of play with longer periods using the car. Neither child used the car to access or retrieve objects.

The results related to adult initiations were mixed relative to our hypothesis that adult initiations would decrease during intervention. The findings somewhat supported this hypothesis for John, whose school environment had a high adult-to-child ratio. John almost always had an adult available to help him, and his data reflect almost continuous adult initiations during some baseline sessions. In this situation, though he was positioned on swings and moved around the environment by adults, he had limited control. When John was in the car, although adults maintained a high level of contact with him, adult initiations generally were lower than during baseline sessions. In contrast, the findings for Diane provided no support for the hypothesis.

As expected, both children exhibited considerable laughter and smiling during the initial training. This affective response was transitory, with the data during intervention being less variable than during baseline. For future research, we question the usefulness of this dependent measure. In reviewing the videotapes, several observers noted the children's intense concentration and attention to the environment during the intervention phases. This attending behavior seemed to reflect the children's engagement in the playground or gym experience. A datum that focuses specifically on those behavioral characteristics might prove more useful than general affect data.

Some of the findings related to John's affect parallel the findings of Lloyd, Kermoian, and Campos (1994), who studied a group of locomotor 8-month-old infants and a group of prelocomotor infants of the same age. These researchers reported that locomotor infants expressed more negative affect when their goal-directed activity was blocked than did prelocomotor infants. John was noted as being a generally positive, compliant child. However, both a classroom aide and his therapist commented that he was saying "no" more often and being more assertive once the car was introduced into his program. This observation was consistent with the data in that he exhibited no negative affect during the first baseline phase but displayed negative affect during the 2nd day of intervention and during the second baseline on a day when he was using the adapted tricycle, a toy that allowed self-initiated mobility. In parallel, John asserted himself by initiating negative contacts with adults on these same days. The possible impact of self-initiated movement on assertiveness merits further study as related to the introduction of mobility technology to children with complex developmental delays.

Use of the powered mobility riding toy in the protected school environment had advantages. When the children ran into things, either accidentally or on purpose, they experienced the consequences of their actions. For example, adults admonished John for running into walls, "running away," or not moving with the group. Additionally, when John bumped into another child on a tricycle, the bumped child took it in stride and sped off, admonishing, "Watch where you're going!" Free play during gym class and outdoor recess provided learning opportunities in an environment where bumps are common occurrences, and others in the environment provide appropriate feedback. Compared with John, Diane had a more cautious approach. She soon learned how much space she took up in the car and how to maneuver without bumping into things. She carefully waited for clearings in the preschool traffic, sometimes taking more time than would be desirable for efficient movement. Thus, Diane was able to develop skills at her own pace in the free-play environment.

Conclusion

Despite the two children's differing approaches, our experiences with them suggest that powered mobility play on the playground or in the gym provided developmentally appropriate mobility education that we predict will facilitate the transition to wheelchair use in the larger community. We need additional research to verify this prediction and increase our understanding of the effects of powered mobility on children with complex developmental delays. As a next step, single-subject studies should be extended over longer periods and meet the conditions required for application of inferential statistics. Further, efforts should be made to extend this research by using dependent variables related to developmental levels of play, self-assertiveness, and attention to the environment. Finally, longitudinal studies of children with complex developmental delays who use powered mobility riding toys could determine the extent to which powered mobility play facilitates the transition to powered mobility use in the community.

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