

# Power Mobility and Socialization in Preschool: A Case Study of a Child With Cerebral Palsy

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**Purpose:** Power mobility training for young children and infants appears feasible under controlled conditions. Dynamic, natural environments provide the ultimate test of training. The purpose of this case study was to determine whether it was feasible for Will, a 3-year-old boy with cerebral palsy, to use a power mobility device (UD2) in his preschool classroom and to quantify his classroom mobility and socialization. **Methods:** Will, 2 peers (typically developing), and 2 teachers were filmed daily in class during a baseline phase without UD2, followed by a mobility phase with UD2. We coded socialization and mobility measures from video recordings. **Results:** Will was more mobile and interactive when driving UD2 than during the baseline phase; however, he remained notably less mobile and interactive than his peers. **Conclusions:** The use and assessment of power mobility in a preschool classroom appear feasible. Issues important to maximizing children's use of power mobility for classroom participation are discussed. (*Pediatr Phys Ther* 2010;22:322–329) **Key words:** assistive technology, cerebral palsy, motor activity, outcome measures, preschool child, rehabilitation, socialization, wheelchair

## INTRODUCTION

For infants who are developing typically, the emergence of independent mobility via crawling and walking is associated with advances in motor, social, emotional, language, cognitive, and perceptual development.<sup>1–3</sup> For children and adults with mobility impairments, such as those with significant cerebral palsy (CP), a power chair can provide both independent mobility and associated improvement in quality of life.<sup>4,5</sup> Recent work from our laboratory and others suggests that power mobility training

may be feasible and developmentally effective for very young children, especially if provided under controlled, experimental conditions.<sup>3,6,7</sup> Our training uses an experimental power mobility device (UD2) that is small enough to be driven in narrow spaces common to homes and classrooms. Thus, in this case study, we investigate whether it is feasible for a child with CP to drive UD2 in his preschool classroom.

Most studies of early power mobility training have been performed in relatively open, controlled spaces such as clinics and laboratories. Studies of early power mobility use in the home, including the preliminary findings from the first randomized clinical trial,<sup>8</sup> collectively reported that training was feasible and effective for young children aged 11 to 39 months.<sup>9–13</sup> Children of preschool age, even those with cognitive impairments,<sup>14</sup> improved with training, including the use of power mobility in the gymnasium or playgrounds.<sup>15</sup> What is not clear, and is the focus of this case report, is whether a preschooler would transfer his or her mobility level in open environments to the more closed and structured classroom.

A preschool classroom provides researchers and clinicians the opportunity to assess a child's use of power mobility in a dynamic, real-world environment common

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to many US children.<sup>16</sup> Power mobility may be particularly important in the preschool years because children's social skills are expanding as they move and interact with peers and teachers.<sup>16–18</sup> Although rarely quantified in formal studies, observing preschoolers at play suggests that their socialization is closely related to effective, efficient mobility. Not surprisingly, significant mobility impairments, such as those associated with CP, increase an individual's risk for social isolation, rejection, and mental health issues.<sup>19</sup> For example, a study of social adjustment found that 10-year-old children with CP had fewer friends, were more socially isolated, participated less in social and leadership activities, and were more victimized by their peers than their classmates who were developing typically.<sup>20</sup> If feasible, the regular use of power mobility in the classroom could, in part, help to lessen the risk for social isolation and increase the potential for friendships.

The specific purpose of this case report was to determine whether it was feasible (*a*) for a 3-year-old boy with CP who had completed basic training in the gymnasium and playground to use UD2 in a preschool classroom and (*b*) for us to simultaneously measure his mobility and his socialization with peers and teachers with and without UD2. Given his past power mobility training and his established relationships with peers and teachers, we expected that he would readily use UD2 in the classroom for both mobility and socialization similar to his classmates.

## DESCRIPTION OF THE CASE

This case report describes the performance of Will, a 3-year-old boy, with a diagnosis of spastic quadriplegic CP with an athetoid component, over a 4-week period. Will has received therapy continuously since the age of 13 months. Therapy has addressed functional delays in sitting, reaching, and walking and movement impairments involving his limbs and trunk. This case report began after Will's parents and teachers expressed a goal of increasing his mobility and participation in the classroom. Will's parents, teachers, and the families of 2 comparison peers all provided informed consent as approved by the University of Delaware Institutional Review Board. As part of the informed consent, teachers were told about the general focus of the study and that the classroom would be videotaped, but extensive information about specific measures was not discussed.

Will's independent mobility was significantly limited. He had full passive range of motion in both arms and legs; however, all limbs had limited active range of motion and displayed spasticity and stiffness. He also had difficulty initiating and isolating movements. He was unable to crawl but could produce steps with a walker with moderate assistance to remain upright, steer, and turn. His Gross Motor Function Classification System level was III, reflecting his sitting ability and his need for assistive technology for mobility. His Gross Motor Function Measure-66 score at age 3 was 40.91%, which was below average for his age and Gross Motor Function Classification System level.<sup>21</sup>

Will's toddler and preschool teachers noted no significant limitations in his cognitive or language level. Both noted, however, that he interacted less than his classmates did with peers or teachers.

When secured in a chair by a lap bar, Will had full head movement and control, adequate trunk control to play with toys and draw, and adequate bilateral grasp to manipulate a standard joystick. Over a 7-month period before starting this case study, Will learned to use a standard pediatric power chair in various open environments within the childcare facility. He continued to drive his current power chair (Permobil Koala, Lebanon, Tennessee) daily with minimal verbal cues in the hallways, gymnasium, and outdoor playground but did not have power mobility in his classroom, home, or community. Although his current power chair was one of the smallest available, it was too long and wide for classroom use. Thus, without a smaller power mobility device, he was entirely dependent upon his teachers to move him between structured activities and during free play within the classroom.

## DESCRIPTION OF INTERVENTION

Will was enrolled in a center with 250 children, with classrooms for infants through kindergarten. Will's preschool classroom consisted of about 10 to 15 children aged 3 to 4 years and 2 teachers. The 2 teachers were filmed, in addition to 2 classmates who were developing typically—comparison peer 1 and comparison peer 2—as comparison subjects for Will. Will continued to receive therapy, including gait training, during this case study period. He also continued to use his Permobil chair in the gymnasium and outdoors. Will had experience driving UD2 outside the classroom but did not receive any additional training for classroom use. To be clear, Will had not used any power mobility device in his classroom; hence, our “intervention” was to provide Will with a mobility device for classroom use. Goals for the power mobility intervention were to (1) increase his independent mobility within the classroom and (2) increase the amount of time that Will spent interacting with peers and teachers within the classroom.

## Materials

Our robot-enhanced mobility device, which we call “UD2,” is small enough for classroom use (Figures 1a and 1b). It has a PIONEER 3-AT robot for a base (MobileRobots, Inc, Amherst, New Hampshire), which measures 19.7 × 19.3 × 10.2 in (Figures 1a and 1b). A commercial infant seat (Safety 1st Sit n Go Booster Seat; Columbus, Indiana) is attached to a platform that is clamped to the top of the base. To accommodate a child's small hands and low force generating ability, we modified the spring stiffness, size, and shape of the joystick (Logitech Freedom joystick, Fremont, California). The UD2 is equipped with an onboard computer that collects robot movement data such as X-Y position, orientation, and speed. The joystick



**Fig. 1.** (a) The robotic power mobility device (UD2). (b) Will in UD2 in an area of the classroom. This area was where Will spent much of the time in the mobility phase. (c) The area of Will's classroom with tables; the arrow shows ceiling-mounted cameras. The table area was where teachers typically placed Will for most of time in the baseline phase. (d) Different view of classroom area in (c).

communicates directional commands to the robot onboard computer. We used a laptop to collect log files from the onboard computer (Toshiba Satellite A205-S5804; Irvine, California).

### Procedures

There were 2 phases: a *baseline phase* consisting of 10 days *without* the use of UD2 and a *mobility phase* consisting of 13 days *with* UD2. We videotaped classroom activities each morning for 2 hours during the 8 am to 10 am free play period. Video recording took place only for 2 hours per day; however, during the mobility phase, UD2 was accessible to Will all day in the classroom. We used multiple ceiling-mounted cameras within the classroom (Figure 1c) and a camcorder (Sony Hard Disk Drive DCR SR40, San Diego, California) through a 1-way window within the classroom's observation booth. Experimenters remained out of sight of the classroom.

From the 2 hours filmed each day during both phases, each child's 30 "most active" minutes were selected for coding according to the following priority: first, all minutes when the child was moving in space such as walking or driving, and physically or verbally interacting with a peer or teacher; second, all remaining minutes when the child was moving in space without interaction; third, minutes of interacting while stationary but with body movement; fourth, minutes interacting while stationary with no body movement; fifth, minutes of body movement while stationary and not interacting; last, minutes stationary with no body movement and no interactions.

### Mobility Measures

During the mobility phase, the following measures were obtained via coding video footage:

*Percentage time Will was in UD2:* The percentage time that Will was sitting in UD2 during the 30 most active minutes. During this time, he may or may not have been driving.

*Percentage time Will drove UD2:* The percentage time that Will drove UD2 during the 30 most active minutes.

No mobility data were collected during the baseline phase because Will was not independently mobile without UD2. Although we noted the mobility levels of the comparison children in each phase, no formal mobility data were collected.

### Socialization Measures

During the baseline and mobility phases, the following measures were obtained from video footage of all 3 children using the coding definitions of Howes and Matheson.<sup>22</sup>

*Number of minutes spent solitary:* The number of minutes spent greater than 3 ft away from a peer or teacher and not engaged in verbal or physical interaction with another individual.

*Number of minutes spent in parallel play/parallel awareness ("parallel play/awareness"):* The number of minutes spent within 3 ft of a peer where both children are

playing with similar toys but either show no awareness of each other or are aware of but not interacting with each other.

*Number of minutes spent in teacher interaction:* The number of minutes spent interacting verbally and/or physically with a teacher. If a teacher is interacting with a group of peers, then this is coded as only teacher interaction and not peer interaction.

*Number of minutes spent in peer interaction:* The number of minutes spent interacting verbally and/or physically with 1 or more peers.

### Coding Reliability

One primary rater coded each social category for each day per phase for each child. The first 20% of video footage in each phase, which was approximately 2 days of video recording, was also coded by a secondary rater. At least 90% reliability per day coded was achieved between primary and secondary raters. The equation used to calculate reliability for each day was  $\frac{\text{agreed}}{\text{agreed} + \text{disagreed}} \times 100$ . The number of intervals of time that matched  $\pm 5$  seconds and

was labeled as the same social measure was counted as agreements. The number of intervals that did not match  $\pm 5$  seconds or was labeled as the different social measures was counted as disagreements.

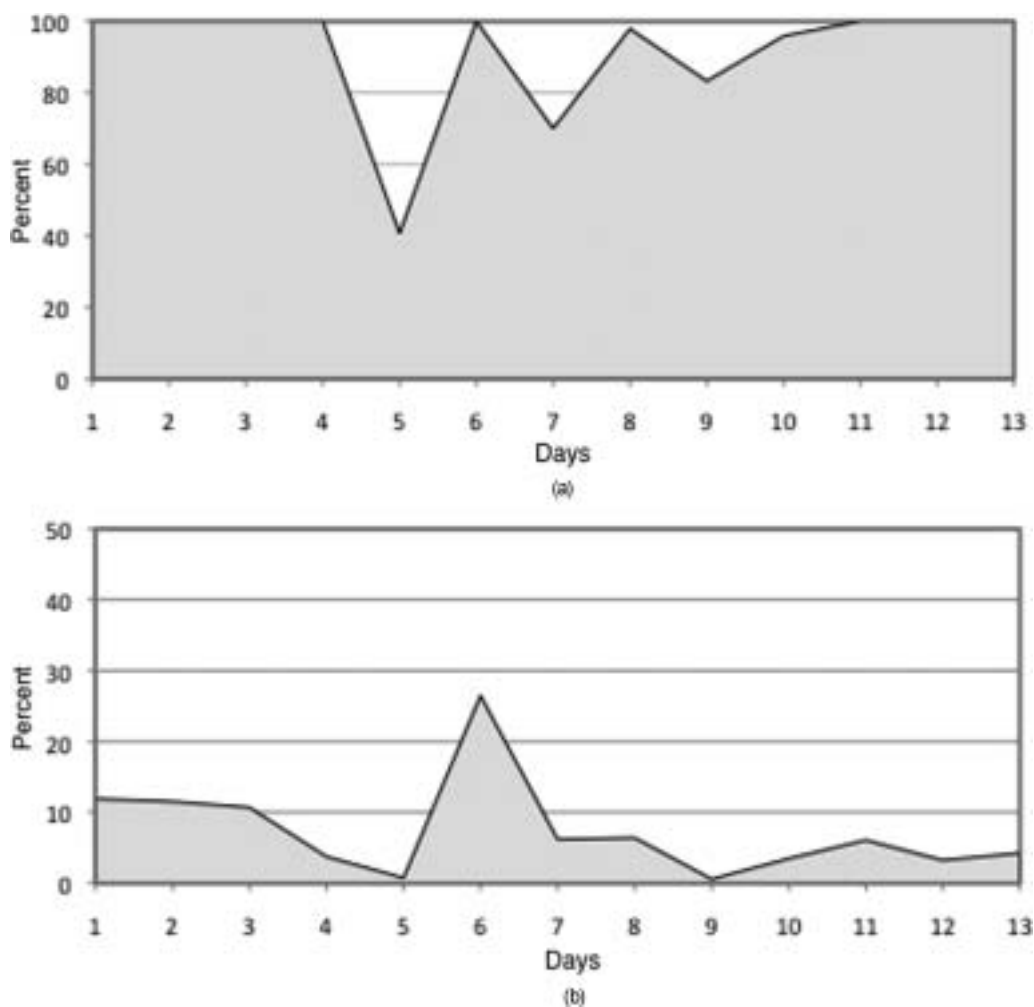
### DESCRIPTION OF OUTCOMES

#### Mobility

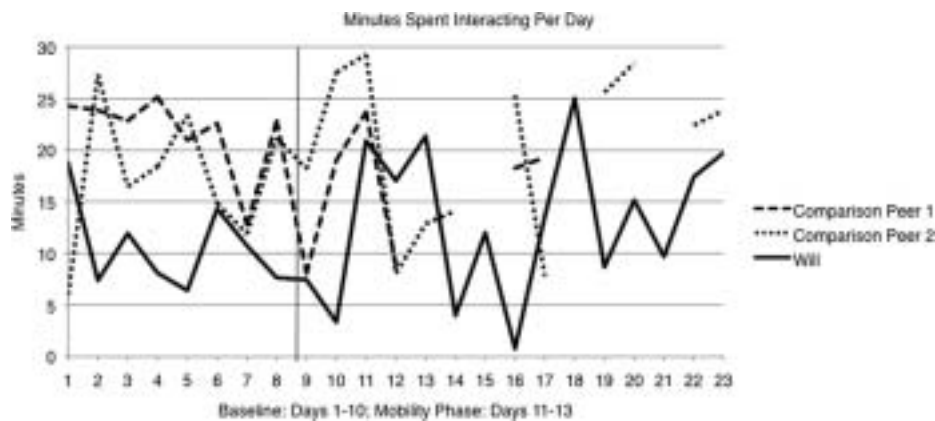
Will generally spent 80% to 100% of his most active 30 minutes sitting in UD2, with only 1 day less than 70% (Figure 2a). Surprisingly, however, Will typically drove for only 5% to 10% or 1 to 2 minutes of his most active 30 minutes. On 2 days, he did not drive at all and 1 day he drove for significantly greater than 10% of his most active minutes (Figure 2b). This is in comparison with comparison peer 1 and comparison peer 2, who were mobile for the majority of their most active minutes.

#### Socialization

Figure 3 shows the daily level of each child's interaction with teachers and peers combined, which we term



**Fig. 2.** (a) Percentage time Will was sitting in the robot during the 30 most active minutes coded each day of the mobility phase; (b) percentage time Will drove the robot during the 30 most active minutes coded each day.



**Fig. 3.** The amount of time (minutes) of each 30 most active minutes per day of the baseline phase and the mobility phase that each subject interacted with either teacher or peers. The black line represents Will's data, the blue line represents Comparison peer 1's data, and the red line represents Comparison peer 2's data. Gaps in the lines represent days during which subjects were not present in the classroom.

general interaction, during the baseline phase. As expected, each child's general interaction level varied from day to day. Despite this variability, Will's minutes of general interaction without mobility were consistently less than both comparison peer 1 and comparison peer 2 (Figure 3). For multiple baseline phase days, Will's interaction minutes were only half those of comparison peer 1 and/or comparison peer 2. In general, Will spent approximately 10 minutes or one-third of his most active minutes interacting with teachers and peers compared with 20 minutes or two-thirds for comparison peer 1 and comparison peer 2.

Figure 4 shows a box plot of the amount of time (minutes) that Will, comparison peer 1, and comparison peer 2 (each with a separate column) participated in the 4 social measures during the baseline phase (boxes on the left) and mobility phase (boxes on the right). When immobile (baseline phase), Will differed from the comparison peers in his socialization within the classroom. Specifically, Will spent more time solitary and in parallel play/awareness and displayed wider variability in the number of minutes he spent in both measures than his comparison peers. Will spent equal or less time interacting with teachers than did his comparison peers. Finally, Will spent much less time interacting with peers with less variability than did his comparison peers. For example, Will often spent less than 2 minutes of the 30 most active minutes per day with peers. We also noted that Will typically spent the vast majority of his most active minutes at 1 location, which was strikingly different than that of his comparison peers. For example, during the baseline phase, he was only occasionally moved between locations by teachers and rarely asked to be moved. This resulted in Will spending up to 45 minutes at 1 location, which was in contrast to his comparison peers who typically spent less than 5 minutes at any 1 location.

When Will had access to UD2 (mobility phase), he spent approximately the same amount of time solitary as in the baseline phase but with less variability in the number of minutes spent solitary per day. He spent less

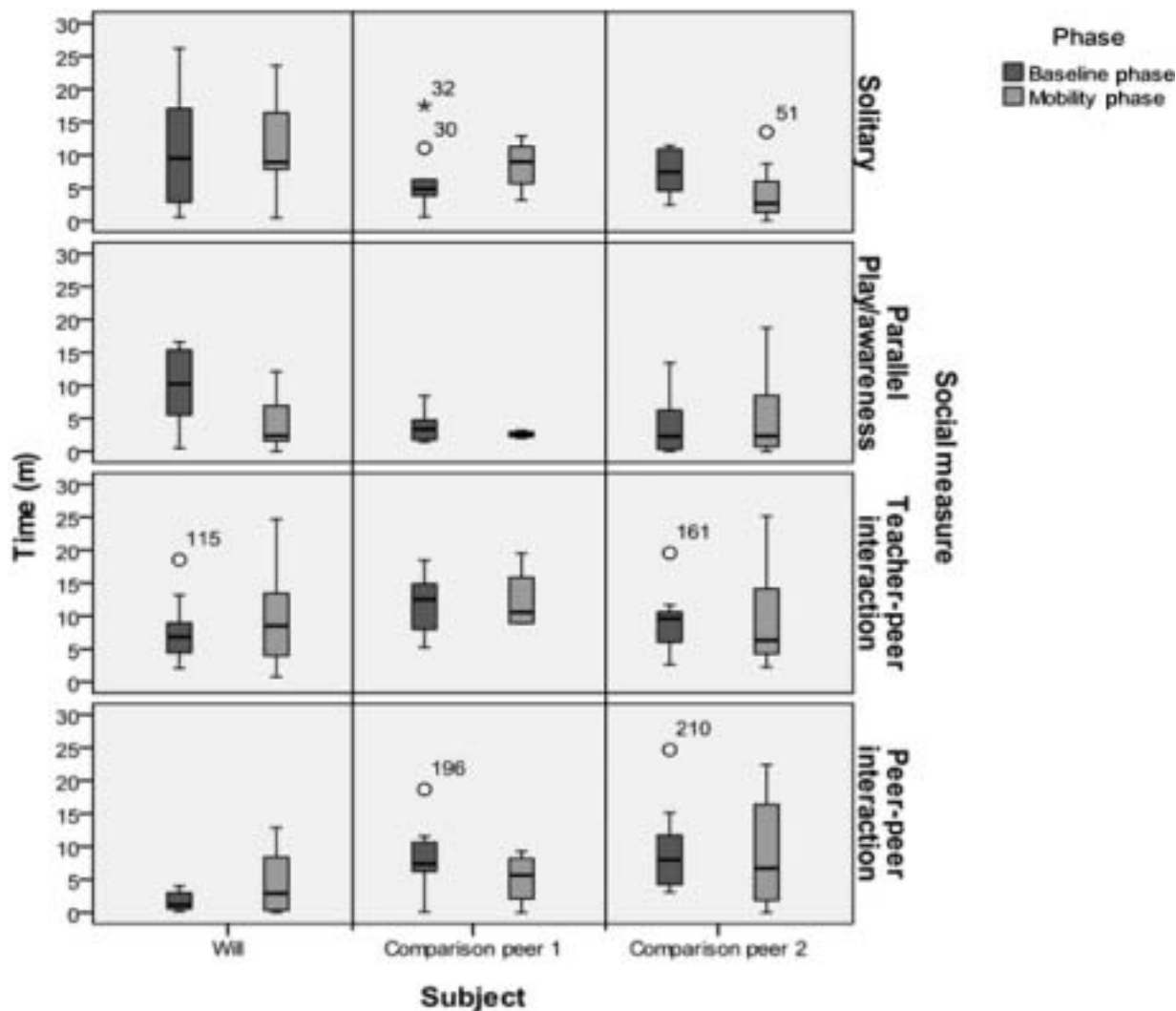
time in parallel play/awareness with less variability than in the baseline phase, which resulted in time and variability more comparable to his comparison peers. Will spent slightly more time interacting with teachers with more variability than during the baseline phase, which resulted in time and variability more comparable to his comparison peers. Finally, Will spent more time interacting with peers with greater variability than during the baseline phase, which was still less than comparison peers, especially peer 2.

In summary, Will's time spent in parallel play/awareness during the baseline phase appears to have been reallocated to time spent interacting with others during the mobility phase. Will also decreased the day-to-day range of time not interacting with others and increased the day-to-day range of time he spent interacting during the mobility phase. Despite these positive changes during the mobility phase, Will spent the majority of his most active time in noninteractive activities (solitary and parallel play/awareness) and less time in interactive activities with peers and teachers than did the comparison children, similar to his baseline phase.

## DISCUSSION

The results of this case study suggest 3 major points. First, power mobility was feasible for use in a preschool classroom by a child with CP. Observations that support this determination are that (a) UD2 was small enough for classroom use, (b) Will was allowed to be in UD2 for the majority of his most active minutes (Figure 2a), (c) Will took the opportunity to drive UD2 for a portion of most days (Figure 2b), and (d) UD2 did not appear to be a barrier to his socialization. Indeed, Will's use of UD2 may have positively influenced his interaction with peers (Figure 4).

Showing that power mobility is feasible in each of a child's natural environments is an important first step because barriers exist to the daily use of assistive technology.<sup>23</sup> We hope that evaluating young children



**Fig. 4.** Box plots of time (minutes) that each subject spent solitary, in parallel play/awareness, teacher-peer interactions, and peer-peer interactions. The boxes on the left represent baseline phase values; the boxes on the right represent mobility phase values. The central horizontal line marks the median value per subject. The top and bottom edges of the box mark the limits within which fall the central 50% of the values. The whiskers extend to the highest and lowest scores for each subject. Circles indicate the outliers within 1.5 to 3 box lengths from the 75th percentile (top edge of the box); asterisks indicate outliers greater than 3 box lengths from the 75th percentile.

and infants for power mobility may soon become standard practice<sup>24</sup> because of emerging device technology and the realization that mobility is a critical factor in a child's development.<sup>1,2</sup> Future group studies are, of course, required to validate this case study and much of the pediatric power mobility literature. Interestingly, preliminary results from the first randomized clinical trial of power mobility in young children found several positive effects with a range of pediatric populations.<sup>8</sup>

The second major point is that our equipment and protocol successfully captured Will's mobility and all 3 children's socialization with peers and teachers. Preschool classrooms are commonly used in studies on the development of socialization across populations developing typically and with special needs, ranging from how children with special needs interact with peers to behavioral interventions that increase this interaction.<sup>25</sup> Our results expand the use of these methods to assessing the integration of power mobility into early education classrooms. More-

over, these methods are common in the literature, low tech, reliable, require no formal training, and allow comparison of multiple children. Thus, they may be particularly useful for gathering information of interest to clinicians, teachers, and families.

Third, simply providing short-term access to power mobility in the classroom may not have been adequate to stimulate changes in mobility and socialization. Specifically, although Will used power mobility daily in the gymnasium and playground, he did not use UD2 in the classroom for more than 10% of the available time (Figure 2b). Although the results of this case report are purely suggestive and require validation in formal group studies, we later propose several factors that may have kept Will from automatically transferring his power mobility level from other environments to the classroom.

First, the physical and social characteristics of a classroom differ from that of a playground and gymnasium. These differences include the amount of open space,

teacher's rules for activity levels, toys and activities available, and the activity level and social expectations of peers. Interestingly, several of these characteristics have been proposed to decrease the motivation and opportunity for significant mobility in the home and the community.<sup>26</sup> That is, the narrow spaces between tables, bookshelves, and play stations; the restricted activity levels; the nature of indoor activities; and the social expectations characteristic of the home and classroom may limit independent power mobility.

Second, the mobility devices used in and out of the classroom were different. The UD2 drives with different characteristics (eg, seat height, dimensions, smoothness, cornering, velocity, acceleration, and joystick sensitivity) in comparison with the standard power chair he used outside of class. These differences and that Will had more experience with his standard power chair may have constrained his use of UD2.

Third, the typical experiences and expectations were different in and out of the classroom. Will's experiences out of the classroom were largely those of being mobile by using power mobility, whereas he had never been mobile in the classroom. Thus, his teachers and peers had only interacted with him while he was essentially immobile in the classroom. Their interactions may have been stable enough not to be significantly altered by a few weeks of access to power mobility. Indeed, during the baseline phase, Will rarely was moved between locations by his teachers and rarely requested to be moved even when sitting in 1 location for up to 45 minutes. Because our focus was on the feasibility of Will's independent use of UD2 in the classroom, we provided no additional power mobility training. Behavioral interventions that educate and train the child, his teachers, and peers on mobility and socialization in addition to providing power mobility may be helpful.

We speculate that Will's social interactions did not increase to the level of the comparison peers during the mobility phase because of 1 or more of the following factors: First, the lack of a peer-typical mobility via UD2 may have limited his socialization. Second, certain characteristics of the mobility device itself may have limited his socialization. For example, the device's height, overall footprint, and front tray limited how close Will could get to his peers and teachers as compared with peers locomoting typically. Third, certain characteristics of the mobility device may have limited his access to toys, especially when they were being played with on the ground or on a table. Given the importance of toys to children's peer-to-peer interactions, this lack of ready access may well have limited Will's socialization. These and other limitations need to be minimized or eliminated in the design of future devices. We have found that the most creative, effective pediatric mobility device designs emerge from a team including early educators, families, pediatric clinicians, and industry experts in addition to clinical researchers and engineers working with experimental devices performing in real-world settings.

Finally, how did Will's socialization with peers increase (Figure 4) if he was not highly mobile in UD2? A

few observations taken together suggest a nonintuitive effect of the access to UD2 and highlight the importance of classroom mobility. During the baseline phase, Will was typically placed at a specific table near other tables for the extent of free play (Figures 1c foreground and 1d) whereas comparison peer 1, comparison peer 2, and most other children played in other classroom areas and occasionally passed by his table. Because UD2 could not fit under his table, during the mobility phase, Will was initially placed in UD2 each day in a variety of start locations away from his table. From these different locations, he would often drive to the middle of high-traffic areas where children constantly moved near him (Figures 1b and 1c background). Thus, his socialization with peers may have increased, in part, because he was initially placed and then drove in "high-traffic" areas where more children were involved in more activities. This nonintuitive effect of using power mobility in the classroom highlights a key connection between mobility and socialization: namely, that mobility places you in the action, which increases your chances of interaction. Surprisingly, an additional 10 minutes of socialization per day ultimately yields an additional 113 hours or approximately 3 weeks of socialization per school year.

In conclusion, this case report suggests that providing power mobility within a preschool classroom is feasible for certain children with mobility impairments. Given the benefits of mobility, the interest in early power mobility, and the various barriers to and opportunities for classroom participation of children using assistive technology, we believe that larger-scale follow-up studies that also examine mobility issues in real-world environments will have significant impact on clinicians, educators, families, and funding agencies. These studies should consider the methodology, observations, and issues discussed here to maximize the effect of increasing mobility and socialization in early education settings.

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