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The Positive Effects of Early Powered Mobility on Children's Psychosocial and Play Skills

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Powered mobility can have an important cognitive and psychosocial impact on young children who are unable to move independently. Twenty-three children with physical disabilities between the ages of 18 months and 6 years participated in this study. Data evaluating social skills, frequency of mobility play activities, frequency of interaction with toys/objects, and play/verbal developmental levels were collected at wheelchair evaluation, wheelchair delivery, and approximately 6 months later. Significant increases were found in parental perceptions of positive social skills for younger children after receiving a wheelchair; slightly older children showed improvements in social skills before the wheelchair was received; no changes were found in negative social skills. Parental ratings also indicated a significantly greater difficulty remaining engaged in tasks after receiving a wheelchair. A significant increase was noted in the number of mobility activities during indoor free play but no difference was seen in interaction with toys or objects. Improvement in the qualitative level of outdoor interactive free play was reported but there was no change in verbal interactions. This article discusses the potential positive impact of early powered mobility. These findings may be helpful in justifying the recommendation of powered mobility to young children and in justifying medical necessity of powered mobility for reimbursement by third party payers.

Keywords: pediatric powered mobility, social skills, mobility play activities, object interactions

Young children typically become independently “mobile” sometime during their first year of life. This mobility is important because it allows children to explore their world and learn how they can control their lives through motor movement such as crawling and walking. Exploration provides an opportunity for quality play, which is important in the cognitive, social, linguistic, and emotional development of a young child (Gustafson, 1984; Pellegrini & Smith, 1998). Quality pretend play has been found to be associated with advancement in areas such as problem solving (Wyver & Spence, 1999), social competence (Creasey, Jarvis, & Berk, 1998; Haight & Miller, 1993), perspective-taking (Burns & Brainerd, 1979), and language development (Sawyer, 1997; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004). In contrast, children with severe physical disabilities that limit their mobility often must rely on others to bring them objects to play with, move them from room to room for play, or initiate play with them. This inability to move independently reduces opportunities for play, exploration, and social interaction with peers, and increases the risk for developmental, cognitive, and psychosocial delays (Guralnick, Connor, Hammond, Gottman, & Kinnish, 1995; Verburg, Snell, Pilkington, & Milner, 1984).

Powered mobility is one means to help young children with severe physical disabilities move, play, and interact in their environment. Early provision of powered mobility is believed to facilitate and enhance learning, socialization, and self-esteem by enabling independent, self-initiated movement and interactions (e.g., Wiart, Darrah, Hollis, Cook, & May, 2004). While there has been relatively little published recently on the benefits of powered mobility, earlier research has shown improvements in psychosocial and cognitive developmental skills (Nisbet, 2002; Paulsson & Christofferson, 1984), increases in curiosity and outgoing social interactions (Butler, 1986), independence (Bottos, Bolcati, Sciuto, Ruggeri, & Feliciangeli, 2001), and communication (Jones, McEwen, & Hansen, 2003), as well as a sudden interest in other forms of movement such as a rocking horse and in activities involving movement in a wheelchair, such as baseball, hiking, playing follow the leader, or trick-or-treating (Butler, 1986; Butler, Okamoto & McKay, 1983; Douglas & Ryan, 1987). One case study introduced powered mobility to two children with profound cognitive disabilities and found that after using powered mobility for approximately one year, the children showed increased wakefulness and alertness, had greater interest in their environment, and began limited intentional use of their arms to move the joystick. According to parents, no other activity had made such an impact in a short period of time (Nilsson & Nyberg, 2003).

Although very young children can safely operate powered mobility, some state funding agencies are reluctant to pay for a powered wheelchair as part of a young child's intervention

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plan (Guerette, Tefft, & Furumasu, 2005). Often families and clinicians are asked to provide objective evidence of the benefits and medical necessity of early powered mobility to physicians and insurance companies in order to receive a referral, recommendation, and/or funding. Thus, our goal in the current study is to document additional objective and subjective evidence on the impact of the provision of early powered mobility on children's social skills, verbal and mobility interactions, interaction with toys/objects during play, and developmental level of play—factors typically delayed secondary to impaired movement. We hypothesized that the provision and regular use of a powered wheelchair would: (1) increase parents' positive perceptions of their child's social skills, (2) increase the number of mobility activities during free play, (3) increase the number of interactions with toys/objects during free play, and (4) enhance development in the child's qualitative level of play activities and verbal interactions. In a concurrent phase of the study, we also looked at the impact of the wheelchair on family-centered outcomes such as parental stress, negative emotions, and family social interactions (Tefft, Guerette, & Furumasu, 2011).

Method

Participants

Children with cerebral palsy (CP) between the ages of 18 months and 6 years, and children with other orthopedic disabilities that cause a severe limitation in locomotion (e.g., arthrogryposis, congenital muscular dystrophy, osteogenesis imperfect, spinal muscular atrophy, spinal cord injury) between the ages of 18 months and 3.5 years were recruited to participate in this study. These age ranges were chosen because children as young as 18 months have been shown to be able to safely operate a powered wheelchair, and nearly all children with orthopedic disabilities who have no cognitive delays are able to drive by 3.5 years (e.g., Butler et al., 1983; McEwen, Jones & Neas, 2006; Verburg et al., 1986). Children with CP often have cognitive delays and/or sensory-motor planning difficulties (Rosenbaum et al., 2007) and these may delay readiness to drive a powered wheelchair. Thus, we extended the age range for the children with CP to 6 years. The study included young children who would likely be able to become independent, functional, powered wheelchair users. Participants were recruited at the outpatient rehabilitation clinics at four centers across the United States. All children who were referred to the centers for a powered mobility evaluation were screened for inclusion in the study. Physical and occupational therapists at each center with expertise in pediatric powered mobility performed chart reviews and clinical evaluations, then administered a cognitive wheelchair screening (Pediatric Powered Wheelchair Screening Test: PPWST; Furumasu, Guerette, & Tefft, 2004; Tefft, Guerette, & Furumasu, 1999). Children with profound cognitive delays as determined by chart review, clinical observation, and administration of the PPWST were excluded, but no diagnosis was excluded without assessment. Clinicians evaluated a total of 53 children. Based on this information, 32 were recommended for a powered wheelchair and were invited to participate in the current study. The remaining 21 were not recommended for a powered wheelchair at that time, but were typically recommended some

sort of targeted intervention such as developmental play activities, motor access activities, or practice with a mobility toy; these children were not followed during this study.

Complete pre/post data sets were collected for 23 of the 32 children (13 with CP, 10 with other orthopedic disabilities). The average age of children with CP was 47.0 months, and the average age of children with other orthopedic disabilities was 30.1 months. Of study participants, 14 were joystick users and 9 accessed their wheelchairs using hand or head switches; particular access methods and set-ups were determined individually to provide the most consistent, accurate access for each child. Of the 9 children for whom incomplete data sets were collected, 2 subjects exceeded the maximum study age while waiting for wheelchair delivery, 2 children died, 1 child became increasingly adept at walking and using a manual wheelchair, 1 child did not receive a wheelchair due to insurance denial, and 3 were lost to follow up.

Assessment Instruments

Social skills

No single existing social skills assessment instrument encompassed the full age range of our study participants; therefore, two instruments assessing similar social skills were used. The Adaptive Social Behavior Inventory (ASBI; Hogan, Scott, & Bauer, 1992) and the Preschool and Kindergarten Behavior Scales (PKBS; Merrell, 1994) are behavior rating scales that provide summary scores of ratings of the child's social skills and behaviors. Younger children (ages 18 months–3.5 years) were evaluated using the ASBI and older children (ages 3–6 years) were evaluated using the PKBS. A child entering the study at 3 years or older was evaluated using the PKBS in order to allow follow-up with the same assessment instrument. Both behavior ratings scales utilize parents' familiarity with their child to provide data on low-frequency but important social behaviors, and capitalize on observations over a period of time in the child's own environment. The ASBI is a 30-item scale that uses parental report to evaluate social behavioral competence. It provides a summary "prosocial" scale score and a negative social scale score. The prosocial scale includes items that reflect children's abilities to understand others and express themselves in a positive way, as well as items that reflect children's abilities to accept rules and get along with others. Examples include "Asks or wants to play with other children," and "Waits her/his turn in games or other activities." The negative social skills scale contains items that reflect negative social responses such as "Gets upset when you don't pay enough attention" and "Is bossy, needs to have his/her way." The ASBI has been shown to have good convergent (construct) validity and reliability (Greenfield, Iruka, & Munis, 2004; Greenfield, Wasserstein, Gold, & Jorden, 1997). The PKBS is a 76-item behavior rating scale that also uses parental report to evaluate similar positive social skills (i.e., cooperation, interaction, independence) as well as problem behaviors such as attention difficulties, aggressive behaviors, and social withdrawal. The PKBS also provides a standard summary score for both positive and negative social skills. Items such as "Works or plays independently" and "Is confident in social situations" are examples of positive social skills, while

“Disobeys rules” and “Disrupts ongoing activities” are examples of negative behaviors. Studies have shown the PKBS to have good reliability and support both convergent and divergent (construct) validity of the scales (Canivez & Bordenkircher, 2002; Edwards, Whiteside-Mansell, Conners, & Deere, 2003; Jentzsch & Merrell, 1996).

Parental perceptions of their child’s social skills were also evaluated using the Survey of Technology Use (STU; Scherer, 1998). This instrument was validated as part of the Matching Person and Technology model (Scherer, 1997), and has good divergent (construct) validity and good internal consistency and reliability (Scherer & Glueckauf, 2005). The STU was used to assess parents’ impressions of their child’s activity styles and behavioral/personality traits. Parents rated activity styles such as *active/passive*, *group/solitary*, and *purposeful/aimless* on a semantic differential scale that used opposing phrases to anchor both ends of a 5-point response scale. For example, in rating how active a child was, the parent selected a point along a continuum with the endpoints being *actively engages in activities* versus *passively observes/participates*. The survey also used semantic differential scales to assess the parents’ perspectives of their child’s behavioral/personality traits in areas such as self-esteem, motivation, flexibility, and cooperation.

Frequency of mobility play activities and interactions with toys

To obtain *quantitative* measures of each child’s mobility activities (i.e., play activities that involve movement from one location to another) and interactions with toys/objects, children were observed by a member of the project staff in at least one 12-minute free play session to establish quantitative measures of play activities. These naturalistic sessions were meant to reflect a typical play period for the child, and the child generally played with a parent or sibling (if at home) or with an aide or friend (if at school). Whenever possible, the observer also recorded a second 12-minute period of *outdoor* free play; however, location and weather often precluded this. The length of time for observations was based on times used in other studies (e.g., McConnell & Odom, 1999 recorded a maximum of two 5-minute sessions per day, while Abrahamsen, Ronski, & Sevcki, 1989 videotaped children in 20-minute sessions), as well as clinical estimation of the length of time young children with disabilities would attend to play tasks.

Project clinicians developed an Observational Data Form to record these data (see Appendix). The form was designed based on an observer sample recording format and on observer impressions scales for evaluating social skills/competence in young children with disabilities (McConnell & Odom, 1999). The form was revised several times after project researchers reviewed video recordings of three pilot children ages 2 to 4 years engaging in free play activities. The three primary researchers and one independent clinician established consensus as to how different actions and behaviors were to be tallied or coded, and specific scoring criteria were established. To quantify play activities, we used an event recording method in which *each occurrence* of a mobility activity or interaction with a toy/object was tallied; activities such as “moves to get ball,” “moves with or follows another child,” were categorized as a mobility activity, while actually throwing or pushing a ball or completing a puzzle was

categorized as an interaction with an object. Ongoing play with the same object was tallied once and was not recorded again unless the child stopped the activity and then returned to it later. These tallies were summed to determine a quantitative frequency measure for mobility play activities and for interaction with toys/objects. As we were primarily interested in the *frequency* of play with an object, the *duration* was not recorded.

Quality of play activities and verbal interactions

To obtain *qualitative* measures of the developmental level of the child’s play and verbal interactions, we used a time-sample recording procedure as described in Merrell and Gimpel (1998). Every three minutes during the 12-minute free-play observation session, the examiner made a qualitative rating of the developmental level of the child’s play activities and verbal interactions for the last 30 seconds of the previous 3-minute time segment. This resulted in four play ratings and four verbal ratings which were averaged to provide qualitative summary scores of the developmental level of play activities and verbal interactions observed during the free play period(s). Each qualitative rating was made on a 4-point scale according to specific Piagetian-based behavioral anchors that relate to increasing developmental levels of play and verbal interactions (see Appendix). These developmental ratings were similar to those used by Nabors, Willoughby, and Badawi (1999) during observational assessment of play with preschool children with and without disabilities.

Procedure

Prior to the initial enrollment of subjects, project researchers visited each site and trained site clinicians regarding the administration of each of the assessment instruments. These clinicians practiced administering each of the instruments, viewed and scored practice videotapes on the Observational Data Form to ensure consensus in observer ratings, and were given feedback to ensure proper administration of all instruments. During the site visit, project researchers watched and assisted site clinicians administering assessment instruments and observing a child enrolled in the study to ensure consistency.

Figure 1 presents the general flow of the study. Data sets, which included parental ratings of social skills (ASBI/PKBS and STU) as well as clinician observations and ratings of each child’s mobility activities and play/verbal interactions (Observational Data Form), were collected at three times during the study. For each child, we obtained informed consent and then collected a battery of baseline data at the time the clinician recommended a wheelchair (pre-test 1). Next, we collected a second set of parental assessments and observational data immediately prior to wheelchair delivery (pre-test 2). In 3 cases, the wheelchair was not delivered within a time span of seven months so we collected an additional set of pre-test data in order to control for developmental maturation and other changes that may occur over time. In these cases, the second and third sets of data were used as the pre-test data. Three to seven months after the child had received and had begun using the wheelchair, a final post-test set of parental assessments and observational data was collected.

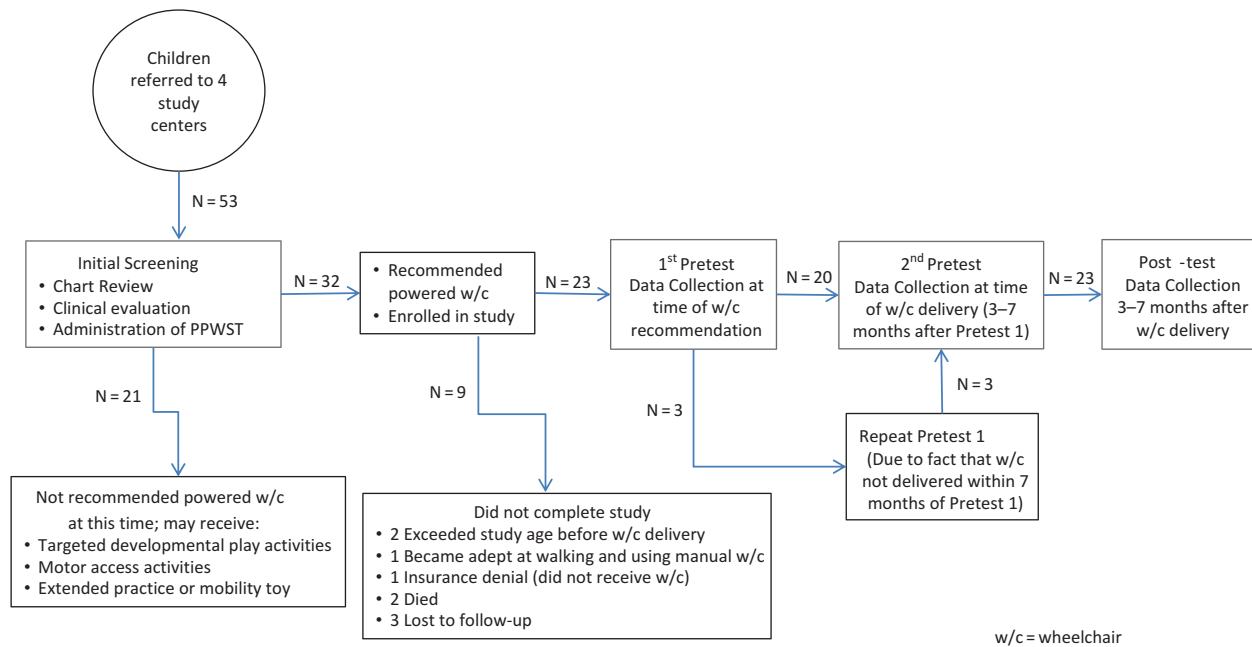


Fig. 1. General flowchart of the study (color figure available online).

Data Analysis

Data for each outcome variable were analyzed using the General Linear Model (GLM) procedure in MiniTab15, a type of analysis of variance that allows specification of “phase” (pre-test1, pre-test2, post-test) as a within subject factor and “subject” as a random factor in the model. A small number of items were omitted by parents when completing the forms. The GLM analysis is effective at imputing missing values with plausible estimates, even in small samples (Sui, Fouladi, & Shieh, 2002). A confidence level of 0.05 was specified for each analysis. For each factor in which a significant difference was found, a Tukey post-hoc analysis was used to determine where the significant difference(s) occurred.

The magnitude of effect for each significant variable was calculated by computing a standardized mean difference (δ) using the formula for Cohen’s d modified for use in repeated measures designs (Olejnik & Algina, 2000). Cohen (1988) suggests interpreting standardized mean differences of .20 as a small, .50 as a medium, and .80 as a large effect.

Results

The average time between pre-test 1 and pre-test 2 assessments was 5.4 months ($SD = 1.6$ months) and the average time between pre-test 2 and the post-test was 5.9 months ($SD = 2.0$ months). The variability in the timeframe between pre-test 1 and pre-test 2 was often contingent upon factors affecting the wheelchair delivery (e.g., length of time for insurance processing; insurance denial/resubmission). In addition, many of the children in our study had health, transportation, or family problems that occasionally resulted in postponement of pre- or post-test follow-up assessments, contributing to variability in these times.

Social Skills

Table 1 shows the results of the social skills assessments. Analysis of the ASBI data showed a significant difference in means between pre- and post-tests for the “prosocial” component, $[F(2,9) = 5.30, p = .02]$ with positive social skills increasing significantly during the post-test phase. The standardized mean difference was $\delta = .57$, indicating a moderate effect size. No significant differences were found between phases in negative social skills, which were fairly low throughout $[F(2,9) = 0.96, NS]$.

For the PKBS, there was a significant difference between means in the standard composite score of positive social skills, with parental ratings of positive social skills increasing between the first and second pre-tests, and remaining elevated during the post-test phase $[F(2,10) = 3.78, p = .04]$. The standardized mean difference was $\delta = .72$, indicating a moderate to large effect size. There was no significant difference between means of the standardized scores of negative behaviors on the PKBS $[F(2,10) = 1.12, NS]$.

Finally, on the STU there was a significant difference between means in the pre- and post-testing in the child’s ability to remain engaged in a task $[F(2,21) = 4.07, p = .03]$. The magnitude of this effect was $\delta = 1.06$, indicating a large effect. As can be seen in Table 1, parents reported that the child needed more support or prompting to remain engaged *after* having had the wheelchair for several months. Parental impressions of three other personality-related social factors—self-esteem, self-confidence, and composure—showed significant increases from pre-test 1 to pre-test 2 $[F(2,21) = 3.31, p = .05; F(2,21) = 6.91, p = .00; F(2,21) = 4.76, p = .02]$, respectively] and then remained elevated during the post-test phase. The standardized mean differences for these effects ranged from moderate to large ($\delta = .56, \delta = .90$, and $\delta = .67$, respectively).

Table 1. Descriptive statistics for social skills on the Adaptive Social Behavior Inventory (ASBI), Preschool & Kindergarten Behavior Scales (PKBS), and Survey of Technology Use (STU).

Dimension	N	Pre-test 1 Mean (SD)	Pre-test 2 Mean (SD)	Post-test Mean (SD)
ASBI				
• Prosocial*	10	49.5 (11.9)	48.5 (8.7)	55.3 (8.5)
• Negative social skills (NS)		9.2 (2.7)	10.1 (2.6)	9.1 (2.1)
PKBS				
• Social Total**	11	90.0 (17.5)	100.7 (12.1)	99.9 (12.0)
• Problem Behavior Total (NS)		91.6 (11.3)	87.7 (9.7)	90.9 (9.6)
STU (1–5 scale)				
• Ability to remain engaged*	22	4.3 (1.5)	4.9 (0.3)	4.0 (1.4)
• Self-esteem**		4.1 (1.0)	4.6 (0.7)	4.4 (0.9)
• Self confidence**		3.7 (1.2)	4.6 (0.7)	4.6 (0.8)
• Composure**		4.1 (1.2)	4.7 (0.7)	4.7 (0.7)

*Indicates significant different between pre- and post-tests.

**Indicates significant difference between pre-test1 and pre-test2.

NS indicates not significant.

Mobility Play Activities and Interactions with Toys

Table 2 shows the quantitative findings from the Observational Data Form. During indoor free play, there was a significant increase in the mean number of mobility play activities that the children engaged in during the 12-minute observation period from the pre-tests to post-test [$F(2,20) = 4.53, p = .02$], with the number of mobility activities nearly tripling during the post-test phase. The standardized mean difference was $\delta = .43$, indicating a small to moderate effect. During outdoor free play, there was not enough frequency data to perform a statistical analysis, however, as can be seen in Table 2, for the children for whom frequency data were available, there were no mobility activities in the pre-testing phases, but an average of 9.7 mobility activities during the post-testing phase. There was no difference across phases in the amount of interaction with toys or objects provided to the child by others [$F(2,20) = 0.58, p = .57$], or with toys obtained by the child herself [$F(2,20) = 1.66, p = .20$].

Quality of Play Activities and Verbal Interactions

Table 3 shows the qualitative findings from the Observational Data Form. Slightly more than half (56%) of the observations were conducted at school with the child playing with an aide or friend, while the remaining 44% were done in the home with the child playing with a parent or sibling; again, location and play partners were chosen to represent a typical play period for the child. During indoor free play, the average developmental level of play increased significantly from pre-test 1 to pre-test 2, then remained elevated during the post-test [$F(2,20) = 3.52, p = .04$]. For outdoor free play, there was a significant difference the quality of interactive play from pre- to post-test [$F(2,6) = 4.24, p = .04$]. The standard mean differences for these effects were $\delta = .67$ and $\delta = 1.8$, indicating a moderate to large effects. The mean qualitative level of play outdoors on a 0–4 ratings scale did not change during the two pre-testing phases (average level of 2.0 which corresponds to playing alone and watching others with no interaction/sharing). This number increased to 2.9 during the post-testing phase, corresponding to playing alongside

another and playing briefly with another with limited sharing, turn-taking, and interacting. There was no change in the mean quality of verbal interactions across phases during indoor or outdoor free play [$F(2,20) = 1.4, p = .26$; $F(2,6) = .78, p = .89$, respectively].

Discussion

In our first hypothesis, we anticipated that parents' perceptions of their child's positive social skills would increase significantly after several months of independent powered mobility. As measured by the ASBI, parents perceived an increase in positive social skills at the post-test assessment, indicating that they believed their children helped and cooperated more with others, interacted better with other children and adults while playing games, and were more independent in their daily lives. One parent commented that her child "Gets involved now." Parents of slightly older children (those evaluated by the PKBS) also perceived improvement in positive social skills. However, this change was inconsistent with our hypothesis as it occurred *prior* to the children actually using a wheelchair at home. Parents reported a significant increase in positive social skills between pre-test 1 and pre-test 2, and their ratings remained elevated at the time of the post-test. A similar trend was also seen in parents' reports of social behavioral and personality traits such as composure, self-confidence, and self-esteem in the STU. One explanation for this difference in findings may relate to the amount of wheelchair exposure that each child had *prior* to actually receiving their wheelchair. We reviewed the data to determine the number of sessions each child received playing/practicing in the wheelchair around the time the wheelchair was being ordered but prior to receiving and using it at home. The primary purpose of these clinical sessions was to establish motor control and wheelchair access. We found that the slightly younger children who were evaluated by the ASBI had an average of 3.4 sessions in the wheelchair prior to recommendation. Many of these children were participants with orthopedic disabilities only, and after an average of 3–4 sessions they had

Table 2. Descriptive statistics for motor play activities and interactions with toys/objects on the Observational Data Scale.

Dimension	<i>N</i>	Pre-test 1 Mean (SD)	Pre-test 2 Mean (SD)	Post-test Mean (SD)
• # of indoor motor activities*	21	0.6 (1.3)	0.8 (1.8)	2.1 (4.1)
• # of outdoor motor activities (NS)	3	0 (0)	0 (0)	9.7 (7.4)
• # interactions with toys/objects (provided by others) (NS)	21	2.8 (1.5)	3.5 (2.1)	3.0 (2.2)
• # interactions with toys/objects (obtained by self) (NS)	21	0.8 (1.5)	0.6 (1.2)	1.2 (2.7)

*Indicates significant different between pre- and post-tests.

NS indicates not significant.

Table 3. Descriptive statistics for quality of play and verbal activities on the Observational Data Scale.

Dimension	<i>N</i>	Pre-test 1 Mean (SD)	Pre-test 2 Mean (SD)	Post-test Mean (SD)
Quality of indoor play**	21	2.4 (0.7)	2.8 (0.5)	2.7 (0.6)
Quality of outdoor play*	7	2.0 (0.8)	2.0 (0.8)	2.9 (0.7)
Quality of verbal activities during indoor free play (NS)	21	2.1 (0.9)	2.4 (0.9)	2.4 (0.9)
Quality of verbal activities during outdoor free play (NS)	7	2.5 (0.4)	2.5 (0.5)	2.6 (0.7)

*Indicates significant different between pre- and post-tests.

**Indicates significant difference between pre-test1 and pre-test2.

NS indicates not significant.

consistent wheelchair access and it was apparent that they would be able to operate the wheelchair, even if they were not yet proficient drivers. In contrast, those evaluated with the PKBS tended to include more children with CP, who have been found to require additional practice of motor tasks (Thorpe & Valvano, 2002) or who may have needed extra sessions to help establish proper seating, motor control, and/or wheelchair access. These children received an average of 5.3 sessions in the wheelchair. It is possible that parents, after having seen their child driving in the wheelchair typically five or more times, may have anticipated its benefits or had actually begun to see a positive impact of the wheelchair in terms of their child's social skills and behavioral traits (e.g., playing games or being mischievous in the wheelchair), and may have reflected this in their ratings. The fact that these ratings remained elevated after the introduction of the wheelchair is encouraging, especially since in both pre-test 2 and the post-test, parental ratings on the PKBS placed their child in the "high functioning" level of positive social skills, almost at the top of the scale (up from "average functioning" during pre-test1). For the children who had fewer practice sessions in the wheelchair, this positive impact was not evident until they had received and begun to use the wheelchair regularly. It is also possible that other factors such as social maturation or unidentified school interventions may have contributed to these positive changes in social skills. However, anecdotal comments by parents to clinicians, as well as post-test assessments gathered for the family-centered part of this study indicated parents' excitement regarding of the benefits of the wheelchair (Tefft et al., 2011). In these data, parents rated the impact of the wheelchair as an average of 4.5 on a 5-point scale in terms of helping the child reach goals and a 4.6 in terms of improving the child's

quality of life. These positive ratings of the social impact of the wheelchair are consistent with the findings of other researchers. For example, in a case report of a 20-month old girl with spinal muscular atrophy, Jones et al. (2003) reported improved social-personal interactions after providing a powered wheelchair. They found gains in both the personal-social skills portion of the Battelle Developmental Inventory and the social function portion of the Pediatric Evaluation of Disability Inventory (PEDI), and hypothesized that the wheelchair provided opportunities to explore that may have contributed to her social gains. In another study, Wiart, et al. (2004) reported that mothers perceived that the powered wheelchair impacted their children's social skills by allowing them to be more independent and to better engage in age-appropriate, meaningful activities with their peers.

There was an unanticipated finding relating to social skills in the current study. On the STU, parents perceived a significant difference in their child's ability to remain engaged in a task between pre- and post-testing; however, the child needed *more* support or prompting to remain engaged after the introduction of the wheelchair. With the ability to move about independently came more opportunity for spontaneous exploration and/or distraction. The child could now "wander about" and explore new things of interest, and this may have resulted in a decreased ability to remain focused on a specific task. Alternatively, what appeared to be distractibility or frequent shifts in attention may actually have reflected an age-appropriate attention span as well as the child's newfound ability to control their choices of what to do or where to go. Other researchers have noted a similar response in young child with the introduction of a powered mobility toy. Rather than using the mobility toy as a means to move about, it became the primary method of play. The child

used it to ride in circles and over bumps, to bump into walls purposefully, to disregard parents/therapists attempts to bring him back, and to wander off to pursue his own interests (Deitz, Swinth, & White, 2002). It would be interesting to look specifically at the children's ability to remain task-focused before and after receiving and using a powered wheelchair for an extended period of time, and to record the length of time spent on different play activities, the number of shifts in attention/play, as well as have parents log occurrences/circumstances in shifts in attention. Abrahamsen et al. (1989) present a detailed coding system/approach for obtaining information on attention shift, attention complexity, and task-orientedness. It may be helpful from a clinical perspective to prepare parents for the possibility that their child may appear to be more "distractable" as an initial reaction to the wheelchair. Although parents of children in the current study noted greater difficulty with their child remaining engaged in a task, they did not report an increase in negative social behaviors such as disrupting other children during play, leaving a game or conversation, or being defiant. These behaviors on both the ASBI and the PKBS remained fairly low throughout the study.

Findings from this study offered support for our second hypothesis that the introduction of a powered wheelchair would increase the number of mobility activities during free play. Children demonstrated a substantial increase in the frequency of mobility activities in which they were engaged, and participated in more types of mobility activities during free play with a powered wheelchair. Parents reported that their children were now engaged in activities such as playing kickball, freeze tag, or hide-and-seek, and having a scavenger hunt with a sibling. One child went to the playground and was thrilled to drive over crunchy leaves. This increased ability of the children to participate in mobility activities allowed them to be more integrated in family and play activities. In fact, in data collected from the family-centered portion of this study, parents' perceptions of their child's social activities and interactions with the family significantly increased after the child had used the wheelchair for several months (Tefft et al., 2011). These findings were supported by a recent case report which also found that a 3-year-old child with CP was more mobile and more socially interactive with his peers after receiving a powered wheelchair. However, these authors noted that the child was still notably less mobile and less socially interactive than his peers (Ragonesi, Chen, Agrawal, & Galloway, 2010).

Although the number of mobility activities increased, the number of interactions with toys or objects did not increase as hypothesized with the use of powered mobility. It appeared that the wheelchair itself was viewed as a dynamic toy, used to explore, play, and interact with the environment and family, and that the activity of self-initiated movement may have been more appealing and interesting to the children than retrieving and playing with a toy or object. It is possible that although the children could *move to* a toy, they likely still needed someone to hand it to them due to physical limitations with reaching, lifting, or grasping. Thus, the use of a powered wheelchair did not manifest itself in an increase in interactions with toys or objects during play.

Finally, our fourth hypothesis, that the powered wheelchair would enhance the development of the child's qualitative level of play activities and verbal interactions was only partially

supported—the developmental level of play increased but there was no change in verbal interactions. Not being able to move or control their environment lends itself to playing alone and not interacting with others. Children with disabilities have been found to engage in more solitary and adult play than other children their age, and to engage in more passive "onlooking" behavior than typically developing peers (Hestenes & Carroll, 2000). When they do play with peers, they often take on a lower status or a more passive role which can make them feel isolated and lead to confusion in identity formation (Doubt & McColl, 2003; Missiuna & Pollock, 1991; Tamm & Skar, 2000). In our study, there was no difference in the developmental level of outdoor free play for children between pre-test1 and pre-test2. However, once the children received and had begun using their powered wheelchairs (post-test), their level of play significantly increased and they began limited sharing, turn-taking, and interacting. It is possible that the greater independence and/or control of situations provided by the wheelchair afforded an *opportunity* for interacting at a higher level in play. Socially, they now had the means to participate in more interactive types of play (e.g., hide-and-seek, freeze tag, follow-the-leader) than before. Future studies might explore not only how the powered wheelchair affects children's social skills, but how it affects their ability to participate more actively in school and how it might impact their ability to learn and to achieve various age-appropriate educational goals.

Other authors report gains in language skills with the introduction of powered mobility (e.g., Jones et al., 2003). Despite gains in social skills in this study, the developmental level of the children's verbal interactions during free play did not show an increase with the use of powered mobility. A number of children in this study were non-verbal and while the wheelchair did not affect their verbal interactions, it is possible that other types of non-verbal communication (e.g., gestures/facial expressions, etc.) may have been impacted but were not recorded in the current study. For non-verbal children, it would be interesting in future studies to explore potential impact of powered mobility in communication *intentions* such as gestures, looks, or vocalizations using an assessment such as INCH: Interaction checklist for augmentative communication—Revised (Bolton & Dashiell, 1984).

The current study had several limitations. First, we specifically chose not to include a control group because we believed that delaying delivery of a powered wheelchair for a year or more for children who appeared ready for one could negatively affect their cognitive and psycho-social development. However, lack of a control group requires that caution be used when interpreting these results. Rates of development in social and play skills can be variable and do not necessarily progress in a linear manner and thus could have been influenced by factors other than the powered wheelchair. While our sample size was larger than in many other studies, it was nevertheless a relatively small sample statistically. The small sample size of the overall study, as well as smaller sample size for outdoor free play observations (which were limited by weather and feasibility of going outdoors), may have impacted our ability to detect potential differences. The relatively short duration of follow-up (i.e., approximately 6 months) due to constraints on the length of the study was also a limitation. It would be interesting to follow the children for a year or more to determine whether there were any additional changes

after the child had gained more experience using the wheelchair. The length of time of the observations (i.e., 12-minute sessions) may also be a limitation. It is possible that longer sessions would have yielded additional information on mobility activities or play interactions with toys or people. However it appeared that prior to receiving the wheelchair, the children typically had very little mobility or interaction with toys/objects and did not have much opportunity to engage in interactive play activities. It seems unlikely that this would have changed with additional observation time. Perhaps multiple short sessions that assessed every child both at home and in a school setting would have yielded more thorough information. Finally, sources of response bias by the observers must also be considered. The ASBI, PKBS, and STU were self-report questionnaires which reflect the perceptions of the parents regarding their child's social skills. While parental rating scales can provide objective, reliable data (Martin, Hooper, & Snow, 1986), there exists the possibility of response bias such as leniency or severity (being excessively critical or generous) in parental ratings of their child's social skills. The inclusion of parental interviews may have helped to elucidate some of the findings regarding parental impressions of social skills. The Observational Data Form was developed for use in the current project and its reliability and validity have not yet been established. Bias may have occurred during the subjective ratings of quality of play and verbal interactions during the observational periods, however, every effort was made to minimize bias by providing extensive training using videotape examples, and by using very specific objective anchors on the form to assist raters during subjective real-time rating.

In summary, through the current study we suggest that powered mobility increased parents' positive perceptions of their child's social skills, increased the number of mobility activities during play, and may have positively impacted the quality of play for the children. These findings may be helpful in justifying the recommendation of powered mobility to young children and in justifying medical necessity of powered mobility for reimbursement by third party payers. Mobility is associated with the acquisition of important cognitive and perceptual skills in children without disabilities. Young children with physical disabilities should be given the same opportunities through powered wheelchair mobility. By providing a means to spontaneously explore the environment, satisfy their curiosity, and provide a means for more interactive play, powered mobility can have positive effects on a young child's psychosocial development.

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Appendix

Observational Data Form

Location of observation (group setting preferred): ☐ Home ☐ School
 Child seated: ☐ On floor ☐ In wheelchair ☐ In scooter ☐ Other _____
 Child's language status: ☐ Verbal ☐ Communication device ☐ Preverbal/nonverbal

Frequency Tallies*:	Frequency	Comments
Interaction/play with a toy or object (e.g., pushing toy car, kicking ball) • (toy provided by another) • (child gets toy him/herself)		
Mobility Activities (e.g., moving from one point to another to get object, playing follow-the-leader)		

*To be conducted during the 12-minute free-play observation period

Qualitative Assessments:	At 3 mins		At 6 mins		At 9 mins		At 12 mins		Avg. Score	
	Play	Verbal	Play	Verbal	Play	Verbal	Play	Verbal	Play	Verbal
During free play indoors (12-minute observation; score every 3 minutes)*										
During free play outdoors (12 minute observation; score every 3 minutes)*										

*Rate what the child has been doing for the 30 seconds prior to each 3-minute marker according to scales below

Play Scale (for Qualitative Assessments)	Verbal Scale (for Qualitative Assessments)
1= No play observed (toys may be present but child has no play contact with toys; may fidget with toys) 2= Plays by self (plays with toys, either alone or in the presence of another person), watches others but does not interact/share 3=Plays alongside another; watches or plays briefly with another person with limited sharing, turn-taking or interacting (1-2 interactions) 4= Interactive play with another; engages in pretend play with more extensive turn-taking, sharing, using same toy (not fighting over it)	1 = No verbalizations observed 2 = Talks with self (no verbal interaction with another) 3 = Engages in limited verbal interactions with another (makes requests, responses, comments, statements but does not add additional information; 1-2 interactions during time period) 4 = Engages in reciprocal conversation with another (more than 1 interaction per person; child adds new info or expands on ideas; child maintains verbal contact)