Beginning power mobility Phase 2:
Exploring power mobility use in early childhood
Final report

Results from this study were presented at PMG Conference July 2019 Telford, UK.
This paper is an adaptation of text and data from two articles:

Livingstone RW and Field DA **Exploring change in young children's power mobility skill following several months' experience**
Disabil Rehabil: Assist Technol 2020 DOI: 10.1080/17483107.2020.1847207 Copyright Taylor & Francis, which has been published in final form at https://doi.org/10.1080/17483107.2020.1847207

Livingstone RW and Field DA **Exploring young children's activity and participation change following 6 months' power mobility experience**
Br J Occup Ther 2021: 84(11),713-722 Copyright SAGE,
which has been published in final form at https://doi.org/10.1177%2F0308022620973935

Unless specifically indicated by relevant journal copyright acknowledgement, tables and figures are a combination of data from both papers or are unique to this web publication.

In addition: parent and therapist QUEST D and Aesthetic data (see Table 3) are taken from
Field DA and Livingstone RW **Parents' and Therapists' Satisfaction with Four Early Childhood Power Mobility Devices**
Can J Occup Ther 2022 DOI: 10.1177/00084174221098879 Copyright SAGE
which has been published in final form at
https://journals.sagepub.com/doi/pdf/10.1177/00084174221098879

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Abstract

Introduction: This pre-post study explored effect of an average of 6-months' experience in one of four early power mobility devices at home or in the community for young children with mobility limitations.

Methods: Power mobility skill was measured with the Assessment of Learning Powered mobility use (ALP). Satisfaction with child achievement of parent-selected goals was measured using the Wheelchair Outcome Measure for Young People (WhOM-YP) and compared with power mobility skill and parent/therapist rating of how the device fulfilled expectations for goal achievement. Child and environmental factors influencing ALP phase at loan-end were explored. Correlations between three paediatric power mobility skill measures, ALP, Power Mobility Program and Power Mobility Training Tool were completed. Parent and therapist satisfaction with device features was measured using the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST 2.0). Parent and therapist ratings of device expectation fulfilment and QUEST device sub-scale satisfaction were compared.

Results: Forty-six children aged 13 - 68 months (mean 40.40; SD 15.60) with limited mobility participated, with cerebral palsy being the most common condition (n=33; 71.74%). ALP change scores ranged from -2 to +4 ALP phases (median 1.0). Wilcoxon signed rank test was significant for pre-post differences with a large effect size (z=5.50, p<0.001; r= 0.57). Wilcoxon signed rank test measured significant, positive change in goal achievement (z= 4.90; p<0.001; r = 0.51). Fair to good, statistically significant Spearman correlations were seen between power mobility skill and goal achievement, as well as parent and therapist device expectation scores (r_s = 0.48, 0.46 and 0.66 respectively; p<0.001). Kruskal-Wallis test revealed significant effect of device, access method, diagnostic group and communication abilities on ALP phase achieved. End of loan correlations between ALP and the two other paediatric measures were strong (r_s=0.92). Parent satisfaction with device features as measured with QUEST 2.0 decreased from loan-start to loan-end (z= -3.32; p<0.001; r=0.34). Therapist device sub-scale satisfaction showed fair, significant correlation with power mobility skill (r_s =0.48; p=0.004) while parent ratings did not. Parent and therapist ratings did not differ significantly.

Interpretation: Positive change was demonstrated with most children (n = 39; 84.78%) changing at least one ALP phase during the study. Children at all phases of power mobility skill, in all devices and using different access methods demonstrated activity and participation change that was associated with positive change in power mobility skill. Satisfaction with some device features decreased over the loan, however most parents/therapists were 'quite satisfied' and devices met expectations for goal achievement. Different trajectories of skill development may be associated with different diagnostic profiles and access abilities. This study adds validity evidence supporting use of the ALP with young children and also the WhOM-YP with young children by parent-proxy rating.

Introduction

For children with disabilities, participation in meaningful activities is facilitated by environmental factors such as family support, genuine friendships and opportunities.[1] Learning, playing and taking part in family-life is critical to young children's well-being.[2] Mobility experience allows children to explore, to access play and to build friendships,[3] while efficient, independent mobility facilitates social participation.[4] In contrast, a lack of mobility limits young children's potential to be active and may contribute to passive and dependent behaviour, restricting activity and participation in everyday life.[3,4]

Power mobility devices assist young children with mobility limitations to explore independently and include switch-adapted ride-on toys or cars, novel powered devices specifically designed for young children as well as more typical paediatric power wheelchairs.[5] Although research suggests a positive impact of power mobility on a range of outcomes including developmental change, independence, social development and peer participation, evidence is limited.[6]

Paediatric power mobility skill measures are in the initial stages of development and little evidence supports use of any to evaluate change over time.[7] Power mobility interventions are now considered for children across the learning continuum,[5] and outcome measures used should be sensitive enough to discriminate change for different ages, diagnoses and developmental profiles. Three different power mobility learner groups have been proposed: exploratory, operational and functional. These have different learning trajectories, goals and expectations for power mobility use.[7]

Exploratory learners enjoy exploring movement and may take considerable time to establish cause-effect with the switch or joystick. Operational learners establish cause-effect fairly quickly but require an extended period of time to learn to steer and operate different device functions. Functional learners, quickly learn how to operate the device and begin to use the device purposefully to participate in daily life. While all young children start at the exploratory stage, what distinguishes the three groups of learners is the speed of skill development, anticipated use and supervision requirements.[7]

The three learner groups may be understood within the context of three stages of power mobility skill development.[7] The Assessment of Learning Powered mobility use (ALP)[8] includes eight phases from novice (ALP 1) to expert (ALP 8) and is divided into three stages of transition: ALP 1-3 where individuals progress from being unaware of effects to establishing cause-effect; ALP 4-5 where individuals explore different effects of the joystick/switches and search the pattern for steering; and ALP 6-8 where individuals establish control of steering, use the device for functional tasks and may progress to proficient and expert use.

Paediatric power mobility outcomes research has primarily explored impact on independent mobility and developmental change, while impact on participation is limited[6] and predominantly found in qualitative literature.[9] A recent feasibility study reported positive change in participation-oriented goals for four of five school-aged children with CP after they participated in a 3-week therapeutic summer camp aimed at developing power mobility skills.[10] A newly published systematic review of power mobility impact on young children's social skills confirmed a potential positive impact despite strength of conclusions being limited by the studies' design, conduct or measurement limitations. Included studies evaluated activity and participation outcomes such as social participation and peer or adult interaction as well as the broader concept of social functioning.[3]

Although many measures have been developed to measure participation in children, few are suited for children using power mobility and even fewer for young children at the beginning stages of power mobility skill development.[11] The Wheelchair Outcome Measure for Young People (WhOM-YP) is an individualized, client-centred measure developed for children or young people who use wheeled mobility. It allows parents and/or children (depending on the child's age and abilities) to identify meaningful participation-focused outcomes related to in home and/or out of home use of a wheeled mobility device.[12] Respondents rate importance and satisfaction with their (child's) performance of an individualized goal while using their mobility device. This can be completed pre-post introduction of a new device to measure change over time. A different, but related concept, is to measure satisfaction with whether a wheeled mobility device assisted with goal achievement as much as expected or not. This is referred to as a device expectation-fulfilment rating and is rated post-intervention. It may be used to compare therapist and client ratings.[13]

In previous research, factors influencing power mobility skill proficiency in children (14-30 months) following 12 months' power wheelchair experience included cognition, proportional joystick use and a diagnosis without brain involvement.[14] In another study, a three-factor model predicting proficiency in 80% of 80 children (mean 10 years, 2 months) following 5-12 months practice included proportional joystick with hand access, ability to stop the power wheelchair on command and self-propel a manual wheelchair.[15]

Both analyses were retrospective and dichotomized proficiency as achievement/non-achievement of specific skills. Neither explored factors influencing learning trajectory or described skill progression for those not achieving proficient power mobility use. Power mobility skill development is complex and additional research is required to further distinguish skill progression trajectories for children across the learning continuum. To our knowledge, no research has yet examined the relationship between power mobility skill, impact on young children's activity and participation and parent satisfaction with different early power mobility devices.

The primary purpose of this paper is to measure change in young children's power mobility skill over 6-months (with ALP as our primary measure) using one of four different early power mobility devices. The secondary purpose is to measure change in young children's achievement of parent-selected activity and participation goals (using WhOM-YP), and explore associations between goal achievement and power mobility skill. Additional purposes are to: (i) explore trends and associations between child and/or environmental factors and ALP phase achieved; (ii) describe the correlation between ALP and two other paediatric power mobility skill measures (Power Mobility Program

(PMP)[16] and Power Mobility Training Tool (PMTT);[17] (iii) explore associations between parent and therapist device satisfaction and expectation fulfilment and power mobility skill change; and (iv) explore whether parent and therapist ratings differ.

Method

This pre-post design study recruited a purposeful sample from participants in our previous cross-sectional study where children and their families were introduced to the four early power mobility devices in single play-based exploratory sessions.[18] Inclusion criteria were broad to explore the influence of different child and environmental factors and children with cognitive and sensory limitations were deliberately included. Children up to 6 years with a diagnosis or delay suggesting delayed or limited mobility in early childhood whose parents were interested in a six-month loan of a device to use with their child at home were eligible.

Devices included: Wizzybug (www.designability.org.uk/product/wizzybug/); Bugzi (http://meru.org.uk/what-we-do/bugzi/); Tiger Cub power wheelchair (now discontinued) and switch-adapted ride-on toy cars (various models- hereafter referred to as Car). These devices were selected as most suitable for our population and to provide a range of different features. Wizzybug and Bugzi provided supportive adjustable seating, while Tiger Cub provided adjustable tilt-in-space and custom seating. Car was used with either simple seating supports or custom seating, depending on child needs. Bugzi was accessed with hand or head switches, or a digital joystick and Car was accessed by various types of hand-activated switches. Wizzybug had a proportional side-mounted joystick while Tiger Cub was accessed with remote proportional and/or sensitive joysticks (mounted specifically for the child in midline or other position) or a proximity head array. All parents provided written informed consent, and ethics approval was granted by the University of British Columbia Children's and Women's Research Ethics Board.

Descriptive information collected at loan-start included child age, diagnosis, location and home environment. For children with diagnoses meeting the contemporary definition of cerebral palsy (CP),[19] Gross Motor Function Classification System (GMFCS),[20] Manual Ability Classification System (MACS)[21] or miniMACS[22] (children under 4 years) were completed and a similar descriptor of function was completed for children with other diagnoses. Communication Function Classification System (CFCS)[23] and Level of Sitting Scale (LSS)[24] were completed for all children.

Families and community therapists were trained in device use, and postural supports and access (joystick, switches) were individualized for the child. Devices were set up with pelvic positioning belts for all children, and pelvic and thigh medial and/or lateral supports, trunk lateral supports, anterior trunk and shoulder support, head support, foot support or arm support were provided as appropriate to the child's postural control and for positioning and safety.

Children were videoed using the device and training suggestions provided. Video was recorded by researchers, while parents and community therapists encouraged child participation. Power mobility skills (as detailed in the PMP and PMTT) were elicited through play and exploration appropriate to the child's age and abilities, and video-length varied according to child tolerance. Parents identified three meaningful activity and participation goals they thought achievable over the loan period. Importance and satisfaction were rated using the WhOM-YP. Parents and community therapists independently completed the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST 2.0) device sub-scale [25] and an additional rating of device Aesthetics. Telephone follow-up occurred 2-4 weeks later to record average device use (sessions per week and session time:15 minutes; 30 minutes; 1 hour; 2 hours; ≥3 hours). Families were encouraged to contact researchers at any time if additional support, training ideas or adjustments to seating or access method were required. Parents and therapists were encouraged to have the child use the device at least three times a week, but this was not controlled.

At loan-end, the child's use of the device was videoed again, parents and therapists completed the QUEST 2.0 device sub-scale and Aesthetics rating, and parents rated satisfaction with their child's progress towards the three goals. Both parents and therapists also completed a retrospective device expectation fulfilment rating adapted from the Individually Prioritized Problem Assessment.[13] Parents reported amount of device use and any barriers and facilitators during the loan-end appointment using the same scale as at start-of-loan.

Measures

GMFCS, MACS, Mini-MACS and CFCS classifications range from I to V with V being the most severe and were rated by parent and community therapist consensus. LSS was researcher administered to classify sitting ability as follows: unplaceable (level 1); requiring support from the head (level 2), trunk (level 3) or pelvis (level 4); able to bench sit with feet unsupported for 30 seconds without movement (level 5); able to move in and out of the seated position forward (level 6), sideways (level 7) and backwards (level 8). LSS has a significant inverse correlation with GMFCS in children with CP.[26]

Three measures of power mobility skill: ALP, PMP and PMTT were later scored from the videos by consensus of two consistent raters who were involved in the study, and participated in start and/or end of loan appointments for some children. To help reduce bias, videos were randomly selected and scored on average 8-10 months following assessments. All measures have evidence of face and content validity. Inter-rater (κ_w 0.87) and intra-rater reliability (κ_w 0.52) were reported for a sub-set of nine children in the original PMP research.[16] Gefen et al., recently estimated inter-rater reliability for the PMP and ALP to be good to excellent and intra-rater reliability on the PMP to be excellent. Their study examined repeated ratings of two experienced professionals (intra-rater reliability) for 30 children on the PMP (intra class correlation ($ICC_{2,1}$) 0.97/0.98) and compared ratings between these same raters (inter-rater reliability) for PMP ($ICC_{2,1}$ 0.84/0.87) and ALP ($ICC_{2,1}$ 0.83).[27] Good inter-rater reliability has also recently been estimated between experienced professionals and family members or caregivers ALP ratings (κ_w 0.85).[28]

The ALP is suitable for all ages, motor and cognitive abilities. It is process-based and describes tool use and occupational performance in power mobility devices. The PMP and PMTT are both skills-based, but the PMTT was developed for children at the very early stages of skill development. While the PMP is the most well-known paediatric power mobility skill-based measure, it is frequently modified due to difficulties in measuring some tasks.[7]

The WhOM-YP has respondents using an 11-point ordinal scale to rate the importance of and satisfaction with performance of self-identified activity and participation outcomes using a mobility device.[12] Individual summary scores include average satisfaction (total score ÷ number of goals). It has good to excellent ($ICC_{2,1}$ 0.85-0.90) test-retest reliability for parent-ratings and for children aged 8-17 years ($ICC_{2,1}$ >0.80). Validity evidence includes discrimination of known groups (experienced and inexperienced power wheelchair users) and good association between child and parent satisfaction ratings for indoor (r_s 0.75) and outdoor participation (r_s 0.79). Minimal detectible change (MDD_{95}) of 1.8 is estimated for parent-proxy rating of children's outdoor participation goals.[12]

The QUEST 2.0 is a valid and reliable survey of device satisfaction.[25] The device sub-scale includes 8 items with satisfaction rated on a 5-point satisfaction scale from 1 (not satisfied) to 5 (very satisfied) with features such as size, weight, durability, etc. The QUEST device sub-scale is reported to have strong measurement properties with adult populations [29] and has also been used in paediatric power mobility outcomes research.[30] Summary scores include average item score (total score ÷ number items completed). Average scores ≥4.0 suggest an acceptable level of device satisfaction. Parents rated an additional feature (Aesthetics) on the same scale and scores are reported separately.

The device expectation fulfilment rating was originally designed to measure how the device had assisted the individual to overcome specific problems. In this study, parents and therapists rated how much they felt the device had assisted the child in achieving each of the three goals from the WhOM-YP. The device expectation fulfilment rating uses a 5-point ordinal scale from -2 (much less than expected), -1 (less than expected), 0 (as expected), 1 (more than expected) and 2 (much more than expected) and we report the sum of the three scores. This scale has been shown to be sensitive to change in mobility device outcome research with adult populations.[13]

Statistical Analyses:

REDCap[31] electronic data capture tools were used to manage study data. Descriptive analyses of participant characteristics (age, sex, diagnostic group, functional classifications and environmental factors) included frequencies, percentages, range and measures of central tendency and dispersion. Since measures used primarily ordinal data and data was not normally distributed, non-parametric tests were selected.

Wilcoxon signed-rank test (dependent samples) compared power mobility skill on the ALP, PMP and PMTT pre-post loan, as well as pre-post WhOM-YP, QUEST device sub-scale and Aesthetics scores. Wilcoxon Mann Whitney test (independent samples) compared parent and therapist QUEST device sub-scale, Aesthetics and device expectation fulfilment ratings. Effect size was estimated using the formula z/sqrt(n)[32] and interpreted as follows: <0.3 = small; 0.3-0.5 = moderate; >0.5 = large.[33]

Kruskal-Wallis test explored effect of child and environmental factors on ALP phase with effect size (ε^2)[32] estimated and interpreted as follows: <0.08 = small; 0.08 - <0.26 = medium; ≥0.26 = large).[34] Post-hoc-Conover tests with Bonferroni correction were completed if the null hypothesis was rejected.

Spearman's correlation coefficients examined associations between ALP and PMP/PMTT and between ALP phase at loan-end with WhOM-YP device satisfaction and expectation fulfillment, as well as correlations between WhOM-YP and child age or loan-length. Estimates were interpreted as follows: >0.75 = excellent, 0.5-0.75 = good, 0.25-0.5 = fair and 0-0.25 = weak.[35]

Parent-selected goals were categorized according to the International Classification of Functioning (ICF).[36] Significance levels for all analyses were set to $p \leq 0.05$. R version 3.5.1 was used for all statistical analyses.[37]

Results

Forty-six children (25 male, 21 female) aged 13 to 68 months participated. Diagnoses were grouped into four categories to assist with statistical analyses. The largest group was CP (n = 33; 71.74%) comprising children diagnosed with cerebral palsy and also children with genetic or metabolic conditions that fall under the umbrella of CP.[19]

Other category (n = 8) included children with diagnoses such as meningomyelocoele or Down syndrome and developmental delays that do not fit the clinical profile of a cerebral palsy-like condition. Neurodegenerative conditions (n = 2) included children with Pelizaeus Merzbacher Disease and MucolipidosisII while Neuromuscular (n = 3) included children with Spinal Muscular Atrophy types 1 and 2 and Central Core Myopathy.

Table 1: Participant descriptors

Age	**No.**	**Diagnostic Grouping**				**Sex**		**GMFCS***			**MACS/miniMACS***			**CFCS**			**LSS**		
mos	*(%)*	*O*	*CP*	*NM*	*D*	*M*	*F*	*I/II*	*III*	*IV/V*	*I/II*	*III*	*IV/V*	*I/II*	*III*	*IV/V*	*6-8*	*5*	*2-4*
13-18	6 (13)	2	2	2	-	3	3	1	1	4	4	1	1	-	-	6	-	-	6
19-24	4 (9)	1	2	-	1	1	3	-	1	3	1	2	1	-	1	3	-	2	2
25-30	5 (11)	-	4	1	-	2	3	-	1	4	1	2	2	-	1	4	-	2	3
31-36	3 (6.5)	2	1	-	-	2	1	-	1	2	1	2	-	-	1	2	-	2	1
37-42	3 (6.5)	-	3	-	-	3	-	-	-	3	-	-	3	-	-	3	-	-	3
43-48	13 (28)	2	11	-	-	7	6	1	6	6	3	6	4	2	2	9	3	6	4
49-54	3 (6.5)	-	3	-	-	-	3	-	-	3	-	-	3	-	-	3	-	-	3
55-60	3 (6.5)	-	3	-	-	3	-	-	1	2	-	1	2	-	1	2	-	1	2
61-68	6 (13)	1	4	-	1	4	2	-	1	5	1	1	4	-	1	5	2	-	4
Totals	**46**	**8**	**33**	**3**	**2**	**25**	**21**	**2**	**12**	**32**	**11**	**15**	**20**	**2**	**7**	**37**	**5**	**13**	**28**
%	*100*	*17*	*72*	*6.5*	*4.5*	*54*	*46*	*4.5*	*26*	*69.5*	*24*	*33*	*43*	*4.5*	*15*	*80.5*	*11*	*28*	*61*

* equivalent level of function for children not diagnosed with cerebral palsy; O: Other diagnosis, CP: cerebral palsy; NM: Neuromuscular disorder; D: neurodegenerative disorder; M: Male; F: Female; GMFCS: Gross Motor Function Classification System; MACS: Manual Abilities Classification System; CFCS: Communication Function Classification System; LSS: Level of Sitting Scale

Table 2: ALP phase, loan and environmental data *(primarily adapted from Disability & Rehabilitation Assistive Technology)*

	Total Group	**Wizzybug sub-group n = 15**	**Bugzi sub-group n = 10**	**Tiger Cub sub-group n = 10**	**Ride-on-car sub-group n = 11**
Loan length (days)	Range 92-294 Mean 192.40 SD 42.79	Range 92-294 Mean 206.90 SD 52.55	Range 163-225 Mean 182.9 SD 18.07	Range 175-203 Mean 186.0 SD 8.39	Range 108-274 Mean 187.10 SD 59.50
Loan >180 days	30 (65.22%)	11	6	8	5
Loan ≤ 179 days	16 (34.78%)	4	4	2	6
Location					
Metro	15 (32.61%)	8	3	3	1
Day	19 (41.30%)	2	4	4	9
Distant	12 (26.09%)	5	3	3	1
Urban	38 (82.61%)	13	9	7	9
Rural	8 (17.39%)	2	1	3	2
Device used at:					
Home	33 (71.74%)	11	4	8	10
(Pre)school/daycare	7 (15.22%)	2	4	1	-
Community	2 (4.35%)	1	-	1	-
CDC	4 (8.70%)	1	2	-	1
Season of Loan					
Summer	30 (65.22%)	10	5	7	8
Winter	16 (34.78%)	5	5	3	3
Mobility outcome					
Manual mobility	7 (15.22%)	5	-	1	1
Power mobility	26 (56.52%)	9	6	6	5
Dependent mobility	11 (23.91%)	1	4	2	4
Walking	2 (4.35%)	-	-	1	1
Parent					
Mother	39 (84.78%)	10	10	9	10
Father	5 (10.87%)	4	-	1	-
Foster	2 (4.35%)	1	-	-	1
Primary Language					
English	43 (93.48%)	14	9	9	11
Farsi	1 (2.17%)	1	-	-	-
Russian	1 (2.17%)	-	-	1	-
Arabic	1 (2.17%)	-	1	-	-
Parent education					
≤ Secondary school	17 (36.96%)	7	4	2	4
> Secondary education	29 (63.04%)	8	6	8	7
ALP loan-start					
5	1 (2.17%)	-	-	1	-
4	9 (19.56%)	3	3	2	1
3	11 (23.91%)	6	4	4	4
2	12 (26.09%)	5	1	2	4
1	6 (13.04%)	1	2	1	2
ALP loan-end					
7	2 (4.35%)	-	-	2	-
6	4 (8.70%)	3	-	1	-
5	11 (23.91%)	3	3	4	1
4	8 (17.39%)	5	2	-	1
3	17 (36.96%)	4	3	3	7
2	4 (8.70%)	-	2	-	2

CDC: Child Development Centre; SD: standard deviation

Table 2 details parent and environmental information as well as ALP scores at loan-start and end. Accompanying parents were primarily mothers (n = 39; 84.78%), with two foster parents and five fathers participating in loan-start and end appointments. All parents communicated in English and it was the primary language for 93.48%. Time since participation in the Power Mobility Day single exploratory session to loan-start was variable (1 day - 17 months) depending on device availability. Device loans took place between May 2016 and February 2019 and were anticipated to average 6 months (180 days). Loans ranged from 3 to 9 months (mean: 192.40; SD 42.79 days) with most variability seen in loan lengths for Wizzybug and Car.

Reasons for loans < 170 days included: timing of researcher visits (n = 3), community therapist availability (n = 2), parent request (n = 5) and child's own power wheelchair delivery (n = 1). Most common reason for loans > 190 days was family availability (n = 8). Some children used the devices in training sessions with their occupational or physiotherapists at their local Child Development Centre, while two parents arranged to use a larger space within their community for training purposes. Six physiotherapists and 13 occupational therapists participated in the study. Some therapists were involved with multiple children. Following the loan, 26/46 (56.52%) children continued to use power mobility.

Within the first month, device use ranged from 15-180 minutes per session (mean 64.57; SD 50.08). At loan-end two children were not using Wizzybug, one was not using Bugzi and one was not using the Car, primarily due to environmental factors such as weather or lack of space. Of these, one child began to scoot on the floor, another was able to wheel a small manual mobility device while the remaining two used their supportive gait trainers within the home. Average time of device-use at loan-end ranged from 0-360 minutes per session (mean 62.28; SD 68.04). Number of sessions per week ranged from none to daily use, with 2-3 times per week being the most common.

Power mobility skill measures were scored from video taken at loan-start (mean 5.11; SD 4.15; range 0-17.32 minutes) and loan-end (mean 9.08; SD5.67; range 0-28.19 minutes). The variability of video-length depended on child tolerance and performance. Upon review, there was no association between power mobility skill scores, device or access method used and video-length.

Of 46 children, 39 progressed by at least one ALP phase. One child with a degenerative condition lost skill over the 6-month period while six others' ALP phase remained stable. See Figure 1 for details.

Figure 1: ALP change scores (n = 46)

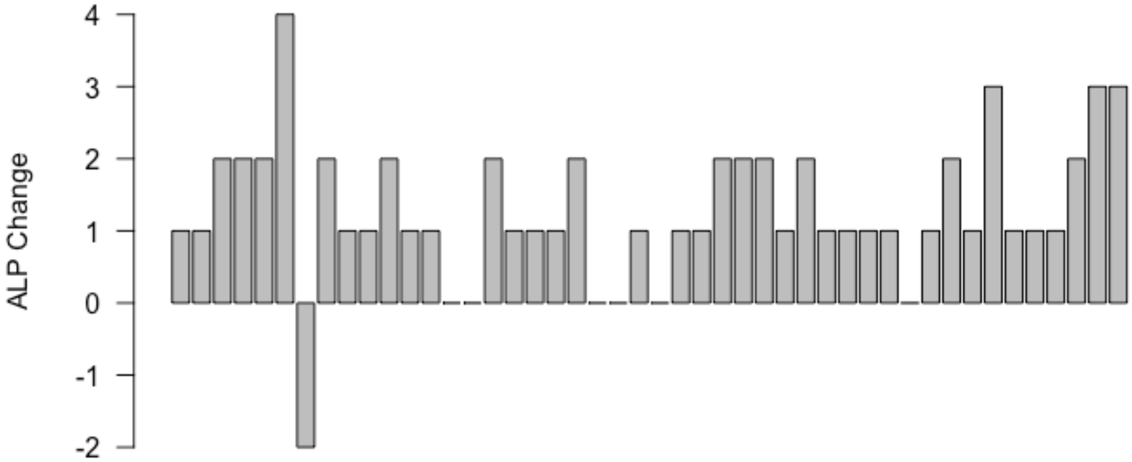
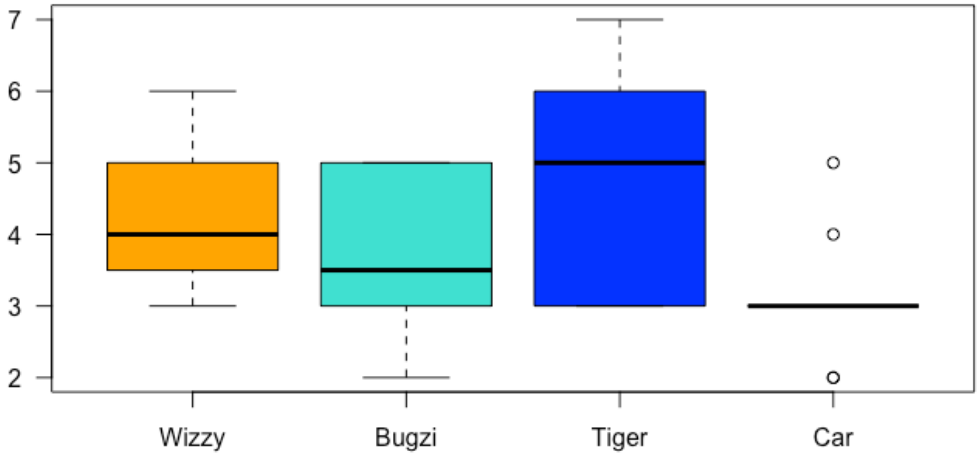


Figure 2 demonstrates ALP phase at loan-end separated by the four different devices. Of the six children whose ALP phase did not change over 6 months' experience, four accessed Car with a single-switch. Due to the limitations of the device, most children achieved an ALP phase of 3 (established cause-effect), with only a few outliers demonstrating greater or lesser tool-use abilities. The two remaining children whose ALP phase did not progress beyond ALP phase 3 (Bugzi with multiple switches; Wizzybug with proportional joystick) had significant motor access difficulties and may have been more successful with a different access method.

Figure 2: ALP phase at loan-end by device (n = 46)



As shown in Table 3, Wilcoxon signed rank test confirmed large statistically significant positive change in ALP phase pre-post loan (z= 5.50: r = 0.57; p<0.001). Differences for PMP and PMTT were also significant. Likewise, Wilcoxon signed rank test confirmed strong, significant positive change in WhOM-YP median average satisfaction scores pre-post loan with pseudo(median) change of 3.17 (CI_{95} 2.17 – 4.17). Parent QUEST device subscale scores showed moderate significant decrease over the loan while therapist scores remained stable. Wilcoxon Mann Whitney tests did not reveal any statistically significant difference between parent and therapist QUEST device sub-scale, Aesthetics or device expectation ratings.

Table 3: Pre-post loan Change *(combined data from Disability & Rehabilitation Assistive Technology, British Journal of Occupational Therapy and Canadian Journal of Occupational Therapy)*

Measure	**Loan Start** ***n*** **median (IQR)**	**Loan End** ***n*** **median (IQR)**	**Pre:post^a** **n z *p*** **(CI^{95})**	**Effect size** **r (CI^{95})**	**(pseudo)median change**
ALP	46 3.00 (1.00)	46 4.00 (2.00)	46 5.50*, <0.00	0.57 (0.42 – 0.70)	1.00 (0.98 – 1.58)
PMP	46 14.50 (12.75)	46 26.50 (21.75)	46 5.56*, <0.001	0.58 (0.42 – 0.70)	12.00 (8.99 – 17.99)
PMTT	46 21.00 (13.75)	46 32.00 (13.75)	46 5.50*, <0.001	0.57 (0.42 – 0.70)	10.50 (8.50 – 12.50)
WhOM-YP	46 3.33 (2.33)	45 7.00 (3.67)	45 4.89*, <0.001	0.51 (0.34 – 0.65)	3.17 (2.17 – 4.17)
QUEST D parent	46 4.50 (0.63)	45 4.13 (0.88)	45 -3.32*, <0.001	0.34 (0.15 – 0.58)	-0.37 (-0.50 – -0.19)
QUEST D therapist	37 4.38 (0.63)	35 4.38 (0.94)	30 -1.05, =0.29		
Aesthetics parent	46 5.00 (1.00)	45 5.00 (1.00)	45 -1.91, =0.06		
Aesthetics therapist	37 5.00 (1.00)	35 5.00 (0.00)	30 1.65, =0.10		
Device expectation fulfilment - parent		45 0.00 (3.00)			
Device expectation fulfilment - therapist		31 1.00 (3.50)			

^{a}Wilcoxon signed rank test *Statistically significant difference at p<0.05 IQR: inter-quartile range; CI^{95}: 95% confidence interval; ALP: Assessment of Learning Powered mobility use; PMP: Powered Mobility Program; PMTT: Power Mobility Training Tool: QUEST D: Quebec Evaluation of Satisfaction with assistive Technology 2.0 device sub-scale; Aesthetics: Aesthetics question used with QUEST rating scale; WhOM-YP: Wheelchair Outcome Measure for Young People

Kruskal-Wallis test identified relatively strong significant effect of device, diagnostic group, communication and access method on ALP phase (see table 4). Post-hoc tests revealed significant differences between Wizzybug and Tiger cub in comparison to Car; between children with neuromuscular and neuro-degenerative or other diagnoses; and between joystick and hand switch as well as head versus hand switch users. Significant differences in ALP phase were also found between children classified as CFCS III versus those classified as CFCS V. No statistically significant associations were identified between ALP and child age, motor abilities or environmental factors.

Table 4: ALP phase at loan end and associated variables *(copyright Disability & Rehabilitation Assistive Technology)*

	Independent variable	***Kruskal-Wallis test*** **Group comparisons χ^2**	**ε^2 (CI^{95})**	***Post-hoc tests*** **Comparison**	**(median ALP comparison)**	**p^a**
ALP phase at loan end	Device	χ^2(3)=11.37*, *p=0.01*	0.25 (0.10-0.51)	Wizzybug: Bugzi	(4.00:3.50)	*0.73*
				Wizzybug: Tiger cub	(4.00:5.00)	*1.00*
				Wizzybug: Car*	(4.00:3.00)	*0.04*
				Bugzi: Tiger cub	(3.50:5.00)	*0.21*
	Diagnostic group	χ^2(3)=12.01*, *p=0.007*	0.27 (0.10-0.48)	Bugzi: Car	(3.50:3.00)	*1.00*
				Tiger cub: Car*	(5.00:3.00)	*0.01*
				CP: Neuromuscular	(4.00:7.00)	*0.09*
	Access	χ^2(3)=15.07*,*p=0.002*	0.34 (0.18-0.58)	CP: Degenerative	(4.00:2.50)	*0.30*
				CP: Other	(4.00:3.00)	*0.39*
				Neuromuscular: Degenerative*	(7.00:2.50)	*0.01*
				Neuromuscular: Other*	(7.00:3.00)	*0.01*
	CFCS	χ^2(4)=11.89*, *p=0.02*	0.26 (0.10-0.53)	Degenerative: Other	(2.50:3.00)	*1.00*

Joystick: Digital Joystick	(4.00:3.50) *1.00*
Joystick: Hand switches*	(4.00:3.00) *0.001*
Digital Joy: Hand switches	(3.50:3.00) *1.00*
Digital Joy: Head switches	(3.50:5.00) *0.74*
Hand switch: Head switches*	(3.00:5.00) *0.009*
CFCS III:V*	(5.00:3.00) 0.03
All other level comparisons non-significant	

ε^2: Epsilon Squared; CI^{95}: 95% confidence interval; ALP: Assessment of Learning Powered mobility use; CFCS: Communication Function Classification System; CP: cerebral palsy; [a]Conover post-hoc with bonferroni correction; *Statistically significant difference at $p<0.05$

Excellent spearman correlations[35] were seen between loan-start ALP phase and ratings for PMP (0.83, $p<0.001$) and PMTT (0.88, $p<0.001$) and loan-end ALP phase and ratings for both measures (0.92, $p<0.001$).. No statistically significant associations were identified between ALP and child motor abilities or any environmental factor including age (see Figure 3), loan-length and season of use. No statistically significant trends or associations were identified between any child or environmental descriptors and WhOM-YP goal achievement, QUEST device satisfaction or device expectation fulfilment ratings. Figure 4 demonstrates associations between loan-end ALP and PMP or PMTT scores

Figure 3: ALP change by age (n = 46)

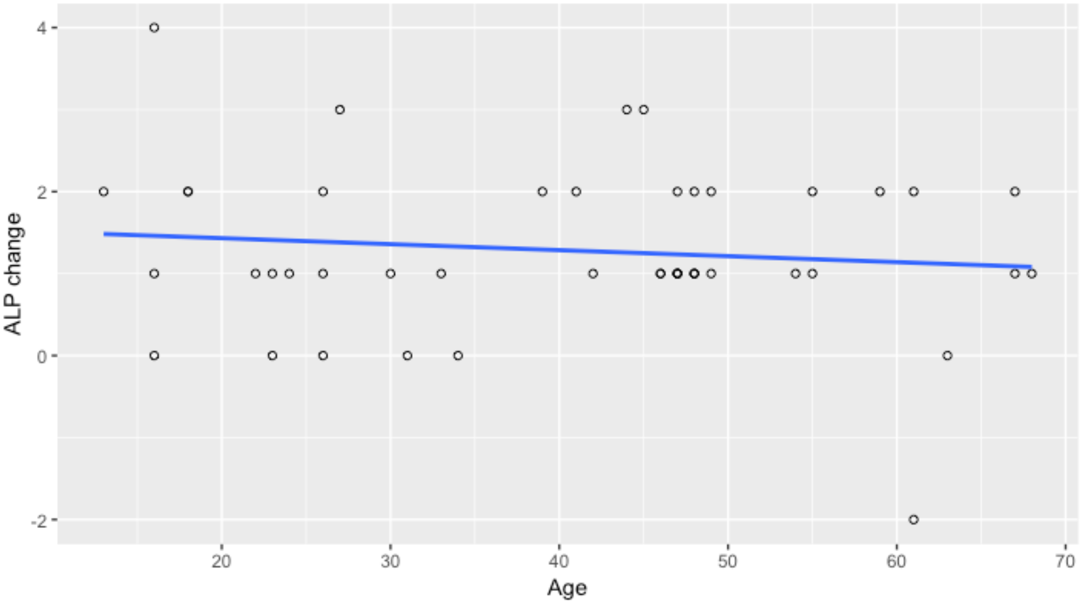
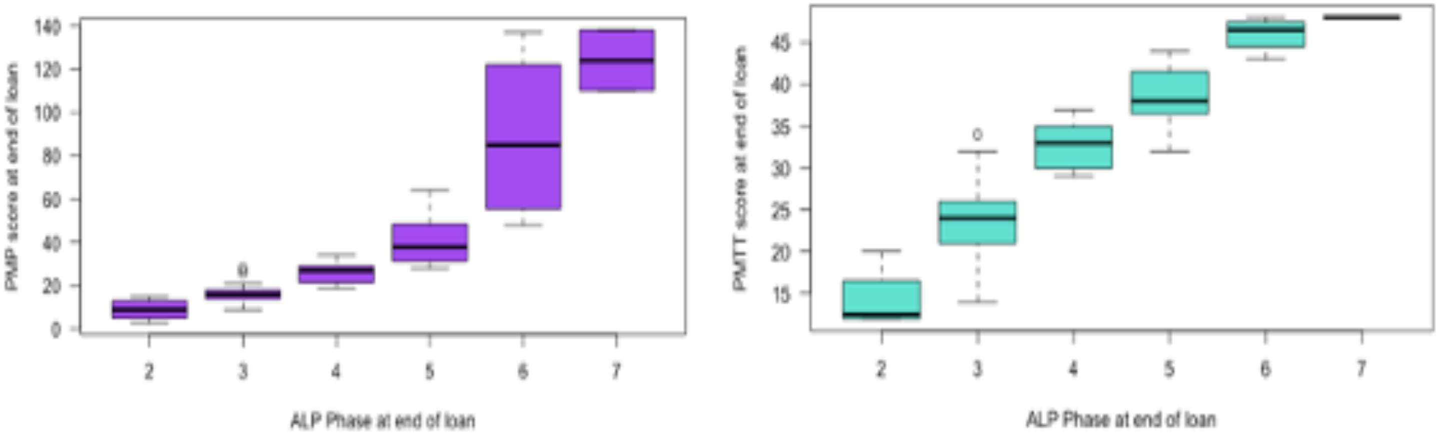


Figure 4: Correlations of ALP phase at loan-end with PMP and with PMTT *(copyright Disability & Rehabilitation Assistive Technology)*



Fair to good, statistically significant ($p<0.001$) Spearman correlations were measured between ALP at loan-end and parent WhOM-YP[38] ($r_s = 0.48$; CI^{95} 0.18-0.70) (see Figure 5) as well as parent ($r_s = 0.46$; CI^{95} 0.20-0.67), and therapist ($r_s = 0.66$; CI^{95} 0.39 – 0.83) device expectation fulfilment scores (see Figure 6). Therapist QUEST device sub-scale ($r_s = 0.48$; CI^{95} 0.08- 0.75; $p=0.004$) showed fair, significant correlation with ALP phase, but parent QUEST and aesthetic ratings did not. However, confidence intervals are wide and all estimates should be interpreted cautiously.

Figure 5: ALP phase and WhOM-YP[38] activity and participation goal achievement *(copyright British Journal of Occupational Therapy)*

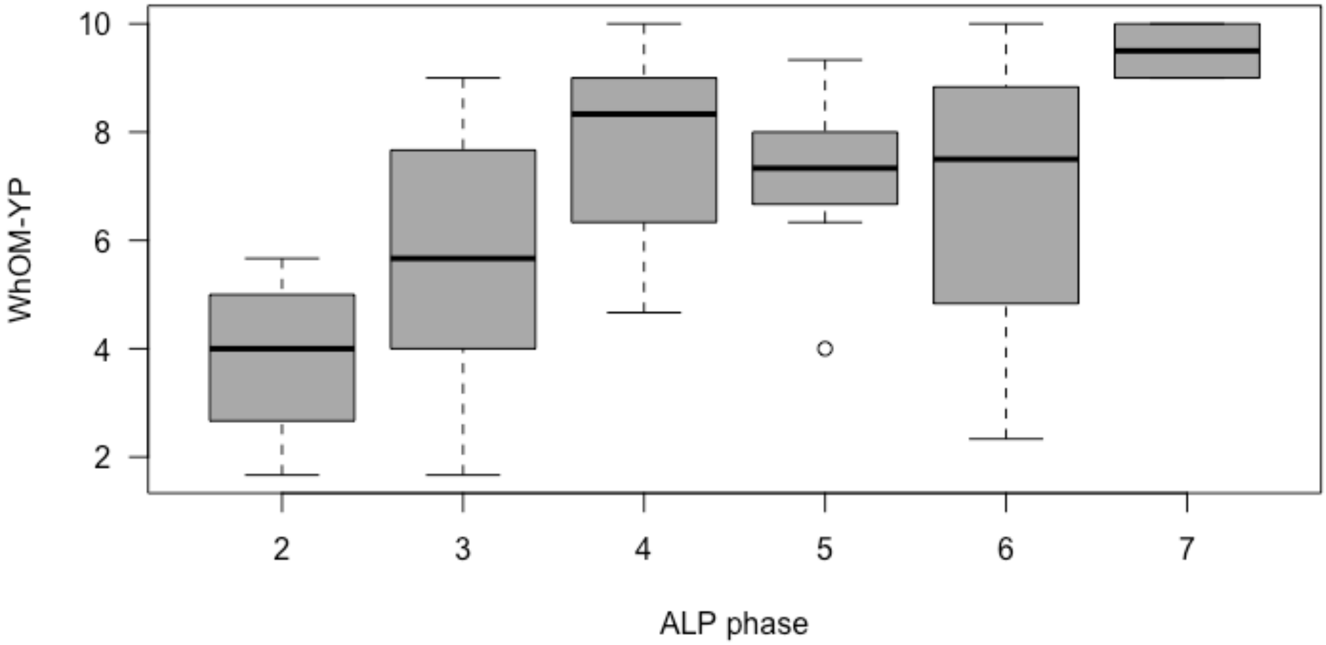
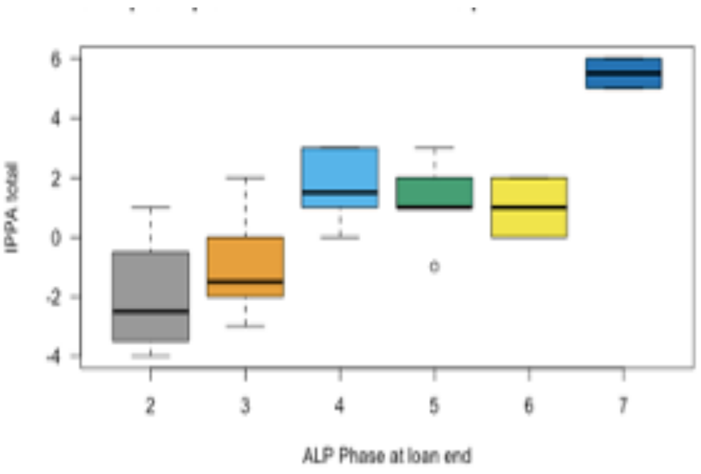
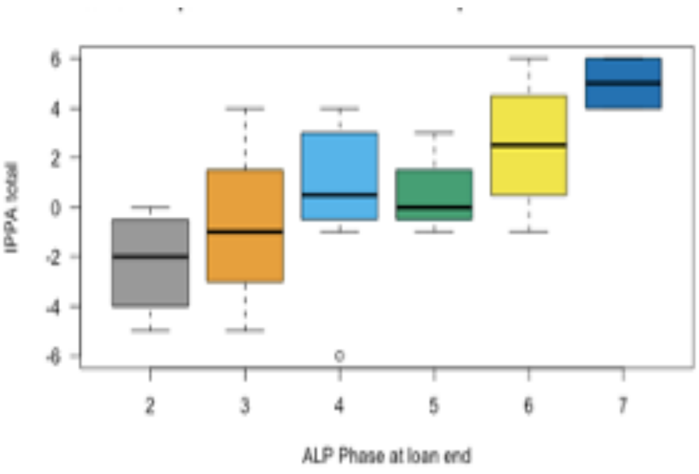


Figure 6: ALP phase at loan-end in relation to therapist and parent device expectation fulfilment ratings



Therapist device expectation fulfillment (n = 31)



Parent device expectation fulfillment (n = 45)

Although there was no statistically significant association between ALP change or loan-end scores and amount of device use, only 2/10 children who used the device less than 30 minutes 2-3 times a week achieved ALP 4 or higher. Both accessed Wizzybug with a joystick, but preferred floor or gait trainer mobility and were classified as GMFCS and MACS levels III. In contrast 2/9 children who used the device at least 2 hours several times a week did not progress beyond ALP 3 with 6-months' experience. Both were classified as GMFCS and MACS levels V and skills did not progress due to access difficulties.

Parent-selected activity and participation goals were categorized according to the ICF. Goals such as enjoying movement, playing, moving around in different environments, increasing independence and understanding how to use joysticks, switches and direction were most common.

Table 5: Examples of parent-selected activity and participation goals *(copyright British Journal of Occupational Therapy)*

Code	Category	Example of parent-identified goal
Chapter one: Learning and Applying knowledge		
d110	Watching	Increase use of vision
d131	Learning through actions with objects	Increase understanding of cause-effect Initiating movement Opportunity to learn
d137	Acquiring concepts	Increase understanding of direction and spatial awareness Understand steering and direction Establish a sense of independence
d155	Acquiring skills	Increase ability to use the joystick
d160	Focusing attention	Increase visual attention Understanding and exploring movement in space
Chapter Two: General tasks and demands		
d210	Undertaking a single task	Increase independence Be able to do what she wants to do Increase active participation in movement activities with others
Chapter Three: Communication		
d310	Communicating with – receiving - spoken messages	Ability to follow directions
Chapter Four: Mobility		
d445	Hand and arm use	Increase use of hands Increase use of right hand and arm Increase ability to use switches/joystick
d455/465	Moving around/Moving around using equipment	Moving around by herself Move by herself more easily
d460	Moving around in different locations	Moving around in the yard Moving around at preschool Moving around inside the house Moving around at the grocery store/mall Moving and exploring outside
Chapter Eight: Major life areas		
d815	Preschool education	Playing with other kids at preschool
d880	Engagement in play	Playing with other children Going for a walk Playing chasing games Social interaction and playing with other kids
	d8800 Engaging in solitary play	Enjoying movement for its own sake Playing independently

Discussion

This study described and compared change in young children's power mobility skill following an average of six-months' experience in one of four early power mobility devices. Positive change in power mobility skill was measured in 39/46 children and included those using all four devices and various access methods. Power mobility skill change pre-post loan was statistically significant ($p<0.001$) and effect size large.[33] Positive, significant change in activity and participation goal satisfaction was also measured in children using each of the devices and for children using switches with hand or head access as well as proportional or digital joysticks. Differences between loan-end ALP phase and access method, device type, diagnostic group and communication function were statistically significant. However, these factors were not statistically significantly associated with goal achievement satisfaction measured using the WhOM-YP. Correlations between the three paediatric power mobility skill measures were excellent, with stronger correlations between loan-start and loan-end, than change scores. Parent and therapist device QUEST satisfaction scores, aesthetic scores and device expectation fulfilment scores did not statistically significantly differ from each other.

Although positive change in activity and participation goal achievement was measured in our study across the entire sample, some differences of clinical interest can be seen when children were grouped by ALP phase. These differences could not be confirmed as statistically significant due to our small sample size. Although child age was not significant in relation to power mobility skill (similarly to other analyses[14,15]), the four children with CP (4/33; 12%) who achieved ALP phase 6, were all older (46-55 months at loan-start) in comparison to the two children with neuromuscular conditions (16 and 27 months at loan-start) who achieved phase 7. The youngest child with a neuromuscular condition (13 months at loan-start) required further practice and experience following the study to achieve competent control, providing further confirmation that children without cognitive delays, who can use joysticks, typically achieve control of steering around 2 years-of-age.[5]

Figure 5 demonstrates that median goal achievement was higher for the two children functioning at ALP phase 7. This is not surprising as children with spinal muscular atrophy have demonstrated ability to develop proficient power wheelchair use at very young ages [39] and may be described as functional learners who very quickly move beyond the phases of learning to steer and operate the machine.[7] Having achieved proficient control, these children were able to enhance their participation in meaningful activities with others, rather than primarily focusing on how to move from one point to another.

Previous research has shown that children with diagnoses involving the brain (such as CP) require longer periods of time to achieve proficient control of a power wheelchair than those who have diagnoses not including the brain.[14] Although children functioning at ALP phase 6 demonstrate intentional steering, they may have difficulties in tighter or busier spaces. Children who are still 'learning how to operate the machine' have more difficulties with shifting attention between the power wheelchair controls and the activity.[40] The wide spread of parent WhOM-YP satisfaction scores for children achieving ALP phase 6 suggests more variability in these children's abilities to use the power wheelchair for meaningful activities. This variation may be related to differences beyond the child's motor and sensory abilities, such as their level of attention, the activity demands or physical, social or attitudinal environmental factors.[40,41]

It is interesting that similar median WhOM-YP satisfaction is seen for children who achieved ALP phases 4,5 and 6 despite variability in range. Children achieving these phases of skill development with 6-months' experience may be considered operational learners, who require longer periods of learning to use the power wheelchair safely and to use it within functional activities.[7] One potential explanation of the variability in range is that ALP phases 4 and 5 are set within a stage of learning described by the authors as the difficult transition.[8] At this stage, children have a solid understanding of cause-effect and are exploring different effects of the switches or joystick as they start to search for the pattern of steering. This can result in frustration as children move beyond merely enjoying and exploring movement to exhibiting the desire to move intentionally to a goal but perhaps being unable to achieve the desired effect.

Many children who were able to establish cause-effect (ALP phase 3) with 6-months' experience are considered exploratory learners and this sub-group included 11 children with CP, one child with a degenerative condition and five with Other stable conditions. Although age was not significant across the total group, some children who did not progress beyond cause-effect were under 2 years-of-age by loan end and may prove to be operational learners with a slower progression towards control of steering over time. For example, two children diagnosed with spina bifida achieved ALP phase 3 (cause-effect) at the end of 6 months, despite having sufficient hand control to learn to use a joystick and demonstrating ability to wheel a caster cart or similar device. However, they were both under 24 months by loan-end and their use of the power mobility device was limited by weather, while they could either scoot on the floor or use their manual device within the home.

Children who achieved ALP phase 2 by the end of 6-months' experience are considered exploratory learners. Exploratory learners require close and constant adult attention to keep them safe while they explore movement and, over time, establish cause-effect.[7] This sub-group included children with severe, profound cognitive disability, two diagnosed with CP and one with autism and a child with a neuro-degenerative disability.

Visual analysis suggests that children using Bugzi may be older and have more complex profiles, however statistical analyses were influenced by the one child with a degenerative condition who lost skill over the course of the study. Statistically significant differences were found in ALP phase achieved in either Wizzybug or Tiger cub in comparison to Car, which was primarily selected for younger children, or those functioning at earlier developmental levels. Most had not established cause-effect with a single-switch at loan-start and could be considered exploratory learners.[7] Only a few had sufficient hand function to use the steering wheel allowing them to explore multiple effects of the device. As a result, children using Car had the lowest median ALP phase (phase 3) of any device group.

Results for device are also influenced by access, since access methods were not evenly distributed across devices. Proportional joystick use predicted proficiency in two other analyses,[14,15] and all 15 children using Wizzybug and 8/10 children using Tiger Cub were proportional joystick users. In this study, all six children who achieved ALP phases 6 or 7 used proportional joystick access. In contrast, all 11 children who used Car accessed a single switch with their hands, and significant ALP phase differences were identified between joystick and hand access (p = 0. 001). However, hand switch users started with the lowest median ALP[8] phase (2) and most typify exploratory learners with a longer, slower learning trajectory.[7]

Of six children who did not change ALP phase over the study timeline, only one used a proportional joystick while five used hand switches. Gefen reports that 80% of children requiring power mobility can use proportional joysticks[15] in comparison to 50% in this study. This difference is explained by the younger age sample and variety of devices included with only 25 (54.35%) device loans having proportional joysticks available.

Two children used digital joysticks and results are skewed as one was the child who lost function over the loan period. Of five children using multiple hand switches in Bugzi, only one achieved ALP phase 4 by loan-end. Interestingly, little variation in ALP is seen with the five head switch users, in comparison to other access methods. All started at ALP phase 3 (understanding cause-effect) and 4/5 achieved phase 5 (searching the pattern for steering) by loan-end. Post-hoc tests for loan-end ALP phase revealed significant differences between hand and head switch users.

While children using head switch access, likely represent a more complex group, head access may have allowed easy exploration of multiple switches and directionality in comparison with hand switches. However, no child using head access was able to establish control of steering within six months. This longer learning trajectory and need for extended practice has previously been recognized for children using alternate access methods.[15,42] For children with cognitive or complex motor limitations, a period of training in therapy sessions followed by at least 2-3 months practice at home prior to determining eligibility for power wheelchair prescription has been recommended.[43] For individuals with significant cognitive limitations, more than two years training may be required to achieve steering control.[44]

It has long been recognized that currently available access technologies limit ability of individuals with the most complex disabilities to achieve independence with power mobility.[45] While we endeavoured to include a wide range of access options within our study, they did not meet the needs of all children. Technologies under development such as eye-gaze,[46] brain-interfaces,[47] robotic devices,[48] or smart wheelchairs[49] may offer potential, but need careful consideration in relation to the child's developmental level, as well as any cognitive or sensory limitations. Use of line-following or other complex technologies may impede learning for children who have not achieved ALP phase 5.

While CFCS was significantly related to loan-end ALP phase, only 9/46 children were classified as CFCS I-III. Loan-start ALP was higher (median 4) for these children reducing change potential. Most children under 2 years were classified as CFCS IV or V and as a result, this classification was less discriminating for the younger children. It is not surprising that differences in power mobility skill were identified between children with the most limited communication abilities (CFCS V) and those communicating effectively with familiar adults (CFCS III).

The WhOM-YP was used with parent-proxy ratings in this study. Likewise, the COPM[50] has also been used with parent-proxy rating in paediatric research and ability to detect change above the published minimal clinically important difference (MCID) of 2 points has been measured.[51]

Although MCID has not yet been determined for the WhOM-YP, the median change of more than 3 points measured for the entire group exceeds the previously estimated MDD[95] of 1.8. The WhOM-YP has also been used to evaluate change in individualized goals by five school-aged children following a 3-week power wheelchair training camp. WhOM-YP proxy-ratings were completed by teachers who also evaluated goal achievement rating (using a 5-point ordinal scale ranging from -2 to +2) that confirmed positive results.[10]

Variability in parent-goal satisfaction was seen across all ALP phases, except for the two Functional learners. This variability may relate to parent expectation of the level of independence that their child would experience in the power mobility device and the amount of adult supervision and support necessary. Based on parent comments at loan-end, some parents thought their child would be able to play independently in their home or outside space and were unprepared for the level of adult input required.

Where the focus was on solitary or parallel play or on power wheelchair movement, goals may have been met satisfactorily for operational learners. However, goals that require incorporating the use of the device into a more complex occupation such as 'going for a walk', or 'moving around at the grocery store', may have been challenging if the child was still struggling to steer accurately or had difficulty dividing their attention. In contrast, parents of older exploratory learners who achieved cause-effect in the power mobility device were highly satisfied, as they had not experienced this success with other switch activities.

Exploratory learners who had greater therapist support and input during the loan appeared to have higher parent satisfaction scores, although therapist support was not systematically recorded, or available for all children. While functional learners may be anticipated to progress quickly at home, with limited therapist input, exploratory learners, in particular may benefit from more structured training in a therapeutic environment. Nilsson found that individuals with profound cognitive disabilities were more likely to achieve control of steering if they were provided with a long period (over 2 years) of structured training with a significant amount of the training being carried out by a professional.[44] Therapists may have the motivation and persistence to provide consistent intervention, and to recognize small signs of progress, even when that progress is slow.

For some children in this study, therapist input was provided through regular home visits, where the home environment was conducive to regular use of the power mobility device. Other children attended the child development centre for a block of intervention, while others used the device in preschool or kindergarten as part of a more structured educational program. Successful activity and participation outcomes were identified from each of these approaches in children achieving every ALP phase. Less successful outcomes appear to be associated with families who did not have regular therapist input and who were less able to provide regular and consistent practice for their child. This impact of training environment and therapist support is a factor that should be measured more systematically in future and larger studies.

While some families made successful use of Cars outside in summer, over winter this was much more difficult. After the first round of loans, we chose only to loan Cars over winter to children who had access to large indoor spaces such as school gym and hallways or child development centre. Reports of occupational therapists using Car interventions to promote switch access and social interaction suggest that training in an institutional setting such as a rehabilitation centre, child development centre or school setting may be helpful if space at home is limited.[52] Therapists may consider providing power mobility training as a specific intervention if they have devices that can potentially be used with several different children in individual or group therapy sessions. This approach may be particularly helpful when working with exploratory learners, or young children beginning to learn operational control.

Correlations between ALP and PMP or PMTT were stronger at loan-end than change scores. This difference may be explained by the difference in spread of scores for children at different stages of tool-use. Figure 4 demonstrates the ceiling effect on the PMTT for those achieving ALP 6 and above. The PMP has a wide spread of scores, but limited change is seen for children achieving below ALP 5. PMP appears less useful for exploratory learners, but discriminates skill for children progressing through operational to functional skills, while PMTT is most useful for guiding training for exploratory and operational learners.[7]

Parent and therapist retrospective ratings of whether or not the device met their expectations in terms of the child's goal achievement did not differ significantly. Parent median score was 0 (as expected) while therapist median score was 1 (more than expected). Spearman correlations between the child's ALP scores and device expectation scores were significant for both parents and therapists, although confidence intervals were wide ranging from weak (0.20) to good (0.67) for parents and fair (0.39) to excellent (0.83) for therapists. This retrospective rating provides additional validity evidence supporting that the positive change in goal achievement measured using the WhOM-YP was meaningful to both groups.

Although parent QUEST device sub-scale satisfaction scores decreased significantly from loan-start to end, this likely represents a more realistic appreciation of the device following real-life experience. Loan-end median score of 4.13 indicates that parents were still 'quite satisfied' with the devices. In contrast, therapist ratings did not change over the loan and this difference may relate to therapists having had greater prior experience with the devices. Therapist rating (n = 30/46) was significantly associated with child power mobility skill, while parent ratings (n=45/46) were not. However, confidence intervals were particularly wide ranging from very weak (0.08) to very strong (0.75) suggesting great variability and we cannot place much confidence in the overall estimate.

Therapist numbers were lower than parents (due to changes in caseloads during the loan) and may have influenced results. Although, an individual item comparison is beyond the scope of this analysis, it is possible that therapists may have considered ease of use and/or effectiveness in relation to child power mobility skill, while some parents may have scored these items in relation to their own use. We had hypothesized that Aesthetics would be a factor significant to parents and median ratings remained high from loan-start to loan-end, however Aesthetic ratings were not correlated with child power mobility skill.

In this study four children were not using the power mobility devices by loan-end and two parents, chose to end the loan early. The assistive technology literature suggests that lack of relative advantage influences device continuance or discontinuance.[53] For these children, the relative functionality of their other mobility methods, the environmental barriers (space in the home or weather limiting outdoor use), or parent attitudes may have influenced the decision not to continue with power mobility at that point in time.[54] The child's ability to use the device may not have matched parent expectations for participation in family activities,[55] or parents may have been more focused on physical development or walking as a primary or long-term goal.[56] One child who had just started to scoot independently on the floor was frustrated with being unable to go where she wanted in the Wizzybug. Interestingly, a significant proportion of older children with CP still find floor mobility within the home more convenient, although they may be proficient power wheelchair users outdoors, in the community and at school.[57]

Limitations:

This study was limited by not having a control group however this was not our intent, due to the exploratory and clinical nature of the study. Additionally, the primary purpose was to measure change in power mobility skill over time, and this would be unlikely to show change in a group of very young children with complex disabilities who were not provided with power mobility practice or experience. We used a purposive sample to observe the possibilities of power mobility interventions for the range of diagnoses, ages and clinical profiles (including children with significant cognitive and sensory impairments) within typical early intervention caseloads and this heterogeneity limited sub-group analyses. Only six children achieved control of steering within the six-month time frame limiting comparisons of children across driving skill sub-groups. Device type and access method are closely linked, as all children using the Car used hand switches, and most were unable to operate the steering wheel, limiting potential skill progression. However, device was predominantly selected by parents, and the access method individually selected for child abilities, suggesting this was an appropriate match.

Cognition has been suggested to be an influencing factor on power mobility skill progression and a reliable measure may have further discriminated learning trajectories. However, due to study design and lack of a simple, reliable measure valid for our varied sample, this was not possible. Limited therapist availability and therapist change during the study reduced the number of complete pairs available for therapist and parent score comparison and this may have affected our results. Average scores for the QUEST device sub-scale and WhOM-YP were used in this analysis. An individual item or goal analysis may have revealed different associations or results, but was beyond the scope of this paper. In addition, due to the clinical nature of the study, amount of power mobility experience was not controlled and varied due to multiple factors. This variability will have influenced our results, but also demonstrates the feasibility of introducing power mobility with young children in typical clinical practice settings.

Conclusion

Positive change in power mobility skill was measured in 39/46 children aged 13-68 months following an average of 6-months'experience. Change was measured for children who started the loan at all ALP phases in each of the four devices and using all access methods. While proportional joystick access was associated with control of steering, head switch access may also allow children with significant motor control limitations the opportunity to explore direction, although a longer learning trajectory should be anticipated. Power mobility skill progression differed for children with different diagnoses and access methods, although there was no significant association across the entire group with children's motor abilities, age or environmental factors including loan-length. Positive change in children’s power mobility skill correlated with achievement of parent-identified activity and participation goals measured using the WhOM-YP. Positive change was measured for children achieving all ALP phases from curious novice to proficient use. However, differences in goal achievement were seen between children functioning at exploratory phases where they were establishing cause-effect, as opposed to those who were exploring directional control or starting to use the power mobility device functionally.

Correlations between ALP, PMP and PMTT were excellent. While change was measured using the ALP for children of all abilities, results confirmed previous suggestions that the PMP is most useful for functional and perhaps older operational learners, while PMTT is most useful for exploratory and younger operational learners. Parent device satisfaction as measured with the QUEST device sub-scale decreased during the loan, but likely represented a more realistic perspective once they had experience using the device in their daily life. Median device expectation fulfilment was ‘as expected’ for parents and ‘more than expected’ for therapists providing additional validation that the WhOM-YP change scores measured change meaningful to both groups. This study provides further evidence supporting the different profiles and learning trajectories that may be associated with Exploratory, Operational and Functional learner groups. Further studies with more controlled, experimental designs are required to confirm these preliminary findings.

Conflict of Interest:

The authors declare no conflict of interest

Funding:

A small-scale research grant from Posture & Mobility Group (UK) funded researcher time to complete the video-analysis of children’s driving skills pre-post power mobility loan.

Contributions:

RL initiated the idea and designed the study with consultation from DF. RL and DF conducted the study. RL completed the statistical analysis with consultation from DF. RL wrote the first draft of the manuscripts on which this report is based. Both authors revised and refined the manuscripts for publication. RL combined the manuscripts to create this final report and refined it with DF. Both authors are in agreement with the final version. RL is the guarantor.

Acknowledgements:

The authors would like to acknowledge: Lori Roxborough MSc, OT/PT for her encouragement and support in development of this research project; Susan R Harris PT, PhD for her advice regarding study design and ethics application; Jane Shen MASc for setting up the database in REDCap, preparing the data for analysis, checking data output and presentation of statistical results; Boris Kuzeljevik MA for providing statistical consultation; Sunny Hill Foundation for Children for funding the devices; Sunny Hill Health Centre for Children for supporting study conduct; our colleagues on the Positioning and Mobility and Assistive Technology Teams and in the community who assisted us with supporting the loans; and we would especially like to acknowledge all the families, children and community therapists around the province for their support and participation. Finally, we would like to thank PMG for funding our time for the analysis and covering expenses for presentation of results at PMG conference 2019.

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