A critical review of power mobility assessment and training for children

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Abstract

Purpose: Assessment and training of young children using powered mobility tends to be based on expert opinion although research in this area has recently been completed. This paper critiques available research and discusses the studies in relation to theory and expert opinion.

Method: A literature review was completed to identify research regarding powered mobility training for children with developmental disabilities. Two recent qualitative studies were identified and their models and assessment tools were compared and discussed with recommendations for clinical practice and research.

Results: The focus of the two studies is on a continuum of learning, the reciprocal relationship of trainer and trainee, and impact of the social and attitudinal environment on powered mobility skill development. The assessment tools and training protocols are backed up by motor learning principles and expert opinion. Further research is required to incorporate the tools into clinical practice and to examine additional psychometric properties.

Conclusions: Rather than focusing on readiness skills or pass/fail tests, clinicians should explore early mobility options for clients at the beginning of the continuum of learning, reflect on how they relate to and impact on their clients' learning, and set up the environment to facilitate independent learning and exploration.

Introduction

Restricted mobility in young children is associated with passive, dependent behaviour and can have long-term impacts on academic and social achievement [1]. Children unable to move by themselves may pass a critical time for learning cognitive, emotional and social skills [2]. Research has shown that providing powered mobility devices to children with disabilities can improve social [3], communication [1,4,5], and cognitive skills [6,7], as well as increase initiation [8], exploration [9], and independence [10] without affecting motor development [11].

Powered mobility can assist young children to play and explore and allow older children to participate in tasks such as moving around school, playing outside and in gym [12]. However, therapists still tend to delay introduction of powered mobility devices well beyond the age that typical children begin to move independently [13] and find it difficult to provide the time and practise opportunities required by children who have learning, sensory and perceptual delays as well as motor disabilities [14,15].

Powered mobility assessment

The most widely known, research-based, assessments [16-18] were designed from an adult perspective. Even those developed for children [19-21] consist of checklists related to the ability to operate the powered wheelchair rather than a developmental progression of mobility skills. Other than identifying which skills are lacking, the checklists provide limited direction for training and little guidance for children at the early stages of mobility skill development.

Powered mobility training

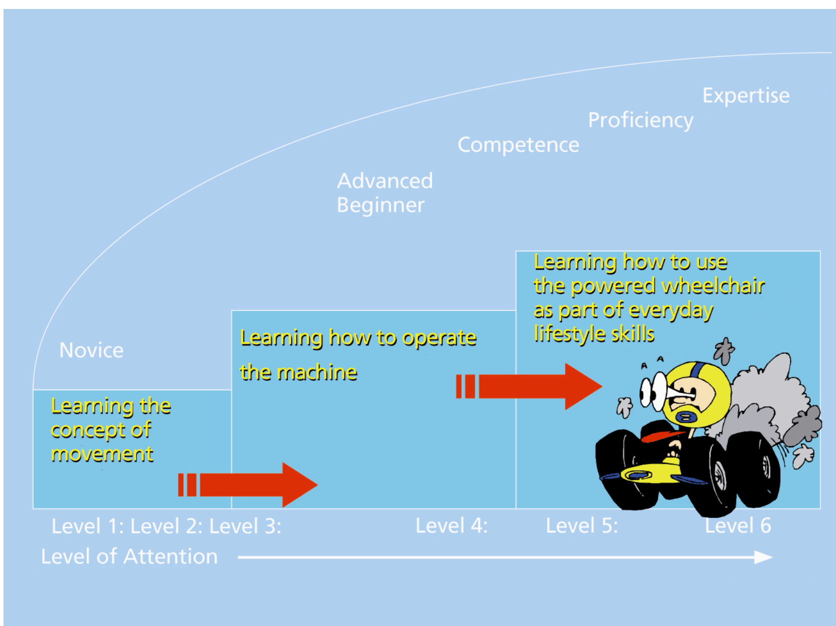
There is little evidence regarding the best methods for training children to use powered mobility. Published suggestions tend to be based on expert opinion rather than research. However, qualitative research exploring powered mobility training and learning has recently been completed in the UK [22,23] and in Sweden [24]. This paper will describe, critique, and discuss these studies [22-24] in relation to the literature and develop recommendations for practice and research.

Durkin, an occupational therapist working with children with multiple and complex disabilities in a special school setting in England, conducted a grounded theory study to explore the question ‘how does a child learn to use powered mobility to explore their environment?’ She aimed to identify the components and progression of powered mobility learning and to develop a model that could be used as the base for a clinical assessment tool. Durkin endeavored to conduct a child-centred study and incorporated children’s views into the assessment framework that emerged.

Durkin chose a constructivist methodology, observing 11 children developing typically and aged 6 months to 5 years [22]. She used the process of constant comparison and coding of the video data to develop the emerging themes. This led to theoretical sampling of 7 experienced powered mobility users in a focus group, and a further observational study of 11 children with disabilities at different stages of powered mobility learning. She also conducted focus groups with 22 peer professionals to widen clinical applicability.

Durkin demonstrates clearly in her thesis [22] how the themes of ‘partnerships and models’, ‘listening to disabled children’ and ‘engaging with children through play’ subsumed all other categories leading to the emergence of the core category: the 'responsive partner'. Three stages of developmental learning were identified: 1) learning the concept of movement; 2) learning how to operate the machine; and 3) learning how to use the powered wheelchair as part of everyday lifestyle skills

Durkin [22] found these three observable stages insufficient for a detailed clinical assessment and explored themes of distractibility and judgement within the literature. This led her to weave two established models into her constructional framework(Figure 1): Reynell's model of attention levels from level 1 (extreme distractibility) to level 6 (attention well established and maintained) [25] and Dreyfus and Dreyfus' five progressions of skill development from novice to expert [26].



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<u>Case study example based on Durkin's tool</u>

Tara is an eight-year-old girl, gross motor function classification system (GMFCS) level V [27], meaning that she has severely limited self-mobility, even with use of assistive technology. Tara drives using a proportional head control and, although able to steer well in open spaces, frequently wants to be pushed when in congested or cramped areas to ensure safety. Tara has a scattered pattern of skills but overall she is functioning as an advanced beginner with difficulties in the areas of judgement and attention. Durkin [22] suggests that children need to be able to spontaneously shift attention before they can begin to participate in group activities and move on to 'learning to use the powered wheelchair as part of everyday lifestyle skills'.

Durkin's assessment tool (see Appendix) has not been developed to provide specific suggestions for intervention. However, in reflecting on Tina's results, it could be suggested that she needs more experience driving in different environments to develop her judgement skills. These may include a play-based environment where she can feel free to explore and play without worrying about bumping into things. Gradually she could begin to participate in group games or driving in more challenging environments.

In a qualitative thesis published in Sweden, Nilsson [24] worked with a wide age range of individuals with cognitive and physical disabilities and completed a grounded theory study to explore the question 'what can be achieved by training people with profound cognitive disabilities in a joystick operated powered wheelchair'? Over a period of 12 years, 45 individuals with profound cognitive disabilities participated in the project. After the first five years, theoretical sampling for two additional reference groups took place: 17 typically developing infants and 64 participants with lesser degrees of cognitive disabilities aged 16 months to 86 years. Nilsson video recorded participants, kept field notes and completed interviews with caregivers, making repeated comparative analysis of themes. Comparisons were also carried out between study groups and with the literature. Quantitative analysis was also completed with some of the data.

The process of ‘growing consciousness of joystick use’ emerged as the core category with eight phases defined: phase 1**:** A new activity. Trainee is not aware of possible effects; phase 2: The beginning of understanding of the possible effects; phase 3: Control of basic effect – onset of movement; phase 4: Exploration of effects, direction and speed; phase 5: Experimentation to find a pattern for steering; phase 6: Control of steering, but coarse and unsafe; phase 7: Smooth control of direction and speed. Safe; phase 8: Navigate in different milieus to do other things.

The process was developed into a tool (see author’s website for ordering information on published dissertation: http://www.lisbethnilsson.bd.se/publication.htm) for assessing participant’s phase of consciousness of joystick use. The data were analysed to find out which strategies helped or hindered progress and suggested training strategies have been included with each level. A special training wheelchair that provides a predictable response in all directions, unlike standard powered wheelchairs, was identified as an important strategy, especially for those in the first five or six phases of joystick consciousness [28]. Inter-rater reliability of the tool was analysed between experienced and inexperienced raters and suggests good clinical utility with a weighted kappa of 0.85.

Nilsson used the chi-square test to analyze possible associations between participant and training characteristics and the achievement of steering control [24]. No trainee characteristics were linked to a successful outcome (achieving phase 6 or above), but several characteristics of the training environment were found to be significant.

These included more than 30 training sessions (*p*=0.004), training for longer than two years (*p*= 0.016), training at two or more locations (*p*=0.007) and a greater proportion of training completed with a professional trainer (*p*=0.045). Due to the small sample size and the lack of statistical power, no multi-variate analyses were performed.

Case study example based on Nilsson's tool

Tyler is a 13-year-old boy with spastic diplegia and cortical visual impairment, GMFCS level III, meaning that he is able to walk with assisted mobility devices indoors but has difficulties outdoors and in the community [27]. He has established cause-effect with the joystick and is beginning to understand that he can move the joystick in different directions to achieve a different response. While Tyler shows anticipation of crashing into an obstacle, he does require verbal or manual assistance to free himself. He does not yet deliberately drive towards specific goals.

Nilsson suggests that trainees should be encouraged to change from pushing to pulling the joystick when stuck and to experiment with different directions [24]. Verbal feedback and manual guidance are recommended to encourage the trainee to explore joystick function. Manual guidance should be reduced to the forearm and elbow, and used only as necessary to reduce frustration and allow achievement of desired goals [24]. As Tyler progresses, the trainer should stand back more and allow him to experiment and explore the relationship between joystick function and interaction with the environment.

Critique

The development of theory grounded in real life clinical practice is important both for the progression of the profession and for client-centred practice [29]. It is significant that both Nilsson and Durkin chose to use grounded theory, an appropriate approach to both research questions, as there is little known about powered mobility learning and it is unclear why some individuals develop this skill while others are unsuccessful. Identification of a core category is essential and both studies used them as a basis to generate theory.

In Durkin's study [22], the 'responsive partner' was the theory that emerged. The role of the adult is not to train the child, but to set up a suitable environment and respond to the child in a manner that elicits new learning while the child plays in the powered mobility device. In Nilsson's study [24], the core category of the 'process of growing consciousness of joystick use' was elevated to a higher theoretical level as the 'theory of de-plateauing'. Nilsson defines this as 'to elevate above expected plateaus or predetermined ceilings for development'. The theories that emerged relate strongly to the impact of the social and attitudinal environment surrounding the learners and the impact that others' expectations and mind-set can have on learning. Each author stresses the process of reciprocal learning between the trainer and the learner.

The overall rigour or **trustworthiness** of a qualitative research study can be established by considering credibility, transferability, dependability and confirmability [30]. In Durkin's study [22], evidence of credibility is provided by triangulation among sources and methods as well as member checking where possible. Data collection took place over a long period of time with a wide range of participants and there is evidence of a reflective approach to the study. The participants, setting, methods and analyses are described in detail and a clear audit trail is provided suggesting that the research is both dependable and transferable. The author used a journal, involved others in sections of her research and checked concepts with the literature thereby increasing confirmability.

In Nilsson's study [24], evidence of credibility is also provided by the study taking place over a very long period of time with a wide range of participants and triangulation among sources and methods. The study is strengthened by the combination of qualitative and quantitative analysis and by the use of a team of researchers. More evidence of the audit trail would have enhanced the dependability of this study.

Lincoln and Guba suggest additional **authenticity** criteria [31]. Fairness includes member checking, use of informed consent and empowering of stakeholders. Both Durkin [22] and Nilsson [24] incorporated fairness into their studies as much as possible, given the difficulties of informed consent when working with young children or individuals with profound disabilities. Ontological authentication includes the raising of consciousness in participants from their own experience and perspective. In Durkin's study [22], this concept was demonstrated through the use of focus groups with peer professionals and children with multiple and complex disabilities. Educative authentication implies that stakeholders come to appreciate the experiences of others. In Nilsson's study [24], caregivers and workers demonstrated increased awareness of their own impact on the learning of the participants. Catalytic authentication implies that the development of theory must facilitate and stimulate action. Durkin [22] has begun to disseminate her findings within the UK and is attempting to stimulate a move from the medical model that has inhibited the use of powered mobility with children with complex needs to a social disability model. Tactical authenticity, or empowering participants, can be clearly seen in Durkin's child-led study [22]. Likewise, Nilsson's study involved a population often overlooked due to their apparently poor prognosis for learning new skills and demonstrated that unexpected levels of tool use can be achieved [24].

The theories that have emerged in both studies relate to the process of developing powered mobility skills. Kuhn, as cited in Siegert et al. [32], recommends that four factors should be considered when critiquing a theory. Accuracy is suggested from the data and external consistency with relevant literature. Internal consistency is demonstrated by the 'fit' of the different aspects of the findings with each other and the way they mesh together. The scope of each study differed. One included children and attempts to explore the whole process of learning powered mobility skills [22]. The other involved a wider age range but studied only joystick use [24]. Durkin details her categories and themes very clearly, but it is more complex to follow how all aspects fit together to reach the core category. Nilsson's eight-phase process of growing consciousness is a simpler progression to understand. Both studies have potential to stimulate debate and further research and could therefore be considered fruitful.

Models for practice are used to organize and categorize ideas, helping to structure thinking about complex problems. They should focus on specialized areas of practice in order to explain clinical phenomena and suggest appropriate intervention [33]. Clinical utility is very important [34] and enhanced by use of illustrative case histories and treatment plans to accompany the model [35]. A good model should explain and, if possible, predict future individual performance, be easily understandable and internally consistent, offer practical guidance to non-professionals as well as to professionals, and stimulate further study [36].

Durkin's constructional framework is an iconic model demonstrating in visual form her findings about the process of learning powered mobility skills [22]. It is somewhat complex to understand, particularly for non-professionals. Reynell's attention levels were developed around language skills [25]; the chronological ages indicated for each level do not correspond with age levels for achieving directional control described by other researchers, raising questions about the model's internal consistency. The embryonic assessment tool linked to the model has a holistic approach to assessment, including issues of judgement, emotional development and lifestyle skills. The case histories provided in the thesis enhance clinical utility but the tool requires further development for use in practice.

Nilsson's eight-phase process is a simple chart demonstrating progress from lower to higher phases of growing consciousness [24]. As well as being a descriptive model of joystick skill development, it has proved to be a clinically useful assessment tool with acceptable inter-rater reliability. The tool is relatively simple for non-professionals to understand and appears to have internal consistency. Clinical utility is enhanced by the provision of clear observable phases along with descriptors of treatment or intervention strategies.

Discussion

Trustworthiness appears adequate in both studies and they have a number of similarities: 1) the models and assessment tools focus on a continuum of learning rather than pass/fail skills tests; 2) the emphasis is on early phases of powered mobility learning which have been overlooked or minimally addressed in other assessment tools; 3) the reciprocal relationship between the trainer and participant is emphasized as well as the impact of the social and attitudinal environment; and 4) the participants and settings have similar characteristics. Despite the wide age range of subjects in Nilsson's study [24], the median age was 11 years and many participants would have the diagnosis of cerebral palsy or similar developmental disabilities.

One discrepancy between the two is that while Nilsson describes the 17 typically developing infants steering between 7 and 8 months of age [24], Durkin describes the two infants in her study as not showing any understanding of direction and reports directional control as emerging in the 18-24 month category [22]. An explanation of this discrepancy may be that Durkin provided the babies and toddlers with single switches and only introduced a joystick once the children could operate four directional switches, arguably a more perceptually-and-cognitively-complex task. Durkin felt that it was important to establish that the child understood how to press, hold and release the switch to control movement rather than use a joystick where the control might be more serendipitous (personal communication, 29th January 2008). There may also be differences between the authors as to the meaning of steering control as agreement or clarification of this term has not been reached in the literature.

The assessment tool emerging from Nilsson's study [24] contains more detail on the early stages of powered mobility learning. Durkin's tool [22], while covering the early stages, has more detail on higher skill levels. This is likely due to the focus on individuals functioning at early developmental levels in one study and the inclusion of children functioning at higher developmental levels in the other.

Another difference between the two studies is in the type of approach. Durkin emphasizes the importance of providing opportunities for play while learning powered mobility skills [22]. Children do not need an adult to train them but set up a suitable environment and relate to them in a way that elicits learning. Nilsson [24], on the other hand, describes her approach as training, the adults/staff as trainers, and the participants as trainees. However, with minor differences, the descriptions of how the trainer works with the trainee are very similar. Each emphasizes allowing sufficient time for processing and problem solving, and following the subject's lead.

Previous studies [4,10] have suggested that length and duration of practise is linked to successful outcomes in powered mobility training and may, in fact, be more important than differences in abilities. Nilsson's findings [22] confirm this as no individual characteristics were found to impact on successful outcomes, but longer periods of training were highly significant.

Motor learning principles suggest greater learning from self-directed exploration and problem solving. While children should be encouraged to explore, they should not be told where or how to move [5]. Children will learn to stop from experience rather than from adult direction and adults should control the environment while the child is in control of movement [37]. This principle of setting up the environment to encourage exploration and independent learning is emphasized in both studies as well as in the literature [38,39].

Nilsson's findings that training in more than one environment was associated with more successful outcomes [24] also fits with motor learning principles which reinforce the importance of altering type of practise and environment [40]. Gentile suggested that younger children benefit more from blocked practise whereas older children benefit more from random practise [41]. An intense initial training program in a structured and controlled environment may be optimal for young children to help them gain initial skills. This should be followed by random experience, found in natural environments, to allow generalization and skill retention [5].

Durkin's model suggests beginning with switches and then progressing to a joystick [22]. Kangas has argued that a joystick is too unpredictable at the beginning stages of learning [37]. However, Nilsson suggests that transitioning from switches to joystick may be difficult [24]. This is backed up by motor learning principles which reinforce the importance of practising the end task rather than pre-requisite tasks or components [42], especially for children with cognitive limitations [43].

As per Wright-Ott [38], Nilsson recommends use of hand over hand modelling in the early stages of learning powered mobility skills [24]. The technique of providing physical prompts and gradual prompt withdrawal has been described as a successful method of teaching young children to use other assistive technologies [44]. However, motor learning principles suggest that while guidance may be helpful in early stages, it will not facilitate learning if it is overused or limits exploration [42].

Wright-Ott has suggested that it is not necessary to train children and that an adult directive approach can actually suppress learning in young children [38]. Nilsson, however, found that subjects training with a professional trainer were more likely to be successful, possibly because they were more persistent despite slow progress, allowing participants' time for processing and learning [24]. Durkin's [22] and Nilsson's [24] emphasis on the need to wait for responses from children before intervening, unless the child is frustrated or in danger, is reinforced in the powered mobility literature [5,37-39].

Paediatric powered mobility training suggestions [20,21,37-39] recommend using short and simple verbal instructions such as 'let's go', 'you're turning', 'you're stopping', 'where's mom?' etc. rather than directional instructions. Durkin [22] states that children at the beginning stages of learning powered mobility skills cannot benefit from adult verbal direction until they are able to shift attention. Nilsson [24] on the other hand uses simple verbal descriptions right from the beginning to provide feedback on what the participant is doing and what is happening.

It has been suggested that communication with young children should always be positive; rather than saying 'you crashed', adults should say 'you found the wall' [38]. However, use of a low soft voice and intonation may be more important than the actual words used (Nilsson, personal communication, March 9th 2008). The findings of Nilsson's [24] and Durkin's [22] studies confirm that crashing or bumping into obstacles is a necessary stage of learning powered mobility skills.

Until now, much of the limited research on use of powered mobility with young children has focused on identifying prerequisite skills [2,45,46]. Nilsson's findings suggest that powered mobility learning begins at the pre-awareness phase [24]. Likewise, Durkin suggests that 'learning the concept of movement' is part of the continuum of learning [22]. What were previously identified as prerequisite skills may, in fact, be developmental skills achieved as a result of independent mobility experience [12]. The only prerequisite may be the desire for mobility [47].

Recommendations for research

Nilsson's eight-phase tool [24] is better able to capture and differentiate beginning skill levels in comparison to the other assessments [19-21] and may therefore be more useful in research involving children at early stages of mobility skill development. As an evaluative measure, examination of additional psychometric properties such as intra-rater reliability, longitudinal validity (ability to detect change over time), responsiveness (ability to detect clinically important change) and increased interpretability would be helpful if it were to be used in a research setting.

Durkin's tool is currently in the embryonic stages and needs to be further developed [22]. However, it provides some clarification of terminology that may be useful in the research setting by providing a common language when describing children's abilities in terms of powered mobility skill development. The terms competent, proficient, functional, or good-enough have been used by various authors [2,5,6,10] with differing meanings making it difficult to compare research findings and results.

Recommendations for clinical practice

As Kangas [47] suggested, therapists need to give up their ideas of how they introduce powered mobility to adults and realize that young children may be learning to move for the first time. In contrast to previously available powered mobility assessment tools for children [19-21], the tools developed by Durkin [22] and Nilsson [24] are based on a developmental progression of mobility skills and provide guidance for working with complex children at the beginning stages of learning to move independently.

Durkin's assessment tool has the advantage of a holistic approach with the incorporation of judgement, attention and emotional development [22]. While providing useful information about level of attention and beginning skills on the continuum, it has less differentiation of abilities in the early stages of skill development. It therefore appears most useful for children who have achieved the advanced beginner level, but are having difficulties progressing through to the higher levels of skill development.

Nilsson's process [24] is further developed at this point in time, offering many practical suggestions for training linked to each phase, making it easy to incorporate into practice. This tool was written specifically for joystick use so some modification is required for use by children using other access methods. It appears most useful for individuals with severe and complex disabilities who are likely to remain in the early stages of powered mobility skill development for some time and whose progress into the upper phases of skill is likely to be slow.

The 'responsive partner' theme that emerged in Durkin's study [22] has already been successfully used in the field of speech and language therapy with children [48]. The theory of 'de-plateauing' that emerged in Nilsson's study [24] can be seen to have relevance for a wide range of audiences and clinical groups where others' lack of expectations can limit client's progress and opportunities.

Conclusion

Powered mobility training for young children should be less directive and more playful and encouraging, similar to the way adults encourage infants learning to crawl or walk. Nilsson's [22] and Durkin's [24] work inspires clinicians to explore early mobility options for those at the beginning of the continuum of learning, reflect on how they relate to and impact on their clients' learning, and set up the environment appropriately to facilitate independent learning and exploration. Further research is required to incorporate the tools developed by Nilsson and Durkin into clinical practice and to establish psychometric properties. Exploration of the frequency, duration and location of practice and training opportunities for children learning powered mobility skills would also be beneficial.

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Figure 1 Durkin's constructional framework (copyright International Journal of Therapy and Rehabilitation)

Appendix

Component Skills	Novice	Advanced Beginner	Competent	Proficient	Expert
Has attained attention level 1	☻				
Has attained attention level 2	☻				
Has attained attention level 3		☻			
Has attained attention level 4			☻		
Has attained attention level 5				☻	
Has attained attention level 6					☻
Understands the concept of movement	☻				
Exhibits a desire to begin to explore beyond the world of their tray		☻			
Rational wheelchair driver has own goal in mind			☻		
Concentrating on getting from A to B often ignores the environment and people around them			☻		
Perceives the task of powered mobility as a whole				☻	
Demonstrates fluid performance					☻
Able to press a single switch, hold and release	☻				
Understands 2 switches have different functions	☻				
Chooses to operate forward switch		☻			
Chooses to operate reverse switch		☻			
Motivated to learn how the machine operates		☻			
Understands the use of electronic mobility guidance systems		☻			

Refining manoeuvring skills				☻	
Consistent precision control of powered w/ch					☻
Consciously deliberates a situation and performs their own judgement of how to resolve the situation			☻		
Makes judgements based on prior concrete experiences				☻	
Takes care of themselves within the powered w/ch				☻	
Intuitively organises and understands the task they are encountering				☻	
Takes care of others while driving powered w/ch				☻	
Knows what to do based on mature and practiced understanding					☻
Able to fully use the powered wheelchair as part of their everyday lifestyle skills					☻
Adapts to many and varying environments					☻
Highest Skill Achieved					
Overall Skill = Lowest Achieved					