The Effect of a Non-Powered, Self-Initiated Mobility Program on the Engagement of Young Children with Severe Mobility Limitations in the South African Context

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Abstract

Aim: To determine the effect of a non-powered, self-initiated mobility programme on the engagement of young children with severe mobility limitations, in the South African context.

Methods: A multiple-probe-across-participant design was used. Four children (aged 2-6 years) with severe mobility limitations underwent an intervention that targeted non-powered, self-initiated mobility. The intervention comprised eight sessions over a two-week period. Engagement was measured during each baseline, intervention and post-intervention session using the Individual Child Engagement Record – Revised (ICER–R). The data was presented graphically and analysed using statistical procedures appropriate for single-subject designs.

Results: Participants demonstrated an improvement in engagement during the time in which non-powered, self-initiated mobility programme was introduced. A reciprocal deterioration in non-engagement was also demonstrated. The results of the study are discussed in terms of various intrinsic and extrinsic factors.

Conclusions: The use of a non-powered, self-initiated mobility programme may be effective in improving engagement in some young children with severe mobility limitations.

KEYWORDS**:** engagement, non-powered mobility, severe mobility limitations, single-subject designs, multiple-probe design.

Background information

Children's development requires their active involvement in experiences and interactions (McWilliam and Bailey, 1995; Shonkoff and Phillips, 2000). This is termed engagement, and is defined as the time children spend interacting in a developmentally and contextually appropriate manner with the environment(Kishida and Kemp, 2006; McWilliam and Bailey, 1995). Engagement of children is typically measured in terms of the amount of time involved in activities. Such involvement can be active, e.g. manipulating an object, speaking; or passive, e.g. observing a story being read. If a child is not engaged in an activity in some form they are considered to be non-engaged. As with engagement this can take the form of passive non-engagement such as sleeping, or active non-engagement such as running around when this is not appropriate to the situation (LeLaurin, 1985; Iacono et al., 1998; de Kruif and McWilliam, 1999; Kishida and Kemp, 2009; Kemp et al., 2013).

For typically developing children, engagement increases (in time and level) with age and access to appropriate experiences (McWilliam and Bailey, 1990). Greater time and active engagement on a task, increases success, which in turn increases motivation, engagement and persistence on the next task (Linnenbrink and Pintrich, 2003; Malone et al., 1999; Yarrow et al., 1982), furthermore greater time in tasks, leads to more opportunities for development in other areas such as cognition, language, social and motor skills (McWilliam and Bailey, 1995; de Kruif and McWilliam, 1999; Almqvist, 2006; Carini et al., 2006; McWilliam et al., 2010).

Children with disabilities however, have shown, engagement which occurs for shorter periods of time and at lower levels than their typically developing peers. According to McWilliam and Bailey (1990, 1995), children within inclusive preschool settings with mild to

moderate developmental delays spend a greater proportion of their time in passive engagement, and less time in active engagement with adults than do their peers.

A possible reason for the decreases in engagement for children with severe mobility limitations may be the challenge they face in accessing experiences. Limitations in mobility render them dependent on others for all tasks, including the provision of activities(Arthur-Kelly et al., 2007). In addition, for children with severe mobility limitations, learned helplessness is a commonly reported challenge (Basil, 1992; Mikulincer, 1994). Learned helplessness refers to a decrease in motivation and persistence when a lack of motor control leads to inconsistent results (Abramson et al., 1978). Children with severe mobility limitations are therefore at risk of not only having limited access to experiences, but also being unmotivated when taking part in these activities.

Due to the challenges that children with severe mobility limitations experience with access to experiences, powered mobility has been suggested as a means of supporting their access and thus facilitating their engagement in experiences. This premise has been supported in studies which have shown that the use of powered mobility for children with severe mobility limitations has been shown to have positive developmental results (Wiart, 2011) in terms of receptive language, functional mobility, self-care and caregiver assistance (Jones et al., 2012); self-initiated mobility, interaction with objects and communication (Butler, 1986); mobility and independence (Bottos et al., 2001) and social interaction (Deitz et al., 2002). Such development is dependent on the ability to engage in each area in order for progress to occur (de Kruif and McWilliam, 1999; Almqvist, 2006; Adamson et al., 2008). However, since powered mobility is beyond the reach of the majority of children with disabilities in South Africa – due to these costing more than the entire annual income of the average worker (Statistics South Africa, 2012) – this study considered the possibility of a non-powered, self-

initiated mobility option which was implemented in a training programme . We aimed to determine the effect of the non-powered, self-initiated mobility programme on the engagement of young children with severe mobility limitations, in the South African context.

Method

Design

A multiple probe design across participants was used for this study (Gast and Ledford, 2010; Horner and Baer, 1978) . In such a design, the independent variable is applied to multiple participants in a sequential manner. In single-subject experimental designs such as the multiple probe design across participants, each participant serves as its own control. This is achieved through establishing a baseline prior to the implementation of intervention. Results obtained during and following intervention are compared to the baseline of each participant, rather than to a separate control group (Gast and Ledford, 2010). The effectiveness of the independent variable is evaluated based on changes in the dependent variable across multiple participants (Baer, Wolf, & Risley, 1968; Gast & Ledford, 2010; Horner & Baer, 1978). The independent variable, for this study was the non-powered, self-initiated mobility programme and the dependent variable was engagement, measured using the Individual Child Engagement Record – Revised (ICER–R) (Kishida and Kemp, 2009).

Participants

The selection criteria for participants were determined by the need to identify young children with severe mobility limitations i.e. no independent mobility: who would be able to participate in the non-powered, self-initiated mobility programme. Due to the programme being presented in isiZulu, a home language of isiZulu was required as were the peripheral sensory abilities of hearing and vision as the programme relied on the provision of verbal input and visual cueing. Based on these needs the following selection criteria were followed: children who (i) were between the ages of 2 years and 6 years 11 months: young children are generally classified as those eligible for early intervention. Early intervention focuses on the provision of services to children who are not yet eligible to begin schooling. In South Africa children are required to attend school from the age of 7 years hence this was used as the

upper age limit. Furthermore the mobility device used positioned the children in a prone position which becomes inappropriate as children grow older. (ii) had severe mobility limitations as shown by a Gross Motor Functioning Classification Scale level of V, as determined using the family report questionnaire (Dietrich et al., 2007) (translated into isiZulu for this study); (iii) had isiZulu as their home language, and (iv) had no diagnosed peripheral visual or hearing impairment.

Ethical approval for the study was obtained from the ethics committee at the University. Participants for the study were recruited from non-governmental organisations who serve children with disabilities in the Ethekwini area of KwaZulu-Natal. A number of organisations were approached, but only one was both willing and able to participate. The centre was a rehabilitation centre for young children with neurological impairments based in a semi-rural location.

Children identified as possible participants by the director of the centre, a physiotherapist, and their parents were invited to an information morning. Five parents attended the information morning. Of the five parents, four had children who met the selection criteria and they gave their consent for participation in the study. The fifth child was excluded as she was already moving independently at the session, without assistance.

Independent variable

The non-powered, self-initiated mobility programme, or the independent variable, was developed specifically for this study in order to teach the children the motor skills required to make use of an adapted scooter board (see Figure 1) as a mobility device. The programme was based on the principles of motor control theory in which both implicit and explicit learning contribute to motor skill learning (Horn, 1997; Steenbergen et al., 2010; Willingham, 1998). The programme followed the motor control processes outlined by Willingham (1998):

i) goal selection (identification of the required change in the environment, e.g. crash down the skittles); ii) goal identification (identification of the object(s) that will be changed e.g. skittles); iii) target selection (selection of the body part to perform the action, e.g. foot); iv) target sequencing and muscle activation (movement production); and v) repetition.

The motor skills taught using motor control processes in the non-powered, self-initiated mobility program consisted of i) the initiation of movement, and ii) the continuation of movement. Each component was taught for 4 sessions (total 8 sessions of 30 minutes each). The implementation of the motor control processes was facilitated through the use of a least to most prompt hierarchy (Mcdonnell and Ferguson, 1989) which structured the amount of input and type of input provided. Verbal input and backward chaining (Horn, 1997) were used as prompts. Backward chaining involves the analysis of a movement into its individual components, the movement is then taught beginning with the last component, as the last component is achieved so earlier components are added to it. The prompt hierarchy was implemented within each of the motor control processes. It began with goal selection and identification with the least amount of input provided, in this case a verbal prompt (e.g. "we're going to get the car"). If no response to this was evident, then target selection was continued also with a verbal prompt: "use your hand to push". A lack of response to the verbal input was followed by light tactile input to the target body part, for instance a tap to the hand. If no response was forthcoming, then the verbal and tactile inputs were combined. If the child was still unable to respond to the input provided, then target sequencing was begun. In target sequencing, a verbal prompt was used in conjunction with body part placement, for example, "push with your hand" while the hand was placed in the correct positioning for pushing. If no response was obtained, the verbal command was repeated and facilitation of the movement was provided using backward chaining. Every verbal and

physical prompt was strictly scripted for this study. The prompt hierarchy is represented in Table 1.

Motor skill process	Strategy	Prompt level	Action	Example
Goal identification	Verbal input	Least	Verbal input	"Push it, it will play a song"
Target identification	Verbal input		Verbal input	"Push on your hands"
	Chaining		Light touch	A gentle tap to the toes
	Verbal input and chaining		Light touch and verbal	(A gentle tap to the toes) "Here"; "Push off your toes"
Target sequencing	Verbal input and chaining		Verbal input and body part placement	The foot is placed vertically and with the ankle at 90 degrees so that the toes are touching the ground. "Push on your toes"
	Verbal input and chaining		Verbal input with chaining (backward)	The foot is facilitated through the movement until the final component, which the child is encouraged to produce independently.
Repetition	Verbal input	Most	Verbal input	"Let's do it again."

Mobility Device

The mobility device used for this study was an adapted scooter board. The adaptations included a wedge to raise the chest and straps for safety. The adapted scooter board is illustrated in Figure 1. The children were positioned on the mobility device throughout all phases of the study.

Figure 1: Image of an adapted scooter board

Toys

Six toys were selected for use in the general play procedures of the study. These were cause-effect-type toys and were selected due to their high reward in play. The toys selected included a soccer ball, a music ball that played a tune when pushed, cars, trains, a bubble machine and skittles (bowling).

Translated materials

Materials used in this study were translated into isiZulu using a four step process. The following materials were translated for this study: The consent forms used to obtain parental consent to participate in the study. The GMFCS Family report questionnaire (Dietrich et al., 2007). The script for general play procedures (Appendix A). The script for the non powerered, self-initated mobility programme Appendix B).

The translation process began with a forward translation of the materials from English to isiZulu by Translator 1.Translator 1's first language was isiZulu. A blind back translation was then conducted by Translator 2 whose first language was also isiZulu. The translations were compared for difference which were discussed with an isiZulu speaking therapist who provided further input. She also commented on the cultural validity of the translations and agreement was reached on the best form to be used (Hambleton and Kanjee, 1993).

Dependent variable/ Probe

The Individual Child Engagement Record – Revised (ICER–R) (Kishida and Kemp, 2009) was used as the probe test for engagement. It was developed by Kishida and Kemp (2009) to measure engagement in children with severe impairments and was found to be a valid and reliable measure of engagement by the authors. Both the intra-observer reliability

and concurrent validity of the ICER-R (Kishida and Kemp, 2009) have been positively correlated with the E-Qual-III (McWilliam, 1995), an established and validated measure of engagement. The correlation of the two measures provided evidence of acceptable inter-observer agreement when scoring engagement using the E-Qual-III, at 86.2% (range 77.5-94.9) and a mean kappa co-efficient of .75 (range .65-.86). Inter-observer agreement for the ICER-R was acceptable for engagement and non-engagement (91.4%, kappa co-efficient .73). It was noted though that low levels of agreement for engagement types seen infrequently were noted. Mean discrepancy scores between raters produced a kappa co-efficient of .44 (range 0-1.5). Overall a large positive statistically significant relationship for Total Engaged behaviours as measured using the E-Qual-III and the ICER-R was identified, using a Pearson product-moment correlation ($r=.976$; $p<.001$) (Kishida et al., 2008).

Probes using the ICER_R were conducted after each session using recorded data. Each probe began five minutes after the start of the session, which was determined as the point at which the participant was first offered a choice of toys to play with 15 minutes of the session was then probed. In order to facilitate probing audio tones were digitally added to the video recording every 15 seconds using digital editing. Each time a tone was heard engagement was probed according to the guidelines provided by Kishida and Kemp (2009). This required the scorer to determine if the child was engaged at that exact time. The probe test was conducted in the same manner across all phases of the study. On the conclusion of scoring, the number of occurrences of engagement or non-engagement were summed to provide an engagement/non-engagement score (Kishida & Kemp, 2008).

Procedures

The study commenced with a baseline phase for all children. The non-powered mobility programme was then implemented with the first participant, while the remaining children

remained in baseline phase. After 1 week the non-powered, self-initiated mobility programme was started with the next participant and the second motor skill component started with participant 1. On completion of the second intervention week, the non-powered, self-initiated mobility programme was withheld from participant 1. This same process was repeated for the remaining children. Probes were conducted during each session with all children.

All procedures for this study were implemented at the rehabilitation centre, where the children received their regular intervention outside of the study. All procedures were implemented by the first author.

Baseline phase

The baseline phase comprised a minimum of three and a maximum of six sessions involving general play procedures which followed a set script (see appendix A). Throughout the baseline phase, toys were kept within reach of the child. The exact number of baseline sessions for each child was determined by the number of sessions required in order for a stable baseline to be obtained. A stable baseline was defined as one in which no change of greater than 10% of possible engagement was observed across three sessions. Thereafter they were seen weekly in order to continue to monitor baseline levels.

Intervention phase

The -non-powered, self-initiated mobility programme was implemented after the baseline phase. The programme was implemented over two weeks with 4 sessions per week. Each session was 30 minutes in duration. General play procedures were continued as in the baseline phase, but toys which rolled out of reach of the children provided the goals for the non-powered, self-initiated mobility programme.

Post-intervention phase

During the post-intervention phase the children were seen weekly. General play procedures were continued as in the baseline and intervention phases (Appendix A). When a toy rolled out of reach of a participant, no prompting of movement was provided, but if the child unsuccessfully attempted a movement, this was completed for them by the researcher using full facilitation.

Treatment integrity

Treatment integrity was determined for general play and prompting procedures, through the use of checklists for each area (Appendices A & B). The scoring of the checklists required that the researcher had used the correct input in the correct sequence in order to be scored as correct. To do so, the researcher watched the video recordings of all the sessions and ensured that the correct procedures were implemented consistently by calculating the percentage of correctly applied procedures in each session. Thereafter, an independent rater observed 30% of the baseline and 25% of the intervention for procedural reliability of both the general play and prompting procedures (all sessions scored by the independent raters were blind to previous scores). Inter-rater reliability for these sessions was calculated as 93% and 97% respectively.

Intra-rater reliability of the actual data collected was assessed through re-scoring of sessions by the researcher, using the ICER-R (Kishida & Kemp, 2009), one month after the completion of the experimental phase of the study. Inter-rater reliability was also determined by comparing the scores obtained on the ICER-R (Kishida and Kemp, 2009) by the researcher and two independent raters. Both intra-rater (0.096 using the Wilcoxon One-sample Test) and inter-rater reliability (0.1968 using the Kruskal-Wallis test) showed no

significant difference between the data ratings of the researcher and the inter-raters, providing evidence of reliability.

Data Analysis

The effect of the non-powered, self-initiated mobility programme was evaluated based on changes on the ICER–R (Kishida and Kemp, 2009) across phases per participant. Repeated across multiple participants. In order to determine the evidence of change between phases, the data obtained from the ICER–R (Kishida and Kemp, 2009) was presented graphically and analysed in terms of level, trend and variability, it was then compared to the stable baseline. A stable baseline was one in which the data fell within 10% of the trend. Typically where scores are percentages, a stability envelope of 20% of the trend is applied. As recommended by Gast and Spriggs (2010) where the scores obtained are not percentages the researcher should determine an appropriate stability envelope to apply. In order to provide consistency across participants the stability envelope selected was one related to the possible data achieved. Based on this a stability envelope of 6 points or 10% of the possible data was selected. The level of a phase was determined by the median and included a measure of immediacy (difference between the average of the medians of the first three sessions of the intervention phase and the last three sessions in the baseline phase) (Horner et al., 2012). A change in level, which was a change in the median from one phase to the next of greater than 10% of the total possible score (60) was selected, and a change determined to be immediate was also determined as a change of greater than 10% of the total possible score (60). The trend was determined through the use of relative change (RC) (the difference between scores in the second half of the data and those in the first half of the data within a phase) (Horner et al., 2012). A change in trend was a change in RC of greater than 6 points between phases (10% of the total possible score). Variability was the amount of change present within a

phase. A change in variability was a change of greater than 25% in the amount of variability between phases (Gast and Spriggs, 2010).

The analysis of the data concluded with a statistical analysis of the data. This was conducted using the Non-overlap of All Pairs procedure, NAP (Parker and Vannest, 2009). The NAP procedure is one in which all data points in a phase are compared to all data points in the next phase for overlap. It is designed specifically for use in single subject research designs, or designs with low numbers of data points within each phase. The NAP is preferred to statistical measures such as the PAND, PEM and PND as well as R^2, and has shown positive correlations with visual graphic analysis (Parker and Vannest, 2009). Confidence intervals were set at 85%, due to the small number of data points used during the NAP procedure.

Results

Participant description

Four children participated in the study. Three of them were boys and one was a girl. They ranged in age from 2 years 10 months old to 6 years 9 months old. Table 2 provides a description of the participants.

Table 2 illustrates that three of the children had cerebral palsy, while the fourth had an acquired impairment (TB meningitis) which resulted in cerebral palsy. All the children attended the rehabilitation centre on a monthly basis for gross and fine motor, cognitive and communication input provided in a group setting.

Table 2: Participant descriptions

Participant No.	1	2	3	4
Age at baseline	3 years 1 month	2 years 10 months	5 years 4 months	6 years 9 months
Gender	Male	Male	Female	Male
Home language	isiZulu	isiZulu	isiZulu	isiZulu
Diagnosis	Cerebral palsy, spastic quadriplegia	Cerebral palsy: spastic quadriplegia and Laryngomalacia (resolved)	Spastic quadriplegia and epilepsy resulting from TB meningitis.	Cerebral palsy, spastic quadriplegia
Current medical intervention	None	None	Currently on anti-epileptics daily	None
GMFCS level (Palisano et al., 1997):	V	V	V	V
MACS level (Eliasson et al., 2006) (Cooley Hidecker et al., 2011)	IV	IV	V	V
CFCS Score (Cooley Hidecker et al., 2011)	IV	IV	V	V
Sensory impairment	None reported	None reported	None reported.	None reported
Age at referral to the rehabilitation centre	1 year	Birth	Age 4	3 years – attended regularly for one year only
Additional therapy	None	None	Physiotherapy and occupational therapy every 8 weeks at a government hospital, focused on the maintenance of range of movement in her joints.	None
Previous mobility device use	None, carried by caregiver	None, carried by caregiver	None, carried by caregiver	None, carried by caregiver
Primary caregiver	Mother	Mother	Mother	Grandmother
Physical abilities	Able to maintain head up when in upright and prone position. Actively moves limbs but generally makes use of a gross extension pattern.	Able to maintain head up when in upright and prone position. Actively moves limbs, but movements are gross and unrefined.	Able to maintain head up when upright. Lifts head momentarily when in prone position. Generally passive with limited initiation of limb movement.	Able to maintain head up when upright. Lifts head momentarily when in prone position. Generally passive with limited limb movement.
Description of play	Enjoys looking at and touching toys.	Loves cars and kicking balls.	Enjoys spending time with people and watching TV.	Looks at toys with which he would like to play. Enjoys social interaction.

Figure 2 provides a graphic representation of the data obtained on the probes. It illustrates that for all children, increases in engagement and decreases in non-engagement were present during the intervention phase.

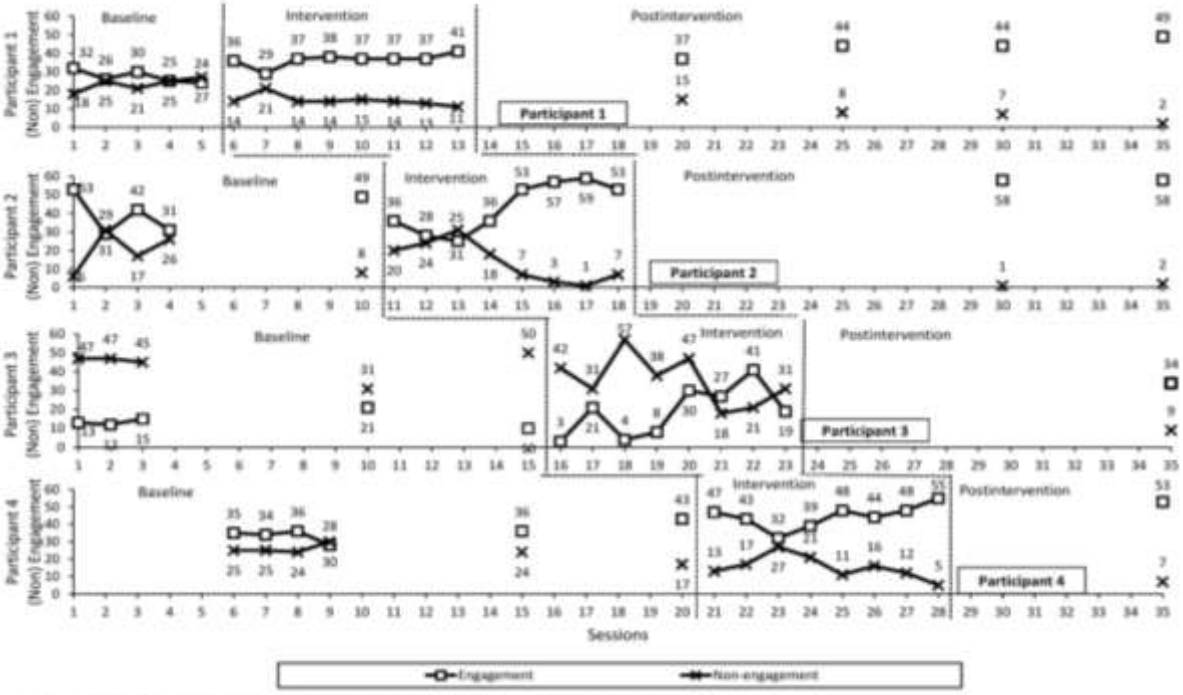

Figure 2: Engagement and non-engagement of participants 1-4 across the study

Child 1 maintained a stable baseline for engagement. During the intervention phase he showed a slight decrease during session 7, but this was followed by increase for the remainder of the phase. For non-engagement, child 1 had a stable baseline. He showed a small increase in non-engagement in session 7, but this then decreased for the remainder of the phase.

Child 2 had a variable baseline, no stability was achieved (80% variability). Child 2 began the intervention phase with a decrease in engagement to session 13. However following this a steady increase was seen for the remainder of the phase. For non-engagement child 2 also had no stable baseline. He showed an increase in non-engagement to session 13, whereafter this decreased for the remainder of the phase.

Child 3 maintained a stable baseline for engagement. Her results in the intervention phase were variable, but followed a generally increasing trend. For non-engagement she had a variable baseline. During the intervention phase, although her results were variable a decreasing trajectory is evident for non-engagement.

Child 4 showed a stable baseline for engagement. During the intervention phase a decrease in engagement is evident to session 23, following which an increasing trend is evident for the remainder of the phase. For non-engagement an increase is evident to session 23, followed by a decrease for the remainder of the phase.

Table 3: Summary of Engagement and Non-engagement Data Across Participants 1-4

	Participant 1		Participant 2		Participant 3		Participant 4	
	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention
Engagement								
Level	26	37[a]	42	44.5	13	20[a]	35.5	45.5[a]
Trend	-4.5	1	-1	23[b]	3	14[b]	0.6	7[b]
Variability (%)	20	12.5	80	25	20	50	16.7	25
Immediacy	7.7[a]		-11[a]		-6[a]		5	
NAP	0.971***		0.559*		0.636*		0.865**	
CI at 85%	0.812, 0.996		0.298, 0.743		0.391, 0.797		0.595, 0.969	
Active (%)	43	66[a]	51	72[a]	18	18	32	34
Passive (%)	57	34[a]	49	28[a]	82	82	68	64
Non-Engagement								
Level	25	14[a]	17	12.5	47	34.5[a]	24.5	14.5[a]
Trend	4.5	-2.5[b]	-1.5	-18.75[b]	-6.5	-15.75[b]	-0.93	-8.5[b]
Variability (%)	20	16.7	80	37.5	40	62.5	16.7	25
Immediacy	-7.96[a]		8[a]		-6.5[a]		-5	
NAP	0.970***		0.595*		0.712**		0.871**	
CI at 85%	0.677, 0.998		0.321, 0.777		0.534, 0.828		0.709, 0.946	
Active (%)	41	15[a]	77	80	22	34[a]	22	11[a]
Passive (%)	59	85[a]	23	20	78	66[a]	78	89[a]

[a]*Change of >10% of the possible total from the baseline phase*
[b]*Change of >10% of the total possible score from the baseline phase*
**NAP effect 0-0.65 weak* (Parker and Vannest, 2009)
***NAP effect 0.66-0.92 medium* (Parker and Vannest, 2009)
****NAP effect 0.93-1.00 large* (Parker and Vannest, 2009)

Within a multiple probe design across participants, a change in level, trend or variability as a result of the independent variable must be replicated across at least three

participants to indicate an effect (Horner et al., 2012). Table 3 provides a summary of the results across children. The results of child 2 are included in the table, but not in the evaluation for effect as no stable baseline was established for engagement.

Table 3 illustrates that three of the children (1, 3, 4) showed an effect of improvement in the median level of engagement, from the baseline to the intervention phase. A reciprocal deterioration in non-engagement was also recorded for these children. The changes in level were immediate for two of the children (1 & 3). All four children showed an effect of change in trend from the baseline to the intervention phase. In respect of engagement, one child changed from a negative to a flat trend (1), and three from flat to positive trends (2, 3, 4). In non-engagement, changes in trend were also seen with one child changing from a positive to a flat trend (1), two from flat to negative trends (2, 4) and one from a negative to an even more negative trend (3).

The statistical analysis of the results confirmed a strong effect on engagement and non-engagement for Child 1 and a moderate effect on both engagement and non-engagement for Child 4. A moderate effect on non-engagement was evident for Child 3. Child 1 and Child 2 were seen to have an improvement in the percentage of active engagement used between phases, while this remained stable for Child 3 and Child 4. In respect of non-engagement, Child 1 and Child 4 had deterioration in the percentage of active non-engagement, while for Child 3 the percentage of active non-engagement increased. Child 2 maintained similar levels of active and passive non-engagement across phases. Overall, changes in median level and trend were identified in 3 children, and were corroborated by significant NAP results for those children. This provides an indication that the engagement of the children increased, and their non-engagement decreased with the introduction of non-powered, self-initiated mobility.

Discussion

The findings of this study are in line with the model of change in motor abilities and engagement in self-care and play for children with CP (Chiarello et al., 2011). In this model, changes in engagement in play as a direct result of changes in gross motor abilities (mobility) are proposed. As identified in this study a possible reason for the relationship between gross motor abilities and engagement may be linked to access, as the gross motor abilities taught in the non-powered, self-initiated mobility programme, provided for the development of self-initiated mobility. Greater access to mobility in turn provideed for more opportunities for success, increased motivation and engagement in play.

It is evident, though, that the improvement in engagement was not immediate. For all children an initial period of deterioration was evident prior to improvement being seen. A possible reason for this may be that for children with severe mobility limitations, the learning of new motor movements is challenging; hence, as the mobility learning began, the participant's focus was solely on motor skill learning. As engagement was measured in respect to engagement in play, deterioration in engagement was evident. However, as the programme progressed and the motor skills of the children improved, so their focus reverted to play and engagement was seen to develop.

One area where the current study did not support the literature concerned the relationship between age and engagement. Early studies on the effect of age on engagement (McWilliam and Bailey, 1990, 1995) indicated that age was related to engagement with younger children having lower engagement than their older peers. In the current study, however, Child 1 and 2 (younger) showed the highest engagement, and Child 3 and 4 (older) the lowest engagement (based on overall engagement). Two possible reasons for this have been considered. The first is that for children with severe mobility limitations, age is not a determinant of functional skills. At the start of the study, Child 1 and 2 both had slightly

higher MACS (Eliasson et al., 2006) and CFCS levels of IV (Cooley Hidecker et al., 2011) and were more active in their interaction with objects and people. Child 3 and 4, however, were more passive in their interaction with objects and people MACS (Eliasson et al., 2006)and CFCS level V (Cooley Hidecker et al., 2011), and they remained still unless specifically required to move. Thus the children who had the greatest engagement were also those who had the higher functional abilities at the start of the study. The assumption that engagement is affected to a greater extent by functional abilities than by age is supported by the work of Casey et al. (2012), who reported that the time spent in engagement could be predicted by a number of factors – of which developmental quotient was one of the most significant. The second possible reason for the older participants having lower engagement scores relates to the length of time for which they have been unable to move independently, with greater time leading to more experiences of uncontrollability and greater decreases in motivation and engagement (often termed learned helplessness) (Mistrett et al., 2001).

Clinically, the most important implication of this study is that a two-week intensive non-powered, self-initiated mobility programme was accompanied by an improvement in the engagement of children with severe mobility limitations. Secondly, the use of non-powered, self-initiated mobility may possibly benefit young children with severe mobility limitations, who are unable to access powered mobility.

Limitations of this study include the lack of measurement of motor skill or mobility development. This was not done as it was postulated that due to the limited intervention period, developmental gains would not be measurable. A further limitation of this study was the use of purposive and convenience sampling, which has an impact on the generalizability of results. This was further compounded by the lack of stable baseline data for all participants as well as half of the participants not completing the post-intervention phase of the study. Finally a limitation of this study is that although gains in engagement were identified, due to

the small sample population, and the application of only one type of intervention, no comparison can be made directly alternative non-powered mobility devices, nor to powered mobility. Such comparisons will be required in order to identify the implications of the physical effort required to make use of non-powered devices, versus powered devices.

Conclusion

The current study suggests that the use of non-powered, self-initiated mobility could possibly provide an independent mobility opportunity for young children with severe mobility limitations, and that the use of non-powered, self-initiated mobility could possibly result in improvements in engagement for such children. As this was the first study of this kind, further studies on the effect of non-powered, self-initiated mobility on development is warranted, as well as comparisons between powered, and non-powered, self-initiated mobility devices are recommended.

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Declaration of interest

The authors report no conflict of interest that might be interpreted as having influenced this research. The authors alone are responsible for the content and writing of this article.

References

Abramson LY, Seligman MEP, Teasdale JD, Garber J, Miller S, Irwin F . (1978). Learned helplessness in humans : critique and reformulation. Journal of Abnormal Psychology 87:49–74.

Adamson LB, Bakeman R, Deckner DF, Romski M . (2008). Joint engagement and the emergence of

language in children with autism and down syndrome. Journal of Autism and Developmental Disorders.

Adolfsson M, Malmqvist J, Pless M, Granuld M . (2011). Identifying child functioning from an icf-cy perspective: everyday life situations explored in measures of participation. Disability and Rehabilitation 33:1230–1244 Available at: http://www.ncbi.nlm.nih.gov/pubmed/20958202 [Accessed May 14, 2014].

Almqvist L . (2006). Patterns of engagement in young children with and without developmental delay. Journal of Policy and Practice in Intellectual Disabilities 3:65–75 Available at: http://doi.wiley.com/10.1111/j.1741-1130.2006.00054.x.

Arthur-Kelly M, Bochner S, Center Y, Mok M . (2007). Socio-communicative perspectives on research and evidence-based practice in the education of students with profound and multiple disabilities. Journal of Developmental and Physical Disabilities 19:161–176 Available at: http://link.springer.com/10.1007/s10882-007-9045-9 [Accessed April 9, 2014].

Baer DM, Wolf MM, Risley TR . (1968). Some current dimensions of applied behavior analysis. Journal of Applied Behavior Analysis I:91–97.

Basil C . (1992). Social interaction and learned helplessness in severely disabled children. Augmentative and Alternative Communication 8:188–199.

Bottos M, Bolcati C, Scuito L, Ruggeri C, Feliciangeli A . (2001). Powered wheelchairs and independence in young children with tetraplegia. Developmental Medicine & Child Neurology 43:769–777.

Butler C . (1986). Effects of powered mobility on self-initiated behaviors of very young children with locomotor disability. Developmental Medicine & Child Neurology 28:352–332.

Carini RM, Kuh GD, Klein SP . (2006). Student engagement and student learning: testing the linkages*. Research in Higher Education 47:1–32 Available at: http://link.springer.com/10.1007/s11162-005-8150-9 [Accessed April 28, 2014].

Casey A, McWilliam A, Sims J . (2012). Contributions of incidental teaching, developmental quotient, and peer interactions to child engagement. Infants & Young Children 25:122–135 Available at: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00001163-201204000-00003 [Accessed February 19, 2013].

Chiarello LA, Palisano RJ, Bartlett DJ, McCoy SW . (2011). A multivariate model of determinants of change in gross-motor abilities and engagement in self-care and play of young children with cerebral palsy. Physical & occupational therapy in pediatrics 31:150–168 Available at: http://www.ncbi.nlm.nih.gov/pubmed/20964514 [Accessed March 31, 2014].

Chiarello LA, Palisano RJ, McCoy SW, Bartlett DJ, Wood A, Chang HJ, Kang LJ, Avery L . (2014). Child engagement in daily life: a measure of participation for young children with cerebral palsy. Disability and Rehabilitation [Early onl:1–13 Available at: http://www.ncbi.nlm.nih.gov/pubmed/24467674 [Accessed April 16, 2014].

Chiarello LA, Palisano RJ, Orlin MN, Chang HJ, Begnoche D, An M . (2012). Understanding participation of preschool-age children with cerebral palsy. Journal of Early Intervention 34:3–

19 Available at: http://jei.sagepub.com/cgi/doi/10.1177/1053815112443988 [Accessed May 1, 2014].

Cooley Hidecker MJ, Paneth N, Rosenbau PL, Kent RD, Lillie J, Eulenberg J, Chester KJ, Johnson B, Michalsen L, Evatt M, Taylor K . (2011). Developing and validating the communication function classification system for individuals with cerebral palsy. Developmental Medicine & Child Neurology 53:704–710.

de Kruif RE., McWilliam RA . (1999). Multivariate relationships among developmental age , global engagement , and observed child engagement. Early Childhood Research Quarterly 14:515–536.

Deitz J, Swinth Y, White O . (2002). Powered mobility and preschoolers with complex developmental delays. The American journal of occupational therapy : official publication of the American Occupational Therapy Association 56:86–96.

Dietrich A, Abercrombie K, Fanning J, Bartlett D . (2007). Gmfcs family report questionnaire: children aged 2 to 4 years. Available at: www.canchild.ca.

Eliasson A-C, Krumlinde-Sundholm L, Rösblad B, Beckung E, Arner M, Ohrvall A-M, Rosenbaum P . (2006). The manual ability classification system (macs) for children with cerebral palsy: scale development and evidence of validity and reliability. Developmental medicine and child neurology 48:549–554.

Gast DL, Ledford J . (2010). Multiple baseline and multiple probe designs. In: Single Subject Research Methodology in Behavioral Sciences (Gast DL, ed), pp 276–328. London: Routledge.

Gast DL, Spriggs AD . (2010). Visual analysis of graphic data. In: Single Subject Research Methodology in Behavioral Sciences (Gast DL, ed), pp 199–233. London: Routledge.

Hambleton RK, Kanjee A . (1993). Enhancing the validity of cross-cultural studies: improvements in instrument translation methods. In: Paper presented at the annual meetings of the American Educational Research Association 1993. Atlanta, GA.

Horn EM . (1997). Achieving meaningful motor skills: conceptual and empriical bases of a neurobehavioral intervention approach. Mental Retardation and Developmental Disabilities 144:138–144.

Horner RD, Baer DM . (1978). Multiple-probe technique: a variation of the multiple baseline. Journal of applied behavior analysis 11:189–196.

Horner RH, Swaminathan H, Sugai G, Smolkowski K . (2012). Considerations for the systematic analysis and use of single case research. Education and treatment of chidlren 35:269–290.

Iacono T, Carter M, Hook J . (1998). Identification of intentional communication in students with severe and multiple disabilities. 14:102–114.

Jones M, McEwen IR, Neas BR . (2012). Effects of power wheelchairs on the development and function of young children with severe motor impairments. Pediatric physical therapy : the official publication of the Section on Pediatrics of the American Physical Therapy Association 24:131–140; discussion 140 Available at: http://www.ncbi.nlm.nih.gov/pubmed/22466379 [Accessed April 9, 2014].

Kemp C, Kishida Y, Carter M, Sweller N . (2013). The effect of activity type on the engagement and

interaction of young children with disabilities in inclusive childcare settings. Early Childhood Research Quarterly 28:134–143 Available at: http://linkinghub.elsevier.com/retrieve/pii/S0885200612000336 [Accessed July 10, 2014].

Kishida Y, Kemp C . (2006). A measure of engagement for children with intellectual disabilities in early childhood settings: a preliminary study. Journal of intellectual & developmental disability 31:101–114 Available at: http://www.ncbi.nlm.nih.gov/pubmed/16782595 [Accessed April 9, 2014].

Kishida Y, Kemp C . (2009). The individual child engagement record - revised icer-r manual. :6.

Kishida Y, Kemp C, Carter M . (2008). Revision and validation of the individual child engagement record : a practitioner-friendly measure of learning opportunities for children with disabilities in early childhood settings. Journal of intellectual & developmental disability 33:158–170.

LeLaurin K . (1985). The experimental analysis of the effects of early intervention with normal, at-risk, and handicapped children under three. Analysis and Intervention in Developmental Disabilities 5:129–150 Available at: http://linkinghub.elsevier.com/retrieve/pii/S0270468485800100.

Linnenbrink E a., Pintrich PR . (2003). The role of self-efficacy beliefs instudent engagement and learning intheclassroom. Reading & Writing Quarterly 19:119–137 Available at: http://www.tandfonline.com/doi/abs/10.1080/10573560308223 [Accessed April 9, 2014].

Malone, Michael D, Langone J . (1999). Teaching object-related play skills to preschool children with developmental concerns. International journal of disability, development and education 46:235–336.

Mcdonnell J, Ferguson B . (1989). A comparison of time delay and decreasing prompt hierarchy strategies in teaching banking skills to students with moderate handicaps. Journal of applied behavior analysis 48:85–91.

McWilliam R, Bailey DB . (1990). Factors influencing child engagement in mainstream settings. Early Childhood Research Quarterly:1–37.

McWilliam RA . (1995). E-Qual observational coding system. Chapel Hill, NC: Frank Porter Graham Child Development Center University of North Carolina at Chapel Hill.

McWilliam RA, Bailey DB . (1995). Effects of classroom social structure and disability on engagement. Topics in Early Childhood Special Education 15:123–147 Available at: http://tec.sagepub.com/cgi/doi/10.1177/027112149501500201.

McWilliam RA, Scarborough AA, Kim H . (2010). Early education & development adult interactions and child engagement. :37–41.

Mikulincer M . (1994). Human Learned helplessness: A coping perspective. Springer US.

Mistrett S, Diamond CM, Ruedel KLA, Berman K, Mcinerney M . (2001). Synthesis on the use of assistive technology with infants and toddlers (birth through age two).

Parker RI, Vannest K . (2009). An improved effect size for single-case research: nonoverlap of all pairs. Behavior therapy 40:357–367 Available at: http://www.ncbi.nlm.nih.gov/pubmed/19892081 [Accessed March 27, 2014].

Phillips RL, Olds T, Boshoff K, Lane AE . (2013). Measuring activity and participation in children and adolescents with disabilities: a literature review of available instruments. Australian occupational therapy journal 60:288–300 Available at: http://www.ncbi.nlm.nih.gov/pubmed/23888979 [Accessed July 9, 2014].

Shonkoff JP, Phillips DA . (2000). From Neurons to Neighborhoods: The science of early development (Shonkoff JP, Phillips DA, eds). National Academies Press. Available at: htto://www.nap.edu/catalog/9824.html.

Statistics South Africa . (2012). Census 2011 Statistical release - P0301.4. Pretoria. Available at: http://www.statssa.gov.za/publications/P03014/P030142011.pdf.

Steenbergen B, van der Kamp J, Verneau M, Jongbloed-Pereboom M, Masters RSW . (2010). Implicit and explicit learning: applications from basic research to sports for individuals with impaired movement dynamics. Disability and rehabilitation 32:1509–1516 Available at: http://www.ncbi.nlm.nih.gov/pubmed/20575752 [Accessed March 26, 2014].

Wiart L . (2011). Exploring mobility options for children with physical disabilities: a focus on powered mobility. Physical & occupational therapy in pediatrics 31:16–18 Available at: http://www.ncbi.nlm.nih.gov/pubmed/21077754 [Accessed April 3, 2014].

Willingham DB . (1998). A neuropsychological theory of motor skill learning. Psychological review 105:558–584 Available at: http://www.ncbi.nlm.nih.gov/pubmed/9697430.

World Health Organization . (2007). International Classification of functioning, disability and health (ICF-CY). Geneva: WHO Press.

Yarrow, Leon J, Morgan GA, Jennings, Kay D, Harmon, Robert J, Gaiter J . (1982). Infants' persistance at tasks: relationships to cognitive functioning and early experience. Infant behavior and development 5:131–141.

Appendix A

General Play Procedures checklist

General Procedures:	Yes	No	Comments
Therapy room set up with toys in view of the participant			
Participant positioned in prone/ sidelying on scooterboard with straps			

Provide a tally each time procedures are correctly(white)/ incorrectly(grey) followed at each stage of choosing
A response from the participant can be verbal, eye gaze, or in the form of a gesture.

A: The participant is given a choice of items to play with. (Begin at 1)	1. The therapist places three boxes within reach and in front of the participant and says "Ufuna ukudlala..(name item)"/ "Do you want to play with (name item)" As each box is placed. (if participant responds go to B below – if participant provides a clear positive response prior to all boxes being offered proceed immediately, if no response go to 2)	2. If no response to 1. The therapist says takes an item out of each box, shows it to the participant and says "Sine…..(name of item),"/ "we've got (name item) does this for each item one at a time. (if participant responds go to B below, if no response go to 3)	3. If no response to 2: The therapist performs an action including sound effects, with each of the toys and leaves the toy in front of the box within reach of the participant. (if participant responds go to B below, if no response go to 4)	4. If no response to 3: The therapist states "Awushongo ukuthi ufunani, awuthi ngikukhethele sidlale kancane uzobuye usho ukuthi ufunani futhi."/ "You did not say what you want, I will choose what we will play, in a short (time) you can choose what you want."
B: The participant makes a choice. (Select either 1 or 2)	1. The therapist acknowledges the participant's choice through describing how the choice was made. E.g "Ngiyak'bona ubuka/khomba (name item). Ufuna ukudlala ngako."/ "I can see you are looking at/ showing me the (name item). You want to play with it." All other items are removed.		2. If the participant does not select one of the toys in front of them, but provides a response suggesting that they might like an alternative toy from the shelf, then the therapist says "Awuthandi lamathoyisi kodwa ngiyakubona ubuka lezikhafthini. Aw'thi sibuke ukuthi kunani phakathi"/ "You don't like these toys, but I see you looking at these boxes, shall we see what is inside?". The boxes in front of the participant are put away and the other three games placed in front of the participant and a choice of these offered. (Go back to A)	

Appendix B

Prompt checklist

Instructions:

1. Provide a ✓ for each step correctly completed and a × if it is incorrect. Checks are provided for both application and sequencing.
2. Multiple checks and crosses may be applied if prompting is repeated in order for movements to be repeated.
3. Begin a new line when a new goal is set (e.g. target has been reached and the game is restarted).

Requirements for correct completion of a step:

- **Goal identification:** The clear identification of the item/ person which is to be reached by the movement using the verbal script.
- **Target identification**: The clear identification of the body parts to be used in the movement verbally using the verbal script.
- **Target identified by touch and then facilitated with backward chaining**: The target is given touch/ sensory input and then if required backward chaining provided for the movement to be completed. The sequence of touch then chaining needs to be correctly applied (Backward chaining: the provision of facilitation for the first part of the movement with the participant being required to complete the final step/s themselves).
- **Verbal Feedback**: feedback from the prompt script, provided timeously and specifically

Verbal script for prompting English and Zulu:

Verbal Prompts:

English :	**Zulu:**	**English:**	**Zulu:**	**English**	**Zulu:**
Put it here.	Beka lana.	Push on your hands.	Fusha ngezandla.	Let's go down..	Asehle.
Push.	Fusha.	Use your legs.	Enza ngemlenze.	Come here.	Woza lana.
Push a little bit more.	Fusha futhi kancane.	Push on your hands.	Fusha ngezandla.	There's still one left.	Kukhona okusele
Let's do it again.	As'phinde senze futhi.	Pop the bubbles.	Bhamisa amagwebu	Can you get it?	Awuzame ukuwisa futhi
Turn around.	Jika.	Push on your feet.	Fusha nge'yawo.	It's gone!	Akusekho!
Catch it.	Bamba.	Push it, it will play a song.	Cindezela, lizocula	Use your hands.	Enza ngezandla.
Crash down the skittles.	Phihli wisa ophini.				

Verbal feedback:

English :	**Zulu:**	**English:**	**Zulu:**	**English**	**Zulu:**
Pop pop pop.	Bha bha bha.	Well done!	Wenza kahle.	Your legs are very strong.	Inamandla emlenze yakho.
Crash.	Phihli.	You are a star!	Uyayenza lento yakho!	You're going.	Uyahamba manje.
You're using your hands and your legs!	Usebenzisa konke! Izandla nemlenze.	Yay	Yay!	You're very fast.	Wu! Uyasheshisa eh?
You're a bit tired today.	Ukhathele namuhla.	Look at you driving your car	Ish, awubheke ushayela imoto yakho!	Today we're going slowly.	Sizihambela kancane namuhla.
This is a strong hand.	Sinamandla lesandla.	You're turning and turning.	Uyajika jika.		

Prompt Hierarchy Checklist

	Goal identified (goal to be achieved)	Target Identified verbally (body part)	Target Identified by touch and then facilitated with backward chaining.	Verbal feedback
1				
2				
3				
4				
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