CHAPTER THREE

Phase Two: Pilot Study One

3.1 INTRODUCTION

In order to answer the research question posed in Phase Four of this research, a method of recording and measuring the effects of Neuro-Developmental Treatment (NDT) on function during task performance was developed. This chapter reports on the first of two pilot studies that were conducted to:

a) Identify suitable functional activities during which the impact of NDT on children with different types of cerebral palsy (CP) could be studied.

b) Break down each activity into measurable motor phases using biomechanical task analysis.

c) Generate Goal Attainment Scaling (GAS) that reflected increments of the desired change in performance.

This Pilot Study One was guided by the research sub-question: *"How can Goal Attainment Scaling (GAS) be used to reliably evaluate change in task performance from video taped pre-test and post-test data of two children with cerebral palsy (CP) who had each received a one hour session of NDT?"* The contribution of this pilot study in the overall research is highlighted in Figure 3.1.

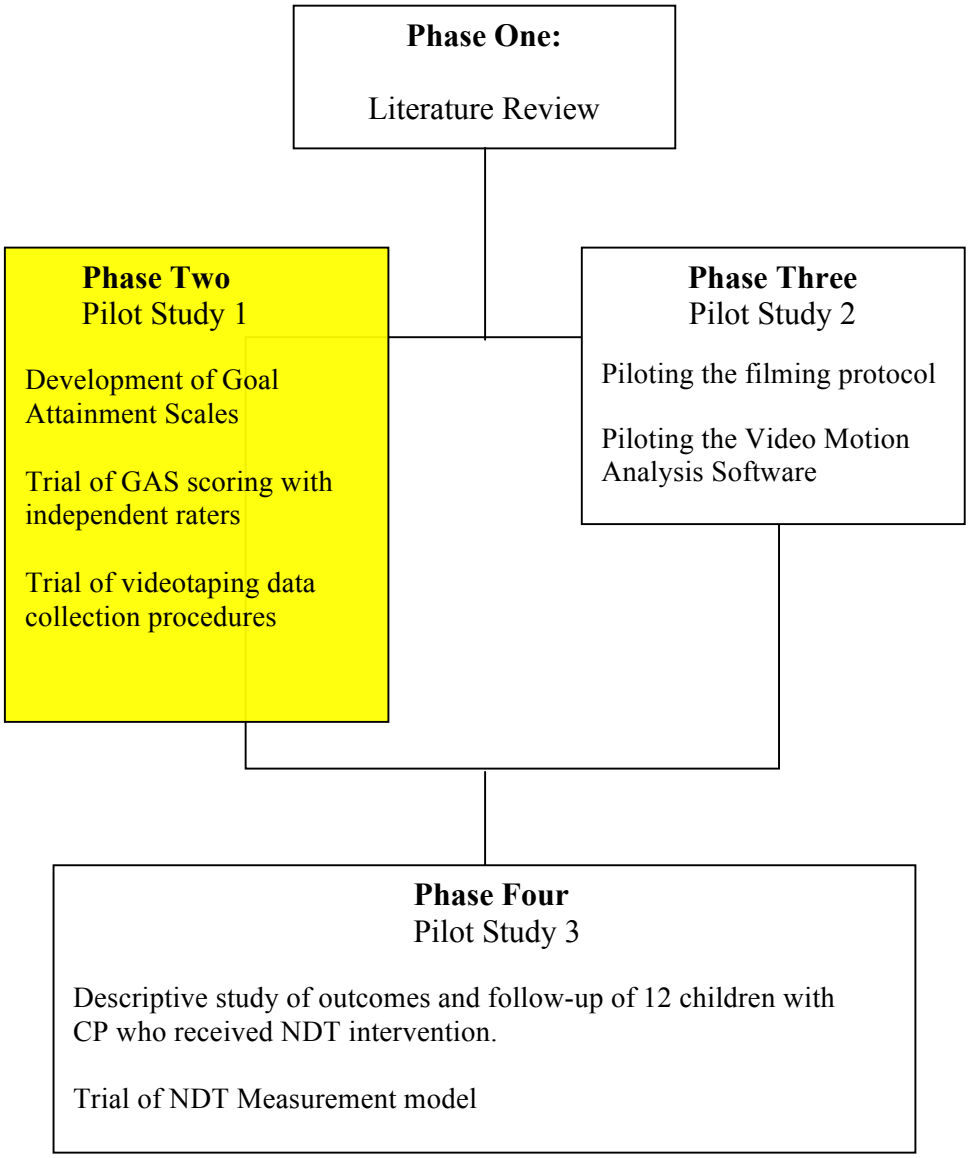

Figure 3.1: Visual representation of the four phases of the study, with Phase Two highlighted.

Pilot Study One was directed by two aims. First, the use of GAS as an outcome measure of performance in daily living tasks was trialed. Expert NDT practitioners, who were blinded to the stage of intervention, evaluated change in the performance of two children with CP who had received a one hour session of NDT. They used GAS scales developed by the researcher from videotaped pre- and post-performances of daily living tasks. Second, this part of the research

represented the first of two training periods for independent raters in using these outcome measures, preparing them for rating the final phase of the study that is reported in Chapter Five.

3.2 METHODOLOGY

3.2.1 Design

A modified critical case study was used to trial the use of Goal Attainment Scaling (GAS) to describe the functional and motor changes that were evident after one hour of NDT intervention in two children. Case study design is particularly suited to situations where little is known about phenomena, or when a number of human factors are involved (Salminen, Harra, & Lautamo, 2006). In this part of the research, little is known about the impact of the phenomenon of NDT upon task performance. The number of human factors that are involved include classification of cerebral palsy, type of activity performed, intervention time, motor function (system-based, task-related posture and movement behaviours as well as associated non-motor behaviours, such as vision and self-regulation) and level of functional performance in specific tasks. Case study research has contributed important information about the functional changes experienced by children after occupational therapy intervention (Case-Smith, 1996; Hoare, Imms, Rawicki, & Carey, 2010; Uyanįk, Bumin, & Kayihan, 2003), and after NDT intervention specifically (Arndt, Chandler, Sweeney, Sharkey, & McElroy, 2008; Bar-Haim et al., 2006; Girolami & Campbell, 1994; Tsorlakis, Evaggelinou, & Tsorbatzoudis, 2004; Uyanįk, Bumin, & Kayihan, 2003; Yin, 2003). In this research, critical case study was used specifically to a) trial the use

of GAS for use in the final phase of the research, and b) as a means to train expert independent raters in its use for the final phase of the research.

3.2.2 Participants and recruitment methods

In critical case study research, 'typical' subjects, deemed to represent the essential propositions under study (Yin, 2002) and the target subject group for future research are selected (Miles & Huberman, 1994; Yin, 2003). In this study, there were two groups of participants: the child participants and the instructor participants.

3.2.2.1 Child participants

The videotaped performances of functional tasks of two children with cerebral palsy were chosen from a 'bank' of videotapes that are available for educational use by NDT Course Instructors. The videotaped material consisted of pre- and post- treatment videotapes of two children who had received 'demonstration NDT treatments' by two NDTA Instructors during an NDTA™ eight week Paediatric Certification Courses in the USA. The treatments had been recorded on mini-digital videotapes, for which parents had given consent.

The two children selected for the study, from the range of videotaped data, met the following criteria which reflected the major variables under study in this research: a history of referral to occupational therapy for *difficulties in motor aspects of daily activities*, diagnosis of *cerebral palsy* and associated co-morbidities, receiving *NDT intervention*, and family *consent* for use of videotaped material for research purposes.

One of the children (J) had been selected to receive NDT intervention that was to be videotaped from a group of children whose parents had 'volunteered' them to be participants in regular treatment practicums of an NDT Certificate course. A demonstration treatment session by the Coordinator Instructor (Physical Therapist) for the course was recorded. The second child (S) was receiving intervention at the facility where an NDT certificate course was being held. The NDTA ™ Occupational Therapy Instructor for the course selected him for an NDT demonstration treatment session.

Children are generally selected for demonstration treatment sessions on the basis of differences in age, severity, type of cerebral palsy, and comfort with observation by a small number of therapists. The purpose of the demonstrations was to show therapists who were receiving postgraduate training in NDT how intervention can be directed towards improved function in a nominated daily task. Consent was obtained for use of videotaped material collected during the course by the Coordinator Instructor.

Individual characteristics available for each child are summarized in Table 3.1. Child J was five years of age and his diagnosis was CP characterised by mild spastic diplegia. While no other co-morbidity was known, he did have an orthopaedic physician monitoring ongoing lower extremity development. He lived at home with his family, attended mainstream school and functioned at an age appropriate level in his learning ability. He required some assistance in activities of daily living. However, he was able to ambulate independently in the community, without the assistance of a walker or from another person.

Child S was twelve years of age with a diagnosis of CP with spastic athetosis and cognitive impairment and reduced expressive language. He was able to answer yes / no questions and follow verbal instructions. In addition, he had a visual impairment. He lived at home with his family and attended a special class for children with disabilities. He required full physical assistance for all daily care.

Table 3.1: Children, tasks and task symbols

Child's intial	Child's age	Child's diagnosis	Task	Pre-test symbol	Post-test symbol
J.	5 years	CP mild spastic diplegia	Baseball swing	'Baseball bat'	'Baseball ball'
S.	12 years	CP 'spastic athetosis'	Drinking from a cup	'Black cup'	'White cup'

3.2.2.2 Instructor participants

Thirteen of the total cohort of American NDT 'Coordinator Instructors' (n=17) were invited to participate in the study through an emailed letter from the researchers (Appendix I). Consent was either returned by email or personally delivered to the researcher at an Instructor Group meeting. Ten of the Coordinator Instructors (CIs) agreed to participate, with the remaining three instructors not available to participate.

Participant instructors met the following criteria: membership of the NDTA Instructors' Group NDTA™ (2006) indicating that they possessed a high level of

skill in evaluation of motor aspects of functional performance, consent to participation (See Appendix I), experience as paediatric therapists, and were not known to the two child participants described above.

3.2.3 Functional tasks chosen for measurement pre- and post-Neuro-Developmental Treatment

Child J, the first of the children described previously, played in the community T-ball team, but with difficulty. He was motivated to improve his 'baseball' (T ball) swing (Figure 3.2). The second child, (S), was only able to drink from an 'infant' closed cup independently. Child S and his family wanted him to drink from an open cup independently, particularly when he was drinking in community contexts. These tasks became the designated intervention goals for the children, and are included in Table 3.1. The task symbol names referred to in Table 3.1 were used as 'identifiers' of either the pre-test or the post-test performance which was viewed by 'blind' raters and scored as described below.

Figure 3.2: Pre-test of baseball swing

3.2.4 Data collection instruments

3.2.4.1 Biomechanical task analysis

As stated in Chapter Two, task analysis is an initial part of the NDT process. The process of task analysis involves breaking a skill or activity down into its component parts and sequencing those parts into a progression. Biomechanical task analysis involves further identification of motor components or 'focal points' of the activity that assist or hinder task performance (Short, 2005). Use of biomechanical task analysis within a natural environment yields information about the steps of the task that may or may not be difficult, the actions which are either present, missing, or inhibitive to task performance, and the impact of environmental variables (such as people and objects) on each part of the task. In this study, biomechanical task analysis was performed on each child's task performances, and a sequence of steps of the tasks, and the actions that were strengths or difficulties were identified. Generally, this information is used by therapists in making decisions about which steps or movements within the task performance to target in NDT intervention, and to set goals relative to those decisions. Information from the biomechanical task analyses was used by the therapists who treated the two child participants in this study to assist them in choosing NDT intervention strategies in the form of physical and verbal prompts which were subsequently applied to generate more effective performance, and hence, meet the designated session goal.

In this study, the biomechanical analysis was utilized to generate a specific Goal Attainment Scale for each of the two child participants, relative to their functional goals of T-Ball and drinking, as described in the following section. For example,

in viewing the video footage of child J's T-Ball biomechanical task analysis prior to intervention, it was noted that child J was unable to maintain an aligned right hip over a semi-flexed knee as he rotated to swing the bat and, as a result, he required three steps to regain his balance post-swing. This was recorded at the GAS -2 level, reflecting the baseline performance below a nominated desired performance, which was set at 0. During later stages of the NDT session, he was able to maintain hip alignment (closed chain abduction) for balance, and as a result, he only required one step post-swing, to regain his balance. This was recorded at the GAS +2 level, reflecting the extent to which intervention exceeded the desired outcome of 0. This process is further described in the following section.

3.2.4.2 Goal Attainment Scaling (GAS)

Goal Attainment Scaling (Kiresuk et al, 1994) was chosen as a way to measure change between pre- and post-NDT intervention, as it is reported to have the capacity to measure specific and targeted change in a range of daily living tasks. GAS is a reliable, sensitive, and valid intervention outcome measure in paediatric practice, and has been widely used in situations where individual and unique outcomes are the focus of intervention (Cardillo & Smith, 1994; Ottenbacher & Cusick, 1989; Wallen, O'Flaherty, & Waugh, 2004). GAS was piloted in this part of the research to evaluate its effectiveness as a measure of immediate change after short periods of NDT intervention.

Support for the use of GAS in this research includes the following rationale. First, it provides a flexible measure for stating 'reasonable' short term objectives

which can be clearly placed on a scale (Maloney, Mirrett, Brooks, & Johannes, 1978; McLaren & Rodger, 2003). Second, it is able to measure outcomes despite diagnosis, severity or the treatment program being used (Lannin, 2003; Maloney, Mirrett, Brooks, & Johannes, 1978; McLaren & Rodger, 2003). It is able to measure small functional changes, especially by children who have severe and profound disabilities (Lannin, 2003). Third, valid conclusions can be drawn from functional changes recorded on the GAS scale (McLaren & Rodger, 2003). Fourth, it is a viable clinical practice, allowing for collaborative goal setting with, for example, parents and children. Once the scaled goal statements are recorded, it can be quickly scored in clinical situations (Lannin, 2003; McLaren & Rodger, 2003). Finally, individual goal setting is an inherent part of accepted NDT practice and is therefore paramount to include in any study that aims to demonstrate NDT effectiveness.

As discussed in the previous chapter, while there is significant support for the use of GAS, the literature also cites difficulties that must be addressed when using it for research purposes. Of significance, is the situation where the commonly used -2 to +2 scale is no longer useful, such as when a person's condition either deteriorates, or becomes exceptionally good (Law, Oi-Sheung, & Sui, 2004). However, an extra score level can be added (- 3 and +3) to allow for floor and ceiling effects (See Table 3.2; Novak & MacIntyre, 2006; Steenbeek, Ketelaar, Galama, & Gorter, 2007). The expanded scale was used in this first pilot study to allow for a larger than expected response, with the intention of reviewing it's usefulness before the next phase.

Table 3.2: Seven level Goal Attainment Scale (Novak & MacIntyre, 2006)

Seven Level Goal Attainment Scale Representing Performance Outcomes:
+ 3 exceeded expected performance on at least three dimensions
+ 2 exceeded expected performance in two dimensions
+ 1 exceeded expected outcome in one dimension
0 represents expected performance outcome, as expressed in goal, following e.g. one session of NDT
- 1 represents one dimension from completely reaching expected outcome
- 2 represents the pre-test performance
- 3 represents a lower than expected performance on at least three dimensions

While GAS has been shown to be a reliable outcome measure, the degree of reliability is somewhat dependent upon three variables: use by experienced 'goal setters', precision in goals set, and multiple measurement periods (Lannin, 2003; Law, Oi-Sheung, & Sui; McLaren & Rodger, 2003). The first two of these variables has been addressed in this phase of the research. All three variables have been addressed in the last phase of the research, described in Chapter Five.

3.2.4.3 Development of individual GAS tables

As displayed in Tables 3.3, 3.4, 3.5 and 3.6, each GAS score sheet included the following (as directed by parents and /or children): first, the functional limitation,

that is, the motor difficulty each child had in carrying out the nominated task (T-Ball and drinking from a cup); and second, a realistic functional measurable goal. This goal related to the functional limitation and aimed for a measurable change following intervention. A seven point GAS scale was generated utilizing the process described below. The goal, or expected outcome level for the two children, was written according to the GAS method, with 0 reflecting the desired goal, and progress in excess of the desired goal located at +1, +2 or +3 level and performance less than the desired goal at -1, -2 or -3 level (Kiresuk, Smith, & Cardillo, 1994).

For the purposes of this study, the 'pre- and post-test behaviours' were then set using a modification of the GAS scale, to capture floor and ceiling effects (Novak & MacIntyre, 2006). Extensions of the nominated 'pre-test behaviours' were set at 'below expected level' (-3) and post-test behaviours were set at 'above expected level' (+3) by the researcher (Table 3.2). In preparation for later studies, a way to express functional change in maximum numerical terms was sought. The scale was written using this GAS scale modification to determine whether it would be possible for expert NDT practitioners to accurately observe, and mark on a seven point scale (-3 to +3), the details of performance criteria change after treatment (Marson & Dran, 2008).

The GAS scales for the two children were 'broken down' and documented in the following way.

First, the two videotapes, each of a one hour NDT demonstration treatment, were observed in full. Then, for each tape, the pre-test and post-test periods of task performances *only*, were selected for repeated 'step by step' observation. A biomechanical analysis was derived from the filmed data at both pre- and post-test. Comparisons were made to determine the type and scope of motor and functional change noted during task performance.

Second, using the information from biomechanical analysis and additional observations, descriptive words that related to each child's actions were written into GAS levels. Intervening GAS levels (-2 to +2) were 'filled' by entering hypothetical one point differences in one or more potentially measurable parameters of change, such as weight distribution, alignment of hip with knee and foot, pelvic femoral rotation and stance / step. Changes towards improved function were included in ascending order within statements. The *actual* pre- and post-test levels, allowing for ceiling effects such as the child performing better than expected, were added to these levels and described respectively as "Performance at a lower (-3) or higher (+3) level than -2 (or +2)", without the 'descriptive words' for the reasons described (as stated in Tables 3.3 and 3.4). The format of pre-test and post-test scales was identical for both tasks ('swinging the bat' or 'drinking from a cup').

Slow play, 'step by step' playing, replays and editing continued, to ensure all written observations were accurate in describing the visual data for each child. The GAS levels descriptions were closely linked to the words written into the

functional measurable goal. For example, lower extremity actions in the task of hitting the ball were described in detail (See Tables 3.3 and 3.4).

Finally, each pre- and post-test scale was assigned a code that nominated them as either pre- or post-test video footage. The codes were 'baseball bat' and baseball ball' for child J, and 'black cup' and 'white cup' for child S.

The GAS levels are outlined in Tables 3.3 and 3.4. In each table, the relevant functional difficulty is labeled "Activity limitation". The functional goal nominated as an intervention outcome is labeled "Functional Goal". For ease in reading this report, some differences that were used to nominate performance level are highlighted in child J's GAS scale (Table 3.3). These relate to his ability to regain stance. In the GAS scale for child J, the seven parameters of potential change were combined in the levels of the scale. The performance level of all parameters is not described at every level. For example, there was no description of 'length and alignment' at the right hip at -2, though it was described (and indicated positive change in function) by the +1 level. The seven parameters of movement were:

1. Initiate with a step (mentioned all levels).
2. Transfer weight.
3. Neutral pelvic femoral rotation.
4. Rotate upper body to right (after the fact, there should also have been mention of pelvic rotation).
5. Maintain length and alignment: right hip.
6. (and) swing at the same time.
7. Regain stance.

Four separate GAS charts were developed: two each for the two children. The pre-test charts for child J and child S were respectively labeled for the CI raters: 'Baseball bat' and 'Black cup' and the post-test charts 'baseball ball' and 'White cup'. Even though the charts contained *identical descriptions* at each GAS level for each child, *separately labeled charts* were created for both ease of identification for the researcher for accuracy in randomization and packaging and charting the results returned from the CIs. The labels chosen were neutral words to avoid indication to CIs of the accompanying DVD pre- or post-test video footage.

Table 3.3: GAS score sheet for child J with differences between each level highlighted.

CHILD J: "BASEBALL BAT" / "BASEBALL BALL"

Activity limitation: Hitting with a baseball bat.

Functional goal: Using the small red baseball bat and tennis ball on the Tee* 'J.' will hit the ball by stepping to the right with semi flexed knee and rotate his upper body to the right; then regain stance through one step in one trial.

Score	ATTAINMENT LEVEL *Please note: The statement at each level below is preceded by . . . "Using the small red baseball bat and tennis ball on the Tee. . . ."	**Please ✓ level (ONE ONLY) represented in DVD**
+3	Performance at a higher level than +2	
+2	. . J. will hit the ball efficiently by stepping & transferring weight to his right leg then maintaining length and aligned right hip (over semi-flexed right knee, & foot) and neutral pelvic femoral rotation, as he rotates his body towards the right while swinging; then regain symmetrical but unsteady leg stance, by stepping right foot to left foot, feet together - in 1 of 1 trial.	
+1	. . J. will hit the ball efficiently by stepping & transferring weight to his right leg then maintaining length and aligned right hip (over semi-flexed right knee, & foot) and neutral pelvic femoral rotation, as he rotates his body towards the right whilst swinging; then regain stance through 1step - in 1 of 1 trial.	
0	. . J. will hit the ball by stepping to the right with semi flexed knee & rotate his upper body to the right; then regain stance through 1step, in 1 of 1 trial.	
-1	. . J. will hit the ball by stepping to the right with semi-flexed knee & rotate his upper body to the right; then regain stance through 2 steps, in 1 of 1 trial.	
-2	. . J. will hit the ball by first stepping to the right with semi-flexed knee & rotate his upper body to the right; then regain stance through stepping to the left & back (right foot across left, then left step and right foot step to left foot) in 1 of 1 trial.	
-3	Performance at a lower level than -2	

Table 3.4: GAS score sheet for child S.

CHILD S. "BLACK CUP" / "WHITE CUP"

Activity limitation: Drinking independently from his cup during family outings.

Functional measurable goal: *Seated in his wheelchair, with support under both elbows & verbal encouragement*,* S. will take his spout cup towards his mouth, by moving his head forwards in the midline, looking towards his cup, & holding his cup (need not be symmetrically held) with 2 fingers & thumbs (both hands), in two of two trials.

Score	ATTAINMENT LEVEL *Please note: to save space, the statement at each level below is preceded by "Seated in his wheelchair, with support under both elbows & verbal encouragement," . .	**Please ✓ level (ONE ONLY) represented in DVD**
+3	Performance at a higher level than +2	
+2	. . S. will drink from his spout cup by moving his head forwards in the midline, looking towards his cup & holding it symmetrically with 3 fingers & thumbs (both hands), for the duration of 1 sip, in 1 of 2 trials.	
+1	. . S. will take his spout cup to his mouth by moving his head forwards in the midline, looking towards his cup & holding it symmetrically with 3 fingers & thumbs (both hands), in 1 of 2 trials.	
0	. . S. will take his spout cup towards his mouth, by moving his head forwards in the midline, looking towards his cup, & holding his cup (need not be symmetrically held) with 2 fingers & thumbs (both hands), in 2 of 2 trials.	
-1	. . S. will take his spout cup towards his mouth, with his head in the midline, by holding his cup (need not be symmetrically held) with index fingers & thumbs, in 2 of 2 trials	
-2	. . S. will take his spout cup towards his mouth by holding his cup (need not be symmetrically held) with index fingers & thumbs, in 1 of 2 trials	
-3	Performance at a lower level than -2	

3.2.4.4 Goal Attainment Scaling video editing process

A video camera was used to edit the original videotapes of the two children's performances, by means of a cable link to imovie™ on a Macintosh PowerBook G4 laptop. The videos were edited to include only the pre- and post-performances by both children from the 'one hour' treatment tapes.

The video footage that was chosen for inclusion on the DVDs best portrayed the same performance conditions and same camera angles in both pre-test and post-performance.

To enhance accuracy in the CI raters' observations, 'repeat, play and slow play' performance sequences of task performance were also included in each edited video clip, and followed the 'real time' performance.

All footage was then exported to create pre- or post-DVDs in both PAL and NTSC formats for viewing in both Australia and the USA. The DVDs were labeled to maintain the 'blinded' condition when viewed by raters.

3.3 DATA COLLECTION PROCEDURES

Following receipt of consent from the instructor participants, the researcher sent them a follow up letter and an attached example of a GAS NDT scale and explanation of what would be expected of them in the rating process (Appendices II & III). After the video editing process of the two children was complete, the CIs were posted a randomly assigned pre- or post-test DVD of each of the two

children's performances. Included in each DVD package were viewing and scoring instructions (Table 3.5), and the appropriate GAS score sheet for each child (Tables 3.3 and 3.4). They returned the DVDs and the completed associated scoring sheets to the researcher.

Table 3.5: Rater instructions for viewing and scoring DVDs.

INSTRUCTIONS FOR VIEWING AND SCORING DVDs

1. **Load DVD into DVD player or computer with DVD Drive**
2. **Press 'play' in center of black DVD frame OR 'enter' on remote control, on computer keyboard or on onscreen controls.**
3. **Each clip will run, then repeat/s will follow and finally slow play version/s, all of the same clip.**
4. **Check one (only!) statement that corresponds with your assessment of performance on the GAS chart.**
5. **The charts & DVDs can be matched up by the correct symbols of two different baseball pictures and two different cup pictures!**
6. **Simply *return email me the symbol name on each DVD and your***
7. ***Score* (-3 to +3) which goes with it. E.g. "baseball bat -2"**
8. **Return the DVD to the address provided.**
9. **Could you please email this by 15th June, or sooner if you like!**
10. **I will then mail you the next two DVDs, which will be viewed and scored in the same symbol name and scoring format and returned to me by 6th July.**

Thank you, Kate Bain

After one month, the CIs viewed the third and fourth assigned DVDs, of the two children. They were again blinded to whether each DVD they received comprised video footage of a pre- or post-intervention performance.

The estimated scoring time in the Pilot Study was 10 minutes per child or less for the short clips, which were of one to seven minutes duration. At the conclusion of the pilot study, the 10 CIs each returned the final two scores by email. Following analysis, the CIs were sent a feedback letter of thanks for participation and some information about the results and potential relevance of the rating scale as an outcome measure for further studies (Appendix IV).

3.4 DATA ANALYSIS AND RESULTS

3.4.1 Goal Attainment Scales

3.4.1.1 Analysis

Four sets of GAS scores were obtained from each of the 10 raters (See Figure 3.3).

The GAS scores generated by the researcher were calculated by assigning a score of -3 or +3 respectively to the two pre-test and post-test videos. Individual GAS scores from each of the participating CI raters, ranging from between -3 to +3 were recorded from each of score sheets returned. All sets of scores from the CI raters were entered into a Microsoft EXCEL™ spreadsheet from which bar graphs were generated to allow for visual comparison between and among scores (See Figure 3.3 and Table 3.8).

The CIs' total rating scores were ranked to determine which of the CIs obtained a total GAS score closest to that of the researcher. The scores were ranked using the following ratings: three points were assigned to a rater for an appropriate + 3 or – 3 score, two points for an appropriate + 2 or – 2 score, one point for an appropriate + 1 or – 1 score, 0 points for a 0 score, 0 points if the + or – rating was in the wrong 'direction'. Therefore higher scores were ranked from one being the highest score to eight being the lowest score.

Visual analysis of graphs enabled data sets to be interpreted by visually exploring patterns, structure, and exceptions. Visual inspection and graph analysis are accepted methods of data reduction in applied behaviour research where the number of subjects is very small, or when the research is in the pilot phase (Ottenbacher, 1986).

One of the criticisms of visual analysis of graphed data has been the lack of formal 'decision rules or guidelines' (Ottenbacher, 1986. p.164), and poor agreement between visual and statistical inference (Fish, 1998). However, these criticisms have been applied primarily to visual analysis of a series of data.

3.4.1.2 Results

Comparison of CI GAS scores with researcher GAS scores

The pre- and post-test GAS scores generated by the researcher are presented in Tables 3.6 – 3.7. Each of the scores obtained from the CIs was compared against the researcher's pre-performance score of -3.0 for both tasks, and post performance scores of +3.0 for both tasks.

Table 3.6: Pre- and Post-test GAS scores generated by the researcher for Child J. Pre-test GAS level highlighted in yellow and post-test GAS level highlighted in turquoise.

Score	ATTAINMENT LEVEL *Please note: To save space, the statement at each level below is preceded by . . . "Using the small red baseball bat and tennis ball on the Tee. . . ."	**Please ✓ level (ONE ONLY) represented in DVD**
+3	Performance at a higher level than +2	
+2	. . J. will hit the ball efficiently by stepping & transferring weight to his right leg then maintaining length and aligned right hip (over semi-flexed right knee, & foot) and neutral pelvic femoral rotation, as he rotates his body towards the right whilst swinging; then regain symmetrical but unsteady leg stance, by stepping right foot to left foot, feet together - in 1 of 1 trial.	
+1	. . J. will hit the ball efficiently by stepping & transferring weight to his right leg then maintaining length and aligned right hip (over semi-flexed right knee, & foot) and neutral pelvic femoral rotation, as he rotates his body towards the right whilst swinging; then regain stance through 1step in 1 of 1 trial.	
0	. . J. will hit the ball by stepping to the right with semi-flexed knee & rotate his upper body to the right; then regain stance through 1step, in 1 of 1 trial.	
-1	. . J. will hit the ball by stepping to the right with semi-flexed knee & rotate his upper body to the right; then regain stance through 2 steps, in 1 of 1 trial.	
-2	. . J. will hit the ball by first stepping to the right with semi flexed knee & rotate his upper body to the right; then regain stance through stepping to the left & back (right foot across left, then left step and right foot step to left foot) in 1 of 1 trial.	
-3	Performance at a lower level than -2	

Table 3.7: Pre- and Post-test GAS scores generated by the researcher for Child S. Pre-test GAS level highlighted in yellow and post-test level GAS highlighted in turquoise.

Score	ATTAINMENT LEVEL *Please note: to save space, the statement at each level below is preceded by "Seated in his wheelchair, with support under both elbows & verbal encouragement," . .	**Please ✓ level (ONE ONLY) represented in DVD**
+3	Performance at a higher level than +2	
+2	. . S. will drink from his spout cup by moving his head forwards in the midline, looking towards his cup & holding it symmetrically with 3 fingers & thumbs (both hands), for the duration of 1 sip, in 1 of 2 trials.	
+1	. . S. will take his spout cup to his mouth by moving his head forwards in the midline, looking towards his cup & holding it symmetrically with 3 fingers & thumbs (both hands), in 1 of 2 trials.	
0	. . S. will take his spout cup towards his mouth, by moving his head forwards in the midline, looking towards his cup, & holding his cup (need not be symmetrically held) with 2 fingers & thumbs (both hands), in 2 of 2 trials.	
-1	. . S. will take his spout cup towards his mouth, with his head in the midline, by holding his cup (need not be symmetrically held) with index fingers & thumbs, in 2 of 2 trials	
-2	. . S. will take his spout cup towards his mouth by holding his cup (need not be symmetrically held) with index fingers & thumbs, in 1 of 2 trials	
-3	Performance at a lower level than -2	

None of the CIs were in perfect agreement with the researcher's GAS rating of both pre- and post-performance scores (Table 3.8 and Table 3.9). Overall, total agreement was achieved for six of the 40 GAS scores, or 15% of cases. The majority of CI raters scored at least one GAS level score from the researcher's GAS score of either -3 (pre-test) or +3 (post-test). While there was some difference in the degree of goal attainment, visual analysis of the graphed data indicated that there was, however, agreement between CI raters and the researcher on the direction of post-performance goal attainment in both children (Table 3.8).

Table 3.8: Comparison of the pre- and post-test GAS scores generated by the CIs for each child with the scores assigned by the researcher. (Missing scores denoted by 0).

	CI rater	Pre-test		Post -test	
		CI rater GAS score	Researcher GAS score	CI rater GAS score	Researcher GAS score
Child J	1	-2	-3	+1	+3
	2	-2	-3	+1	+3
	3	-2	-3	+1	+3
	4	-2	-3	+1	+3
	5	-1	-3	+1	+3
	6	-2	-3	+3	+3
	7	-2	-3	+1	+3
	8	-2	-3	+1	+3
	9	-2	-3	+1	+3
	10	+2	-3	+3	+3
Child S	1	-2	-3	-1	+3
	2	0	-3	0	+3
	3	-2	-3	+3	+3
	4	-3	-3	-1	+3
	5	-2	-3	+2	+3
	6	-3	-3	0	+3
	7	-2	-3	+1	+3
	8	-1	-3	+2	+3
	9	-3	-3	+2	+3
	10	-2	-3	+2	+3

Percentage agreement of each Coordinator Instructor (CI) rater with the researcher for their four GAS scores are recorded in Table 3.9. This analysis was carried out to determine the proximity of the CI GAS scores to those of the researcher for the two children at pre- and post-test, in the performance of their two daily tasks. Data was obtained from analysis of the four DVDs of the pre-test DVD and post-test DVD for each of the two children who were each evaluated by each CI rater. Data were analysed using the Statistical Package for Social Sciences version 18.0. The number of agreements of the CI raters with the researcher's GAS level of pre-

test GAS level (–3) or post-test GAS level (+3) were tallied. In Table 3.9, percentage agreement is recorded in column two, with no agreements by the CI with the researcher recorded as 0% agreement; similarly, 25% represented one agreement and 50% represented two agreements. No CI agreed with the researcher beyond 50%. The overall level of agreement between the CI raters and the researcher 15% ± 10.8 at the 95% confidence level (0.05, SD =17.5, n = 10). That is, of a possible 100% agreement by each of the ten raters (if each rater agreed with the researcher on all 4 scores) there was only a 15% agreement, or 6 scores that were in complete agreement with the researcher's -3 or +3 scores.

Table 3.9: Percentage Agreement of the CI raters with the researcher.

CI Rater	Percentage Agreement
1.	**0%**
2.	**0%**
3.	**25%**
4.	**25%**
5.	**0%**
6.	**50%**
7.	**0%**
8.	**0%**
9.	**25%**
10.	**25%**

In summary, there was agreement in the direction of post-performance goal attainment in both children between CI raters and the researcher (see Table 3.8). Agreement with the researcher did not exceed two of four of the GAS levels, as determined by the researcher, for the two children (see Table 3.8).

3.4.2 Coordinator Instructor (CI) rater rankings

Of the 10 raters, eight raters were retained for the second pilot study based on the ranking and the percent agreement between the researcher and CI. This was achieved by visual analysis of the scores as ranked in Table 3.10 and was based on those raters who scored within six points of the researcher's score.

Table 3.10: Visual analysis of raters' scores compared with researcher's scores.
Key: 3 points for an appropriate + or – 3 score, 2 points for an appropriate + or – 2 score, 1 point for an appropriate + or – 1 score, 0 points for a 0 score, 0 points if + or – in wrong 'direction'

RATER NUMBER	RESEARCHER'S TOTAL SCORES	RATER'S TOTAL SCORES	RANKING
1	12	5	6
2	12	3	7
3	12	8	1
4	12	6	5
5	12	6	5
6	12	8	1
7	12	6	5
8	12	6	5
9	12	8	1
10	12	7	4

Rater retained for Pilot Study Two

3.4.3 Identification of changes to the measurement model to better accommodate variables to be measured in future phases of the research

The videotaped data utilized in this study were generated by instructors for teaching, rather than for research purposes. There were few controls put in place to make sure the pre- and post-filmed performances occurred under exactly the same conditions. Therefore, the last part of this pilot study utilized a second detailed biomechanical analysis of the pre- and post-performance data of the two child participants to determine: a) the performance variables that may need to be considered or controlled as measurement variables in later phases of the research which aimed to use pre- and post-videotaping of performance, and b) changes to filming procedures that may lead to improved visual analysis.

Additional quantitative parameters of movements required for hitting a baseball or drinking from a cup were identified and measured. These are listed in Table 3.11 and represented additional movement parameters during task performance that might have been required to measure changes in function and movement in further phases in the research.

During this second biomechanical analysis, it was noted that aspects of motor performance could not be clearly viewed onscreen. For example, raters were unable to clearly judge a change in rotation around the body axis from pre- to post-test swinging the baseball bat, although this had occurred. An example of conditions that differed was shoes being worn at the pre-test phase but not during the post-test.

It was clear that the 'onscreen' measurements used in this pilot study were not always suitable for the type of task analysis used in GAS, and that comparison between the pre and post-test performances of children required a more sophisticated filming procedure that could be used within a clinical setting. This investigation became the target of Pilot Study Two, reported in the Chapter Four.

Table 3.11: Further quantitative outcome measures, by 'onscreen' observation and measurement.

Further Quantitative Outcome Measures, 'Onscreen' Observation and Measurement	**Numerical Value**
1. Time taken to perform task.	% change
2. Goniometric range of movement changes in task component/s (Hough & Hughes, 2006).	Degrees
3. Assistance given: • More distal or proximal on body part • More or less time hands on (same body part).	Millimetres (mms) Seconds
4. Task component performance measures e.g. number of steps taken, number of grasps / re-grasp in task within a certain time frame.	Numerical score
5. Number of trials in a given number, performed successfully.	% correct
6. Number of environmental manipulations – examples: • Verbal encouragement.	% change
7. Presence or absence of certain task related movements (refer to written functional outcome conditions) Examples: • Vision directed to task • One limb moves independent of other • Rotation from midline • Two hands used • Intra or inter limb coordination (e.g. requirement for humeral flexion and elbow extension) • Mirroring • Involuntary movement.	Numerical score applied to yes (1) or no (0)
8. Percentage of hand surface used to assist child's movement e.g. grasp versus fingertip assist.	Surface area in mms converted to %

3.5 SUMMARY OF RESULTS AND OUTCOMES

Pilot Study One addressed the use of GAS by expert NDT practitioners in the measurement of changes in functional performance of a target task by two children with cerebral palsy and in particular the question:

"Could Goal Attainment Scaling (GAS) be used to reliably evaluate change in performance from video taped pre-test and post-test data of two children with cerebral palsy, who had each received a one hour session of NDT?"

The following findings and their contributions to the subsequent phases of the study are summarised below:

3.5.1 Finding One:

GAS scaling was found to be an outcome measurement that could be used to evaluate change in performance. The GAS scaling process described small, clinically meaningful steps of change in performance from pre-test to post-test for both these children with cerebral palsy.

The researcher included more than one parameter for measurement per GAS scale, making it difficult for raters to nominate the extent to which performance could be exactly matched to a particular level in the GAS. For example, in the GAS scale for child J, the seven parameters observed and scaled for goal related potential change, were listed and combined in the various levels of the scale. The disadvantage for this incorrect GAS scale formation is that a progression of function in any one measurement parameter cannot be 'logically' scaled for

rating, through the levels. An example of this is the description "then regain stance through 1 step", which is identical at two levels, 0 and +1 (Table 3.3). Each parameter of potential measured change should have been allotted to a separate GAS subscale for each of the children. Following further study, including correspondence with a GAS author, (Marson & Dran, 2008), GAS scale construction was amended for the final Pilot Study Three.

3.5.2 Finding Two:

Eight expert CI raters who had practiced rating videotaped task performance using GAS as an outcome measure were selected for the next phase of the research, Pilot Study Two on the basis of the proximity of their GAS ratings.

3.5.3 Finding Three:

Percentage Agreement of 'exact agreement' between the 10 CI raters with the researcher for a -3 GAS score at pre-test or a +3 at post-test was, at best 50% for one rater, with five raters having no exact agreement on the four data points. To increase precision and reliability in quantitative measurement the following changes to the measurement model were suggested: use of the standard -2 to +2 GAS scale, improvement in clarity of the video footage (by, for example, incorporating three camera angles), and the use of a filming protocol to include precise replication of conditions for pre- to post-test filming.

3.5.4 Finding Four:

Compilation of a detailed list of other potential 'onscreen' quantitative measurements that could be utilized in future phases of the research, such as change in time taken and joint range of motion.

3.5.5 Finding Five:

Use of this 'list' for visual analysis and onscreen measurement from pre- to post-test video footage only resulted in rudimentary calculations, as 'apparent' change was often difficult to view and measure: for example, a positive change in trunk rotation pre- to post-test. It was determined to further investigate and pilot suitable video motion analysis software for onscreen measurements to be utilized in further phases of the research.

Further discussion of the outcomes of this Pilot Study One and its links to the studies which followed, will be addressed in the final chapter of this thesis.