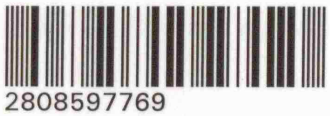

Evaluation of the Effectiveness of the Nuffield Dyspraxia Programme as a treatment approach for children with severe speech disorders

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Abstract

The aim of this study was to evaluate the effectiveness of the Nuffield Dyspraxia Programme (NDP) in the treatment of severe developmental speech disorders. A single subject design was used with four children aged 4-6 years. All scored below the 1st percentile on Percentage Consonants Correct (PCC), had difficulties at a number of speech output levels and were unimpaired on auditory discrimination tasks. Two children met Dodd's criteria for consistent phonological disorder plus articulation disorder, one for inconsistent disorder plus articulation disorder and one for developmental verbal dyspraxia (Dodd 2005). Each child received 20 hours of 1:1 therapy (one hour per week). Assessments were carried out before and after each block of 10 sessions. Micro speech assessments addressed the production of single sounds, words at the CV, CVCV, CVC, multisyllabic and cluster level, and sentences. 'Macro' assessments measured global changes to overall PCC, inconsistency, intelligibility, and oromotor function. Expressive language assessments were used as control measures.

Micro assessment revealed that all children showed change at the single word and sentence levels, ranging from highly significant change at all levels of complexity to small changes in phonetic closeness to target phonemes. In all cases phonetic inventories increased, and number/frequency of phonological processes were reduced. At the macro level, three children showed significant improvement in PCC, and all had increased intelligibility ratings after therapy.

This study shows that the NDP is effective in bringing about micro and macro changes in speech production in the treatment of severe speech disorders. It also reveals that variation in response to therapy may be in part related to the nature of the speech disorder but can also be affected by additional factors such as engagement with the therapy process and emotional and behavioural difficulties.

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1. Introduction

1.1 Speech disorders

It is estimated that between 3 and 10% of children suffer from a developmental speech disorder and that such children make up over 20% of the SLT pre-school caseload (Enderby & Philipp 1986, Janota 2001, Broomfield & Dodd 2004). Many more boys are diagnosed with severe speech disorders than girls (Sheridan et al 1973, Shriberg et al 1997a, Campbell et al 2003).

Children with speech disorders do not form a homogenous group. There is variation in the nature of the speech difficulties (e.g. with individual sounds, phonological contrasts, motoric control of speech), associated difficulties (e.g. syntax, pragmatics) and the impact of these difficulties (e.g. on social participation). Speech disorders can be a result of clear organic causes, such as hearing loss, structural abnormalities and learning disability, but more often there is no known organic cause. It is this latter group that is the focus of this thesis.

1.2 Classifying children with speech difficulties

1.2.1 Subgroups of speech disorders

There are different views on how to classify developmental speech disorders. Shriberg et al (1997, 2003) suggests using aetiology, and has described six groups: genetically transmitted, recurrent otitis media, developmental psychosocial factors, maturational delay in speech systems/dysarthria, craniofacial abnormalities and suspected developmental verbal dyspraxia. However Fox et al (2002) found that over half of a large sample of children with speech disorders could not be classified using this system.

In contrast, Dodd has proposed that speech disorders can be categorized in terms of surface phonological error patterns into five groups (see Table 1.1; Dodd et al 2002, 2005). These subgroups have been identified in a variety of different languages (English, Spanish, Cantonese, German, Mandarin; Dodd 2005).

Table 1.1 Dodd's subgroups (Dodd 2005)

Subgroup	Characteristics
Articulation disorder	Unable to produce specific phonemes in all contexts
Phonological delay	Error patterns typical of normal development in younger children
Consistent phonological disorder	Consistent use of non-developmental patterns in addition to delayed developmental processes
Inconsistent phonological disorder	Multiple error forms for at least 40% of the same items.
Suspected developmental verbal dyspraxia	Inconsistent errors in addition to poor performance on oromotor assessment

1.2.2 Development verbal dyspraxia

Developmental verbal dyspraxia (DVD) is of particular interest to this thesis as the Nuffield Dyspraxia Programme (NDP) was originally developed as a therapy approach for children with this diagnosis. The American Speech-Hearing Association (ASHA 2006) has recently defined DVD as:

'a subtype of severe childhood speech sound disorder due to unidentified neurological differences likely of genetic origin. The core deficits arise at linguistic or early speech motor processing levels. Symptomatology, which changes with age, may include age-inappropriate vowel/diphthong errors, unusual and variable errors in repeated attempts at words, increased number and severity of errors with increasing word and utterance length, and prosodic disturbances.'

The prevalence of DVD is estimated to be 1-2 children per thousand (Shriberg et al 1997a, 1997b).

However, there is substantial debate surrounding the diagnostic criteria for DVD (McCabe et al 1998). For example, the ASHA definition does not make reference to oromotor difficulties, which is in direct contrast to Dodd's classification (see Table 1.1). Others recognize oromotor dyspraxia as a possible feature of DVD (Crary 1993, Evans 1994). The NDP suggests that volitional oral movements are often difficult despite the ability to perform the same movements automatically (Williams & Stephens 2004).

In describing DVD, reference is often made to a 'symptom cluster', including difficulties with motor-speech, phonology and phonetic programme assembly, as well as prosody, language skills and treatment characteristics (Darley et al 1975, Byers-Brown & Edwards 1989, Stackhouse 1992, Ozanne 1995, Ripley et al 1997, Campbell 2002, Strand 2002) – see Table 1.2 for the criteria used by the NDP.

Table 1.2: Characteristics of DVD, taken from NDP 2004

Speech	Treatment	Other
Limited range consonants & vowels	Slow progress in therapy	Family history of speech and language difficulties
Vowel distortions	Resistance to therapy	Delayed language development
Favourite articulations	Difficulties with generalisation	Delayed development of early speech skills
Omission and substitution errors		Feeding difficulties
Glottal stop insertion/substitution		Oral dyspraxia
Inconsistent production		Generalised developmental dyspraxia
Breakdown in sequencing of speech sounds		Literacy difficulties
Prosodic problems		
Resonance difficulties		
Voice difficulties		
Unintelligible speech		

However, a symptom cluster has limitations, for example in determining how many symptoms constitute a diagnosis of DVD, and allowing for changes in presentation with development (Hall 1989, Williams & Corrin 1998). There is also significant debate over whether DVD is distinct from other developmental speech disorders (Guyette & Diedrich 1981, McCabe et al 1998) - see Table 1.3 for Dodd's differential diagnosis of DVD from inconsistent phonological disorder (Dodd et al 2002). Recent work that has attempted to elucidate the symptoms associated with DVD has found that many cases are mis-classified and that the criteria used to diagnose the disorder vary significantly (Campbell 2002, Shriberg 2002). In response to this, some argue that a symptom cluster can be applied clinically without concern over whether children meet exact criteria (as the presence of features of DVD informs intervention; Hall 1992, McCabe et al 1998). Others are searching for diagnostic markers of the disorder, and recent work has reported eight that are sensitive and specific to DVD: articulatory groping, substitution errors, inconsistency, sound and syllable deletions, vowel errors, inconsistent realisation of stress, inconsistent realisation of temporal constraints, and inconsistent nasopharyngeal resonance (Shriberg et al 2003).

Table 1.3: Inconsistent phonological disorder versus DVD (Dodd et al 2002).

Inconsistent Disorder	DVD
Oromotor skills within normal limits	Poor oromotor skills
Word production: imitation better than spontaneous	Spontaneous better than imitation
Able to produce most speech sounds in isolation	Difficulty producing speech sounds
	May have consonant and vowel distortions
Fluent speech	Slow laboured speech
Normal intonation patterns	Atypical intonation patterns
Reduced intelligibility	Reduced intelligibility

1.2.3 The Psycholinguistic approach

Another perspective on the classification of speech disorders is taken by the psycholinguistic approach. This argues that children should be viewed on an individual basis using the psycholinguistic model of speech processing (Stackhouse and Wells 1997

- see Figure 1.1). In this model there are many different levels of processing, all of which can be impaired in children with speech disorders: the child receives information (auditory or visual), stores it as lexical representations within the lexicon (semantic, phonological, grammatical, orthographic, motor program) and then selects and produces spoken words (Stackhouse 2001).

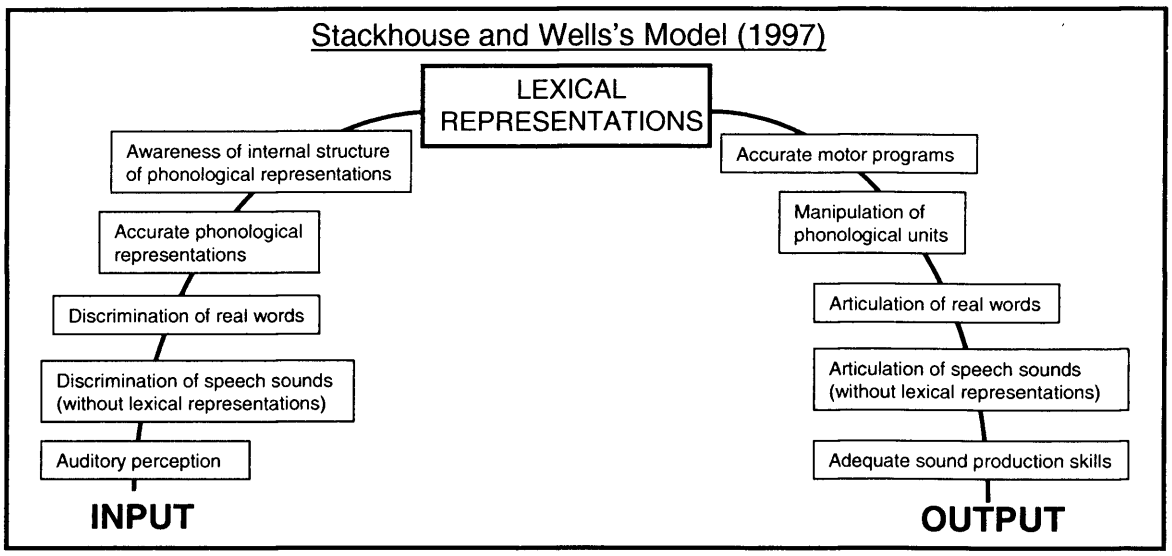


Figure 1.1: The psycholinguistic model of speech processing (Stackhouse & Wells 1997)

Stackhouse & Wells (1997) suggest that detailed assessment provides a psycholinguistic profile whereby levels of breakdown are detected and subsequently targeted in therapy (e.g. inaccurate motor programmes, or inaccurate phonological representations – for further discussion see Section 1.3.4).

1.3 Intervention for speech disorders

1.3.1 Evaluating the evidence

Evidence for the effectiveness of speech and language therapy treatments informs clinical practice, guides service provision, and enhances service users perceptions of a service (Pring 2004). However, evidence-based interventions are in their infancy: communication disorders are poorly understood, theoretically based interventions have not been tested, and studies have often used a combination of therapy approaches (Pring 2004, Williams et al 2006). Moreover, intervention with children occurs in the context of developmental change, which can be hard to differentiate from changes brought about by therapy (Pascoe et al 2006).

As discussed above, children with speech disorders form a very heterogenous group. This heterogeneity does not lend itself to group studies (Waters 2001) and may often be

the reason for negative outcomes in therapy effectiveness (Pring 2004). As a result, researchers advocate the investigation of specific therapy approaches for specific groups of clients and the evaluation of effectiveness using single case studies (Frattali 1998, Pring 2004, Dodd 2005, Pring 2005).

Single case studies describe therapy and participants in detail, and are needed as the first step in establishing evidence-based intervention (Pring 2004, 2005). They can provide evidence for a treatment effect, and narrow hypotheses that are then used as the basis for larger scale studies (Chiat & Hirson 1987, Garrett & Thomas 2006). Such studies provide information on the duration and intensity of therapy needed to effect change and are not limited by issues of subject homogeneity (Pascoe et al 2005). They can also distinguish causes of improvement (e.g. specific result of therapy, maturation or non-specific effects of treatment; Baker & McLeod 2004, Whitworth et al 2005). However, single case studies cannot generalize to other clients: they do not represent a random sample of the population (Pring 2005).

1.3.2 Therapy approaches

Several different approaches are used with children who have speech difficulties (see Table 1.4). These approaches can also be used eclectically (Marquardt & Sussman 1991), for example Almost & Rosenbaum (1998) provided evidence for the effectiveness of phonological contrast and articulation-based therapy using a cycles approach for children with severe phonological disorders in a randomized control trial. Pascoe et al (2006) suggest that an eclectic therapy programme is the most successful approach when treating persistent speech disorders.

Table 1.4: Therapy approaches for developmental speech disorders

Approach	Features	Reference
Articulation-based	Articulation of sounds Motor skill learning: repetition, hierarchy of complexity One sound at a time Can include non-speech oromotor tasks	Van Riper (1963) Yoss & Darley (1974)
PROMPT	Articulation of sounds Motor control and programming Tactile prompts provide information on timing and placement	Chumpelik (1984) Square (1994) Bradford-Heit & Dodd (2005)
Electropalatography (EPG)	Articulation of sounds Plate containing electrodes worn on palate Visual feedback on tongue/palate contact	Hardcastle et al (1991) Morgan-Barry (1995) Carter & Edwards (2004)
Phonological Contrast	Reorganisation of phonological system Addresses errors patterns and develops meaningful contrasts Uses minimal pairs (e.g. key vs. tea) or maximal oppositions (e.g. word initial /s/ v /m/) Child confronted with own errors Targets one at a time/simultaneously or in cycles	Weiner (1981) Hodson & Paden (1983) Gierut (1990)
Metaphon	Reorganisation of phonological system Contrasts sounds metalinguistically (e.g. long/short quiet/noisy sounds)	Dean et al (1995)
Core vocabulary	Improves consistency of keyword vocabulary Whole word approach Teaches pronunciation and then facilitates generalisation	Haynes (1985) Holm et al (2005)
Manual communication	Gestural cueing systems for place/manner of articulation (e.g. cued articulation) Signs and gestures with speech	Jaffe (1984) Hall (1989) Passy (1990)
Language	Language skills (e.g. syntax) and phonological awareness Used with other speech-based approaches Addresses risk of literacy difficulties and comorbidity with language difficulties	Ekelman & Aram (1984) Pannbacker (1988) Stackhouse et al (2002)

1.3.3 Intervention for different subgroups

Dodd (2005) argues that subgrouping children with speech disorders (as outlined in Table 1.1) is essential for selecting treatment approaches. Dodd & Bradford (2000) compared one child with consistent phonological disorder and two with inconsistent disorder on phonological contrast and core vocabulary approaches in a multiple baseline design. The child with the consistent disorder made greatest improvement with phonologically based intervention. In contrast the children with inconsistent disorder achieved greater improvement with core vocabulary therapy (which increased their consistency). This finding was replicated in a larger scale study of 18 children (10 inconsistent, 8 consistent; Crosbie et al 2005). A further case study of a bilingual child with inconsistent disorder found that the core vocabulary approach increased consistency in English and in the untreated language (Holm & Dodd 1999).

The evidence for providing specific intervention for specific subgroups has been extended by a large-scale randomized control study of 320 children (Broomfield & Dodd 2005). Children with articulation disorders received articulation therapy, those with phonological delay/consistent phonological disorder received phonological contrast therapy, and those with inconsistent phonological disorder received core vocabulary therapy. Children who received therapy were compared to those who did not receive therapy for each subgroup. There was a significant improvement in the articulation disorder, phonology delay and consistent groups, and some improvement in the inconsistent group.

However, such studies are limited by little detail on what the therapy involved and the specific characteristics of each child. Moreover, children with similar speech difficulties often have different levels of breakdown and thus different responses to therapy (Pascoe et al 2005) and many other factors influence a child's response to therapy other than the perceptual characteristics of their speech (Almost & Rosenbaum 1998, Weiss 2004, Gardner 2006).

1.3.4 Intervention for the individual: a psycholinguistic approach

Tailoring intervention to the individual is the foundation of psycholinguistic approaches. Specific intervention targets are selected based on the individual child's strengths and weaknesses at the input, output and representational level (see Section 1.2.3; Rees 2001). Therapy programmes incorporate the approaches outlined in Section 1.3.2 in a theoretical framework (Stackhouse et al 2002, Baker & MacLeod 2004, Crosbie et al 2005).

Several in depth case reports have provided evidence for the psycholinguistic approach (Waters et al 2001, Corrin et al 2001, Pascoe et al 2005). Pascoe et al (2005) reported a child with severe phonological difficulties and breakdown in phonological recognition, retrieval of stored motor programmes, creation of motor programmes and motor planning and thus intervention focused on output skills (specifically final consonant deletion). Significant improvements occurred in final consonant production in single words and connected speech, and auditory discrimination that were maintained seven months after therapy (Pascoe et al 2005). Corrin (2001) also found that the psycholinguistic approach was effective in a child with oral and verbal dyspraxia. Her levels of breakdown were with discriminating and producing fricatives, inaccurate stored motor programmes, and with literacy tasks at school. Intervention focused on input and output skills (rhyme and /s/ and /ʃ/), resulting in increased accuracy of phonological representations for target

words, improved ability to segment onset and rime and discriminate between /s/ and /ʃ/ onsets, and to produce /ʃ/ in isolation and in CV/VC frames. There was no improvement in picture naming of /ʃ/ words however, suggesting that motor programmes had not been updated, which was then the focus of the next phase of therapy.

1.4 The Nuffield Dyspraxia Programme

The Nuffield Dyspraxia Programme (NDP) is an eclectic therapy programme appropriate for children with severe speech disorders from 3-7 years of age (Williams & Stephens 2004). It focuses on articulatory skills but, in addition, addresses phonology and syntax and recommends using signing, cueing, phonological therapy approaches and EPG where appropriate. The NDP's overall principles are based on motor learning theories: regular practice, repetitions, feedback, multimodal input and a hierarchy of difficulty (Ellis 1972, Rosenbek et al 1974, Ruscello 1984, Haynes 1985, Hall et al 1993). The programme is also designed within a psycholinguistic framework, and has been used effectively in psycholinguistic therapy studies (e.g. Corrin 2001). The NDP is a multi-target, multi-level approach, and advocates tailoring each intervention plan to each individual using the resources and recommendations as a guide.

The NDP has the following aims:

- to build motor programs from single sounds to CV/VC words, CVCV, CVC, consonant clusters, multisyllabic words, phrases/sentences and connected speech.
- to address oromotor skills and/or auditory discrimination to facilitate speech where appropriate.
- to practice each skill until it becomes automatic (i.e. with repetition and feedback).
- to establish/reinforce phonological contrasts at each level of the hierarchy.
- to establish a full range of psycholinguistic skills
- to promote self-monitoring

The effectiveness of the NDP has yet to be explored in the literature empirically. However one anecdotal report found significant improvements with a child with autism and verbal dyspraxia (Saunders 2006). This child had very unintelligible speech with a restricted range of phonemes, distorted vowels, prosodic abnormalities and poor oromotor skills. After therapy targeting interaction skills and comprehension the NDP was used,

building up from single sounds to sound combinations and including work on oromotor skills and prosody. Homework was carried out at home and at nursery. After 3 months many more sounds were incorporated into Caelen's speech, and he was relying much less on Picture Exchange for Communication (PECs). His expressive and receptive language scores had also significantly increased.

1.5 Study aims

This study aimed to investigate the effectiveness the Nuffield Dyspraxia Programme (NDP-3 2004) as a therapy programme for severe developmental speech disorders in a real-life clinic situation. The cohort of children reported here all had a severe speech disorder with an articulatory component (i.e. they were unable to produce all speech sounds) and features of DVD (Williams & Stephens 2004). Using Dodd's classification, two children had a consistent phonological disorder, one had an inconsistent phonological disorder, and one met full criteria for DVD.

A single subject research design was used with pre- and post-therapy assessment measures at 'macro' (i.e. global changes in speech processing) and 'micro' (specific changes in speech processing) levels. Assessment measures were also used to control for nonspecific/maturational change, and to measure generalisation (Pring 2004, Baker & McLeod 2004 – see Section 2.4.1).

2. Methods

2.1 Participants

Four participants were included in the study (Callum, Daniel, Simon and Gareth) aged 4;3 – 5;1yrs at the start of therapy. All fulfilled the criteria shown in Table 2.1 (see Table 2.2).

Table 2.1 Inclusion criteria

	Criteria	Assessment
1	Aged 4-6 years	
2	Severe speech disorder	Below 1st percentile on Percent Consonants Correct of DEAP
3	Nonverbal skills in normal range	Block Design (WPPSI – see Appendix 1) Matrices (WPPSI – see Appendix 1)
4	Receptive language within one standard deviation of the mean or above	TACL-3 - see Appendix 2).
5	Expressive language at a two word level or above	Renfrew Bus Story
6	No oromotor structural abnormalities	Oral examination
7	No other Speech and Language Therapy provision during the study	
8	Able and willing to attend therapy for five months	Parent interview
9	Absence of sensorineural hearing loss, learning disability or any neurological and psychiatric diagnoses	Medical records, hearing test
10	Monolingual speaker of English	Parent interview

Table 2.2: Baseline screening assessment results (16-84th percentiles fall within 1 standard deviation of the mean)

Name	Age	DEAP PCC (%ile)	WPPSI Block Design (scaled score)	WPPSI Matrices (scaled score)	TACL (%ile)	Bus Story Information (age equivalent)	Bus Story Sentence Length (age equivalent)
Callum	4;5	1	17	16	92	6;9-6;11	5;1-5;6
Daniel	5;0	1	11	10	96	8;5	5;1-5;6
Simon	5;1	1	11	6	45	5;6-5;8	<3;9
Gareth	4;3	1	8	9	61	3;9	<3;9

2.2 Design

A single subject design was used. 'Macro' assessment of speech and language and 'micro' assessment of speech was carried out before and after each 10 week block of therapy (see Figure 2.1). Micro measures are more sensitive to change than standardized tests or test batteries (Pascoe et al 2005).

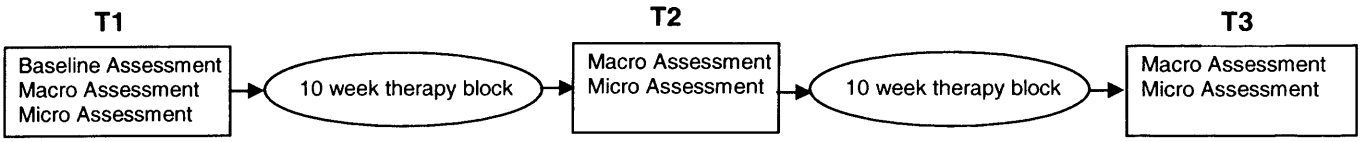


Figure 2.1: Research design

2.3 Assessment measures

2.3.1 Baseline assessments

1. Auditory processing

This was assessed using a picture pointing task that involved minimal pair discrimination (Newton et al in press). Discrimination of place (e.g. pea vs tea), voicing (e.g. pea vs bee), manner (e.g. rice vs dice), voice, place and manner (bed vs shed), distant vowels (car vs key) and close vowels (cup vs cap) were assessed.

2.3.2 Macro assessments

1. DEAP Phonology Assessment (Dodd et al 2002).

This involved naming 50 pictures of target words which included all consonants in syllable-initial and syllable-final positions and all vowels (for word list see Appendix 3). Semantic and forced choice cues were used if necessary. Percentage Consonants Correct (PCC), Percentage Vowels Correct (PVC) and Percentage Phonemes Correct (PPC) were then calculated and error patterns were analysed. Scores were converted to standard scores (with a mean of 10 and normal range of 7-13).

2. DEAP Inconsistency Assessment (Dodd et al 2002)

25 pictures were named on three separate occasions (i.e. separated by different activities), using cues if necessary (for word list see Appendix 4). An inconsistency score was then calculated:

$$Inconsistency = \frac{number\ inconsistent\ items}{number\ items\ produced\ 3\ times} \times 100$$

3. DEAP Oromotor Assessment (Dodd et al 2002)

This involved:

- Diadochokinetic production of 'pat-a-cake' five (3;0-4;11 years) or ten (5;0-6;11 years) times. This was then scored for correct sound sequence, intelligibility and fluency on a 0-3 scale.

- Isolated movements of the tongue and lips through imitation (4 single movements, 3 sequences – see Appendix 5). These were scored on a 0-3 scale.

Scores were converted to standard scores and percentiles.

4. Clinicians rating of intelligibility

This was carried out using a rating scale based on the phonological disorders section of Therapy Outcome Measures (NDP 2004, Enderby & John 1997) – see Table 2.3.

Table 2.3: Clinician's rating of intelligibility

Rating	Intelligibility
0	Completely unintelligible to familiar and nonfamiliar listeners
1	Partly intelligible to familiar listeners in known context, communication partner bears the burden of responsibility
2	Intelligible to familiar listeners in context, partly intelligible in context with nonfamiliar listeners, single words clear connected speech poor
3	Usually intelligible to familiar listeners in and out of context, variable intelligibility in context with nonfamiliar listeners/free spontaneous speech often unintelligible
4	Minor problems but intelligible to everyone, occasionally loses intelligibility at times e.g. when excited or speaking against noise etc.
5	Intelligible at age-appropriate level to familiar and unfamiliar listeners

5. Parents perception of speech intelligibility

This was assessed using a questionnaire (see Appendix 6, adapted from Rees unpublished). Parents were asked to rate the intelligibility of their child's speech in different situations (e.g. telling friends/family something, talking to a stranger when it's noisy), as well as record difficult words/sounds.

6. Renfrew Bus Story (Renfrew 1997)

Each child listened to a story about a bus journey accompanied by a picture sequence (four picture cards of three pictures – see Appendix 7). The child was then asked to re-tell the story from the pictures with the prompt '*Once upon a time there was a....*' and further prompts of '*and then...*' and '*so...*' as necessary. The child's narrative was recorded and then scored for information content. Scores were compared to norms.

The Bus Story narrative was also used to calculate mean length of utterance (MLU). Morphemes were counted according to Brown's rules (Brown 1973; see Appendix 8). MLU was then calculated and compared to published norms (Miller & Chapman 1981):

$$MLU = \frac{\textit{Total number of morphemes}}{\textit{Total number of utterances}}$$

2.3.3 Micro assessments

Detailed speech assessments were carried out at the following levels (NDP 2004 – for word lists see Appendix 9):

- Single sound inventory (imitation)
- CV and VC words (picture naming)
- CVCV words (picture naming)
- CVC words (picture naming)
- Multisyllabic words (picture naming)
- Words including consonant clusters (picture naming)
- Phrases and sentences (imitation)

Scoring of micro measures

Items were scored as correct or incorrect, except for sentences which were scored as follows: 2 if correct, 1 if three or fewer errors, 0 if more than three errors/unable to attempt. Error patterns were also recorded.

A further level of scoring was conducted to detect changes in the child's phonological system in terms of the place, manner, and voicing for consonants (Hall et al 1998) and length and tongue position (front/back, open/close) for vowels. This probe scoring system (PSS) detected subtle changes in the 'right direction' after therapy (Carter & Edwards 2004) and has been used as an outcome measure in therapy studies with children with severe speech disorders (Hall et al 1998, Carter & Edwards 2004). It was calculated as follows:

PROBE SCORING SYSTEM

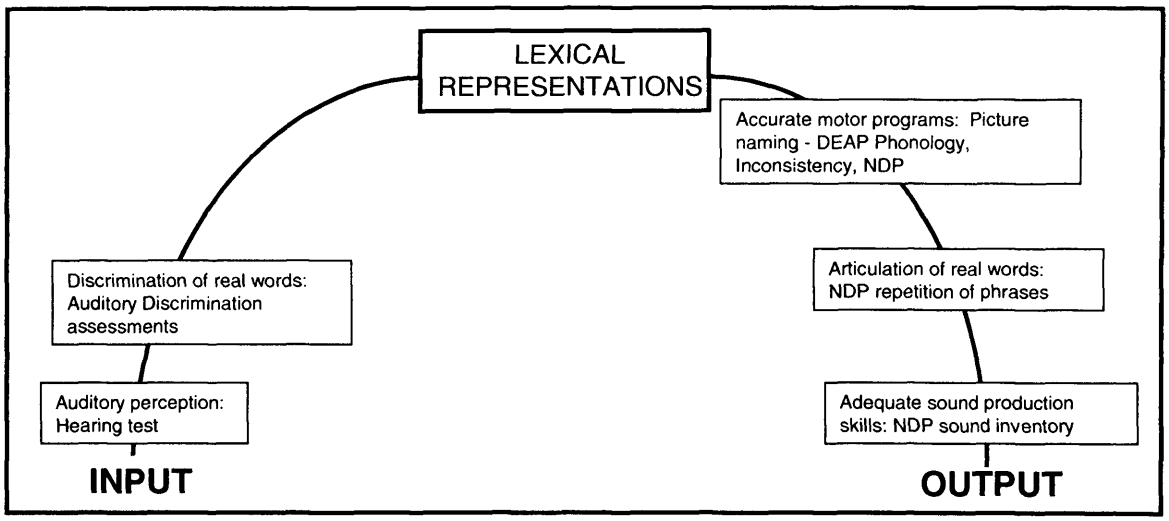
Consonants		**Vowels**	
Absent	-4	Error in length of vowel (long/short/dipthong)	-1
Voicing error	-1	Error in height of vowel (open/close)	-1
Place error	-1	Error in tongue position (front/back)	-1
Affricates: place error	-0.5		
Manner error	-1	**Intrusive sounds**	
Affricates: manner error	-0.5	(Mismatch score for target sound +	
Additional distortion	-0.5	Mismatch score for intrusive sound)/2	

Total score = 'Mismatch Score'

2.3.4 Psycholinguistic Profile

Carrying out a full psycholinguistic battery was beyond the scope of this project. However the assessments used were mapped on to the psycholinguistic model to give insights into levels of breakdown for each child (see Figure 2.2).

Figure 2.2: Assessments on the psycholinguistic model of speech processing (Stackhouse & Wells 1997)



2.4 Analysis

2.4.1 Measuring the effects of therapy

Assessment measures were used in the following way:

a. Experimental measures specifically addressed the effects of therapy on the stimuli used (micro NDP assessments).

b. Generalisation measures assessed generalisation of therapy to different levels of speech production (DEAP Phonology and Inconsistency; Baker & McLeod 2004, Pascoe et al 2006). PCC is a global measure that reflects widespread change in the phonological system (Tyler et al 2003). Clinician and parental ratings of intelligibility measured generalisation to connected speech and everyday contexts: measuring change in everyday functioning is an important outcome measure and addresses *clinical* significance (Kadzin 1984, Breakwell 2000).

c. Control measures addressed abilities that were not expected to change with therapy to control for non-specific effects (Bus Story and MLU; Baker & McLeod 2004). Most single case studies investigating the effectiveness of therapy for speech disorders have used an unrelated language task as a control (Pascoe et al 2006).

2.4.2 Data analysis

Assessment scores were analysed using a single-subject design.

Macro assessments

Pre and post-therapy scores were compared statistically using McNemar's test for related frequencies (Pring 2005). This was calculated as follows:

Post-therapy assessment

Pre-therapy assessment	Correct	Wrong	Totals
Correct		**b**	
Wrong	**a**		
Totals			

$$\chi^2 = \frac{(\mathbf{a} - \mathbf{b} - 1)^2}{\mathbf{a} + \mathbf{b}}$$

Significance was determined from critical values of chi-square (for a single subject: $\chi^2 > 3.84$ at $p<0.05$, $\chi^2 > 6.64$ at $p<0.01$).

To examine changes over the three assessment points, data were plotted and analysed visually (Kadzin 1984, Breakwell et al 2000). Scores were also compared to norms and converted to percentiles therefore measuring change in relation to that expected with age (Broomfield & Dodd 2005). Pre and post-therapy intelligibility ratings were compared quantitatively and qualitatively.

Micro assessments

Assessment scores were analysed using McNemar's test and visual analysis as outlined above. As these assessments had less than 25 items and scores per item, visual analysis was supplemented with nonparametric statistical analysis using Page's trend test (Parkin et al 1998, Pring 2005); binary data cannot be analysed using parametric ANOVA models (Healey 1990).

2.5 Inter-tester reliability

Reliability measures for transcribing and scoring were taken for the DEAP Phonology, DEAP Inconsistency and NDP assessments at two time points. For each child, reliability measures were carried out by a therapist who had delivered therapy to other children in the study. Bus Story narratives were transcribed and scored by the author. Inter-rater reliability was measured using intra-class correlations (which takes into account the variance of the data) and Pearson's r.

2.6 Therapy Programme

Each child participated in two 10 week blocks of individual therapy (1 hour per week). Two experienced Speech and Language Therapists carried out the intervention for two children each. Parents were asked to practice activities between sessions to ensure repeated practice and promote consolidation and generalisation.

Therapy followed the NDP as appropriate for each child. A multi-level, multi-target approach was used (for a general treatment plan, see Table 2.4).

Table 2.4: NDP Treatment Plan

Stage	Therapy targets
1	Establish full range of vowels at single sound level Establish basic range of consonants at single sound level Work on oromotor skills as necessary Monitor voice/resonance Work on basic pitch, volume and length control Establish range of CV words (using consonants and vowels that can be produced) Incorporate new sounds into CV words Begin sequencing single sounds and CV words
2	Consolidate vowels, basic consonants and CV syllables by sequencing Work on motor skills for next 2/3 consonants (e.g. /l ʃ ŋ/) Establish CVCV words with full range of vowels and basic consonants Establish CVC words with full range of vowels and basic consonants Incorporate new sounds, once established at single sound level Consolidate basic pitch, volume and length control Monitor vocal tone, pitch, resonance at CV, CVCV, and CVC levels
3	Establish later sounds (e.g. tʃ dʒ v z/) Increase speed of sequencing and retrieval of CV, CVCV and CVC words Consolidate CVCV and CVC words with current range of sounds, and incorporate new sounds and wider vocabulary Practice 2/3 words phrases, using CV, CVCV and CVC words only Introduce first multisyllabics Introduce first clusters Practice simple intonation patterns at phrase level Monitor vocal tone/resonance and articulation
4	Establish acceptable articulation of last consonants /r θ ð/, and phonological contrasts at single sound and word level Establish a wide range of multisyllabic words and words with consonant clusters Establish consistent and accurate production for a range of phrase and sentence level tasks, including articulation of grammatical words and word joining strategies Extend control of voice and intonation, to include changing focus and shouting Establish strategies for learning new words Establish strategies for maximising intelligibility: pacing, monitoring, communication skills.

Psycholinguistic levels of speech processing were addressed at each level (see Table 2.5).

Table 2.5: Psycholinguistic therapy plan

Psycholinguistic skill	**NDP Therapy**
Motor execution	Oromotor exercises
Motor programs	Single sounds – syllables – words plus kinesthetic and visual cues and feedback Repetition Alternate sequencing tasks Nonword imitation Retrieval of programs + semantic and syntactic links
Motor planning	Sequencing activities Sentence production Prosody tasks
Phonological representations	Making phonological structure of words explicit (visual cues) Auditory modelling Discrimination of child's errors Putting words in sentences
Phonological awareness	Sounds symbol cues Blending/segmentation Onset/rime sorting Syllable segmentation
Auditory discrimination	Phoneme discrimination Minimal pair judgement Auditory modelling
Self monitoring	Developing explicit strategies Pacing speech

3. Results

3.1 Subgroup classification and psycholinguistic profiles

3.1.1 Callum

Table 3.1 shows that Callum's speech was characterised by atypical processes and a reduced phonetic inventory, therefore meeting Dodd's criteria for consistent phonological disorder and articulation disorder.

Table 3.1: Callum's speech and language profile (SLT - Speech and Language Therapy)

CALLUM	
Age	4;5 years
Education placement	Mainstream school – registered as school action plus
Medical history	Heart surgery at 1 week (transposition of great arteries)
Speech development	Limited babble, delayed speech – at 2 years only 2-3 words (unintelligible)
Feeding	Prefers using fingers, sometimes regurgitates food
Motor skills	Normal
Hearing	Normal
Family history	Father had SLT due to omission of speech sounds
Language skills	Age appropriate Uses gesture, mime and facial expression to help get message across
Attention/play/social skills	Age appropriate
Oromotor skills	History of dribbling Reduced lateral tongue movement on examination DEAP oromotor assessment in normal range
Phonetic inventory	p b m t d n k g h w j f ŋ r i ɑ u ɔ ɜ eə aɪ aʊ əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Stimulability	p b m t d n k g h w j /l/ → [l̪] i ɑ u ɔ ɜ aɪ aʊ əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Fronting velars Initial consonant deletion (only /b d m n w/ realised in initial position) Prevocalic voicing Stopping of fricatives Glottal substitution (medial and final positions) Cluster reduction (all initial clusters reduced) Final consonant deletion Breakdown of sequencing in multisyllabic words
Inconsistency	DEAP inconsistency: 24% Inconsistent realisation of phonemes e.g. /t/ → [d] or omitted, /f/ → [w] or [b]).
Voice Prosody Resonance	Normal Abnormal rhythm due to omissions Intermittent hypernasality
Intelligibility	Clinician rating: completely unintelligible to familiar and non-familiar listeners Parent rating: family understand some, others have difficulty School report variability in intelligibility Callum very aware of not being understood
Psycholinguistic profile	Auditory perception: normal Auditory discrimination: 100% Picture naming: inaccurate motor programmes Repetition: inaccurate articulation of real words Sound inventory: reduced
Intervention history	1. 6 week block of group therapy (discrimination and production of /t k s ʃ/) 2. Programme at nursery 3. 14 sessions of private 1:1 therapy (mostly input work: minimal pair contrast therapy, Metaphon, NDP output activities) 4. Programme at school (speech output and literacy)

Callum also had 12 out of 21 possible features of DVD (see Table 3.2; as taken from the NDP 2004).

Table 3.2: Characteristics of DVD (criteria met by Callum shown in bold)

Speech	Treatment	Other
Limited range consonants and vowels Vowel distortions Favourite articulations **Omission and substitution errors** **Glottal stop insertion and/or substitution** **Inconsistent production** **Breakdown in sequencing of speech sounds** Prosodic problems **Resonance difficulties** Voice difficulties **Unintelligible speech**	**Slow progress in therapy** **Resistance to therapy** Difficulties with generalisation	**Family history of speech and language difficulties** Delayed language development **Delayed development of early speech skills** Feeding difficulties **Oral dyspraxia** Generalised developmental dyspraxia Literacy difficulties

Callum's psycholinguistic profile suggested that his difficulties were restricted to output processing (see Table 3.1).

3.1.2 Daniel

Daniel's speech included immature and atypical phonological processes and substitutions (see Table 3.3). In addition, he was unable to articulate a full range of sounds. Daniel therefore met criteria for articulation disorder as well as consistent phonological disorder (Dodd et al 2005).

Table 3.3: Daniel's speech and language profile

DANIEL	
Age	5;0 years
Education placement	Mainstream school
Medical history	None
Speech development	Babbling at 1 year, first words at 18 months, very few words at 2 ½ years (unintelligible)
Feeding	Normal, but messy eater
Motor skills	Normal, but received physiotherapy at 2 years for thumb grip
Hearing	Normal
Family history	Father received SLT
Language skills	Receptive language: age appropriate Expressive language: some evidence of delay on informal testing (word-finding difficulties, immature grammar), age appropriate score on Bus Story
Attention/play/social skills	Age appropriate
Oromotor skills	History of drooling until 4 years Effortful tongue movement on examination, protruded tongue at rest DEAP oromotor assessment in normal range
Phonetic inventory	p b m t d n k g h w f s l ŋ v z i ɑ u ɔ ɜ aɪ aʊ ɪə əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e

Stimulability	p b m t̪ d̪ n̪ k g h w f l i u ɔ aɪ aʊ ɪə əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Fronting s/ʃ→f Stopping of fricatives Fricatives → approximants Cluster reduction (all initial clusters reduced) Deaffrication Fronting of affricates Fronting of velars Glottal insertion Glottal substitution Vowel distortions Breakdown of sequencing in multisyllabic words
Inconsistency	DEAP inconsistency: 24% Some inconsistent realisation of phonemes e.g. /s/ →/t/ or /f/, ʃ→ [f] [t] [ts] or [ʔt]
Voice/prosody/resonance	Normal
Intelligibility	Clinician rating: partly intelligible to familiar listeners in known context, communication partner bears the burden of responsibility. Parent rating: family understand most in context, strangers cannot understand. Parents and school report Daniel is sensitive, emotional and very aware of his speech difficulties
Psycholinguistic profile	Auditory perception: normal Auditory discrimination: 100% Picture naming: inaccurate motor programmes Repetition: inaccurate articulation of real words Sound inventory: reduced
Intervention history	1. Two blocks 1:1 therapy (discrimination and production of vowels and /s/). Very limited progress 2. Private 1:1 therapy (Oct 2004 – March 2005: vowel sounds and tongue exercises)

Using NDP criteria, Daniel had 14 out of 21 possible features of DVD (see Table 3.4).

Table 3.4: Characteristics of DVD (criteria met by Daniel shown in bold)

Speech	Treatment	Other
Limited range consonants and vowels **Vowel distortions** Favourite articulations **Omission and substitution errors** **Glottal stop insertion and/or substitution** **Inconsistent production** **Breakdown in sequencing of speech sounds** Prosodic problems Resonance difficulties Voice difficulties **Unintelligible speech**	**Slow progress in therapy** **Resistance to therapy** **Difficulties with generalisation**	**Family history of speech and language difficulties** **Delayed language development** **Delayed development of early speech skills** Feeding difficulties **Oral dyspraxia** Generalised developmental dyspraxia Literacy difficulties

Daniel's psycholinguistic profile suggested that his difficulties were restricted to output processing (see Table 3.3).

3.1.3 Simon

Simon's speech was inconsistent, and whilst he did find some oromotor movements difficult, his score fell within one standard deviation of the mean (see Table 3.5). Therefore Simon met Dodd's criteria for inconsistent phonological disorder (Dodd 2005). Moreover Simon was unable to produce all sounds in isolation and thus also met criteria for an articulation disorder (see Table 3.5).

Table 3.5: Simon's speech and language profile

SIMON	
Age	5;1 years
Education placement	Mainstream school
Medical history	Mild visual difficulties
Speech development	Age appropriate babbling but few words at age 2 (unintelligible)
Feeding	Normal
Motor skills	Normal
Hearing	Normal
Family history	Older brother has severe speech disorder
Language skills	Age appropriate
Attention/play/social skills	Age appropriate
Oromotor skills	Some difficulty with tongue movements and sequences DEAP oromotor assessment within one standard deviation below mean
Phonetic inventory	p b m t d n k g h w j l ŋ f v s̪ ʃ r z θ tʃ dʒ i ɑ u ɔ ɜ aɪ aʊ əʊ ɪe ɔɪ eɪ ɪ æ ʌ e
Stimulability	p b m t d n k g h w l ŋ v r dʒ i ɑ u ɔ ɜ aɪ aʊ əʊ ɔɪ ɪ æ ʌ
Phonological processes	Devoicing final consonants Fronting (s → f/θ/s̪) Deaffrication Consonant harmony Gliding of liquids Final consonant deletion Glottal substitution Glottal insertion Cluster reduction Vowel distortion Breakdown of sequencing in multisyllabic words
Inconsistency	DEAP inconsistency: 48% Some inconsistent realisation of phonemes e.g. /s/ → [f], [θ], [θ̪]
Voice Prosody Resonance	Normal Atypical due to use of ejectives Mild nasality in connected speech
Intelligibility	Clinician rating: partly intelligible to familiar listeners in known context, communication partner bears the burden of responsibility Parent rating: family can understand most, others find it difficult to understand
Psycholinguistic profile	Auditory perception: normal Auditory discrimination: 83% (some errors on discrimination of place, voice, manner and close vowel contrasts) Picture naming: inaccurate motor programmes Repetition: inaccurate articulation of real words Sound inventory: reduced
Intervention history	1. Block of group therapy (discrimination of /p k f t d s/, production of /f s/) 2. Block of 1:1 therapy (production of /f/ and /s/ in words and phrases)

Using NDP criteria, Simon had 12 out of 21 possible features of DVD (see Table 3.6)

Table 3.6: Characteristics of DVD (criteria met by Simon shown in bold)

Speech	Treatment	Other
Limited range consonants and vowels **Vowel distortions** Favourite articulations **Omission and substitution errors** **Glottal stop insertion and/or substitution** **Inconsistent production** **Breakdown in sequencing of speech sounds** Prosodic problems **Resonance difficulties** Voice difficulties **Unintelligible speech**	**Slow progress in therapy** **Resistance to therapy** **Difficulties with generalization**	**Family history of speech and language difficulties** **Delayed language development** **Delayed development of early speech skills** Feeding difficulties **Oral dyspraxia** Generalised developmental dyspraxia Literacy difficulties

Simon's speech difficulties were mainly restricted to output processing (see Table 3.5). He did make some errors on the auditory discrimination of real words suggesting some difficulty at the input level (although this was in line with typically developing children of his age; Newton et al in press).

3.1.4 Gareth

Table 3.7 shows that Gareth met Dodd's criteria for DVD (he scored 92% on the inconsistency assessment and scored below normal limits on the DEAP Oromotor assessment).

Table 3.7: Gareth's speech and language profile (SLT - Speech and Language Therapy)

GARETH	
Age	4;3 years
Education placement	Mainstream nursery
Medical history	Mother had antibiotics for streptococcus during pregnancy and labour
Speech development	Babbling normal, but delayed speech at 2 years
Feeding	Normal
Motor skills	Normal
Hearing	Normal
Family history	Maternal grandfather, mother and sister have speech and language difficulties
Language skills	Receptive language age appropriate Expressive language delayed
Attention/play/social skills	History of attention difficulties; can switch attention with support
Oromotor skills	DEAP oromotor assessment: below average range on sequenced and DDK movements
Phonetic inventory	p b t̪ d̪ n̪ m k g ŋ w j s ʃ v z l dʒ i ɑ u ɔ aɪ aʊ əʊ ɔɪ eɪ ɪə ɪ æ ʊ ʌ e
Stimulability	p b m k g j s l dʒ i ɑ u ɔ aɪ aʊ əʊ ɔɪ eɪ ɪ æ ʊ ʌ e
Phonological processes	Fronting (g→d, f→ɸ) Backing (t→g) Stopping (f→b)

	Context sensitive voicing (prevocalic voicing/final devoicing) Deaffrication Consonant harmony Final consonant deletion Glottal substitution Cluster reduction Vowel distortion Atypical realisations (k→x) Gliding of approximants Approximants →fricatives (w→ɸ/ʃ, l→ʃ)
Inconsistency	DEAP inconsistency: 92%
Voice Prosody Resonance	Abnormal loudness and hoarseness Normal Normal
Intelligibility	Clinician rating: partly intelligible to familiar listeners in known context, communication partner bears the burden of responsibility Parent rating: difficult to understand (people other than family or out of context)
Psycholinguistic profile	Auditory perception: normal Auditory discrimination: 83% (some errors on discrimination of place, voice, and close vowel contrasts) Picture naming: inaccurate motor programmes Repetition: inaccurate articulation of real words Sound inventory: reduced
Intervention history	1:1 therapy (attention, cooperation, expressive language)

Gareth had 14 out of 20 possible characteristics of DVD (as outlined by the NDP; see Table 3.8).

Table 3.8: Characteristics of DVD (criteria met by Gareth shown in bold)

Speech	Treatment	Other
Limited range consonants and vowels **Vowel distortions** Favourite articulations **Omission and substitution errors** **Glottal stop insertion/substitution** **Inconsistent production** **Breakdown in sequencing of speech sounds** Prosodic problems Resonance difficulties **Voice difficulties** **Unintelligible speech**	**Slow progress in therapy** **Resistance to therapy** **Difficulties with generalization**	**Family history of speech and language difficulties** **Delayed language development** **Delayed development of early speech skills** Feeding difficulties **Oral dyspraxia** Generalised developmental dyspraxia

Gareth's psycholinguistic profile suggested that his speech difficulties were mainly restricted to output processing. He did make some errors on the auditory discrimination of real words suggesting some difficulty at the input level (although this was in line with typically developing children of his age; Newton et al in press).

3.1.5 Summary

Table 3.9 illustrates the variation in phonological and psycholinguistic profiles across study participants.

Table 3.9. Summary of study participants

	SUBGROUP						
	Articulation	Phonological Delay	Consistent Disorder	Inconsistent Disorder	DVD	Input errors	Output difficulties
Callum	√		√				√
Daniel	√		√				√
Simon	√			√		√	√
Gareth					√	√	√

3.2 Inter-tester reliability

The high correlations shown in Table 3.10 indicate high reliability of transcription and scoring across assessments (measures over 0.75 indicate high reliability; Law et al 1998).

Table 3.10: Reliability measures for assessment transcription and scoring

Assessment	Intra-class reliability measure	Pearson's correlation
DEAP	0.84	0.76
NDP	0.96	0.92
Bus Story	0.98	0.98

3.3 Changes with therapy

3.3.1 Callum

3.3.1.1 Therapy programme

Callum's therapy programme is outlined in Table 3.11. Therapy was carried out at all levels using discrimination, production and phonological awareness tasks. The therapist also used cued articulation and core vocabulary lists for some activities. Alongside the 1:1 therapy, Callum's school carried out a therapy programme four times a week.

Table 3.11. Callum's NDP therapy

Level	Therapy
C	/p b t d k g m n h l w j f s tʃ dʒ/
V	/ɑ i u ɔ eʊ aɪ aʊ/
CV	/p b t d k g m n j f v s z tʃ dʒ/ + vowel
CVCV	pVpV
CVC	/s/+VC
Multisyllabic	e.g. cinema, pineapple, caterpillar, butterfly, ambulance: vocabulary of interest (holiday, pokeman) and task- related (zoo, make a scene).
Clusters	s-clusters (/sp/ and /st/)
Word combinations	CVCV nouns and verbs in subject-verb and verb-object structures Use of 'is' in subject and verb-object sentences

3.4.1.2 Micro speech assessments

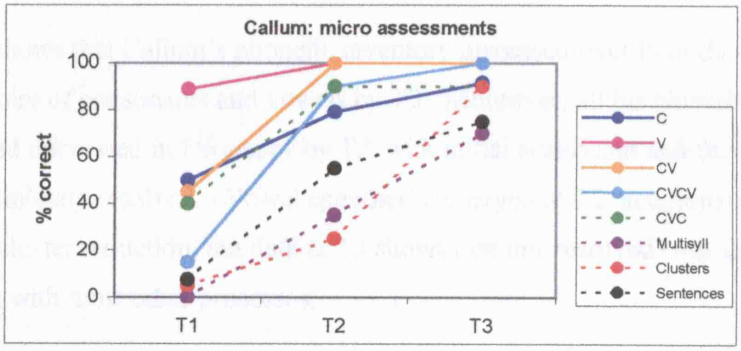
Table 3.12 shows that Callum made significant change at all levels over the course of therapy (except isolated vowels which were near ceiling before therapy).

Table 3.12 Callum's percentage correct scores for micro speech assessments (* = p<0.05 ** = p<0.01 *** = p<0.001)

Micro assessment	T1	T2	T3	McNemar Test (T1 vs T3)	Page's Trend Test (T1, T2, T3)
Single consonants	50	79	91.7	**	*
Single vowels	89	100	100		
CV and VC words	45	100	100	**	*
CVCV words	15	90	100	**	***
CVC words	40	90	90	**	**
Multisyllabic words	0	35	70	**	***
Cluster words	5	25	90	**	*
Phrases/sentences	7.5	55	75	**	***

Callum made a large amount of change over both therapy blocks, reflected in significant trends over all time points (see Table 3.12, Figure 3.1). There was less change at lower levels of the hierarchy during the second block due to ceiling effects. Figure 3.1 shows that Callum's accuracy reflected the complexity of the words although all levels showed similar rates of change. Callum received therapy at all levels of complexity (see Table 3.11) and all levels increased. The large changes that occurred at the CVCV and cluster levels indicate that generalisation to untreated stimuli occurred (very few stimuli were treated at these levels; see Table 3.11, 3.12 and Figure 3.1). Change was more marked for clusters during the second block (when clusters were targeted in therapy).

Figure 3.1. Change over time on micro speech assessments



Further analysis was conducted to examine the phonetic similarity between Callum's realisations and the target stimuli using the probe scoring system. Table 3.13 shows that by T2 all Callum's consonants were accurate or very close to the target in all contexts

except for clusters and multisyllabic words, and by T3, clusters were also accurate/phonetically close (see Figure 3.2). Vowels were accurate in all contexts except multisyllabic words (which became more accurate over therapy; see Table 3.13).

Table 3.13 Callum: probe scoring

Consonants	**T1 mismatch score**	**T2 mismatch score**	**T3 mismatch score**
Single consonants	-23	-5	-2
CV/VC words	-29	0	0
CVC words	-42	-2	-1
CVCV words	-66	-7.5	-4
Cluster words	-125	-69.5	-2
Multisyllabic words	-186.5	-66.5	-26.5
Vowels			
Single vowels	0	0	0
CV/VC words	0	0	0
CVC words	0	0	0
CVCV words	0	0	0
Multisyllabic words	-17	-5	-5

Figure 3.2. Consonant mismatch scores over time

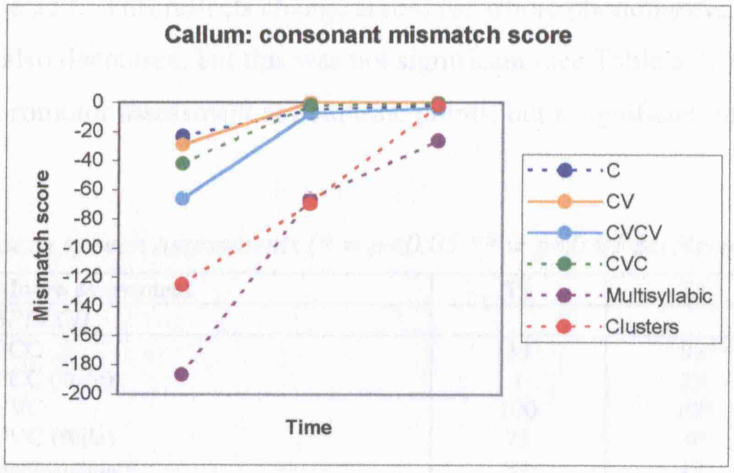


Table 3.14 shows that Callum's phonetic inventory increased over both therapy blocks to a full repertoire of consonants and vowels by T3. Moreover, all his phonological processes had decreased in frequency by T2, with initial consonant and final consonant deletion completely resolved. Vowel epenthesis emerged at T2, accompanied by a decrease in cluster reduction, but data at T3 shows that this resolved over the second block, along with most other processes.

Table 3.14: Change in phonetic inventory and phonological processes

Callum	Pre-therapy	Post-T1	Post-T2
Consonant inventory	p b m t d n k g h w j f l ŋ r	p b m t d n k g h w j f s ʃ l ŋ v z tʃ dʒ	p b m t d n k g h w j f s ʃ l ŋ v z tʃ dʒ r ʒ
Vowel inventory	i ɑ u ɔ ɜ eə aɪ aʊ əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪe əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪe əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Fronting velars (15%) Initial consonant deletion (49%) Prevocalic voicing (50%) Stopping of fricatives (86%) Glottal substitution (12%) Cluster reduction (72% - all initial) Final consonant deletion (22%)	Fronting velars (11%) Prevocalic voicing (3%) /s/ → [sˡ] initially (25%) Glottal substitution (3%) Cluster reduction (43%) /ə/ insertion in cluster (22%)	Glottal substitution (2%) Cluster reduction (3%)

3.3.1.3 Macro speech assessments

Callum's PCC significantly increased, resulting in a greater change than would be expected from his age: the severity of his speech disorder decreased from the 1st percentile to the 25th. This reflects change across his whole phonological system. Inconsistency also decreased, but this was not significant (see Table 3.15). Callum scored highly on the oromotor assessment at both time points, but a significant increase occurred in DDK rate.

Table 3.15. Macro speech assessments (= p<0.05 ** = p<0.01 McNemar Test)*

Macro assessment	T1	T3
SPEECH		
PCC	39	93**
PCC (%ile)	1	25
PVC	100	100
PVC (%ile)	75	50
Inconsistency	32	12
Clinician intelligibility rating (/5)	0	4
Parent intelligibility rating (/35)	15	28
OROMOTOR		
Single movements (% correct)	100	100
Single movements (%ile)	63	50
Sequenced movements (% correct)	89	100
Sequenced movements (%ile)	75	75
DDK (% correct)	33	100*
DDK (%ile)	25	63

Both the clinician and parental ratings of intelligibility provide evidence for significant generalization to a range of everyday contexts (see Tables 3.15 and 3.16). Callum's parents emphasized how great his progress had been over the course of the therapy programme:

'His speech has improved more than I could imagine. The ability to say his own name was a huge leap forward and overall taking part in this study has turned Callum's and our lives around completely!'

Table 3.16 Parent rating of intelligibility in different contexts

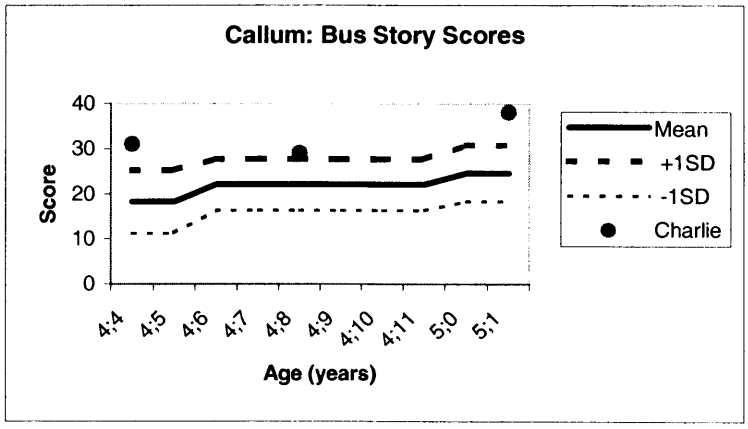
Context	Pre-therapy	Post-therapy
Asking family and friends for something to eat or drink.	Quite easy	Very easy
Telling family and friends about something he/she saw or did.	Bit difficult	Quite easy
Calling out to friends in games (e.g. football).	Difficult	Quite easy
Explaining a game to a friend.	Difficult	Quite easy
Talking to a stranger when it is noisy.	Impossible	Quite easy/bit difficult
Telling a story/joke to a group of people.	Difficult	Quite easy/bit difficult
Asking a question in a big class.	Impossible	Quite easy

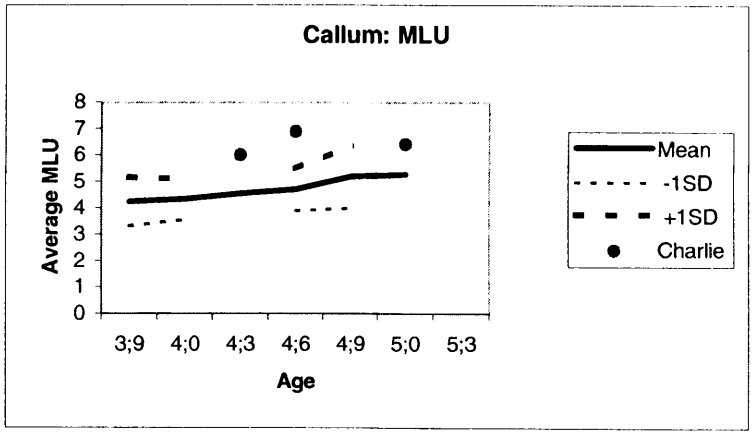
3.3.1.4. Control language assessments

Callum's Bus Story scores and MLU were over one standard deviation above the mean for his age at all time points (see Figure 3.3) and small changes that did occur were not significant.

Figure 3.3 Bus story scores and MLU (norms taken from Renfrew 1997 and Chapman & Miller 1981).

	T1	T3
Bus Story Information Score	31	38
Bus Story Information (%ile)	97	98
MLU	6	6.4





3.3.1.5 Change in subgrouping

By the end of therapy, Callum no longer met criteria for a severe speech disorder or consistent phonological disorder.

3.3.2 Daniel

3.3.2.1 Therapy programme

Daniel's therapy programme is detailed in Table 3.17, and involved production and discrimination tasks, cued articulation and articulograms. Core vocabulary was used for work on consonant clusters. A programme for school was set up at the onset of therapy, but this was terminated at the request of Daniel's parents after two weeks.

Over the first four therapy sessions Daniel was tearful, distressed and uncooperative. He denied any difficulties that he had, and didn't want to try new or difficult tasks. A joint meeting with the Psychologist revealed that Daniel's parents perceived SLT as a stressful and negative experience and didn't readily acknowledge Daniel's speech difficulties. Following this, Daniel and his parents attended four sessions with the Psychologist, and a behavioural management programme for home was put in place. The SLT programme was adapted to focus on Daniel's strengths, small achievable steps and familiar contexts, and improvements were seen in his engagement with therapy. During the second therapy block Daniel's family moved areas and school.

Table 3.17: Daniel's NDP therapy

Level	Therapy
Oromotor	Lip shapes for vowels, breath support for speech
C	/p b t d k g m n f s w l h j v/
V	/ɑ i u ɔ/
CV	/p b t d k g m n f s l h w ʃ/ + /ɑ i u ɔ/, /ðə/
CVCV	
CVC	/t/ and /ts/ in final position e.g. boot, boots
Multisyllabic	Words with /s ʃ tʃ dʒ/
Clusters	Production and discrimination (s+p, s+t, s+n, b+l, k+l, f+l, s+l, b+r, t+r, k+r, f+r, g+r)
Word combinations	Cluster words and multisyllabic words in sentences, sentences with 'is'

3.3.2.2 Micro speech assessments

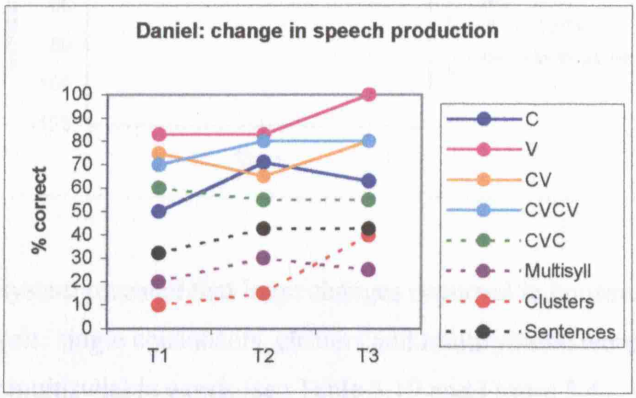
Overall, Daniel showed small increases on all micro speech measures except CVC words, but these were not significant. There was however a significant trend of improvement in consonants clusters (see Table 3.18, Figure 3.3).

Table 3.18 Daniel's percentage correct scores for micro speech assessments (* = p<0.05 ** = p<0.01 *** = p<0.001)

Micro assessment	T1	T2	T3	McNemar Test (T1 vs T3)	Page's Trend Test (T1, T2, T3)
Single consonants	50	71	63		
Single vowels	83	83	100		
CV and VC words	75	65	80		
CVCV words	70	80	80		
CVC words	60	55	55		
Multisyllabic words	20	30	25		
Cluster words	10	15	40		*
Phrases/sentences	32	42.5	32.5		

Daniel showed some differences in Block 1 and 2 of therapy: some levels reached a plateau at Block 2 (CVCV, sentences), whilst others showed greater change over the second block (vowels, clusters; see Figure 3.3). Figure 3.3 shows that accuracy was related to complexity, with no interaction between complexity and change.

Figure 3.3 Daniel: change over time on micro speech assessments

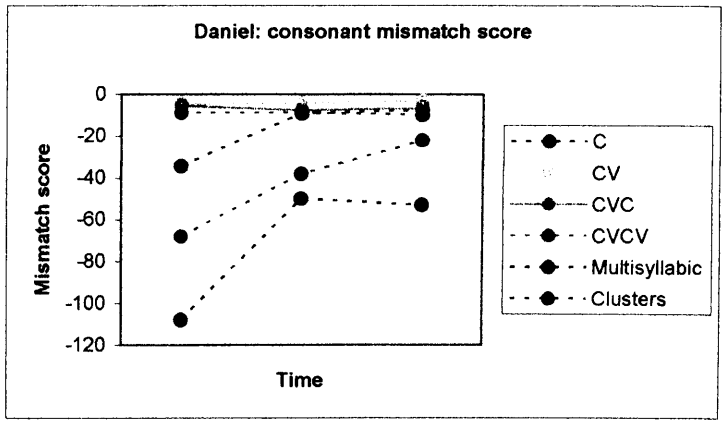


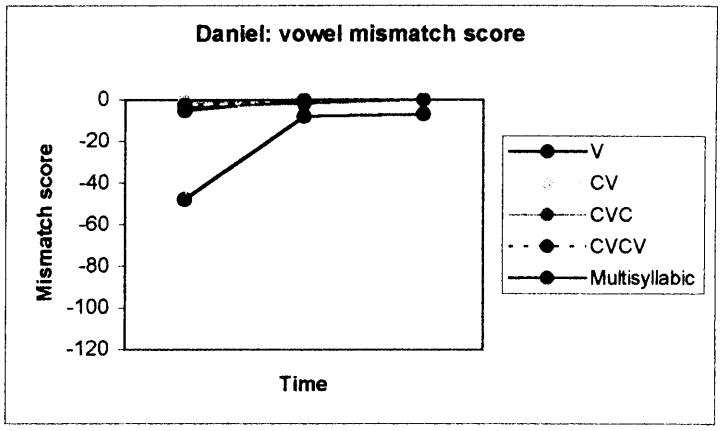
As there was little change over time, relationships between therapy and change cannot be comprehensively explored. However, clusters were targeted in the second block of therapy, and an improvement was seen at this level (see Figure 3.3, Table 3.18).

Table 3.19. Probe scoring of NDP assessments: Daniel

Consonants	T1 mismatch score	T2 mismatch score	T3 mismatch score
Single consonants	-34.5	-9.0	-7.25
CV/VC words	-4.5	-4.0	-3.0
CVC words	-5.5	-7.5	-6.5
CVCV words	-8.8	-8.75	-9.75
Cluster words	-68.0	-38.25	-22.0
Multisyllabic words	-108.0	-50.0	-53.0
Vowels			
Single vowels	-5	0	0
CV/VC words	-1	-2	0
CVC words	-3.5	-2	0
CVCV words	-3	0	0
Multisyllabic words	-48	-8	-7

Figure 3.4 Consonant and vowel mismatch scores





The probe scoring system revealed that large changes occurred in consonant mismatch scores at certain levels: single consonants, clusters and multisyllabic words, and vowel mismatch score for multisyllabic words (see Table 3.19 and Figure 3.4). There was little change at the remaining levels, which can be explained by the low mismatch scores at T1 (small errors in realisation and less room for improvement). In addition, Table 3.20 shows that Daniel's phonetic inventory increased and /t/ /d/ and /n/ were no longer articulated with a dental place of articulation. Changes also occurred to the processes in his speech (see Table 3.20):

- initial /s/ changed from [f] at T1 and T2 to [sf] by T3 (e.g. sea → [fi]→[fi]→[sfi]).
- final /s/ changed from [t] to [ts] (e.g. ice → [ait]→[aits]→[aits])
- cluster reduction was reduced, even if all clusters were not accurate e.g. star → [tɑ:]→[dɑ:]→[stɑ:], frog → [fɒg]→[flɒg]→[fwɒg]

Analysis also revealed that some realisations became inaccurate: final /t/ changed to final [ts] e.g boat → [bəʊt]→[bəʊts]→[bəʊts]. Similarly, some words with final /d/ changed

to final [dz] e.g. bird → [bɜrd]→[bɜrdz]→[bɜrdz]. This may reflect an over-generalisation of word-final /s/ (realised at [ts] - see above) or marking plurals (also targeted in therapy).

Table 3.20. Change in phonetic inventory and processes over therapy

Daniel	Pre-therapy	Post-T1	Post-T2
Consonant inventory	p b m t̪ d̪ n̪ k g h w f s l ŋ v z	p b m t d n k g h w j f s l ŋ v z tʃ dʒ	p b m t d n k g h w f s l ŋ v z dʒ ʒ
Vowel inventory	i ɑ u ɔ ɜ aɪ aʊ ɪə əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪe əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪe əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Fronting velars (3%) Fronting s/ʃ→f (48%) Stopping of fricatives (25%) Fricatives → approximants (10%) Cluster reduction (71%) Deaffrication (52%) Fronting of affricates (48%) Glottal insertion (1% of words) Glottal substitution (3%) Vowel distortions (8%)	Fronting velars (3%) Fronting s/ʃ→f (50%) /s/ and /ʃ/ → [ts t d ʔt] (25%) Cluster reduction (54%) /ə/ insertion in clusters (15%) Deaffrication (48%) Fronting of affricates (44%) Glottal insertion (1% of words) Glottal substitution (2%) Vowel distortions (4%) Final /t/ → [ts] (64%) Final /d/ → [dz] (33%)	Fronting velars (4 %) Fronting s/ʃ→f/fs (42%) Stopping /s/ and /ʃ/ → [ts t d ʔt] (18.3%) Cluster reduction (41%) /ə/ insertion in clusters (11%) Deaffrication (54%) Fronting of affricates (42%) Glottal insertion (2% of words) Glottal substitution (2%) Vowel distortion (1%) Final /t/ → [ts] (53%) Final /d/ → [dz] (22%)

3.3.2.3 Macro speech assessments

There were no significant changes on the macro speech assessments (PCC increased by 3% and remained at the 1st percentile). Daniel's oromotor scores were at ceiling at both time points, and his DDK increased from near ceiling to ceiling by T3 (see Table 3.21).

Table 3.21. Macro speech assessments (= p<0.05 ** = p<0.01 McNemar Test)*

Macro assessment	T1	T3
SPEECH		
PCC	58	61
PCC (%ile)	1	1
PVC	91	92
PVC (%ile)	5	1
Inconsistency	24	24
Clinician intelligibility rating (/5)	1	1.5
Parent intelligibility rating (/35)	15	19
OROMOTOR		
Single movements (% correct)	100	100
Single movements (%ile)	50	50
Sequenced movements (% correct)	100	100
Sequenced movements (%ile)	84	84
DDK (% correct)	89	100
DDK (%ile)	50	63

There were small changes in intelligibility ratings across a range of contexts and some of these may have been clinically significant e.g. calling out to friends increased from 'very difficult' to 'a bit difficult' (see Table 3.22). However, by the end of therapy, the

clinician still rated him as 'partly intelligible to familiar listeners in context' (see Tables 3.21 and 2.3).

Table 3.22. Daniel's parental ratings of intelligibility

Context	Pre-therapy	Post-therapy
Asking family and friends for something to eat or drink.	Quite easy	Very easy
Telling family and friends about something he/she saw or did.	Bit difficult	Bit difficult
Calling out to friends in games (e.g. football).	Very difficult	Bit difficult
Explaining a game to a friend.	Difficult	Difficult
Talking to a stranger when it is noisy.	Impossible	Very difficult
Telling a story/joke to a group of people.	Bit difficult	Difficult
Asking a question in a big class.	Difficult	Bit difficult

At the end of therapy, Daniel's parents felt he needed further input to aid his social communication and self-esteem. They highlighted the need for Daniel to engage in the therapy process in order for improvements to be made:

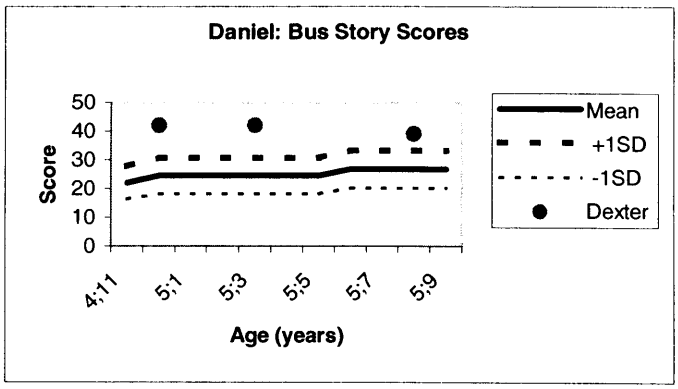
'(Daniel needs to) recognise his improvement and successes, understand that making mistakes is OK, realise the connection between speech therapy and being understood and generalise his new sounds into his regular speaking'

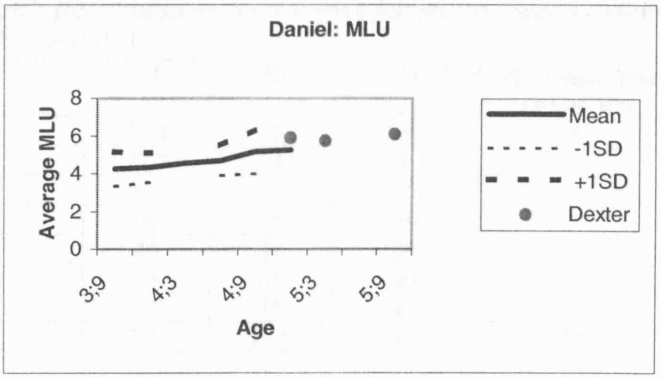
3.3.2.4 Control language measures

Daniel's Bus Story scores were over one standard deviation above the mean at all time points and changed little over time. Similarly his MLU showed little change.

Figure 3.5 Bus Story scores and MLU in relation to norms (taken from Renfrew 1997 and Miller & Chapman 1981)

	T1	T3
Bus Story Information Score	42	39
Bus Story Information (%ile)	99.8	97
MLU	5.9	6.1





3.3.2.5 Change in subgrouping

By the end of therapy, Daniel's classification remained unchanged.

3.3.3 Simon

3.3.3.1 Therapy programme

Simon's therapy programme is outlined in Table 3.23, and involved discrimination and production tasks, sequencing work, articulograms, home practice and encouraged self-monitoring.

Table 3.23 Simon's NDP therapy

Level	Therapy
Oromotor	Lip shapes for vowels, voicing, oral tension, jaw movement
C	/j f s ʃ/
V	/ɑ i u ɜ ɔ ʊ ɪ æ eʊ aɪ eɪ aʊ ɪə/
CV	/t d k g m n f s h ʃ / + vowel, vowel + /b d p t k g ʃ/
CVCV	e.g. cowboy, barking, keeper, leaping, cargo, verbs with /tʃ s/
CVC	CV + /p t b d k g s ʃ/
Multisyllabic	1 session only e.g. petticoat
Clusters	s-clusters (/sp st sk sm spl skr skw/)
Word combinations	Sentences including cluster words, words with final /s p b t d k g/, prosody and connected speech

3.3.3.2 Micro speech assessments

Simon showed a variable pattern of change. His scores on most micro speech measures increased over therapy, and this was significant for single consonants, CVC words and sentences (see Table 3.24). However, there was no change/small decreases in score for CV, CVCV and multisyllabic words.

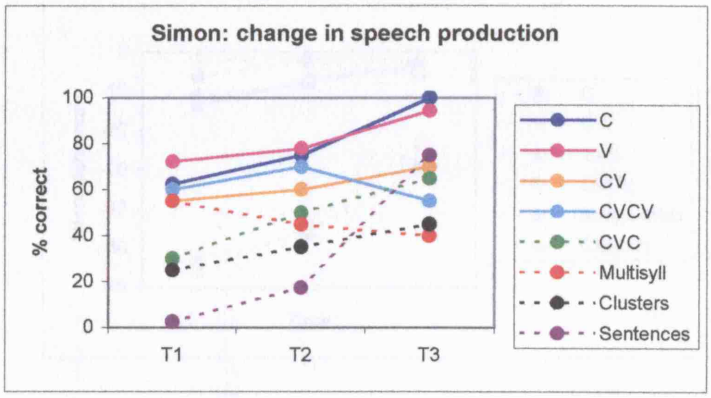
Table 3.24 Simon's percentage correct scores for micro speech assessments (* = p<0.05 ** = p<0.01 *** = p<0.001)

Micro assessment	T1	T2	T3	McNemar Test (T1 vs T3)	Page's Trend Test (T1, T2, T3)
Single consonants	62.5	75	100	*	*
Single vowels	72.2	78	94.4		
CV and VC words	65	60	65		
CVCV words	60	70	50		
CVC words	40	50	65	*	
Multisyllabic words	55	45	40		
Cluster words	25	35	45		
Phrases/sentences	2.5	17.5	75	**	***

Change occurred over both therapy blocks for most micro measures (with significant trends seen for single consonants and sentences – see Table 3.24). Greater change occurred in the second block for single consonants, vowels and sentences (see Figure 3.6).

Simon's profile did not show consistent relationships between complexity and accuracy, for example multisyllabic words were more accurate than CVC words at T1, and sentences were more accurate than most other levels at T3 (see Figure 3.6). There were no clear relationships between complexity and change.

Figure 3.6. Simon: change over time on micro speech assessments



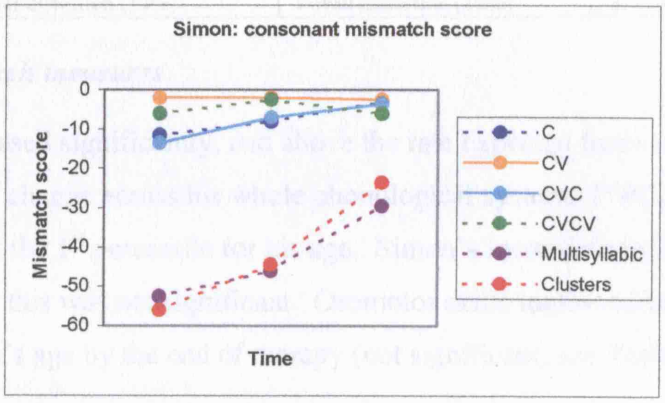
Simon received therapy at all levels (see Table 3.23) and showed increases in score at most of these. However, many of his sessions focussed on the CV level, and only small changes were seen in CV words by T3. The least amount of input was at the multisyllabic level (one session only) and Figure 3.6 shows this level decreased slightly in accuracy over time.

Table 3.25. Probe scoring of NDP assessments: Simon

Consonants	**T1 mismatch score**	**T2 mismatch score**	**T3 mismatch score**
Single consonants	-11.5	-8	-3
CV/VC words	-2	-2	-2.5
CVC words	-13.5	-7	-3.5
CVCV words	-6	-2.5	-6
Cluster words	-52.5	-46	-29.5
Multisyllabic words	-56	-44.5	-23.5
Vowels			
Single vowels	-7	-3	-1
CV/VC words	-9	-9	-5
CVC words	-8	-5	-4
CVCV words	-9	-5	-4
Multisyllabic words	-45	-10	-9

Probe score analysis revealed that Simon's realisations became closer to the target consonants at all levels (with the exception of CV words that were already close to ceiling at T1 – see Table 3.25, Figure 3.7). This is particularly interesting in view of the lack of improvements in overall score seen at the multisyllabic and cluster levels (see Figure 3.6). Striking improvement in vowel mismatch scores can also be seen at the multisyllabic level (see Figure 3.7).

Figure 3.7 Consonant and vowel mismatch scores



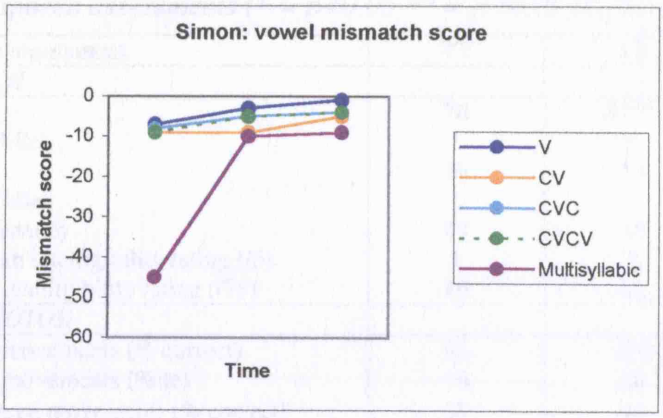


Table 3.26 shows that Simon's phonetic inventory increased over therapy. Although the total number of processes did not decrease, their frequency and their pattern changed: some resolved to be replaced by over-compensatory processes e.g. final consonant deletion and the addition of final consonants, devoicing final consonants and voicing final voiceless consonants. The resolution of final consonant deletion explains the significant improvement seen at the CVC level (see Table 3.24).

Table 3.26. Change in phonetic inventory and phonological processes

Simon	**Pre-therapy**	**Post-T1**	**Post-T2**
Consonant inventory	p b m t d n k g h w j l ŋ f v ʂ ʃ r z θ tʃ dʒ	p b m t d n k g h w l f s ʃ l ŋ v z tʃ dʒ θ ʒ	p b m t d n k g h w j f s ʃ l ŋ v z tʃ dʒ θ ð r
Vowel inventory	i ɑ u ɔ ɜ aɪ aʊ əʊ ɪe ɔɪ eɪ ɪ æ ʌ e	i ɑ u ɔ ɜ aɪ aʊ əʊ ɪɔ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪe əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Devoicing final consonants (45%) Fronting (s → f/θ/ʂ) (68%) Deaffrication (48%) Gliding of liquids (94%) Final consonant deletion (3%) Glottal substitution (3%) Glottal insertion (6%) Cluster reduction (34%) Vowel distortion (19%)	Devoicing final consonants (52%) Fronting (s → f/θ/ʂ) (46%) Deaffrication (26%) Gliding of liquids (84%) Final consonant deletion (1%) Glottal substitution (3%) Glottal insertion (6%) Cluster reduction (26%) Vowel distortion (16%)	Voicing final voiceless plosives (3%) Fronting (s/z → θ/θs) (26%) Deaffrication (26%) Gliding of liquids (87%) Addition of final consonant (3%) Glottal substitution (2%) Glottal insertion (5%) Cluster reduction (11%) Vowel distortion (15%)

3.3.3.2. Macro speech measures

Simon's PCC increased significantly, and above the rate expected from age (see Table 3.27). This reflects change across his whole phonological system. PVC also increased but this remained at the 1st percentile for his age. Simon's inconsistency increased slightly overall, but this was not significant. Oromotor skills improved to fall at or above the mean for Simon's age by the end of therapy (not significant; see Table 3.27).

Table 3.27. Macro speech assessments (= p<0.05 ** = p<0.01 McNemar Test)*

Macro assessment	**T1**	**T3**
SPEECH		
PCC	70	87**
PCC (%ile)	1	5
PVC	76	83
PVC (%ile)	1	1
Inconsistency	48	56
Clinician intelligibility rating (/5)	1	4
Parent intelligibility rating (/35)	19	22
OROMOTOR		
Single movements (% correct)	83	100
Single movements (%ile)	16	50
Sequenced movements (% correct)	67	94
Sequenced movements (%ile)	25	63
DDK (% correct)	100	100
DDK (%ile)	63	63

Increases were seen in intelligibility ratings, particularly by the clinician (increasing to minor problems only). Simon's parents reported small improvements in intelligibility in some contexts (see Table 3.28), and recognised the need for further input:

' Simon has progressed with his speech and I'm very pleased with the speech therapy he has been given. However I do feel he needs further help.'

Table 3.28 Simon: parental rating of intelligibility

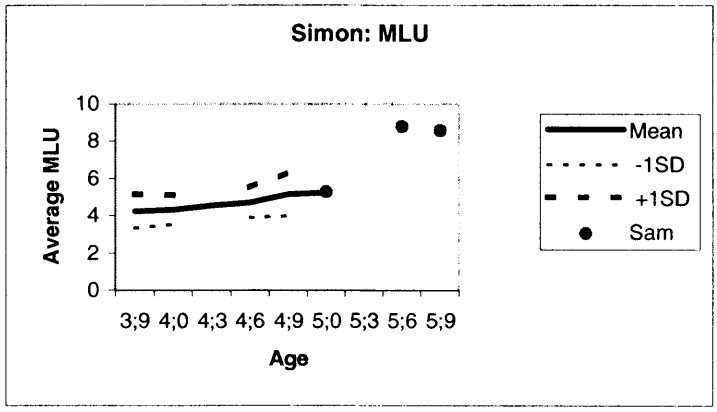
Context	Pre-therapy	*Post-therapy*
Asking family and friends for something to eat or drink.	Quite easy	Quite easy
Telling family and friends about something he/she saw or did.	Bit difficult	Bit difficult
Calling out to friends in games (e.g. football).	Difficult	Bit difficult
Explaining a game to a friend.	Difficult	Bit difficult
Talking to a stranger when it is noisy.	Difficult	Bit difficult
Telling a story/joke to a group of people.	Bit difficult	Bit difficult
Asking a question in a big class.	Bit difficult	Bit difficult

3.3.3.3 Control language measures

Simon showed a significant increase on the Bus Story test from scoring at the mean for his age to over one standard deviation above the mean (see Figure 3.8). MLU also increased over therapy, particularly from T1 to T2.

*Figure 3.8 Bus Story scores and MLU in relation to norms (taken from Renfrew 1997 and Miller & Chapman 1981) * = p <0.05, ** = p<0.01 McNemar test.*

	T1	T3
Bus Story Information Score	26	45**
Bus Story Information (%ile)	59	99.8
MLU	5.3	8.6



3.3.3.4 Change in subgrouping

By the end of therapy the severity of Simon's speech disorder had decreased, but still met criteria for inconsistent phonological disorder.

3.3.4 Gareth

3.3.4.1 Therapy programme

Table 3.29 outlines Gareth's therapy programme. Discrimination and production activities and articulograms were used, and voice, muscle tension and abnormal loudness were addressed in addition to speech processing. Activities were carried out at home throughout the programme and were given to Gareth's school for further practice.

Table 3.29 Gareth's NDP therapy

Level	Therapy
Oromotor	Jaw and tongue movement, muscle tension, voicing, lip shapes for vowels, nasal airstream
C	/p b t d k g m n f s ʃ ʒ/
V	/ɑ i u ɔ ɜ ɪ æ ɒ ɪə aʊ/
CV	/p b t d k g m n f s ʃ h/ + vowel
CVCV	Words including /p b t d k g n/ e.g. poppy butter cuckoo
CVC	/f/+VC
Multisyllabic	e.g. buttercup, ladybird, washing machine, helicopter, pineapple
Clusters	/sp, st, gr/
Word combinations	No more, I do ...., I can...., CVCV + CV/CVCV phrases

3.3.4.2 Micro speech assessments

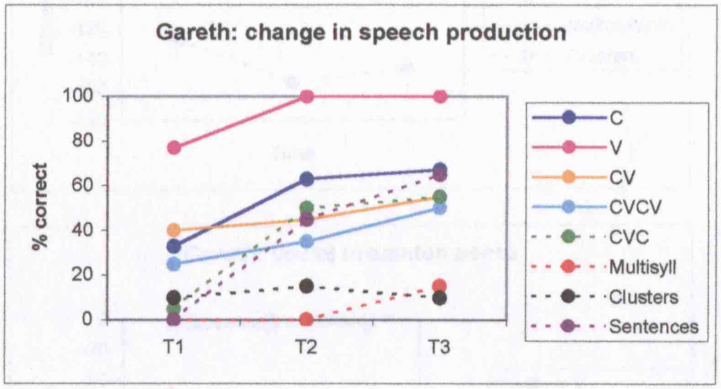
Gareth's scores increased on all micro measures except cluster words with significant change at the single consonant, CVC and sentence levels (see Table 3.30).

Table 3.30 Gareth's percentage correct scores for micro speech assessments (* = p<0.05 ** = p<0.01 *** = p<0.001)

Micro assessment	T1	T2	T3	McNemar Test (T1 vs T3)	Page's Trend Test (T1, T2, T3)
Single consonants	33		67	*	
Single vowels	77		100		
CV and VC words	40		55		
CVCV words	25		50		
CVC words	5		55	**	*
Multisyllabic words	0		15		
Cluster words	10		10		
Phrases/sentences	0		65	**	***

Figure 3.8 shows that change was made over both therapy blocks at most levels, with significant trends over both blocks for CVC words and sentences (see Table 3.30). At T1, accuracy was related to complexity with higher scores for simpler levels, but by T3, sentences scored more highly than all other words. With the exception of sentences, degree of change did interact with complexity, with the most complex levels (multisyllabic words and clusters) showing the least amount of change (see Figure 3.8).

Figure 3.8. Gareth: change over time on micro speech measures

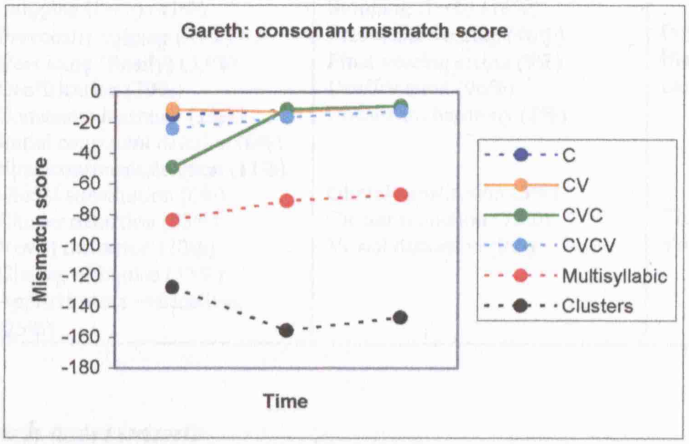


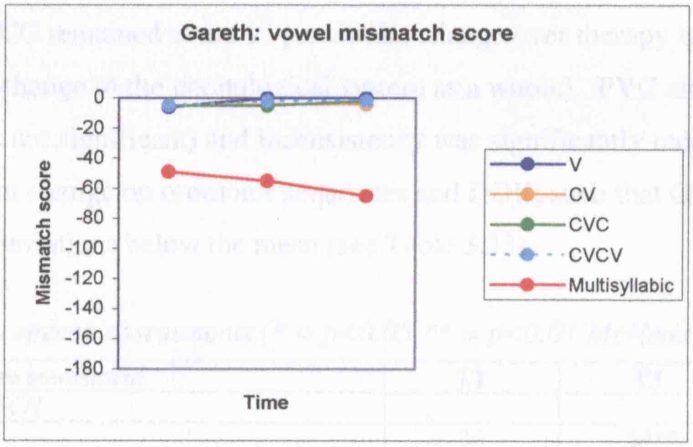
Therapy targeted all levels of complexity and some change was seen at all of these except multisyllabic words. However, very little therapy was carried out at the CVC level and yet significant change occurred. This suggests that generalisation occurred to untreated words (see Table 3.30).

Table 3.31. Probe scoring of NDP assessments: Gareth

Consonants	T1 mismatch score	T2 mismatch score	T3 mismatch score
Single consonants	-15	-12	-9.5
CV/VC words	-11.5	-13	-9
CVC words	-49	-11.5	-9
CVCV words	-24	-16.5	-12.5
Cluster words	-83.5	-71	-67
Multisyllabic words	-127.5	-155.5	-147
Vowels			
Single vowels	-6	0	0
CV/VC words	-5	-4	-4
CVC words	-5	-5	-2
CVCV words	-5	-2	-2
Multisyllabic words	-49	-55	-65

Figure 3.9 Consonant and vowel mismatch scores





Probe score analysis supported the changes seen in overall score: there was improvement in the realisation of consonants at the CVC level and little change in multisyllabic or cluster words (for consonants and vowels; see Table 3.31, Figures 3.8 and 3.9).

Table 3.32 shows that Gareth's vowel inventory increased and the number of processes in his speech decreased over therapy (all processes resolved or decreased in frequency by

T3). Whilst his consonant inventory did not increase in size, the number of stimuable consonants increased from nine at T1 to sixteen at T2 (resulting in the significant change at the single consonant level seen in Table 3.30). The resolution of final consonant deletion is likely to explain the significant improvement seen at the CVC level.

Table 3.32. Change in phonetic inventory and phonological processes.

Gareth	Pre-therapy	Post-T1	Post-T2
Consonant inventory	p b t d n m k g ŋ w j s ʃ v z l dʒ	p b t d m n k g ŋ h j f s ʃ w l tʃ v z	p b t d m n k g h j f s ʃ w l v z
Vowel inventory	i ɑ u ɔ aɪ aʊ əʊ ɔɪ eɪ ɪə ɪ æ ʊ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪə əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e	i ɑ u ɔ ɜ eə aɪ aʊ ɪə əʊ ɔɪ eɪ ɪ æ ʊ ɒ ʌ e
Phonological processes	Fronting (g→d, f→ɸ) (26%) Backing (t→g) (8%) Stopping (f→b) (41%) Prevocalic voicing (55%) Devoicing (finally) (35%) Deaffrication (79%) Consonant harmony (2%) Initial consonant deletion (6%) Final consonant deletion (11%) Glottal substitution (6%) Cluster reduction (85%) Vowel distortion (20%) Gliding of liquids (33%) Approximants →fricatives (25%)	Fronting (g→d, f→ɸ) (22%) Stopping (f→b) (18%) Prevocalic voicing (46%) Final voicing errors (9%) Deaffrication (96%) Consonant harmony (2%) Glottal substitution (3%) Cluster reduction (72%) Vowel distortion (9%)	Fronting (f→ɸ) (12%) Prevocalic voicing (17%) Final voicing errors (8%) Deaffrication (64%) Cluster reduction (62%) Vowel distortion (5%)

3.3.4.3 Macro speech assessments

Whilst Gareth's PCC remained at the 1st percentile, change over therapy was significant (suggesting some change to the phonological system as a whole). PVC also increased (although this was not significant) and inconsistency was significantly reduced. There was also significant change on oromotor sequences and DDK, such that Gareth no longer fell two standard deviations below the mean (see Table 3.33).

Table 3.33. Macro speech assessments (= p<0.05 ** = p<0.01 McNemar Test)*

Macro assessment	T1	T3
SPEECH		
PCC	36	54**
PCC (%ile)	1	1
PVC	76	93
PVC (%ile)	1	25
Inconsistency	92	40**
Clinician intelligibility rating (/5)	1	2
Parent intelligibility rating (/35)	16	46
OROMOTOR		
Single movements (% correct)	58	75
Single movements (%ile)	16	25
Sequenced movements (% correct)	11	67**
Sequenced movements (%ile)	5	25
DDK (% correct)	0	67*
DDK (%ile)	9	25

Intelligibility ratings also increased, particularly by Gareth's parents, suggesting change had generalized across everyday contexts (see Tables 3.33 and 3.34). His progress and ongoing improvement was highlighted:

'He has come a long way from coming here and he is improving everyday'

Table 3.34 Parental intelligibility ratings

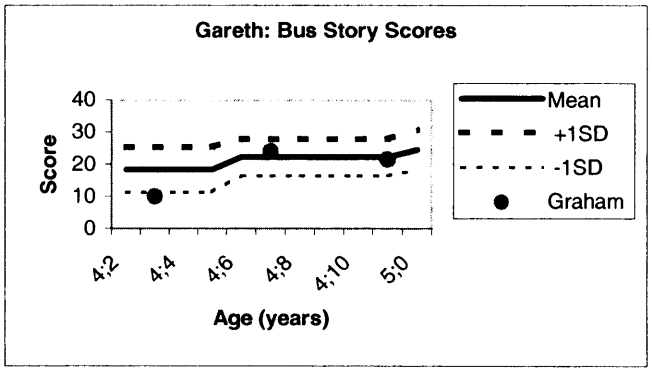
Context	Pre-therapy	Post-therapy
Asking family and friends for something to eat or drink.	Quite easy	Very easy
Telling family and friends about something he/she saw or did.	Bit difficult	Quite easy
Calling out to friends in games (e.g. football).	Difficult	Quite easy
Explaining a game to a friend.	Difficult	Quite easy
Talking to a stranger when it is noisy.	Impossible	Quite easy/bit difficult
Telling a story/joke to a group of people.	Difficult	Quite easy/bit difficult
Asking a question in a big class.	Impossible	Quite easy

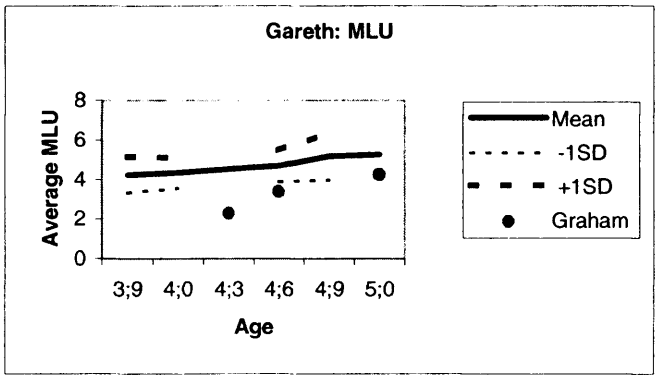
3.3.4.4 Control language assessments

Gareth's language scores did increase slightly above the level expected by age. On the Bus Story, Gareth improved from scoring just lower than one standard deviation below the mean to within one standard deviation (see Figure 3.10).

*Figure 3.10 Bus Story scores and MLU in relation to norms (taken from Renfrew 1997 and Miller & Chapman 1981) * = p <0.05, ** = p<0.01 McNemar test.*

	T1	T3
Bus Story Information Score	10	21.5*
Bus Story Information (%ile)	12	46
MLU	2.3	4.25





3.3.4.5 Change in subgrouping

At the end of therapy Gareth no longer met Dodd's criteria for DVD due to increased oromotor scores. Whilst his inconsistency had decreased significantly, it still fell at the 40% cut off, and thus met criteria for inconsistent phonological disorder.

3.4 Summary

Three out of four study participants showed significant change at a number of levels of speech production (see Table 3.35), and all showed non-significant increases in score. Particularly striking change occurred at the sentence level for Simon and Gareth (see Section 4.4). For these three children, change also generalised to overall PCC. Intelligibility ratings increased for all children, with Callum showing the greatest increases. Significant increases in expressive language (as assessed by the Bus Story) occurred for two of the children (for further discussion see Section 4.3).

Table 3.35 shows that the NDP was effective at bringing about change for children with consistent phonological disorder, inconsistent phonological disorder and DVD. For the child with DVD, the NDP was effective at bringing about change in speech processing at the micro and macro levels, reducing inconsistency and improving oromotor skills. It was also was effective at improving speech at the micro and macro levels for the child with inconsistent disorder. The contrast between Callum and Daniel, who were classified as the same subgroup and had the same psycholinguistic profile, indicates that factors other than the therapy programme itself can influence outcome (see Section 4.1.3).

Table 3.35 Summary of significant pre and post-therapy differences (McNemar test)

	Callum	**Daniel**	**Simon**	**Gareth**
Subgroup	Consistent disorder Articulation disorder	Consistent disorder Articulation disorder	Inconsistent disorder Articulation disorder	DVD
MICRO SPEECH				
Single consonants	*			*
Single vowels				
CV and VC words	*			
CVCV words	*			
CVC words	*		*	*
Multisyllabic words	*			
Cluster words	*			
Phrases/sentences	*		*	*
MACRO SPEECH				
PCC	*		*	*
PVC				
Inconsistency				*
Oromotor movements				
Oromotor sequences				*
DDK	*			*
LANGUAGE				
Bus Story			*	*

4. Discussion

4.1 Is the NDP effective?

This study evaluated the effectiveness of the NDP therapy approach with four children with severe speech disorders using a single case study design. It found that in all cases there was positive change in speech output. This change occurred at a number of different levels: at the single sound level by increasing phonetic inventories, at the single word level by increasing the range of sounds and contrasts used accurately and reducing the number of phonological processes, at the level of the phonological system as a whole by increasing PCC, and by increasing intelligibility. However, the magnitude of this change varied significantly across individuals, ranging from highly significant change on all assessments to micro changes in realisations.

4.1.1 Subgrouping

Dodd's subgroups aim to inform intervention, and there is increasing evidence to support this: children with inconsistent phonological disorders benefit more from core vocabulary therapy, and those with consistent disorders from phonological therapy (Dodd & Bradford 2000, Crosbie et al 2005, Broomfield & Dodd 2005). Our study suggests that children with *severe* speech disorders that are classified as consistent, inconsistent or with DVD can benefit from the NDP.

However, there are a number of caveats to this. Firstly, there were difficulties applying Dodd's criteria to children with such severe speech difficulties. Whilst NDP criteria revealed that all the children had many symptoms of DVD, Dodd's criteria only classified one child with DVD. However, all children had reduced phonetic repertoires and atypical phonological processes (with their speech errors reflecting both components), and so the other three met Dodd's criteria for articulation disorder *and* consistent or inconsistent phonological disorder. No previous studies have investigated the effectiveness of therapy with children who fall into more than one subgroup.

Secondly, there was variation in response to therapy that may have been in part due to the heterogeneity of the speech disorders. Gareth met Dodd's criteria for DVD and showed

widespread improvements in speech accuracy, consistency and oromotor function that generalised to PCC and intelligibility. Simon met criteria for an inconsistent disorder and showed a variable pattern of change: some levels increased in accuracy with therapy and others decreased, and there was no overall improvement in his consistency. However, Callum and Daniel both met criteria for a consistent disorder and despite some similarities (some positive change on speech measures and no increase in language scores) showed very different overall outcomes. Callum showed widespread and significant change at micro and macro levels, whereas Daniel did not show any significant change (see Section 4.1.3 for further discussion).

Finally, the NDP is an eclectic approach that was tailored to each individual: whilst each child received a multi-target, multi-level therapy programme encompassing both discrimination and production work, individual targets and activities varied. Thus this study shows that the NDP is appropriate for children with severe speech disorders of different natures, but to be implemented successfully, requires the skill of the therapist in planning a therapy programme to meet the child's needs.

4.1.2 Psycholinguistic profile

The NDP is designed around a psycholinguistic framework, and addresses all levels of the speech processing system (Williams & Stephens 2004). Taking a psycholinguistic approach has been effective in treating speech disorders in a series of case studies (Waters et al 2001, Corrin et al 2001, Pascoe et al 2005), and it is likely that the combination of input, output and phonological awareness tasks used in this study contributed to the improvements on the speech assessments. Indeed Wolfe et al (2003) found that mixed training of discrimination and production was more effective in bringing about change in speech output skills than production tasks alone.

This study could not investigate the effect of psycholinguistic profile on response to the NDP in detail as there was little variation in psycholinguistic profile across individuals (all scored within the normal range on input tasks and were severely impaired at a number of output levels). Moreover comprehensive psycholinguistic profiling was beyond the scope of the project.

4.1.3 Other factors that influence response to therapy

Daniel and Callum highlighted the variation that can occur in response to therapy despite very similar phonological and psycholinguistic profiles. This variation has been reported in other therapy studies: Baker & McLeod (2004) treated two children with /s/ cluster reduction and phonological disorders with phonological contrast therapy. One generalised to conversational speech in seven sessions whilst the other took five months and needed a modified therapy approach.

It is accepted that knowledge of a child's weaknesses alone does not predict response to therapy. Factors such as the child's engagement with the therapy process, motivation, behaviour, learning style, understanding of his/her difficulties and the child's environment are also important (Chiat 1994, Marshall 1997, Waters et al 1998, Baker & McLeod 2004). For Daniel, the emotional aspect of his difficulties was a barrier to therapy. There are well documented psychosocial sequelae of persistent speech/language disorders such as a greater likelihood of being ignored by peers (Crowe Hall 1991), higher risk of bullying (Knox & Conti-Ramsden 2003), behavioural problems (Conti-Ramsden & Botting 2000), and lower self-esteem (Lindsay et al 2002). These factors are likely to have been exacerbated by Daniel's change of school (a significant childhood stressor and a predictor of depression in childhood; Csorba et al 2001). Moreover, Weiss (2004) iterates the importance of the child's personality and locus of control: greater risk-takers are more likely to try target sounds at different levels of complexity and situations. In addition, response to intervention has been associated with greater internalisation for children with stammers (Madison et al 2001).

Collaboration with a Psychologist suggested that Daniel's attitude to therapy mirrored that of his parents, and parental attitude is known to influence the success of intervention (Kamhi 1999, Weiss 2004). A randomized control trial reported that those children whose parents had good turn-taking, eye contact, ability to give feedback and cooperated with homework activities had a better outcome (Almost & Rosenbaum 1998). Glogowska & Campbell (2000) interviewed parents of children with speech/language delay. 25% found SLT did not match their expectations, and in some cases, this mismatch lead to a loss of enthusiasm. The level of their child's progress was also an important factor in maintaining parent motivation. This is of particular pertinence to children with severe and persistent speech disorders for whom visible improvements are

less common. Therefore the negative attitude of Daniel and his parents may have been associated with his very limited response to previous therapy.

Similarly Daniel's lack of speech practice at school contrasted greatly with the level of input Callum received from school staff. Involvement of school is likely to result in more holistic therapy and generalization. Moreover, the NDP benefits from frequent repetition and thus practice at school and home is likely to be important (Teal 2005).

4.2 Duration of therapy

Profiles of change indicated that improvements were made over both therapy blocks. Despite this progress, two of the children still met Dodd's criteria for a severe speech disorder at the end of therapy, and all parents commented both on their children's progress and the need for further intervention. A survey by ASHA found that after 17 hours of direct therapy, 83% of children with severe articulation disorder had not demonstrated significant change and needed further intervention (Zeit & Johnson 2002). This illustrates the importance of ongoing, direct intervention for the treatment of severe speech disorders (Pascoe et al 2005).

Although this study was carried out in a 'real-life' clinic, its specialist status and ability to offer twenty sessions of therapy sets it apart from community-based clinic services. Providing intensive therapy forms the first stage in evidence-based practice, and this study has provided evidence for the NDP as a treatment for severe speech disorders (Pring 2005, Garrett & Thomas 2006). An extension of this work would be to investigate the effectiveness of the NDP in treating speech disorders in other service delivery models.

4.3 Speech and language

This study revealed Simon and Gareth's expressive language (as measured by a narrative task) significantly increased over therapy. Language tasks are widely used as control tasks in speech intervention studies (Pascoe et al 2006). However, narrative and MLU are likely to be influenced by intelligibility and thus increase as a result of speech intervention, and improvements in speech are also likely to be associated with greater confidence and increased expression using language (Seeff-Gabriel et al 2005). An anecdotal case study reported increases in speech and expressive language measures after

treatment with the NDP (Saunders 2006). Moreover, causal relationships between speech and language have been explored in the literature (Panagos & Prelock 1982, Seef – Gabriel et al 2005). Methany & Panagos (1978) found that articulation therapy significantly improved both articulation and syntax scores in children with speech and expressive language difficulties. Moreover, Girolametto et al (1997) found that expressive language training resulted in significant change in phonetic inventories in toddlers with expressive language delays (although this was not the case in a similar study by Fey et al 1994).

4.4 Methodological issues

Using micro measures at a range of different levels was important to this study as the hierarchy of complexity is intrinsic to the NDP. It allowed the investigation of in-depth relationships between therapy and outcome, and change and complexity. This revealed that, in general, accuracy was related to complexity, and that change was additionally influenced by what had been targeted in therapy. However, the sentences subtest (intuitively the most complex) showed striking change amongst little at other levels for Simon and Gareth. This assessment was a repetition task, whilst all the others involved picture naming, and therefore addressed a different level of the speech processing model (the articulation of real words rather than the accuracy of motor programmes; Stackhouse & Wells 1997). This finding has highlighted the benefit of exploring differences between picture naming and repetition at other levels. This could investigate differences between stored motor programmes and online motor programming, and assess ability to update inaccurate motor programmes (Corrin 2001). Daniel may have shown much greater change on the micro speech measures when tested by repetition.

Secondly, the probe scoring system enabled the detection of changes in the direction of the target that could not be reflected in overall accuracy scores (Hall et al 1998). Probe scoring revealed improvements in phonetic similarity even if overall accuracy decreased (multisyllabic words for Simon), or if no significant change was seen (at a number of levels for Daniel). Small changes 'in the right direction' are an important outcome of therapy, particularly for children with severe and persistent speech disorders (Hall et al 1998, Carter & Edwards 2004). They may also translate into clinically significant changes in intelligibility, which are an important outcome for therapy studies (Breakwell et al 2000, Kadzin 1984).

4.5 Limitations and Future Directions

There are a number of limitations to this study in terms of research design. Firstly, a baseline should have been established by repeated measurement before therapy commenced (Pring 2005). The aim of this is to measure maturation, and in this study, therapy spanned a period of eight months during which maturation is likely to have occurred. Moreover all children had received intervention prior to the study, which varied in approach and quantity. This was due to the 'real-life' clinic setting in which children are required to have had local SLT input before referral to the Nuffield Centre, but may have acted as a confound. Similarly, long-term follow up should have been carried out to assess maintenance (Pascoe et al 2005).

Secondly, the use of the Bus Story was limited as a control measure. Control measures should assess an area this is not expected to change but one that the child is motivated to improve, and must be of equal difficulty and sensitivity to change as the experimental measures (Pring 2005, Crosbie & Dodd 2005). However, tasks that were of sufficient difficulty and complexity such as auditory discrimination could not be used as all speech processing skills were a focus of therapy. Bus Story scores and MLU were also confounded by intelligibility. Other possibilities would be to use receptive or single word tests of syntax (Bryan & Howard 1992).

Another widely used aspect of single-subject research design is the assessment of untreated words that can then be compared to treated words (Pring 2005). This has been applied successfully to intervention studies that have targeted a discrete process, such as final consonant deletion (Pascoe et al 2005, Baker & McLeod 2004). However the NDP is a multi-target, multi-level therapy programme using a wide range of words in therapy. Deriving an untreated word list for all processes and levels of complexity targeted, from a limited corpus of imageable, high frequency words in the pre-school vocabulary and matched for phonetic complexity would be extremely challenging. In order to investigate the effectiveness of the NDP using this design, it would be necessary to focus on children with less severe speech difficulties, who could then be treated on discrete processes.

Finally, the measurement of inter-rater reliability raised a number of issues that are particular to the study of speech disorders. Transcription was carried out from audio

recordings that varied in quality and were limited by the lack of visual cues for phonetic transcription. Future studies should consider using video recordings or on-line transcription by a second marker at the time of assessment. In addition, there was some variability regarding which realisations were deemed 'acceptable' (e.g. /f/ for /θ/ as in 'three' /θri/ when parents say /fri/, addition of /ʔ/ such as pocket → [pɒʔkɪt], insertion of a schwa such as 'blue' → [bəlu]. This highlighted the need for strict scoring criteria.

4.6 Conclusion

This study has shown that the Nuffield Dyspraxia Programme is effective in bringing about change in speech output skills in four children with severe speech disorders. It has also highlighted variability in response to therapy and the complexity of factors involved. This study represents the first stage of evidence-based research on this therapy programme and should be followed by further studies investigating additional children, disorders of varying severity and different models of service provision (Pring 2005, Garrett & Thomas 2006).

WORD COUNT = 9911

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Appendix 1: Description of the WPPSI

Block Design

The participant is given three dimensional blocks to reproduce a pattern. Items begin with red and white blocks with which the participant copies the patterns made by the assessor. Items begin by the assessor making patterns with blocks for the participant to copy, and then progress to using two dimensional abstract patterns presented as pictures. Each item is timed.

Matrices

The participant is shown a 2x2 grid. Pictures are present in 3 sections, and the participant has to choose the missing picture from five possible choices.

For each of the subtests, the raw scores are converted to a scaled score, which takes into account the age of the participant. Scaled scores range from 1 - 19 with a score of 10 corresponding to the performance of the average person at a given age on that subtest. Scaled scores between 7 and 13 are said to fall within the average range.

Appendix 2: Description of the TACL-3 (Carrow-Woolfolk 1999)

For each subtest the participant is asked to point to one of three pictures that match a spoken word or sentence. The pictures for each item include the target plus two semantic/grammatical contrasts of the stimulus or one contrast and one decoy.

For each of the subtests, the raw scores are converted to a scaled score, which takes into account the age of the participant. Scaled scores range from 1 – 20 that fall into the following categories: 1-3 = very poor, 4-5 = poor, 6-7 = below average, 8-12 = average, 13-14 = above average, 15-16 = superior, 17-20 = very superior.

Vocabulary

This sub-test assesses comprehension of single words (e.g. cat, bird, giving, equal). The words include nouns, verbs, adjectives and adverbs and cover the most common and literal meanings, basic percepts and concepts.

Grammatical morphemes

This sub-test assesses comprehension of sentences (e.g. the cat is in the box, they swam). The sentences include prepositions, noun number, noun case, verb number and tense, noun-verb agreement, derivational suffixes and pronouns.

Elaborated phrases and sentences

This sub-test assesses syntactically based word relations, elaborate phrase and sentence constructions including modalities of single and combined constructions (interogative sentences, negative sentences, active and passive voice, direct and indirect object), embedded sentences and partially and conjoined sentences.

Appendix 3: DEAP Phonology word list (Dodd et al 2002)

1. Elephant
2. Umbrella
3. Train
4. Swing
5. Bread
6. Duck
7. Giraffe
8. Five
9. Teeth
10. Watch
11. Orange
12. School
13. Crab
14. Biscuits
15. Thank you
16. Helicopter
17. Egg
18. Splash
19. Square
20. Pig
21. Gloves
22. Queen
23. Three
24. Frog
25. Yellow
26. Strawberry
27. Spider
28. Web
29. Sheep
30. Snake
31. Pram
32. Feather
33. Tomato
34. Monkey
35. Toothbrush
36. Apple
37. Knife
38. Van
39. Ear
40. This
41. Scissors
42. Fishing
43. Lighthouse
44. Zebra
45. Kitchen
46. Sausage
47. Tiger
48. Rabbit
49. Book
50. Boy

Appendix 4: DEAP Inconsistency word list (Dodd et al 2002)

1. Shark
2. Boat
3. Rain
4. Zebra
5. Birthday cake
6. Parrot
7. Jump
8. Vacuum cleaner
9. Bridge
10. Teeth
11. Elephant
12. Slippery slide
13. Tongue
14. Umbrella
15. Five
16. Kangaroo
17. Chips
18. Fish
19. Thank you
20. Witch
21. Girl
22. Helicopter
23. Dinosaur
24. Ladybird
25. Scissors

Appendix 5: DEAP Oromotor assessment (Dodd et al 2002)

Isolated movements

1. Tongue elevation (*'can you put your tongue up to the top of your mouth like this?'*)
2. Lateral tongue movement (*'can you move your tongue from one side to another like this?'*)
3. Lip rounding (*'can you round your lips like this?'*)
4. Lip spreading (*'can you spread your lips like this?'*)

Sequenced movements

1. Blow and put your tongue up
2. Kiss and cough
3. Yawn and lick the side of your mouth

Scoring

3	Accurate performance immediately follows verbal command.
2	Accurate performance preceded by protracted pauses during which unsuccessful movements may be present.
1	Overall pattern of gesture acceptable, but defective in terms of amplitude, accuracy, force and/or speed.
0	An important part of the gesture is lacking; incorrect or non-targeted oral gestures; speech sound is produced; no oral movement

Appendix 6: Parent Questionnaire on Speech Intelligibility: Pre/Post therapy

Child's name: Date:

In order to measure the effectiveness of the therapy that your son/daughter will receive we would like you to complete this form before and after therapy. We would be most grateful if you could complete this form and return it to us as soon as possible.
Thank you!

How would you describe your son/daughter's speech? (Please just tick ONE box)

Family, teachers, friends and strangers understand everything he/she says (He/she never has to repeat anything).	
Most people understand everything he/she says.	
Most people understand most of what he/she says.	
Some people understand most of what he/she says.	
Some people understand some of what he/she says.	
People usually have difficulty understanding what he/she says.	

How easy is it for your son/daughter to make themselves understood in these situations?

5 = very easy (doesn't have to repeat anything
4 = quite easy (occasionally has to repeat)
3 = a bit difficult (often has to repeat)
2 = difficult (sometimes has to repeat)
1 = very difficult (sometimes they don't understand whether/she says even if he/she repeats and shows)
0 = impossible!

Please put a number in EACH box:

Asking family and friends for something to eat or drink.	
Telling family and friends about something he/she saw or did.	
Calling out to friends in games (e.g. football).	
Explaining a game to a friend.	
Talking to a stranger when it is noisy.	
Telling a story/joke to a group of people.	
Asking a question in a big class.	

Are there any particular words or sentences he/she says that are difficult for others to understand (people keep asking him/her to repeat them)?

If yes, they are:

Are there any sounds that are hard for him/her to say?

If yes, they are:

Do you want your son/daughter's speech to be clearer?
(Just tick ONE box)

Definitely	
It would be good.	
Maybe.	
I think so / I don't mind.	
I don't care.	
No.	

Please give reasons for your answer:

What do you think your son/daughter has to do to make his/her speech clearer?:

Any additional comments (continue on separate sheet if necessary):

Thank you so much for filling out this form.

Appendix 7: The Bus Story

Once upon a time there was a very naughty bus. While his driver was trying to mend him, the bus decided to run away.

He ran along the road beside the train.
They made funny faces at each other and raced each other.
But the bus had to go on alone, because the train went into a tunnel.
He hurried into the city where he met a policeman who blew his whistle and shouted, 'Stop, bus'.

But the naughty bus paid no attention and ran out into the country.
He said 'I'm tired of going on the road'.
So he jumped over a fence.
He met a cow who said, 'Moo, I can't believe my eyes'.

The bus raced down the hill.
As soon as he saw there was water at the bottom, he tried to stop.
But he didn't know how to put on his brakes.
So he fell in the pond with a splash and stuck in the mud.
When the driver found where the bus was, he telephoned for a crane to pull him out and put him back on the road again.

Appendix 8: Rules for calculating mean length of utterance (Brown 1973)

Count as one morpheme:

- Reoccurrences of a word for emphasis
- Compound words (e.g. birthday)
- Proper names
- Ritualized reduplications (e.g. choo-choo)
- Irregular past tense verbs
- Diminutives (e.g. doggie)
- Auxiliary verbs
- Irregular plurals

Count as two morphemes:

- Possessive nouns
- Plural nouns
- Third person singular, present-tense verbs
- Regular past-tense verbs
- Present progressive verbs

Do no count:

- Dysfluencies, except for most complete form
- Fillers (e.g. mmmm, oh)

Appendix 9: NDP assessments – stimuli (NDP 2004)

Single Consonants

1. p
2. b
3. m
4. t
5. d
6. n
7. k
8. g
9. h
10. w
11. j
12. f
13. s
14. ʃ
15. l
16. ŋ
17. v
18. z
19. tʃ
20. dʒ
21. θ
22. ð
23. r
24. ʒ

Single vowels

1. i
2. ɑ
3. u
4. ɔ
5. ɜ
6. eə
7. aɪ
8. aʊ
9. ɪə
10. əʊ
11. ɔɪ
12. eɪ
13. ɪ
14. æ
15. ʊ
16. ɒ
17. ʌ
18. e

CV and VC words	CVC words	CVCV words
1. moo	1. cake	1. mummy
2. door	2. boat	2. baby
3. bee	3. bird	3. teddy
4. go	4. down	4. cooker
5. knee	5. moon	5. dirty
6. deer	6. dog	6. dinner
7. boy	7. girl	7. party
8. car	8. tap	8. table
9. cow	9. pig	9. picking
10. two	10. cat	10. cowboy
11. pay	11. duck	11. kettle
12. four	12. farm	12. garden
13. sea	13. horse	13. tiger
14. shoe	14. leaf	14. water
15. chair	15. sun	15. fire
16. lie	16. fish	16. jelly
17. out	17. light	17. kitchen
18. up	18. watch	18. coffee
19. arm	19. jam	19. tissue
20. ice	20. web	20. sitting

Cluster words	Multisyllabic words
1. star	1. pocket
2. sky	2. ticket
3. snake	3. chocolate
4. swing	4. banana
5. blue	5. birthday cake
6. flower	6. dinosaur
7. clock	7. caterpillar
8. tree	8. helicopter
9. pram	9. aeroplane
10. frog	10. crocodile
11. fast	11. television
12. boats	12. ambulance
13. hand	13. fire engine
14. crisps	14. washing machine
15. biscuit	15. computer
16. lift	16. butterfly
17. jump	17. animals
18. monkey	18. umbrella
19. ice-cream	19. hospital
20. Christmas	20. sausages

Phrases and sentences

1. My baby
2. Katy's party
3. Tommy cutting paper
4. Farmer sitting
5. Daddy is talking
6. A cup of tea
7. Two sad cats
8. Get an apple
9. Go in the house
10. Dinosaur museum
11. Do you like jelly?
12. Peter is eating his dinner
13. Lee made a lighthouse
14. I saw five camels at the zoo
15. Mummy's cup is in the cupboard
16. David is cooking chips
17. A tiger is digging in Katie's garden
18. Caterpillars change into butterflies
19. Jack got a train and an aeroplane for Christmas
20. Christopher is the best footballer in our school