Investigating Intervention: Phonological therapy in a psycholinguistic framework

Volume I

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Abstract

This thesis investigates intervention for school-aged children with speech and literacy difficulties. Many previous studies have used phonological analysis as a theoretical basis, while others have used psycholinguistic models. The present study combines these approaches to assessment, intervention and evaluation of outcomes using a single case pre-post design for five children, aged 5;6 – 8;6 years.

The research aimed to determine if intervention could result in (a) specific and (b) generalised improvements in the speech processing skills of children with severe and persisting difficulties. Assessment took place at two levels. First, the macro level focused on global change in each child's speech processing skills using psycholinguistic speech profiling, phonological analyses and intelligibility evaluations. Second, the micro level assessment focused on specific, treated and matched control stimuli, and was used to evaluate generalisation for each child. Changes at each level are used to contribute to the clinical evidence base and to inform theory of children's speech processing.

Key areas highlighted by individual cases include stimuli selection; connected speech; production and perception of consonant clusters, and links between speech and spelling difficulties. Themes emerging across the cases are the links between theory and therapy, the integration of developmental and information-processing perspectives, the complementary relationship between profiling and sub-grouping approaches as a means of dealing with the heterogeneity of the population and intelligibility as a clinical outcome measure.

Intervention brought about significant improvements in each child's speech processing at the micro level. The extent of generalisation varied across children. For some, change extended to the macro level including significantly increased intelligibility. For others, change was limited to the micro level. The fundamentally different nature of the children's speech processing profiles is considered together with ways in which speech-processing models might be developed. The case studies collectively contribute towards the development of a theory of therapy grounded in a psycholinguistic framework.

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Conventions

(From Stackhouse and Wells, 1997 p.xvii)

TIE spoken real word target / stimulus, as in real word repetition test, rhyme production test, spelling to dictation of real words; also used for picture target / stimulus, as in naming test, or silent rhyme detection.

[strai] spoken non-word target as in non-word repetition or discrimination test; spelling non-words to dictation; also used for real word target when phonological information is required.

<tie> written target or response, as in a test of single word reading (real or non-word)

[taɪ] spoken response where phonetic information is required

"tie" spoken response where phonetic information is not required

[b]~[p] [b] contrasted with [p]

[.] micropause (timed pause of less than 1 second)

Children's ages are given using the convention of years; months, e.g. 5;6 = five years and 6 months

Abbreviations

AAC – alternative and augmentative communication

CA – chronological age

DAMP - deficits of attention, motor control and perception

DVD – Developmental verbal dyspraxia

LSA – Learning support assistant

NDP – Nuffield dyspraxia programme (Connery, 1992)

NHS – National Health Service

PACS – Phonological Assessment of Child Speech

PPK – Productive phonological knowledge

SATs – Standard assessment tests

SEN – Special Educational Needs

SENCO – Special Educational Needs Co-ordinator

SLT – Speech and language therapy / therapist

WF – word final segment (e.g. boo<u>k</u>)

WI – word initial segment (e.g. <u>b</u>ook)

WW – segment within a word (e.g. fu<u>nn</u>y)

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In memory of my grandmothers

Mavis Hazel Collen
1918 - 2001

Dorothy Faraday Pascoe
1917 - 2002

CHAPTER 1: INTERVENTION FROM A CLINICAL PERSPECTIVE

Chapter outline Page

1. THERAPY AND THEORY: AN INTRODUCTION TO INTERVENTION STUDIES

Intervention studies can be justified in two ways: Firstly, from a clinical perspective they contribute to the growing body of evidence regarding treatment outcomes. Undoubtedly, an

important goal in the study of children with specific speech, language and literacy difficulties is to enhance current knowledge of effective intervention (Sommers, Logsdon and Wright, 1992; Enderby and Emerson, 1995; Frattali, 1998; Crosbie and Dodd, 2001; Evans, 2001; Gibbon, McNeill, Wood and Watson, 2003). Without detailed studies of intervention, there can be no increase in knowledge about effective clinical practice (Stackhouse and Wells, 2001). Secondly, from a theoretical point of view, intervention studies have the potential to add to knowledge concerning the normal and atypical development of speech, language and literacy and the associated underlying cognitive processes in children (Bishop, 1998b; Baker, Croot, McLeod and Paul, 2001). When intervention is carried out in a controlled way, the outcomes of the programme allow one to return to the theoretical starting point, and reconsider the nature of the speech and language processing system, and difficulties that may affect it.

On the surface, 'therapy' and 'theory' may seem to be comfortable companions, yet the relationship between the two is not necessarily a straightforward one. Clinicians may be more interested in the outcomes of intervention, carrying out intervention studies primarily addressed to this level (Hagstrom, 2001). Some authors have suggested that clinicians may perceive theoretical psycholinguistics or neuropsychology as offering limited applicability to their clinical practice (Evans, 2001). Wilson and Patterson (1990, p.248) note that, "Theories about the nature of the deficit do not relate to questions that have to be asked in treatment." From the opposing point of view, theorists may fail to engage in intervention research for a number of reasons:

> "One reason might simply be the daunting prospect of properly designed and executed cognitive rehabilitation research. The rare examples of this demonstrate that the enterprise requires everything in a good cognitive neuropsychology study (the background assessments, the deficit analysis etc.) plus all the added work and complications of the treatment programme itself, the necessarily longitudinal nature of the research, the need to rule out explanations other than the treatment for any obtained effects etc. It is hard work. A second possible reason is that the potential to learn something of real theoretical significance from the outcome of treatment may not be apparent (or convincing) to many neuropsychologists." (Patterson, 2002 p.570).

Much of the discussion regarding the relationship between therapy and theory has taken place in the context of rehabilitation with adults. Theoretically-motivated therapy approaches for adults with acquired aphasia have been based around cognitive neuropsychological theories. Work with children, carried out from a developmental perspective has been slower to develop, but is becoming more firmly established in the field of psycholinguistics. This thesis provides five examples of single-case study interventions for school-age children with longstanding speech

problems. Treatment efficacy is considered an important aspect of the work, but in addition it is hoped that 'real theoretical significance' can be demonstrated.

While Chapter 2 concerns itself with issues of theoretical importance, this chapter focuses on intervention studies from an effectiveness point of view. It aims to outline the importance of applied intervention research and its value in contributing to a clinical efficacy database. Section 2 of this chapter, provides a broad overview of intervention research in the developmental field. Although this thesis is specifically concerned with school-age children with speech and literacy difficulties, it is useful to consider outcomes studies carried out with the entire developmental group since many of the principles will be shared across different populations within the group. In many ways, work with children poses even more challenges that those cited by Patterson in relation to the acquired adult domain. Challenges facing intervention researchers working with children are introduced in section 3, where it is argued that certain methods, research questions, outcomes measures and ways of sensitively interpreting results are appropriate for working with this client group and can most usefully contribute to knowledge of intervention and theoretical issues. Section 4 focuses on model-based approaches to intervention, specifically introducing and arguing for the use of contemporary psycholinguistic frameworks. This is followed by a second, more focussed review of intervention studies pertinent to this work, in section 5. The studies discussed in this final section of the chapter are single case studies of model-based intervention, carried out with school-age children with speech and /or literacy difficulties.

2. AN OVERVIEW OF INTERVENTION RESEARCH

2.1 Why carry out intervention studies? A clinical rationale

Intervention research is important for a number of reasons. There is the obvious need to serve individual clients in ways that are effective and efficient. It is estimated that approximately 9% of children between 5-7 years of age have speech problems (Law, Boyle, Harris, Harkness and Nye, 1998). These children face an increased risk of social, literacy and academic difficulties and it is imperative to remediate their difficulties as soon as possible. In addition, there is a need to demonstrate the value of speech and language therapy services within a broader setting. If the profession aims to develop and grow, it needs to be able to show its benefit in demonstrable, scientific ways. Current professional concerns in healthcare and education have continued to increasingly necessitate more evidence of knowledge-based practice to underpin service delivery

and development (Byng, Van der Gaag and Parr, 1998; Frattali, 1998). The rationale for evaluating effectiveness of therapy lies not only in accountability, but is also important to direct in therapy planning, and to enhance work satisfaction (Dodd, 1995).

2.2 A historical perspective on phonological intervention

In the 1960's 'speech therapy' was heavily influenced by behaviourism with speech regarded as a specialised behaviour that could be modified by altering the environment and its associated precedents and consequences (e.g. Gray and Fygetakis, 1968; Sloane and MacAuley, 1968). In the 1970's the influence of linguistics became more strongly felt. A shift was seen from articulatory approaches concerned with individual phonemes (e.g. Van Riper, 1963) to phonological therapy (e.g. Ingram, 1974, 1976) which focussed on targeting phonological processes as a more effective way of carrying out therapy. Phonological approaches – like their articulatory predecessors- have the ultimate goal of improving a child's speech production and of helping a child to become more intelligible. In addition, phonological intervention has the goal of "facilitating cognitive reorganisation of the child's phonological system and his [or her] phonologically-oriented processing strategies." (Grunwell, 1985, p.99). There are many different approaches to phonological intervention based on these broad principles. These include minimal pair contrast therapy (e.g. Blache, Parsons and Humphreys, 1981; Weiner, 1981; Barlow and Gierut, 2002), distinctive feature approaches (e.g. Costello and Onstine, 1976; Elbert, 1992; Gierut, 1998a), maximal opposition approaches arising from standard generative phonology theory (e.g. Gierut, 1989, 1992), natural processes approaches (Shriberg and Kwiatkowski, 1980), multiple oppositions approaches (Williams, 2000a,b; Williams and Kalbfleisch, 2002), metaphonological approaches (e.g. Howell and Dean, 1994) and focused auditory stimulation (Rvachew, 1994).

The contribution of linguistics to speech and language therapy has been considerable, and has enabled therapists to develop a more comprehensive understanding of the complexities of communication beyond that of articulation. Linguistic contributions are not limited to phonology. Gallagher (1998) observes the wide-ranging influence of pragmatics and metalinguistic knowledge in the 80's and 90's, and the increased attention given to functional and psychosocial aspects of communication. These are aspects that have influenced the way in which all speech and language interventions are carried out, including phonological therapy. In terms of service delivery there have also been considerable changes since the early years of the profession. Bowen and Cupples (1998) comment on the increasing role of parents - and other involved parties - in the therapeutic processes.

The effectiveness of different types of phonological therapy and its delivery has been evaluated to varying degrees, and this is discussed in subsequent sections.

2.3 What do we know about therapy outcomes for children?

Speech and language therapy for children is generally held to have positive outcomes (Nye, Foster and Seaman, 1987; Gierut, 1998b; Law et al., 1998; Goldstein and Geirut, 1998; Law and Garret, 2003). It is in the area of phonological disorders that much of the outcomes research in speech and language therapy has focused, and shown generally positive results (e.g. see Shriberg and Kwiatkowski, 1994; Law and Garret, 2003). Almost and Rosenbaum (1998) carried out a survey of intervention studies with children with phonological difficulties. The major finding was that children who receive intervention for phonological difficulties improve - with an average effect size of 1.69 reported across all studies regardless of the test used to measure outcomes. Shriberg and Kwitakowski (1994) summarize these positive benefits of phonological intervention as follows:

> "Children who receive phonological treatment exhibit improved intelligibility and general communicative functioning. There are no known risks involved in the treatment, and the long-term benefits for continued communicative, educational and social success are beginning to be documented." (p.1100)

However, it is only in recent years that speech and language therapists have attempted to address the challenging task of documenting the effectiveness of treatment with children. Roulstone (2001) reported that 55% of articles in the International Journal of Language and Communication Disorders in the preceding two years focused on children. Of this number, only 9 were intervention studies. Between 2001 and 2004, an additional 5 studies were carried out with a developmental focus and involving intervention. Sommers et al. (1992) carried out a systematic review of developmental phonological treatment studies reported in the published literature. Results suggested that a great deal more efficacy data is needed, and that for many important and routinely occurring clinical decisions, estimates of efficacy and treatment data are needed that are based on both comprehensive single subject designs and more powerful designs that provide reliable replication. However, they comment on the methodological weakness of the studies, amongst other things scarce reliability data and 'weak study designs'. More recently Law and Garret (2003) carried out a review of the effectiveness of speech and language interventions for children with primary speech and language delay/disorder. The review was limited to randomised control trials of speech and language therapy interventions for children and adolescents with primary speech and language delay/disorder. Twenty-five articles were

found and used in the meta-analysis. The results of these reported trials suggest that speech and language therapy is effective for children with phonological or expressive difficulties, but that there is less evidence that interventions are effective for children with receptive difficulties.

Many of the efficacy and effectiveness studies in the domain of developmental phonological difficulties have focused on pre-school children rather than on the school age child with persisting speech problems. Almost and Rosenbaum (1998) focused their survey specifically on pre-school children, using a cut-off age of 6 years. While, the review of Sommers et al. (1992) cast a broader net in terms of ages of children, it still confirmed that much of the research into phonology has been concerned with pre-school children. This is not surprising if one considers the great emphasis that is rightly placed on early intervention. If children's speech and language difficulties can be identified and addressed at the earliest possible time then the likelihood of preventing or at least minimizing negative academic and social sequelae is increased (Stackhouse, 2001). However, some children *are* appropriately identified from a young age and receive intervention to address their speech and language difficulties for many years without their difficulties being completely resolved. Speech and language problems are often complex and resistant to intervention. The amount of intervention required to remediate some children's complex difficulties is not yet known and in any event may not always be practical to deliver. Ruscello (1995) describes a group of children who do not respond to intervention and whose speech difficulties persist through the school years and often into adulthood. This same group of children is described by Shriberg, Gruber and Kwiatkowski (1994) as having residual phonological errors, most typically thought to affect the fricative and liquid sound classes. These authors emphasise the need to study this subgroup of children since we know that minor speech errors may be negatively perceived by peers (Crowe Hall, 1991) and since the effects of speech on literacy and other academic areas is well-documented. Studying this group of children and finding effective interventions for their persisting problems is an important priority. Nonetheless, we should remember that the children in this group are likely to be heterogeneous and have different residual problems, intervention histories and current needs.

2.4 Approaches to intervention research: A broad review

Efficacy, efficiency and effectiveness are terms frequently cited in outcomes literature, variously used to measure the results of treatment. Effectiveness is considered to be change produced in the context of service provision, often in small-scale studies closely approximating 'real life.' Efficacy, on the other hand implies change produced under experimental conditions usually

involving groups of children. Efficiency refers to the fastest or most direct way of achieving a desired result. Review papers, when combined with a more general literature search, reveal several different approaches to investigations of intervention effectiveness, efficacy and efficiency with a developmental client group. These are outlined in the subsections that follow.

This broad-ranging survey of outcomes research again reveals that most of the intervention research has focused on pre-school children rather than the school-age child. The review that follows focuses primarily on the effects of phonological treatment, although interesting intervention studies addressing other domains of language have also been included on a selective basis. Outcomes research in the area of developmental phonological disorders has predominantly utilised single subject research designs to investigate the question of effectiveness. The review begins by introducing some of the studies carried out using this approach, before moving on to alternative group designs.

2.4.1 Effectiveness studies

Effectiveness studies are concerned with treatment outcomes in routine clinical settings. They typically evaluate specific treatment programmes with small numbers of children using single case studies and multiple baseline techniques. Law (1995) notes that while initially there was a slow shift to the use of single case designs, it was in the area of phonological therapy in which convincing evidence for change by use of this design was shown successfully. Single case studies have become increasingly well-established in the intervention literature, (e.g. Weiner, 1981; Chiat and Hirson, 1987; McGregor and Leonard, 1989; Bryan and Howard, 1992; Stackhouse and Wells, 1993; Dodd and McCormack, 1995; Broom and Doctor, 1995a,b; Constable, Stackhouse and Wells, 1997; Easton, Sheach and Easton, 1997; Holm and Dodd, 1999; Crosbie and Dodd, 2001; Spooner, 2002) and are an important method for providing insights into the nature of individual patterns of change. These case studies cover a range of areas including speech processing and production, receptive and expressive language, reading and spelling.

Case studies vary widely in their theoretical starting point, study design and nature of assessment and intervention. In terms of theoretical starting point, the single subject design is well-suited for evaluating the effectiveness of model-based interventions. For example, psycholinguistic and cognitive neuropsychological models of speech, language and / or literacy provide a detailed framework for assessment and investigation of children's underlying difficulties. Such detailed, theoretically-motivated assessment then allows one to generate hypotheses about the locus of difficulty and to evaluate intervention outcomes within this

framework by returning to original hypotheses. Examples of such model-based interventions include the single case studies reported by Bryan and Howard (1992), Broom and Doctor (1995a, b), Vance (1997), Waters et al. (1998), Norbury and Chiat (2000), Crosbie and Dodd (2001), Spooner (2002) and Stiegler and Hoffman (2001).

While many single case studies have been published, not all of these involve intervention. Many of the model-based approaches require extremely detailed investigation of children's difficulties, and as such provide interesting insights about the nature of the difficulties in their own right (e.g. Chiat and Hirson, 1987; Stackhouse and Wells, 1993; Constable et al., 1997; Ebbels, 2000; Crosbie, Dodd and Howard, 2002). Many of these studies offer suggestions for treatment and discuss the clinical implications of difficulties without systematically evaluating intervention. While single case studies focus on individual children, in some cases comparisons with groups of normally developing controls are necessitated due to a lack of normative data for particular tasks (e.g. Stackhouse and Snowling, 1992; Constable et al., 1997; Crosbie and Dodd, 2001)

However, not all single case studies use psycholinguistic models as their theoretical springboard. Many single case studies have relied mainly on linguistic theory (e.g. Weiner, 1981; Monahan, 1986; Saben and Ingham, 1991; Bernhardt, 1992; Stiegler and Hoffman, 2001) or are less theoretically-explicit in their approach (e.g. Johnson and Hood, 1988). Pratt, Heintzelman and Deming (1993) evaluated the efficacy of the IBM SpeechViewer's Vowel Accuracy Module for the treatment of vowel productions. Six preschool children received the treatment within a single-subject research design, allowing for each child's progress to be evaluated as well as comparisons and contrasts to be made between children. Four children exhibited a treatment effect for the vowels addressed, and these same children demonstrated some generalization to other vowels. While much of this single case research has focused on younger, pre-school children, there are some examples of single case interventions with older children. For example, Gibbon et al. (2003) evaluated changes in speech production occurring after intervention with a 10-year-old girl, and Shuster, Ruscello and Haines (1992) demonstrated effectiveness in their work with an adolescent who exhibited multiple articulation errors.

2.4.2 Efficacy studies

Evaluations of treatment efficacy are concerned with providing answers to the following question: 'Does intervention result in greater improvements than would naturally occur in spontaneous development?' Efficacy studies examine the outcome for groups of children who have received speech and language therapy, comparing them with children who have not and

who therefore act as controls; with additional attempts made to control for treatment versus non-treatment effects, and the amount of treatment given. Ethical dilemmas associated with withholding treatment are typically overcome by using delayed treatment (e.g. see Almost and Rosenbaum, 1998; Glogowska, Roulstone, Enderby and Peters, 2000) especially if children would in the normal course of events be subject to a period of time on a waiting list prior to receiving therapy.

The focus in group studies is on identifying children with broadly similar aetiologies or symptoms, by implication suggesting that the same treatment might be applicable to all members of the group. Randomized control trials (RCTs) are frequently cited as the 'gold standard' of efficacy research (e.g. see Glogowska et al., 2000). One of the first group studies into the efficacy of articulation therapy was carried out with groups of school-age children (kindergarten and first and second grade, i.e. 5-7 years) using randomization techniques (Sommers, Cockerille, Paul et al., 1961). Results from this pioneering work showed that direct and individual speech therapy was successful in reducing articulation errors, when compared to children who only received indirect classroom-based instruction.

The randomized control trial carried out by Almost and Rosenbaum (1998) is one of the few to specifically address children with phonological difficulties, although focusing on pre-schoolers rather than school-aged children. Thirty children with severe phonological disorders were randomly assigned to two treatment groups. Group 1 received treatment for four months followed by four months without treatment, while group 2 underwent four months without treatment followed by four months of treatment. The children were seen individually twice weekly for half hour sessions. A range of outcome measures were used including the Goldman-Fristoe Test of Articulation (Goldman, Fristoe and Woodcock, 1972), the speech severity index of percentage consonants correct (PCC) for single words and connected speech, and measures of mean length of utterance (MLU) to evaluate any generalization to syntactic skills. Group 1 showed significant differences in phonological measures after the first four months of the study when compared to the untreated group of children. At the eight month assessment point both groups had improved significantly from baseline in terms of their speech production. The severity index for conversational speech continued to be significantly different, with group 1 scores higher than those of group 2. It was suggested that children in the earlier treatment group had had longer to generalize the new speech sounds into their connected speech. The expressive language measure (MLU) did not detect a difference between groups at any time suggesting that the benefits of phonological therapy were specific to speech and had no significant impact on language.

While Almost and Rosenbaum (1998) were interested in the effects of phonological therapy on language production, Fey, Cleave, Ravida et al. (1994) investigated the reverse issue: would grammar facilitation affect the phonology of children with speech and language problems? They found that such a broad-based language approach was effective in improving children's grammar but did not significantly improve their speech production. They concluded that children between four and six years of age with phonological difficulties should have intervention directly addressed to their phonology. A recurring theme for many of these group studies is the great variability reported in the way individual participants respond to intervention.

Another, larger (n=159) and more recent RCT aimed to determine the effectiveness of community-based speech and language therapy for pre-school children (Glogowska et al., 2000). This study found no evidence for the effectiveness of speech and language therapy when compared to 'watchful waiting' for this group. However, in evaluating such studies the dosage and nature of therapy given needs to be considered. The children participating in the RCT received very limited amounts of therapy in line with constraints of their service (e.g. see Law and Conti-Ramsden, 2000 for discussion of this issue). The results of this reflect on the limitations of a particular service delivery model, rather than on any particular approach to speech and language intervention. The level of input that children need in order to make progress is an important issue when trying to justify resources (Law and Conti-Ramsden, 2000) and one which requires further investigation. While RCTs are a powerful means for testing experimental hypotheses using methods designed to reduce bias, they leave many specific questions unanswered.

The efficacy of the Metaphon approach has been particularly well-documented (Howell and Dean, 1994; Dean, Howell, Waters and Reid, 1995). A group study (Dean et al., 1995) to evaluate its effectiveness used 50 pre-school children treated by six different therapists. Children were randomly assigned to groups which received different therapy dosage for parts I and II of the programme. Therapy was found to be effective although it seemed that a certain amount of Metaphon therapy is required before significant change is noted in phonological production. Metaphon therapy is thought to be effective regardless of the severity and nature of the child's phonological problems, which the authors note contradicts assumptions that atypical processes are more resistant to therapy (e.g. Dodd and Iacono, 1989). Metaphon is also thought to be an economical treatment procedure: five hours of therapy was able to bring about significant change for most children in the study (Dean et al., 1995). It has however been noted (Grundy, 1995) that this could be due to the meaningful minimal contrast therapy approach itself and not necessarily due to the extra information given regarding properties of individual

phonemes in the shared vocabulary. There are some suggestions that metalinguistic skills, speech processing ability and cognitive abilities may affect outcome of therapy from child to child.

Rvachew (1994) investigated the efficacy of auditory perception training as a means of improving speech production. Participants in the treatment group received systematic exposure to pairs of words minimally contrasted in terms of the children's error sounds (SHOE and MOO) while those in the control group received exposure to random words (CAT and PETE). After the training period children in the treatment group were found to have superior ability to articulate the target sound in comparison to the control children. Previous studies of auditory perception had not found such positive benefits for children's speech (e.g. Williams and McReynolds, 1975) but this may have been because the phonemes contrasted were not specific to the child's input speech difficulties. Locke (1980a) noted that much speech perception training is too general to be of specific value, and that treatment should involve stimuli representing the error sounds and the child's substitution for this sound. Hodson and Paden's (1991) auditory bombardment approach is a procedure designed to provide children with intensive exposure to specific phonological targets and contrasts. Children listen to amplified speech, delivered through headphones, at the beginning and end of every session. This focused auditory stimulation is just one component of Hodson and Paden's programme (see Hodson and Paden, 1991).

Another auditory input approach is that of Tallal and her colleagues (Tallal, Miller and Fitch, 1993; Merzenich, Jenkins, Johnson et al., 1996; Tallal, Miller, Bedi et al., 1996) who evaluated the effect of intensive auditory training on children, using acoustically modified speech. They found that children's language scores improved significantly, mainly in terms of speech discrimination and language comprehension. This was taken as support for their theory that temporal processing deficits underlie children's language difficulties. However, the results of the study revealed only that auditory training has the potential to improve auditory skills, while the effect of such training on speech production remains limited. Further theoretical implications of this work are discussed in Chapter 2.

Bowen and Cupples (1999) used a longitudinal matched group design to investigate the efficacy of 'broad-based phonological therapy.' This eclectic intervention for preschoolers involved family education, metalinguistic tasks, traditional articulation therapy and multiple exemplar techniques. Progress of 14 treated children was compared with that of 8 untreated control children. Highly significant selective progress was found for the treated children only. Non-significant changes in receptive vocabulary pointed to the specificity of the therapy.

In the literacy domain, most of the efficacy studies have focused on children's reading skills. Tan and Nicholson (1997) carried out intervention using flashcards to target single word decoding. It was hypothesised that improving the children's speed of processing at this low level of task would have an effect on higher linguistic levels such as comprehension. The hypothesis was supported, which clearly has important implications both for intervention with such children and in terms of our understanding of the reading process. Table 1.1 summarises the efficacy studies discussed in this section.

Table 1.1
Studies investigating efficacy of speech and language therapy

Author/s	No. of children	Age of children	Intervention	Outcomes
Almost and Rosenbaum (1998)	30	Pre-school	Minimal pair contrast	Positive for phonological outcomes (but negative for grammatical production)
Bowen and Cupples (1999)	22	Pre-school	Broad-based approach involving family education, metalinguistic tasks, traditional phonetic production procedures and multiple exemplar techniques	Positive
Fey et al. (1994)	26	Pre-school (4-6 years)	Grammar facilitation	Negative (for phonological outcomes, but positive for language outcomes)
Glogowska et al. (2000)	159	Pre-school	'Routine' – whatever clinicians normally do; no attempts to control	Negative
Dean et al. (1995)	50	Pre-school	Metaphonological therapy (Metaphon, Howell and Dean, 1994)	Positive
Rvachew et al. (1994)	27	Pre-school	Speech perception training	Positive
Somers et al. (1961)		School-age (5 – 7 years)	Articulation therapy	Positive
Tan and Nicholson (1997)			Flashcards for decoding	Positive improvement in single word decoding and comprehension

2.4.3 Efficiency studies

Efficiency studies are concerned with finding the best intervention for particular difficulties. The starting point for such studies is the assumption that intervention works. Thus, many of these studies use 'tried and tested' techniques that have already been validated in effectiveness research. One of the main questions that this type of study aims to answer is: Does intervention

A work better than intervention B? In these *inter-intervention* studies two different approaches to therapy are compared (e.g. minimal pair treatment v. metaphonological approach), or alternatively providers of therapy (e.g. therapist v. parent) or service delivery models (e.g. group v. individual) are compared. In these types of study 'better' may be measured by means of the effect size achieved, or the speed with which a given criterion level for improvement is reached. Another approach to efficiency is that of *intra-intervention* studies, which look within a given therapy approach for specific ways of maximising treatment success. Many of the studies in the realm of phonological therapy have focused on target selection, asking which targets result in more widespread change and greater improvements. These different approaches to efficiency evaluation are discussed in the following sections as they relate to phonological intervention.

(a) Inter-intervention studies: Does intervention A work better than intervention B?

Meta-phonological approaches

Efforts to improve the effectiveness of intervention for children with phonological difficulties have focused on aspects such as the treatment approach. Phonological awareness is an area that has received increased attention over the past few years. It is the ability to reflect on the sounds of one's language and to manipulate these in abstract ways. Phonological awareness is considered to be an integral aspect of both oral and written language (e.g. Stackhouse and Wells, 1997; Stackhouse, Wells, Pascoe and Rees, 2002). Researchers have begun to consider alternative 'meta' approaches to phonological intervention. For example, Hesketh, Adams and Hall (2000) carried out a comparative outcomes study looking at the effect of metaphonological therapy v. traditional articulation therapy with a group of pre-school children with speech difficulties. They found little difference between the two groups in terms of both phonological awareness and speech production. They concluded by noting that:

> "the study in effect raises more questions than it can answer in that what actually happens in therapy still remains poorly understood, and there is a need for controlled longitudinal research to address the complex set of factors involved in a diverse set of individual children." (Hesketh et al., p.349).

Stackhouse et al. (2002) suggest that researchers need to be clear about what underlying parts of the speech processing system are being tapped in intervention. There may have been no difference between the two groups in Hesketh's study because the 'traditional articulation'

therapy also requires metaphonological knowledge, and is not as different from the metaphonological approach, as one might suppose.

Gillon (2000, 2002) used a phonological awareness intervention approach with children (ages 5;6-7;6) with spoken language impairments and matched controls. Children with spoken language impairment were allocated to three different treatment groups: a) an integrated phonological awareness program, b) a 'traditional' program that focused on improving articulation and language skills, and c) a minimal intervention control group. The phonological awareness tasks in this study aimed generally to improve children's awareness of sound structure in spoken language and to develop explicit knowledge of the links between spoken word forms and written representations, following Hatcher, Hulme and Ellis (1994). The 'traditional' therapy involved a phoneme-oriented, articulatory approach and, in some severe cases, activities from the Nuffield Dyspraxia Program (Connery, 1992) were used. This is a program of graded tasks to teach basic articulatory placement and co-ordination of motor speech sequences. Although no overt mention is made of metaphonological awareness the program can be used in this way (e.g. see Corrin, 2001a,b). Gillon (2000) acknowledges this in her study and notes that most speech and language therapy activities incorporate phonological awareness to some degree. The study found that children who received phonological awareness training obtained age-appropriate levels of literacy performance, and in addition their speech articulation improved. This is an efficient approach to intervention since both speech and important phonological awareness skills underpinning literacy were addressed. Gillon (2000) concluded that the presence of a severe phonological impairment does not restrict a child's access to the benefits of phonological awareness training. The same type of direct phonological instruction appropriate in developing literacy skills is appropriate for children with phonological impairments.

Another efficiency study involving phonological awareness, is that of Major and Bernhardt (1998). These authors investigated the relationships between the phonological and metaphonological skills of 19 children aged 3-5 years with moderate to severe phonological disorders, and the effects of intervention on the children's awareness skills. Intervention outcomes indicated that both phonological and metaphonological intervention may result in a significant increase in children's metaphonological task performance. It was further observed that children with more moderate phonological disorders and good morphosyntactic production skills tended to improve on the metaphonological tasks after phonological intervention alone. Children with more severe phonological and morphosyntactic disorders improved their task performance only after phonological plus metaphonological intervention. A slightly different question was posed by Smith, Downs and Mogford-Bevan (1998), who asked whether

phonological awareness training could facilitate minimal pair therapy for a group of children with persisting phonological difficulties. The child participants in the experimental group were given phonological awareness training followed by conventional speech therapy, and contrasted with a group of children who only received the conventional speech therapy. The speech production of the children in the experimental group improved, as did their phonological awareness, when compared to the children in the control group. However, these authors again noted that their groups of participants were heterogeneous and the patterns revealed in the children's individual responses to therapy was found to be diagnostically significant.

Broad-based language approaches

Hoffman, Norris and Monjure (1990) compared phonological intervention targeting specific processes with broad-based, whole-language treatments for phonologically delayed pre-schoolers. These authors used a narrative-based discourse task, aiming to tap into a variety of levels of language, i.e. semantics, syntax, and phonology. The outcome of the whole-language intervention was positive with gains being made in each of these areas after 6 weeks of intervention. The results were accounted for in terms of a synergistic relationship between the different components of language. This approach of working on higher-level language functions without specifically addressing phonology, seemed promising as an efficient means of remediation. However, subsequent studies (e.g. Tyler and Watterson, 1991; Fey et al., 1994) using similar 'whole language' treatments did not find the same results. These later studies found that whole language treatments affected syntax, but that phonological difficulties needed to be addressed directly if gains were to be made in this area.

Parents and therapists

Traditionally speech and language therapists were solely responsible for providing intervention. However, there has been increasing acceptance of the important role parents and teachers can play in helping children with speech and language difficulties, and this accords well with the typically limited time and resources which constrain therapists from giving intensive individual therapy to all children who require it. Ruscello, Cartwright, Haines and Shuster (1993) investigated an alternative service delivery model with preschool children with speech difficulties randomly assigned to one of two treatments that differed in relation to service delivery. Group I received a treatment that was administered exclusively by the clinician. Group II received a combination that included clinician-administered treatment and parent-administered instruction. Both groups improved significantly, but they did not differ significantly from each

other in the degree of change. Studies such as this one are important for service planning and optimising service delivery.

Results of the review carried out by Law and Garret (2003) confirmed that parent-based intervention is effective in treating children with expressive language delays, but that for children with phonological difficulties clinician-administered therapy is more effective. In evaluating results from these studies, it is important to consider the age and type of difficulties of the children in the studies, and also the resources and support offered to the parents. Young children with phonological delays may be more receptive to parental intervention than older children with persisting problems. Some authors have suggested that it seems unlikely that parent programmes alone are enough to change a child's linguistic skills. These results reinforce the view that structured, direct work is required for children with specific difficulties developing linguistic skills (Lahey, 1988; Tannock and Girolametto, 1992; Fey, Cleave, Long and Hughes, 1993). This finding is not new, but is important given the increasing number of parent programmes being developed, and the decreasing opportunities for direct 1:1 work in schools.

Computers

There are conflicting findings regarding the effectiveness of using computers in speech and language therapy for children. Some studies have found no difference in the outcomes of children who received computer therapy when compared with traditional table-top approaches (O'Connor and Schery, 1986; Ruscello et al., 1993). Other studies examined the effect of combining computer therapy with general classroom work (Schery and O'Connor, 1997) or with more traditional approaches to phonology therapy (Rvachew, Rafaat and Martin, 1999). In all these cases, greater improvement was noted in children who received both computer therapy and standard therapy, rather than standard therapy alone.

Groups and individuals

Another way of coping with limited resources is by offering group therapy, as opposed to one-to-one approaches. Sommers et al. (1961) investigated the outcomes of group therapy for children with speech problems as opposed to individual treatments. They found that over eight months there was no significant difference between the outcomes obtained for each of the two groups. Similarly, results of the meta-analysis carried out by Law and Garret (2003) showed group therapy to be as effective as individual therapy. These studies may tell only part of the story since it seems likely that the children would not have been homogenous, and differences in

response to the intervention may have been obscured by the group means. Table 1.2 summarises the efficiency studies discussed in this section.

Table 1.2
Efficiency studies: Inter-intervention studies to determine if intervention A works better than intervention B

Author/s	Children	Intervention A	Intervention B	Outcomes
Meta-phonological approaches				
Gillon (2001, 2002)	5-7 years	phonological awareness intervention	traditional therapy	Intervention A. Improved speech and reading of phonological awareness group
Hesketh et al. (2000)	Pre-school	metaphonological awareness treatment	traditional articulation therapy	No difference
Major and Bernhardt (1998)	3-5 years	phonological + metaphonological intervention	phonological intervention	Intervention A. Phonological and metaphonological intervention resulted in greater improvement for more children
Smith et al. (1998)		phonological awareness + minimal pair treatment	minimal pair treatment	Intervention A. Speech and phonological awareness improved more as a result of phonological awareness treatment combined with minimal pair work
Broad-based language approaches				
Fey et al. (1994)	Pre-school	whole language treatment	phonological intervention targeting specific processes	Intervention B is better suited to remediating phonological difficulties
Hoffman et al. (1990)	Pre-school	whole language treatment	phonological intervention targeting specific processes	Intervention A resulted in more widespread change, including phonology
Tyler and Watterson (1991)	Pre-school	whole language treatment	phonological intervention targeting specific processes	Intervention B is better suited to remediating phonological difficulties
Parents and therapists				
Law and Garret (2003)*	all ages	clinician-administered	parent administered	Intervention A for children with phonological difficulties; both A and B for general expressive language delay
Ruscello et al. (1993)	Pre-school	clinician-administered	clinician and parent administered	No difference
Computers				
O'Connor and Schery (1986)		traditional 'table-top' therapy	computer-assisted therapy	No difference
Ruscello et al. (1993)		traditional 'table-top' therapy	computer-assisted therapy	No difference
Schery and O'Connor (1997)		computer-assisted + general classroom approaches	general classroom approaches	Intervention A
Rvachew et al. (1999)		computer-assisted + traditional phonology therapy	phonology therapy	Intervention A
Groups and individuals				
Sommers et al. (1966)	5-7 year olds	group therapy	individual therapy	No difference
Law and Garret (2003)*	All ages	group therapy	individual therapy	No difference

* based on composite findings from a systematic review

(b) *Intra-intervention studies: How can we make intervention better?*

Target selection is an important decision facing clinicians as they plan intervention. Which phoneme/s, word or other linguistic unit will be addressed and in what order? These issues are important since the ultimate aim of intervention is to encourage generalization throughout the speech processing system, and careful selection of targets may maximize the generalization achieved, and thus ultimately the efficiency of intervention. An efficient approach to intervention is one which results in widespread change throughout a child's system. What do we know about generalization? A survey of the literature reveals the following findings:

- Treatment of a phoneme in one word position (e.g. word initial position) can generalize to other word positions (e.g. word final) (Elbert and McReynolds, 1975).
- Treatment of one representative aspect of a sound category can facilitate improvement across that category (within class generalization). This has been documented for place, manner and voicing of production, e.g. treatment of fricatives [s] and [θ] enhanced changes in other untreated fricatives (Costello and Onstine, 1976). This type of generalization is thought to be influenced by the relationship that exists between sounds. The fact that children seem to generalize across sounds that have common features is an indication that these groupings have a psychological validity.
- Treating a phonological process with a few examples can extend to all sounds involved in that process (Weiner, 1981; Crary and Hunt, 1982). E.g. Weiner (1981) worked on the error pattern of final consonant deletion and this facilitated improvements in a broad range of final consonants disrupted by the same pattern.
- Treatment of a phoneme using just 3 – 5 different exemplar words could result in widespread generalization to the treated phoneme in other words (Elbert, Powell and Swartzlander, 1991).
- Treatment of more marked clusters will cause generalization to less marked clusters even if the latter are not targeted in treatment. One child in such a study who initially produced no clusters was treated for the cluster [bl] and generalized to nine other clusters (Gierut, 1999). In another study, treatment of specific three element clusters (e.g. [spr]) did not generalize to other three element clusters, although some children generalized to untreated singletons (including affricates) and to untreated two-element clusters (Barlow, 2001).
- Treatment of words can generalize to connected speech (Wright, Shelton and Arndt, 1969; Elbert, Dinnsen, Swartzlander and Chin, 1990).

Generalization is however, not as clearcut as it might seem from these statements. Many of these findings indicate the *potential* for generalization given the right therapy conditions and the right child or children. There is no guarantee that such widespread generalization will occur for all children as a result of all treatments. Generalization remains a challenge for clinicians to achieve, and clinicians and researchers to understand. Stiegler and Hoffman (2001) carried out a singe subject study looking at the effectiveness of a discourse-based treatment for word-finding problems. This novel approach involved picture-elicited narratives, story retelling and conversations on familiar topics, with the aim of reducing children's overt word-finding behaviours. The intervention was effective in achieving this goal, and in addition generalization was noted to spontaneous, conversational speech. The authors noted that therapy addressing specific language concepts in single-skill fashion has shown a disconcerting lack of efficiency (e.g. see Damico, 1988; Fey, 1988; Norris and Hoffman, 1993). Stiegler and Hoffman (2001) caution that single-skill training may not be justified in terms of time and money spent, and advocate the use of more discourse-based treatments, as well as further studies of generalization so that efficiency can be optimized. However, as mentioned in the previous section, results of broad-based language approaches are typically not effective in remediating aspects such as phonology. It seems that there may be a threshold in terms of age and specificity of speech-language difficulties beyond which whole-language interventions are less appropriate.

While some studies have confirmed that the treatment of a sound in one word position can extend to accurate production of that sound to other word positions (Elbert and McReynolds, 1975), there have been different hypotheses about the influence of position of the treated sound in a word. On the one hand syllable initial position has been shown to be the most salient context for consonants (e.g. Walley, Smith and Jusczyk, 1986) and treating sounds in this position may be successful as the child's attention is readily drawn to it (Gierut, 1991). However, other studies have shown that from a developmental perspective fricatives develop word-finally before they are acquired word-initially (Redford, MacNeilage and Davis, 1997) and should thus be addressed in this sequence. A study by Forrest, Elbert and Dinnsen (2000) found that word position did not have any effect on overall outcomes.

Children with speech disorders are a heterogeneous group. Focusing on characteristics which the child brings to intervention, may help in the selection of appropriate targets. For example, the variability of a child's speech errors is considered an important factor. While some research has shown that variability has a negative effect on speech sound learning (Forrest, et al., 2000), others working in a dynamic systems framework suggest that variability should be viewed positively since increased variability marks the emergence of new behaviours (e.g.

Thelen and Smith, 1994). Dodd (1995) and Dodd and Bradford (2000) have considered inconsistent productions in some depth. These authors suggest that some inconsistency is positive and indicates a changing phonological system. However, children who produce multiple error types when attempting to realize a target are a cause for concern, forming part of a diagnostic sub-group for whom a specific therapy approach is considered appropriate. Dodd's criterion for inconsistency is 40% of productions variable within an assessment session, e.g. see Diagnostic Evaluation of Articulation and Phonology - DEAP (Dodd, Hua, Crosbie, Holm and Ozanne, 2002). Results of case studies suggest that these 'inconsistent children' respond well to a core vocabulary approach (e.g. Dodd and Bradford, 2000). Thus, from Dodd's point of view variability is not a prognostic indicator *per se*, but rather a useful diagnostic indicator for selecting the most efficient type of intervention.

Children also bring knowledge of phonemes and the phonological organisation of their language, to intervention. The effects of a child's phonological knowledge prior to therapy is one aspect that has received considerable attention. Proponents of complexity accounts of treatment efficacy suggest that the traditional hierarchy of working from simple to more complex structures or behaviours may not be the most efficient way of working. When more complex behaviours or targets are selected the treatment becomes more difficult but response generalization is more likely to occur and will occur more widely. This phenomenon has been shown in children with phonological disorders (e.g. Gierut, 1998b) and for adults with syntactic (Thompson, Ballard and Shapiro, 1998) and semantic difficulties (Plaut, 1996). Linguistic theories about the relationships between phonemes are used to account for the generalization observed. Rvachew and Nowak (2001) carried out interventions contrasting 'traditional' developmental target selection strategies (i.e. early developmental phonemes about which the child has the most phonological knowledge) with non-traditional target selection criteria as espoused by Gierut (1998). Results of their study did not support the complexity account since the children with developmental targets made greatest overall progress and generalization.

Minimal-pair based intervention has been widely and effectively used in the remediation of children's phonological difficulties. Such approaches have been evaluated and contrasted with other target selection approaches to yield more efficient interventions. Conventional minimal pair approaches address one target phoneme contrasting it with the child's substitute which differs by only one feature. Maximal opposition approaches contrast phonemes which differ widely on a range of features. Gierut (1990) presented some evidence that focusing on maximally opposed words is more effective than minimal pair work, and results in greater generalization. She found that contrasting one new phoneme with an unrelated known phoneme

resulted in greater generalization than the more traditional target-substitute format (Gierut, 1991; Gierut and Neumann, 1992). Similar positive results were obtained by systematically varying contrasts along the dimensions of place, manner and voicing (Gierut, 1989). Barlow and Gierut (2002) note that targeting maximal differences does not necessarily constrain which features will emerge or generalise but leaves this to the child's own problem solving. Minimal pair treatment has been carried out with and without imitation and phonetic cues (Saben and Ingham, 1991). It was found that children may require these procedures together with minimal pair approaches if intervention is to work. This suggests that addressing the function of sounds in communication is important, but may not be the only factor to consider in intervention (Barlow and Gierut, 2002). From a clinical point of view, variable error patterns mean that minimal pairs may be counterproductive since these children do not have a single substitute for each target sound, rather multiple phonemes should be used to represent a target (Forrest et al., 2000). Barlow and Gierut (2002) summarise the research into minimal pairs by noting that the most effective conditions of contrast include pairing two new phonemes that differ maximally and by major class features.

There is a great deal of work to be done in improving the efficacy of speech and language intervention and our understanding of generalization. The question of whether we can say that one intervention is better than another is important. Broom and Doctor (1995a,b) emphasise the wide diversity between children diagnosed with the same condition and suggest that it is unlikely that there is one treatment that will be successful with all children. However, what is needed is an improved understanding of the type of therapy that works best with an individual child or various sub-groups of children.

3. INTERVENTION WITH CHILDREN WITH SPEECH DIFFICULTIES: ISSUES FOR RESEARCH

It has been noted that intervention research with children poses greater challenges to researchers than any other client group (Enderby and Emerson, 1995). Evaluations of intervention are less well-developed in the paediatric domain than for work with adults probably because of the problems in evaluating therapy with this group: children change as they mature and one cannot depend on a stable baseline. Children with speech difficulties constitute a heterogeneous group that is resistant to grouping by medical diagnoses or even by surface speech disorders (Stackhouse and Snowling, 1992; Crosbie et al., 2002). Speech and language therapy is

delivered alongside the educational curriculum which in itself should bring about positive change. So, how can we separate out the effects of our intervention? Selecting control tasks which will remain unchanged during the therapy period can also be problematic (Stackhouse and Wells, 2001). Although therapists are being increasingly asked to supply objective quantifiable evidence of the effectiveness of clinical procedures, it is not always clear how such evidence should be gathered and what it should consist of (Letts, 1995). This section focuses on some of the challenges facing researchers in this area, arguing for the use of single case approaches to answer specific questions about treatment.

3.1 What method should be used?

While randomised control trials and group studies constitute a vital part of outcomes research, there is awareness that different methodologies provide different types of information, all equally important in enhancing the knowledge base. Group studies may not provide much information on the results of treatment with excluded clients, how the treatment works or the duration or intensity of the treatment (Frattali, 1998). Furthermore, studies have shown that children with superficially similar speech and language difficulties may have very different patterns of underlying processing deficit (e.g. Ruscello, 1995; Stackhouse, Nathan, Goulandris and Snowling, 2002; Chiat, 2000; Dodd and Bradford, 2000) so that any particular treatment carried out can be expected to work for some but not all children in the group. There is increasing awareness that children with developmental speech disorders form a heterogeneous population that does not lend itself to large group research. Thus, it is not surprising that when children are grouped and given the same treatment, only some members of the group are able to benefit. Howell and Dean (1994) carried out their first Metaphon evaluation using a group study which allowed, in addition for the study of individual responses to remediation. They found that children varied widely in their responses to intervention, and other group studies (e.g. Fey et al., 1994; Smith et al., 1998) mention the varied response of participants, which may often be hidden by group means. This issue of specificity is an important one (Nathan, Stuart and Dolan, 2000; Best and Nickels, 2000): while it can be stated with some certainty that, for example, Metaphon therapy works, we need to be able to describe what therapy works for which children.

One approach to this problem is sub-grouping children. Dodd's (1995) approach to understanding children with speech disorders involves the sub-grouping of children into diagnostic categories. Intervention research has involved distinguishing the optimum therapy approaches for each of these groups (e.g. Holm and Dodd, 1999; Dodd and Bradford, 2000). According to Dodd, speech and language therapists must identify the phonological sub-group to

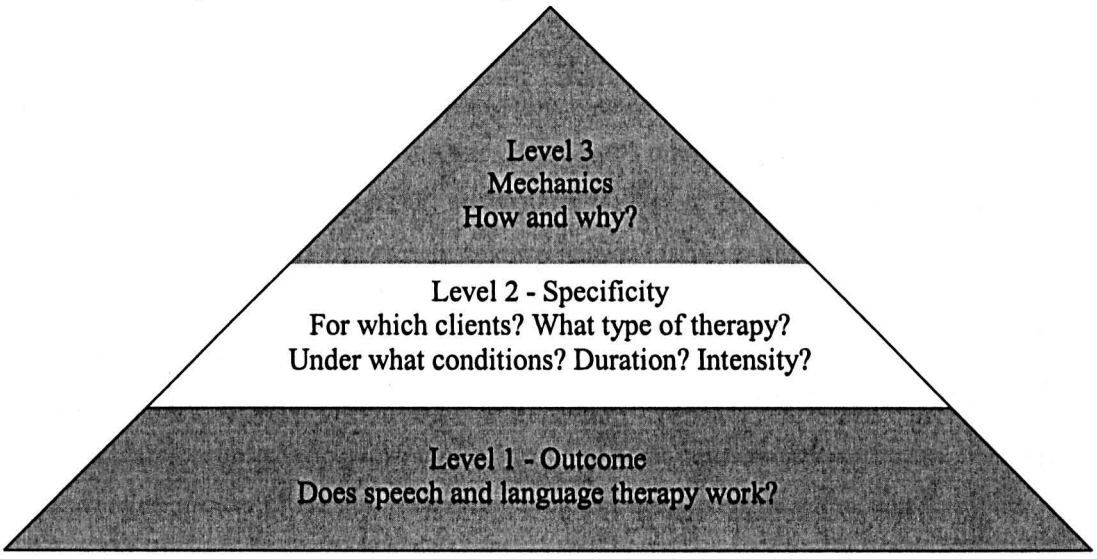
which a child belongs so that they can intervene appropriately, since research indicates that different deficits underlie the different surface error patterns of four sub-groups of speech disorder (Bradford-Heit, 1996; Dodd, Leahy and Hambley, 1989). Similarly, while a metaphonological approach might be useful for many children, children with speech motor constraints on phonological processing may need to spend a relatively long period of time learning to explore articulatory configurations, as discovered by Saben and Ingham (1991) and the adjuncts they described should accompany minimal pair work. Metaphonological therapy may need to be supplemented by explicit training about articulation associated with each sound. Furthermore, the Metaphon approach may be problematic for children with auditory processing problems or learning difficulties (Neville, 1984).

The single case methodology has been widely advocated (e.g. by authors such as Barlow and Hersen, 1984; Hedge, 1985; Howard, 1986; Attansio, 1994; Enderby and Emerson, 1995; Seron, 1997; Millard, 1998; Adams, 2001) who suggest it is the method of choice for clinical sciences involving intensive interaction, such as speech and language therapy. This approach solves the problem of subject homogeneity in that subjects serve as their own control and treatment can be tailormade to their specific needs. By varying aspects such as the time treatment commenced, or the type of treatment given, it may be possible to identify change on particular tasks or times, as being due to specific techniques of therapy, rather than the effects of treatment in general, or of external factors and maturation. The strength of single case and small group studies is in the detail of particular approaches to treatment. While results of case studies can be difficult to generalise, they have a role in establishing methods of treatment which can then be examined in larger scale studies (Adams, 2001). Single case research lacks the 'power' associated with larger studies and randomized control trials, but such studies provide valuable information and have been widely used to explore the nature of individual difficulties, motivations for therapists' intervention and the effects of that intervention.

3.2 What questions should be asked?

Research into intervention can be conceptualised as involving three levels of enquiry with associated questions pertaining to each level in a hierarchical way, as shown in Figure 1.1. (based on Frattali, 1998).

Figure 1.1
Levels of hierarchy in intervention research (based on Frattali, 1998)



Intervention research at its most essential level (level 1), is concerned with evaluating the outcome (successful or otherwise) of different types of speech and language therapy carried out with different client groups. Effectiveness and efficacy approaches to intervention have been discussed in previous sections of this chapter. This is important work which gives other levels of outcomes research a solid foundation: there is no point in contrasting approaches or maximising efficiency, if we do not yet know an approach works. Results of research have generally shown that speech and language therapy does work.

Frattali (1998) has suggested that what is needed at the next level of enquiry (level 2) are insights into the specificity of treatment. What type of treatment works for what client group, under what conditions? This level of investigation equates roughly to efficiency. These are studies which assume that intervention does work and aim to develop ways of improving the levels of success achieved. At this level, one can distinguish between interventions (e.g. as evaluated by Almost and Rosenbaum (1998)) and service delivery models (e.g. as evaluated by Glogowska et al. (2000)). Gallagher (1998) suggests that a review of treatment outcomes research reveals that most research has been carried out at the first and second levels of the hierarchy. However, the review of efficiency studies carried out in section 2.4.3 shows that while a great deal of efficiency studies have been carried out, we are still not able to answer many of the fundamental questions associated with this level.

The most in-depth, but unresearched level of enquiry (level 3) is concerned with understanding the mechanics of intervention: how does therapy bring about change? Authors such as Howell and Dean (1994), Frattali (1998) and Basso and Caporali (2001) consider that at this level of the theoretical framework we need to account not only for *what* is learnt but also *how* it is learnt. The process that constitutes therapy remains poorly understood and seldom considered. It is argued, that before we can begin to answer these level 3 questions, we need to expand our knowledge of effectiveness (at level 1) and of the specifics of therapy (at level 2). Case studies are particularly well-suited to providing detailed answers to these questions.

3.3.What outcomes should be measured?

Measuring therapy outcomes is no simple task. Van der Gaag (1993) describes attempts to come to terms with the problems posed by the definition of what constitutes a successful outcome for all groups of people involved in intervention: children, caregivers, teachers and therapists. Attempts have been made to define the outcome of intervention in ways that are meaningful, practical and coherent for these groups. Outcomes can potentially be diverse, including enhancing existing skills, teaching new skills, assisting with psychological adjustments and empowering carers. From a researcher's point of view, a wide variety of dependent measures need to be included as this is likely to be most informative (Gallagher, 1998). Generalisation needs to be determined beyond the immediate context of the study, and measures should be carefully selected to evaluate this aspect. Gallagher notes that most studies have evaluated generalization in quite limited ways using contexts that are similar to those where intervention took place. At the most simple level, studies aim to show that a new behaviour has been acquired, and more importantly that it has been retained (long term retention or maintenance) after the treatment has been completed. It is also preferable to demonstrate generalization of treatment effects to novel stimuli and to novel behaviours. One would not expect generalization to occur to *any* novel behaviour but rather only to those behaviours that are related 'topographically or structurally' to the trained behaviours (Ballard, 2001). However, this is not always a clear-cut issue and is discussed in the Chapter 2.

There is a wide range of standardized, norm-referenced speech and language assessment tools. These are frequently used as outcome measures for evaluating change following intervention. The advantages of using such tools to measure outcomes are numerous: they are readily available, easy to administer and allow one to compare an individual child to his or her normally-developing peers. Although there may be difficulties when a child comes from a different population not represented by the standardization sample, when carrying out single

case interventions a child acts as their own control and thus, this is not a major difficulty since the child's own individual performance is being compared across time. However, such tests are frequently designed, standardized and used with large groups of children to evaluate broad domains of their language and indicate whether or not intervention is warranted. Such tests as outcomes measures may not be sensitive to the subtle degree of change brought about, particularly for children with very severe difficulties (Ebbels, 2000; Crosbie et al., 2002). If one considers the fine-grained analyses and specific focus of intervention carried out in many single case studies, the use of standardized tests as the sole form of outcomes measurement would not necessarily convey the full picture of change. Stackhouse and Wells (1997) describe ways in which clinicians and researchers can devise their own specific probes for evaluating change in individual children.

The World Health Organisation's (1980) categorisation of impairments, disabilities and handicaps (see Frattali, 1998) is a useful framework for addressing outcomes. In terms of this framework, it has been noted that research into phonological disorders has been focussed largely at the impairment level, with considerable development being made in the area of measurement (Goldstein and Gierut, 1998). However, it is notable that surprisingly little attention has been paid to the development of formal measures beyond the impairment level. Authors such as Enderby and Emerson (1995) and Seron (1997) urge that the way forward in terms of effectiveness research should involve more sensitive outcome measures which can reflect the total impact of therapy including psychosocial change. An intervention study by Dodd and Iacono (1989) used a range of outcomes measures to evaluate change ranging from standardized assessments of phonology to more socially valid measures such as percentages of phonological processes used in a language sample. The RCT of Almost and Rosenbaum (1998) included a conversational measure (PCC) with these authors showing not only that their first treatment group of children improved in terms of single word production, but that they went on to show gains in their conversational speech. Intelligibility is a key functional outcomes measure, yet there have been relatively few intervention studies with children with speech difficulties that have used intelligibility as an outcomes measure. Much of the work in this area relates to children born with cleft palates (e.g. Van Lierde, De Bodt, Van Borsel, Wuyts, and Van Cauwenberge, 2002) or those with hearing impairment and cochlear implants (e.g. Chin, Finnegan and Chung, 2001; Allen, Nikolopoulos, Dyar, and O'Donoghue, 2001), with fewer papers on autism (e.g. Koegel, Camarata, Koegel, Ben-Tall and Smith, 1998), cerebral palsy (e.g. Pennington and McConachie, 2001) and Down syndrome (Kumin, 1994). Chapter 9 focuses specifically on intelligibility, outlining the problems which have resulted in its limited

use as an outcomes measure, and attempting to redress this by including it as an outcomes measure for the cases described.

In summary, outcome measures need to be:

(a) numerous and sufficiently broad-ranging to fully capture the effects of intervention and any generalization which occurs

(b) tailormade for individuals, and sensitive to small and specific changes which may occur as a result of intervention

(c) socially meaningful so that one is able to judge the functional affects of intervention on individuals' daily lives.

3.4 How should intervention procedures be described?

Speech and language therapy is a complex activity and is not one unified treatment. The exact content of therapy sessions is highly variable depending on the children involved, the therapist involved, the treatment setting and the type of therapy taking place. One of the challenges faced in attempting and understanding intervention research is in detailing the components of therapy. Gallagher (1998) notes that procedural description is vital in understanding intervention work – intervention procedures should be clearly and fully specified including programme characteristics such as information about participants, frequency of intervention, length of programme, number of trials per procedure, materials used and feedback given.

Descriptions of tasks can be taken a level further. Authors such as Stackhouse and Wells (1997), Rees (2001a,b) and Stackhouse et al. (2002) place great emphasis on analysis of tasks from a psycholinguistic perspective: what do tasks really tap? Many studies provide broad descriptions of the intervention that takes place, e.g. 'traditional articulation therapy' or 'minimal pair work.' However, depending on the exact nature of stimuli used, the modality in which the tasks are presented and the nature of the feedback given, these tasks could be seen to be tapping into entirely different parts of a child's speech processing system. Apparently simple tasks tap into many different processes and component levels in a functional architecture (Seron, 1997). In order to evaluate and compare different types of intervention, one first needs to be aware of what exactly is taking place in intervention. Single case studies are well-suited to providing this level of detail.

3.5 How should results be interpreted?

McReynolds and Kearns (1983) raise interesting methodological issues about research designs in speech and language therapy. These authors suggest that the most important questions when

evaluating results of intervention are: 'Can change be attributed to therapy?'and 'Is the change real and is the change important?' It is important to consider these questions if we are to avoid a shift from having too little outcomes data, to too much *weak* data (Frattali, 1998). Intervention studies need to be carried out in a carefully controlled way.

These questions are challenging ones to answer (Patterson, 2002). Once appropriate outcomes measures have been selected, and used to successfully measure change, how do we know that change is due to intervention and not to other factors such as educational input, normal maturational processes or the general effects of being involved in therapy such as support, interest and encouragement? Studies need to efficiently isolate the effects of intervention. In their studies of treatment for dyslexia, Broom and Doctor (1995a,b) attempted to control for such aspects by incorporating a range of features. They established multiple baselines with unrelated processing tasks before, during and after intervention which allowed for specific effects of therapy to be noted. Treated items were remediated in a crossover-design, with one set initially being treated while the other acted as a control, and then the reverse of this taking place. Hedge (1985) supports the use of 'multiple-baseline across tasks' designs within a single case study approach. This type of design may be useful because it allows one to make a systematic analysis of a range of behavioural outcomes and allows for monitoring of specificity. The administration and suspension of intervention over time theoretically ensures that if changes occur on the targeted aspects only when the related treatments are carried out, then changes are due to the treatments (Seron, 1997).

Many of the studies with adult clients with aphasia have tried to build up a longitudinal picture of what happened before the intervention. For example, Patterson (2002) describes intervention with an adult with acquired aphasia and concludes that:

> "The success of [this] treatment inspired by cognitive analysis in the absence of significant change consequent upon other techniques at least suggests that cognitive neuropsychological rehabilitation may be on to something." (p.586).

Dodd and Bradford (2000) monitored their participants for at least one month prior to intervention. Several pre-intervention baseline assessments might be carried out (as for example by Crosbie and Dodd, 2001) to ensure that the child's system is relatively stable. However, Broom and Doctor (1995) caution that if participants are tested repeatedly there may also be effects of pre-test sensitization.

Another way of demonstrating specific effects of intervention is to focus on more general areas that are thought to be separate and not directly addressed in therapy. For example,

Bryan and Howard (1992) aimed to improve their participant's phonology. They measured progress on an unrelated control task, sentence comprehension which was thought not to be tapped by the intervention. Similarly, Crosbie and Dodd (2001) measured reading age before and after therapy as an unrelated skill so that any change in auditory perception as a result of their auditory training programme could be attributed to treatment. Again, there are some difficulties with such controls due to modularity constraints. Although it is reasonable to hypothesise that many of these language skills are unrelated, this may not necessarily be the case. Non-language skills such as mathematical ability may provide more reliable ways of addressing this issue.

The other questions remain: "Is the change real and is it important?" One way of confirming how objective change is, is by carrying out point-to-point interrater reliability measures. Typically this is done for approximately 10% - 25% of the pre- and post-intervention data (e.g. Freed, Marshall and Frasier, 1997; Dodd and Bradford, 2000). Long-term follow up is a way of showing that change brought about is permanent and not transitory. The reality and importance of change to people's lives is best addressed by considering the opinions of the children involved and significant people in their environment. This again emphasizes the point of incorporating a range of outcomes measures which include both impairment- and disability-focused measures.

4. PSYCHOLINGUISTIC APPROACHES TO INTERVENTION

A range of different perspectives has been used in conceptualising children's speech and language problems. From a medical point of view, speech and language difficulties are classified according to a clinical entity: dyspraxia, dysarthria, autism and cleft palate are all medical terms used for defining conditions as a result of an observed cluster of deficits. The medical approach is useful in a number of ways, but it does have limitations especially for the speech and language therapist who must devise intervention programmes for a range of individual children grouped under this label. The term specific language impairment is a controversial one that is frequently used once all the other possible medical labels have been ruled out. Children grouped under this label differ widely in terms of the speech, language, literacy and other deficits shown (Bishop, Bishop, Bright et al., 1999).

Alternatively, a linguistic perspective aims to provide a description of observed behaviour at different levels of linguistic analysis. Terms such as semantic, syntactic, articulatory or pragmatic difficulties are used without suggesting aetiologies for the impairment,

and are more helpful for the clinician in devising treatment strategies. However, while the linguistic perspective has provided an invaluable foundation for the profession of speech and language therapy, Stackhouse and Wells (1997) note that the major shortcoming of this approach is that it offers a description rather than an explanation of a presenting disorder. Speech and language therapy research needs to be more theory-driven, as there is danger of becoming stuck in a descriptive phase (Enderby and Emerson, 1995). Language therapy for children has been largely driven by developmental norms rather than by the child's processing skills and has relied on a linguistic *description* of language output and input, for comparison with normal language development.

Baker et al. (2001) have suggested that the psycholinguistic approach may offer a whole new way of conceptualising children's speech, language and literacy difficulties. Closely linked to cognitive neuropsychological approaches to intervention with adults, there is a fundamental agreement that the best way to understand language impairment is by reference to models of unimpaired language processing. The psycholinguistic perspective aims to move beyond the shortcomings of the medical and linguistic approaches by viewing children's speech and language problems as being derived from a breakdown at one or more levels of input, stored knowledge or linguistic output. Models allow us to move away from mere observation and description of symptoms towards explanation in terms of underlying processing representations and mechanisms. The psycholinguistic approach uses detailed assessment to provide explanatory accounts of different underlying deficits in children whose speech and language difficulties may appear superficially similar, thus dealing with the problems of heterogeneity. If intervention is carefully targeted at an individual's specific point of breakdown, and carried out with an awareness of the strengths and weaknesses that underlie the individual's speech processing system, then it seems more likely that (a) intervention will be successful in bringing about change in the speech processing system, and (b) if intervention is *not* successful then it is possible to isolate the level of the speech processing system that therapy tasks were tapping, and make appropriate revisions.

A variety of models to account for language processing have been proposed by authors such as Garrett (1980; 1988), Patterson and Shewell (1987), Ellis and Young (1988); Hewlett (1990), Dodd and McCormack (1995), Stackhouse and Wells (1997) and Chiat (2000). Many of the models have been concerned with a relatively small part of the processing system, and a model that comprehensively accounts for all aspects of speech and language processing has yet to be developed (for a more detailed account of the development of box-and-arrow models see Maxwell (1984), Vihman (1996) and Baker et al. (2001). Hewlett (1990) proposed a detailed

two-lexicon model of speech production by relating underlying phonological processes described in the earlier models to the articulatory-phonetic production of speech. His influential model sought to address some of the limitations of previous two-lexicon models of speech by considering how children select one representation over another, how output representations change to become more adult-like and how off-line rules can be suppressed online. Since the publication of this model, a number of researchers have demonstrated how useful this model can be for exploring and understanding the problems underlying impaired speech development (Williams and Chiat, 1993).

One of the more recent models is that proposed by Stackhouse and Wells (1997) which unlike some previous models (e.g. Ellis and Young, 1988; Hewlett, 1990) specifies various levels of input processing thus allowing for a fuller analysis of a child's processing ability for single words. To date this model has been widely employed in investigations of speech, lexical and literacy difficulties in children (e.g. Constable et al., 1997; Nathan, Stackhouse and Goulandris, 1998; Vance, Dry and Rosen, 1999; Ebbels, 2000; Wells and Peppe, 2001) and treatment of children with speech and language difficulties (Vance, 1997; Waters, Hawkes and Burnett, 1998; Nathan and Simpson, 2001; Spooner, 2002). The psycholinguistic model devised by these authors distinguishes itself from other models in that it is part of a comprehensive psycholinguistic framework which also includes a developmental phase model of speech processing, as well as a speech processing profile. The speech processing profile poses a series of questions, which allows data from a range of assessments to be systematically organized to summarise a profile of an individual child's strengths and weaknesses. Theoretical criticisms of the model are discussed in Chapter 2, but as a whole, Stackhouse and Wells (1997) offer clinicians a systematic, theoretically-grounded approach to intervention (Corrin, 2001a,b).

Speech and language processing models have inherent limitations, and even if further refined, it is doubtful if they could ever shape the clinical process in isolation. Psycholinguistic approaches need to be integrated with linguistic knowledge in order to be effective. Knowledge about a child's personality, learning style and family situation should also be integrated into intervention planning. The case study by Waters et al. (1998) is an excellent example of how these three areas can be combined. The intervention studies presented in this thesis draw on knowledge from two key areas: psycholinguistics and phonology. It is suggested that the psycholinguistic approach is useful in answering the question: 'How?' - How is intervention going to work, i.e. how is change to be brought about in the individual's speech processing system? Knowledge from linguistics – in this case phonology - enables us to answer the more specific 'what?' question, i.e. what is the content of intervention? e.g. what are the stimuli that

will be used in the activities? Finding the source of a child's speech and language difficulties does not equate to knowing how to fix it (Howard and Hatfield, 1987; Chiat and Hunt, 1993; Byng and Black, 1995). Therapy will depend not only on how processing works or fails to work, but on how processing can be affected through intervention. This is an issue that is considered in greater detail in Chapters 2 and 3.

5. APPROACHES TO INTERVENTION RESEARCH: A REVIEW OF PSYCHOLINGUISTICALLY-ORIENTED SINGLE CASE STUDIES

A detailed review of intervention studies of relevance to this project was undertaken. Studies were selected which met the following criteria:

(1) Involved intervention
(2) Single case methodology was used
(3) Conducted within an explicit psycholinguistic / cognitive neuropsychological framework
(4) Participants were school-age children between 5 and 12 years
(5) Intervention addressed aspects of children's speech, language or literacy
(6) Papers were published in English in peer-review journals

5.1 Overview of studies

The following databases were searched: ERIC, MEDLINE and PsychINFO. In addition to this, references were taken from reviews of the literature and reference lists from articles. A total of eight papers were found (Bryan and Howard, 1992; Broom and Doctor, 1995a, b; Waters et al., 1998; Norbury and Chiat, 2000; Crosbie and Dodd, 2001; Stiegler and Hoffman, 2001; Spooner, 2002). Many psycholinguistic investigations were found which (a) did not have an intervention component, or (b) were carried out with adults or younger children. The earliest papers which met the search criteria were from the early 1990's (e.g. Bryan and Howard, 1992; Broom and Doctor 1995a, b) with a steady increase of papers to the present time. Typically these studies focused on one child, with the mean age of participants being 7; 8 years. The paper by Spooner (2002) focused on two children, while Stiegler and Hoffman's (2001) work extended to three children. Unlike the treatment review of intervention for adults with acquired difficulties carried out by Patterson (2002), this review did not set out to exclude any studies in which intervention was not successful. No such studies were found since it is likely that papers are not submitted

when intervention is not successful, but it is suggested that such studies would have been a valuable complement both to the effectiveness database and also in increasing theoretical knowledge. An overview of the papers included in the review is presented in Table 1.3. which is followed by more detailed evaluations of these papers.

Table 1.3
Psycholinguistic interventions for school-age children: Overview of papers included in the review

Author/s	Year	Journal
Broom and Doctor	1995	Cognitive Neuropsychology
Broom and Doctor	1995	Cognitive Neuropsychology
Bryan and Howard	1992	European Journal of Disorders of Communication
Crosbie and Dodd	2001	Child Language Teaching and Therapy
Norbury and Chiat	2000	Child Language Teaching and Therapy
Spooner	2002	Child Language Teaching and Therapy
Stiegler and Hoffman	2001	Journal of Communication Disorders
Waters, Hawkes and Burnett	1998	International Journal of Language and Communication Disorders

5.2 Subject characteristics

Gallagher (1998) notes that sustained attention to subject description is needed including receptive, expressive and pragmatic language characteristics, chronological age, cognitive level, medical conditions, handicapping conditions and school placement. The single case methodology lends itself well to the inclusion of detailed subject information. Indeed each of these papers included full background for their child participants with many providing a comprehensive background history to yield a longitudinal perspective (e.g. Waters et al., 1998). Children experienced a full range of difficulties with many showing complex combinations of deficits (e.g. see Crosbie and Dodd, 2001). The studies typically began with a section devoted to psycholinguistic investigation of the child's underlying difficulties, providing very detailed information about the child's strengths and weaknesses. An overview of subject characteristics in each of the papers is presented in Table 1.4.

Table 1.4
Psycholinguistic interventions for school-age children: Subject characteristics

Author/s	N=	Ages (years)	Sex	Participants' difficulties
Broom and Doctor	1	11	M	surface dyslexia
Broom and Doctor	1	11	M	phonological dyslexia
Bryan and Howard	1	5	M	deviant speech production and delayed vocabulary
Crosbie and Dodd	1	7	F	severe language disorder
Norbury and Chiat	1	8	M	specific language impairment and weak phonological skills
Spooner	2	6 9	F F	severe expressive and receptive language delays
Stiegler and Hoffman	3	9 9 9	M M M	word-finding difficulties
Waters, Hawkes and Burnett	1	5	M	unintelligible speech

5.3 Psycholinguistic models

The studies included in this review used a range of different psycholinguistic, neuro-psychological and developmental models to guide their interventions as shown in Table 1.5.

Table 1.5
Psycholinguistic interventions for school-age children: Theoretical models used

Author/s	Model/s used
Broom and Doctor	Ellis and Young (1988) and Frith (1985)
Broom and Doctor	Ellis and Young (1988), and Frith (1985)
Bryan and Howard	Smith (1978); Spencer (1988)
Crosbie and Dodd	Chiat (2000)
Norbury and Chiat	Plaut (1996)
Spooner	Garrett (1980) and Chiat (2000)
Stiegler and Hoffman	Rapp and Carramazza (1991)and Shallice (1987)
Waters, Hawkes and Burnett	Stackhouse and Wells (1997)

Developmental models such as those of Chiat (2000) and Stackhouse and Wells (1997) seemed to dominate in the more recent studies. These models developed specifically for use with children can be contrasted with some of the models borrowed from adult cognitive neurpsychology and adapted for work with children (e.g. Ellis and Young, 1988; Rapp and Carramazza, 1991; Shallice, 1987). Bishop (1997) cautions that such models may not be appropriate for use with the developmental groups. Few of the papers gave an explicit rationale for using a particular model, with exceptions being Norbury and Chiat (2000) and Broom and Doctor (1995a, b). Many of the studies seemed to be attracted mainly by the clinical utility afforded by the models, e.g. the Stackhouse and Wells (1997) framework allows for explicit consideration of a child's strengths and weaknesses which was important in the work described by Waters et al. (1998).

Papers varied a great deal in terms of how closely tied they were to the models. It was noted, to use Patterson's (2002) words: "whether or not the choice of treatment technique was genuinely guided by cognitive theory" rather than simply being carried out "in the spirit of cognitive neuropsychology." (p.570). Many of the studies introduced a range of models that were used in combination to develop a rationale for intervention (e.g. Bryan and Howard, 1992; Broom and Doctor, 1995a, b). Other studies aimed to explicitly test out a particular model of language processing, for example Norbury and Chiat (2000) tested assumptions underlying Plaut's (1996) connectionist model. The studies by Spooner (2002) and Stiegler and Hoffman (2000) were studies which were carried out 'in the spirit of' psycholinguistics, alluding to theoretical models rather than applying them explicitly or testing them through intervention. This is an aspect that is addressed further in the next chapter.

5.4 Intervention

A range of difficulties were addressed using a variety of approaches. These are summarized in Table 1.6. where it can be seen that all the interventions were successful in terms of their primary outcomes measure.

Table 1.6
Psycholinguistic interventions for school-age children: Interventions, outcomes and results

Study	Intervention	Outcomes *	Result
Broom and Doctor	Reading: linking visual code and meaning	Reading	Improvement on reading of treated words
Broom and Doctor	Reading: building up phoneme-grapheme correspondence	Reading	Significant improvement in phonological reading with generalisation to untreated items, and an overall change in reading strategy
Bryan and Howard	Input tasks to shape phonological representations e.g. same / different judgements and phoneme identification approach	Picture naming and repetition	Significant progress with real word speech production
Crosbie and Dodd	Input - Training auditory discrimination using real and non-words	Real and non-word discrimination	Auditory discrimination improved, but gains did not generalize to other language processes
Norbury and Chiat	Semantic intervention - making explicit links between orthography and meaning	Reading	Reading improved for treated target words
Spooner	Picture-based semantic therapy involving listening and production	Sentence production	Children made progress in the structure and content of their expressive language
Stiegler and Hoffman	Discourse contextual approach, e.g. narratives and story retelling	Overt word-finding behaviours in conversational speech	Overt word-finding behaviours decreased
Waters, Hawkes and Burnett	Input processing using a variety of listening and speaking tasks	Picture naming and spontaneous speech	Significant improvement in speech production

* limited to primary outcomes measure

Three of the studies focused on remediation of reading difficulties (Broom and Doctor, 1995a, b; Norbury and Chiat, 2000). Two of the studies were concerned specifically with speech production (Bryan and Howard, 1992; Waters et al., 1998). While Bryan and Howard worked on output (to improve output), Waters et al. focused on input as a means to improving output. Each of these approaches was successful. Crosbie and Dodd (2001) addressed input and hoped to improve this aspect of speech processing (rather than speech production itself). Their intervention too, was successful. The studies by Spooner (2002) and Stiegler and Hoffman (2000) were concerned with broader aspects of language processing. The former study focused on improving grammar, while the latter addressed word-finding difficulties.

All of the studies gave sufficient detail to enable replication. Dosage was one area in which full information was not always found, for example many of the studies gave an indication of therapy frequency but not of the total duration of the child's involvement. This

remains an important yet unresolved area in intervention research, and information about dosage must be considered as vital.

In terms of outcomes measures, most of the studies addressed the impairment level with a range of specific outcomes measures employed, and designed to be sensitive to the child/children in question (e.g. see Crosbie and Dodd, 2001). Standardised tests were sometimes used as a measure of more global functioning, e.g. Norbury and Chiat (2000) and Spooner (2002). Few socially valid measures were incorporated beyond the impairment level. Waters et al. (1998) provided subjective insights into the improved behaviour of their participant.

5.5 Interpreting the results: design, controls and generalisation

The studies varied widely in their design and the way in which specificity was controlled for. Broom and Doctor (1995a, b) employed a rigorous crossover design using multiple-baselines, and repeated pre- and post-therapy measures. All the other studies opted for less rigorous designs which compared results before and after intervention. The study by Stiegler and Hoffman employed a multiple baselines design. Many of the studies included control measures so that the authors could state with relative confidence that the results seen were due to the specific effects of intervention. Typically such control measures included incorporation of an unrelated language processing task so that it could be demonstrated that general developmental improvements were not responsible for the outcomes observed (e.g. Bryan and Howard, 1992; Crosbie and Dodd, 2001). Some of the studies attempted to achieve a stable baseline prior to intervention (Broom and Doctor, 1995a, b) and carried out long-term follow-up (e.g. Norbury and Chiat, 2000) so that it could be shown that effects of intervention were not transitory. There was no evidence of measures of interrater reliability in these studies.

In terms of generalization, studies were evaluated by noting whether generalization occurred for untreated items (across-item generalization) and whether it extended to related language processing tasks (across-task generalization). While all the studies showed positive outcomes, generalization varied widely between them. Some studies did not achieve any significant generalization (e.g. Broom and Doctor, 1995a, Norbury and Chiat, 2000). Many of the studies were able to show across-item generalization (e.g, untreated wordlists improved in the studies of Broom and Doctor (1995b), Crosbie and Dodd (2001), Spooner (2002) and Stiegler and Hoffman (2000). The studies by Bryan and Howard (1992) and Waters et al. (1998) were the most successful in terms of generalization, since they could demonstrate both across-item generalization as well as across-task generalization. In the case of the former, the child's speech production as well as his auditory discrimination had improved beyond chance levels.

Waters et al.'s child improved in terms of his speech production as well as his phonological awareness and literacy. Table 1.7 summarises the studies by design, controls and generalization observed.

Table 1.7
Psycholinguistic interventions for school-age children: Design, controls and generalisation

Author/s	Design	Controls	Generalisation
Broom and Doctor	Crossover design using multiple-baselines, and repeated pre and post therapy measures	Unrelated language processing task Achieved stable baseline	Not significant
Broom and Doctor	Crossover design using multiple-baselines, and repeated pre and post therapy measures	Unrelated language processing task	Across-item generalization
Bryan and Howard	pre and post therapy measures	Unrelated language processing task	Across-item generalization Across-task generalization (for related language processing task)
Crosbie and Dodd	pre and post therapy measures	Unrelated language processing task Achieved stable baseline	Across-item generalization
Norbury and Chiat	pre and post therapy measures	Long term follow-up Unrelated language processing task	Not significant
Spooner	pre and post therapy measures	none	Across-item generalization
Stiegler and Hoffman	Multiple baseline design with pre-and post-therapy measures	none	Across-item generalization
Waters, Hawkes and Burnett	pre and post therapy measures	none	Across-item generalization Across-task generalization (for related language processing task)

5.6 Summary of psycholinguistically-oriented single case studies

There is only a small group of studies that have carried out model-based interventions with school-aged children. Such studies have demonstrated the efficacy of intervention with each of the studies reporting positive results, however there may be a bias as negative results are not so readily submitted or accepted for publication. Strengths of this group of studies which should be upheld in similar research include detailed subject descriptions and detailed descriptions of procedures enabling replication. Areas to be addressed include the following:

(a) Discussion and publication of treatments with negative outcomes
(b) Inclusion of detailed information regarding intervention dosage
(c) Inclusion of more socially valid measures of outcome
(d) The inclusion of as many controls as possible in the design of the study to ensure that results of intervention are real
(e) Inclusion of an explicit rationale for the model used to guide intervention

(f) Attempts to carry out intervention that are explicitly and genuinely guided by models

Points (e) and (f) are considered in more detail in the following chapter.

6. OUTLINE OF THESIS

Demonstrating the effectiveness of psycholinguistically-oriented intervention is an important aim of this work. Detailed and carefully controlled single-case studies of intervention for five children form the main body of the thesis (Chapters 4-8). This chapter has shown that speech and language therapy is generally considered effective, however it has also been argued that there are questions at higher levels of the intervention research hierarchy that need to be addressed. Each of the single cases addresses general questions about effectiveness as well as more specific questions about the child participants and the strengths and weaknesses they bring to intervention, target selection issues, efficiency and generalisation issues, and therapy outcomes at a variety of levels. These issues are considered as they relate to each individual child in the discussion section of each child's chapter. Chapter 9 is concerned with intelligibility, specifically as an outcomes measure for the interventions, and more generally in terms of deconstructing the concept and reviewing current knowledge in the area. Chapter 10 compares and contrasts the findings for each child, considering contributions of the case-series as a whole to outcomes research. The final chapter, Chapter 11 reviews theoretical issues and debates to which the intervention case studies may be able to contribute. These theoretical issues are introduced in the following chapter.

CHAPTER 2: INTERVENTION FROM A THEORETICAL PERSPECTIVE

Chapter outline Page

INTRODUCTION

Chapter 1 justified intervention studies from a clinical point of view by focusing on the effectiveness of therapy, an important aspect of intervention studies. Intervention studies have additional potential to contribute to theoretical knowledge about the development of speech and language processing and associated cognitive processes. From this perspective, the most important factor is not whether therapy was successful, but rather how changes (or lack of

change) inform hypotheses about the way in which normal speech and language processing takes place. In practice, this may be more challenging than it sounds. On the one hand, it has been noted by some authors (e.g. Wilson and Patterson, 1990) that - from a theoretical perspective at least- there is nothing to be gained from intervention studies that cannot be gained from 'diagnostic investigations.' Other authors such as Bishop (1997; 1998b) emphasise the value of intervention studies for the theoretical knowledge that they bring. Bishop notes, in the context of SLI, that most children present with a range of difficulties and it is difficult to disentangle cause and effect. She suggests that new methodological approaches need to be adopted and suggests intervention studies as one example of an alternative approach.

> "It is time for researchers to recognise that intervention studies are not just an optional, applied adjunct to experimental work, but that they provide the best method available for evaluating hypotheses and unconfounding correlated factors." Bishop (1997, p.919)

This chapter aims to consider these claims by reviewing some current theoretical questions and the way in which intervention research addresses these. Theories of normal speech and language development are first discussed, followed by consideration of how such theories are used to account for disorders of speech and language. In both these sections an attempt is made to show how intervention has – and could – inform theory. The final section of the chapter focuses specifically on intervention, introducing ways in which the interventions described in the thesis might contribute to theory. This final section also emphasises that the distinction between 'intervention from a clinical perspective' (as discussed in Chapter 1) and 'intervention from a theoretical perspective' is not necessarily a clear-cut one. There are many aspects of intervention with equally strong ties to both theory and practice. These aspects are discussed in the final section of the chapter, which aims to bring the two strands together.

2. PSYCHOLINGUISTIC THEORIES OF DEVELOPMENT

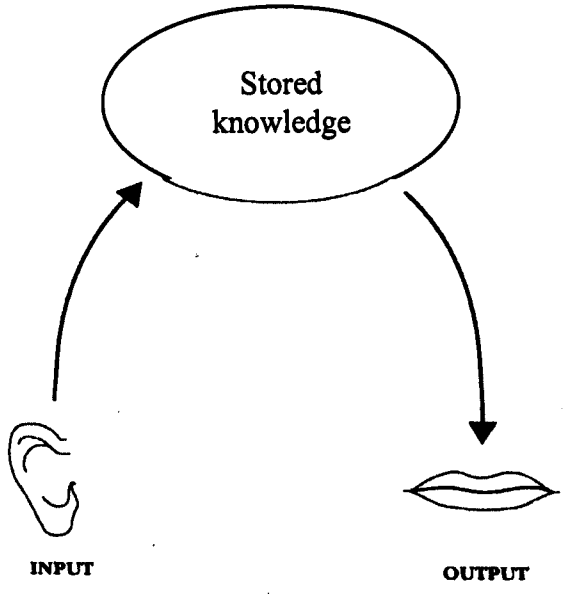
In psycholinguistic terms, there are three broad pre-requisites children need in order to develop speech and language normally. Simply put, these are:

1. INPUT: Children require exposure to speech in their environment, using sensory-perceptual channels to process this input
2. STORAGE: Children require potential for carrying out cognitive functions and storing language knowledge

3. OUTPUT: Children require speech output organs (respiratory, vocal and oral mechanisms) and associated neuro-motor links from the brain

These three essential components of speech and language processing are represented in a simple figure (Figure 2.1) adapted from Stackhouse and Wells (1997).

Figure 2.1
Three pre-requisites for normal speech and language development (from Stackhouse and Wells, 1997)



We know that each of these aspects is important for language development based on the knowledge of children who are lacking one or more of these essential components. For example, children who do not receive speech input in extreme cases of neglect, do not develop language in the normal way (Bishop and Mogford, 1993); brain abnormalities arising from genetic defects may affect the normal developmental course of speech and language development (e.g. Buckley, 1995; Persson, Lohmander, Jonsson et al., 2003).

This simple conceptualization of speech and language processing belies the controversies which surround theories regarding the development of each of these aspects and what might go wrong with each of them to cause speech and language disorders. These are discussed in the sections that follow, with reference to hypothesized models of speech and language processing which refine and explicate the gross model presented here. To some extent the separation between input, output and storage is a false one. Speech and language processing occurs as a continuum so that, for example, at some point in input processing, stored knowledge and cognitive/linguistic processes are invoked. Section 2.1. focuses on stored knowledge. This

'top' part of the processing system is the most complex and controversial, but is a starting point for understanding the tasks which child language-learners face. It lies at the heart of many theories of normal and disordered speech and language development. Section 2.2 returns to a bottom-up perspective, considering input at a pre-lexical level: the essential role of input, and the processes thought to take place as a child makes sense of speech prior to involvement of the higher levels of processing. Section 2.3 focuses on speech output, considering the nature and stages of processes required to move from abstract linguistic ideas into physical production of speech – and how such productions impact on the system as a whole. Section 2.4. discusses current issues common to all aspects of speech and language development theory, with routinely made assumptions reconsidered.

2.1. Stored knowledge

2.1.1 Linguistic knowledge

An underlying representation captures information stored about words (or some other level of linguistic unit) that a speaker knows and uses. Psycholinguistic models of information processing must account for lexical processing in some way. Chiat (2000 p.15) notes:

> "Each word...is a phonological-semantic-syntactic complex. To know words is to have stored such complexes in our minds, in what is termed our mental vocabulary or lexicon."

Stackhouse and Wells (1997) describe lexical representations as consisting of three essential parts: semantic information, a phonological (input) representation and a motor programme (output representation). These are shown in Figure 2.2 with the bold blocks indicating that they are bodies of knowledge built up over time. In addition, the lexical representation may be developed to contain grammatical and orthographic information (see Figure 2.3).

Figure 2.2
Speech processing model from Stackhouse and Wells (1997)

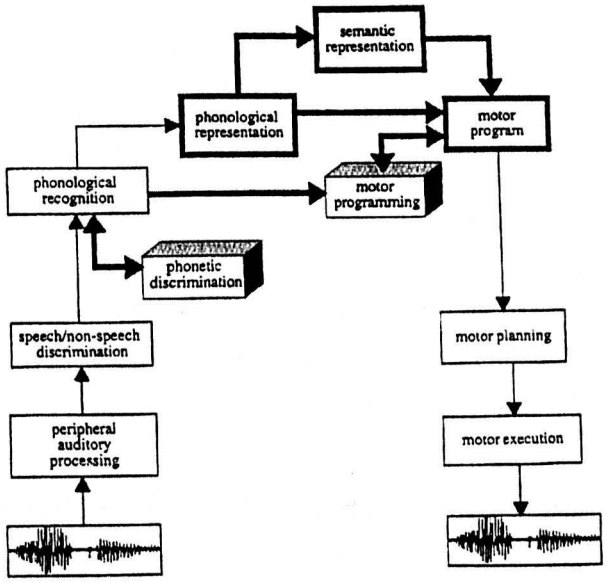
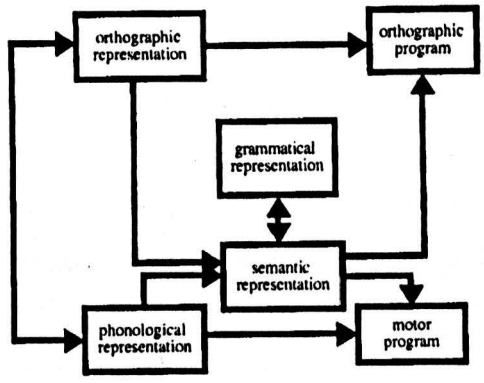


Figure 2.3
Further development of the lexical representation from Stackhouse and Wells (1997)



Other models have conceptualised stores of linguistic knowledge in similar ways. For example, Patterson and Shewell's (1987) cognitive-neuropsychological model shows links between semantic, phonological and orthographic representations. The model has been elaborated by researchers (Butterworth, 1992; Levelt, 1989) who argue that there are two stages in word retrieval: the first stage involving access to an abstract lexical level (the 'lemma', Levelt, 1989) and the second involving retrieval of the spoken form of the word within the phonological output

lexicon. The following sections discuss the most commonly cited representation groupings. Section 2.1.1(a) focuses on the two lexicons thought to underlie children's phonological knowledge, i.e. in terms of the Stackhouse and Wells (1997) model 'phonological representations' and 'motor programmes'. The following sections provide a review of what is known about semantic representations (b), grammatical knowledge (c) and orthographic knowledge (d) with a selective focus on how these aspects tie in with phonological representations.

(a) Phonological representations

Research into phonological acquisition has long been concerned with understanding the nature of children's underlying representations (Dinnsen, O'Connor and Gierut, 2001). While it is certain that the lexicon in childhood is a dynamic entity, what is less certain is the nature of representations within the lexicon and the way in which these change over time.

Early psycholinguistic models (e.g. Smith, 1978; Macken and Ferguson, 1983) conceptualised children's knowledge of word structure as being housed in a single phonological lexicon. Hewlett (1990) notes that two-lexicon models of speech processing came about in order to account for many children who can accurately perceive the differences between phonological contrasts, but who cannot indicate these in their speech (e.g. Menn, 1983; Spencer, 1988; Hewlett, 1990) suggesting a mismatch between the two types of knowledge. Rather than considering one body of knowledge about words, it seemed logical to consider an input lexicon, and an output lexicon with phonological rules accounting for the mismatch between the two. There are good theoretical and empirical grounds for distinguishing between input and output phonological representations (e.g. see Chiat, 1983; Hewlett, 1990) and recent models include both input and output phonological knowledge stores, e.g. see Stackhouse and Wells' model in Figure 2.2 and 2.3 with their 'phonological representation' box on the input side of the model, and a 'motor programme' box representing stored knowledge about output.

Dodd and McCormack (1995) also describe two phonological stores – an input lexicon and output phonological store. In their model of speech processing (based on Duggirala and Dodd, 1991) phonological representations are specified in the mental lexicon, and closely linked to other linguistic knowledge (such as syntax and semantics). They account for the mismatch between young children's recognition and production by means of realization rules suggesting that:

> "When children are generating speech, they select words from the mental lexicon that express their ideas, and the lexical phonological specification is fed through the existing set of realization rules (e.g. cluster reduction...), leading to the assembly of a phonological plan for production." (Dodd and McCormack, 1995 p.68)

Authors such as Dodd, Leahy and Hambly (1989) suggest that the realization rules are derived in an unconscious way from the information contained in the lexicon. The realization rules reflect children's implicit understanding of the sound structure of their ambient language. Dodd and McCormack (1995, p.68) suggest that evidence for this processing route comes from three sources: (a) the consistency of developmental errors suggest that realization rules must be an integral part of the speech production process, (2) the fact that 'across the board' changes occur in many lexical items when a rule is suppressed, and (3) the generalization that is noted in intervention from treated to untreated words. However, there is some debate about 'across the board changes' (e.g. Menn and Matthei, 1992) as well as the nature and extent of generalization. Furthermore, the psychological reality of simplifying rules has been questioned (Hewlett, 1990; Harley, 1991). Lindblom (1992) suggested that children's regular error patterns reflect their immaturity in phonological encoding.

There is some evidence (for example from studies of phonology and morphology, Edwards, Fourakis, Beckman and Fox, 1999) that the relationship between the two lexicons - and other parts of the speech processing system - is a great deal more complex than previously thought. Recent research into children's phonology has seen the development of more complex representation-based accounts of phonological competence and the constraints that act on them (Edwards et al., 1999). Such work has shown that the young child is not a passive acquirer of phonological knowledge and that phonological development is very gradual. A child's first words have phonetic structure similar to the child's concurrent babbling (Vihman, Macken, Miller et al., 1985; Locke, 1989) thus involving a hierarchical reorganization of the same detailed motor and perceptual representations that the infant has practiced in babbling prior to linking the word's shape and meaning. Authors such as Gleitman and Wanner (1982), Bates and MacWhinney (1987), Edwards et al. (1999), and Chiat (2000, 2001) consider language learning as a mapping task. Phonological competence requires that the child builds and links together three representations: input (the acoustic/ perceptual space); output (the articulatory space) and the inverse mapping between production and perception. While a child may be able to articulate a particular phoneme in one set of words, generalization of the motor pattern to other words containing that phoneme will depend on the frequency that the sound is encountered in the same phonetic context as in the novel form. This is discussed in greater detail in the section on input. To some extent phonological knowledge can drive the acquisition of other aspects of language

learning, for example phonological 'bootstrapping' is said to occur when a child encounters an unfamiliar word, and uses this new form as a basis for seeking out associated meaning (Chiat, 2000).

Many theorists assume that the word or lexeme is the storage unit of the phonological lexicon (Treiman and Baron, 1981; Jusczyk, 1986; Waterson, 1987; Ingram and Ingram, 2001), but there may be some evidence for syllables (Ferguson and Farwell, 1975; Levelt, 1989, 1999; Gierut, 1999), or smaller units as the fundamental structure that is stored. Furthermore, the nature of children's representations is likely to be changing over time as development takes place. The lexical restructuring model proposed by Metsala and Walley (1998) claims that children's lexical representations are initially holistic but gradually become more segmental as more words are acquired. According to this model, children differentiate their earliest words based on overall phonetic shape rather than at a segmental level. As the lexicon grows the holistic representations are not sufficient for distinguishing between all words, and the child must necessarily turn their attention to fine-grained phonetic detail.

It has been suggested by authors such as Charles-Luce and Luce (1990) and Dollaghan (1994) that phonological representations are stored in the lexicon by means of lexical similarity neighbourhoods. These are defined as words differing from a target word by a one phoneme substitution, deletion, or addition in any word position (Luce and Pisoni, 1998), e.g. the neighbours of TOP would include TOSS, TAP, COP and STOP. Words that are similar to only a few other words are situated in sparse neighbourhoods, whereas words that are phonologically similar to many other words reside in dense neighbourhoods. In adults, the density of neighbourhood has been found to influence word recognition: words from dense neighbourhoods are recognized more slowly and less accurately than words from sparse neighbourhoods (Luce and Pisoni, 1998). Such findings from developed lexicons have supported the psychological reality of this neighbourhood structure, yet many questions remain about the development of the lexicon in children. Numerous experiments have been carried out to investigate the similarity relationships used to organize words in the developing lexicon (e.g. Charles-Luce and Luce, 1990; Storkel, 2002; Coady and Aslin. 2003). Storkel (2002) found that dense neighbourhoods were organized by phoneme similarity in the onset-nucleus or rhyme positions of overlap. In contrast, sparse neighbourhoods appeared to be organized by phoneme similarity in the onset-nucleus, but manner similarity in the rhyme. Her findings were consistent with the lexical restructuring model of Metsala and Walley (1998), while Coady and Aslin (2003) found that using simplified tasks resulted in findings that children's lexicons contain more closely related words than has previously been suggested. These latter authors suggested that both children and

adults show sensitivity to individual segments *and* larger units, and concluded that "the holistic / segmental dichotomy may be unwarranted (Coady and Aslin, 2003, p.467).

Bird and Bishop (1992) carried out a study with a group of 5 – 6 year old children with speech difficulties, who were matched with children with normal speech development. They aimed to determine if the children with speech difficulties had general linguistic deficits as manifested in difficulties with auditory discrimination, phonological awareness and phoneme constancy. They found that the children with speech difficulties did poorly on phonological input tasks when compared to normal controls. The most striking deficits observed were on phoneme constancy tasks in which children were required to match given phonemes produced in different word contexts. It was concluded that phonologically impaired children do not progress to the stage of analysing words at the level of the phoneme, and that this is likely to have implications for their production of new words. The authors suggested that this explanation is compatible with theories of normal development suggesting phonological representations change from a holistic to a segmental level. They suggest that:

> "It is by no means natural or obvious for the child to analyse words into segments. Indeed there is mounting evidence that some children fail to do so... our study suggests that failure to analyse words at the level of phonemic segments is a fundamental deficit in many children with phonological problems." (Bird and Bishop, 1992, p.308)

While most children are able to perform simple phonological awareness tasks such as rhyme judgement and phonological sorting by initial phoneme, by the ages of approximately 5 years, not *all* children are able to. The ability to carry out phonological awareness tasks at the phoneme level has been shown to predict good reading skills (Bradley and Bryant, 1983) and training in phonological awareness skills at this level can improve reading and spelling of children when compared to control groups (Lundberg, Frost and Petersen, 1988). The role of phonological representations in mediating reading and spelling is an important one. The association between phonological processing difficulties and reading and spelling problems has been shown in a number of single case studies (e.g. Campbell and Butterworth, 1985; Snowling, Stackhouse and Rack, 1986; Hulme and Snowling, 1992) and experimental investigations comparing dyslexic children with normally developing readers (e.g. Wagner and Torgeson, 1987). Hulme and Snowling (1992) described a child with dyslexia and his underlying phonological difficulties. The authors carried out tasks tapping into different levels of phonological processing. They concluded that the child had poorly developed phonological representations, the basis for mappings from phonology to orthography in normal literacy

development. He had compensated by learning to read using visual strategies and this accounted for the mismatch between his real word and non-word reading ability, and the dysphonetic errors that characterised his spelling.

There are however some single case studies that have shown that it is possible for children to read normally in the presence of severe phonological difficulties (Temple, Jeeves and Vilarroya, 1990; Stothard, Snowling and Hulme, 1996). Stothard et al. (1996) describe a girl, aged 6;6 who experienced severe difficulties with phonological awareness tasks as compared to control children, but showed normal reading and spelling development. Closer investigation of her reading did however reveal deficits in her non-word reading, similar to those described in the child investigated by Hulme and Snowling (1992). The two children are contrasted in terms of their phonological processing difficulties, and it suggested that in some cases, as for the girl in Stothard et al.'s paper, phonological difficulties may not be sufficiently severe to constrain reading of real words. This child was found to have some auditory perceptual difficulties which resulted in poor performance on many phonological awareness tasks, but her phonological representations – in contrast to many other children – were normal and thus gave her the basis to develop reading and spelling in the normal way. Cases such as this, remind us that the relationship between phonological processing and literacy is not as clear-cut as it may seem. It is unclear if there is only one path of development, or the ways in which children may compensate for areas of weakness.

The phonological output lexicon is also a controversial construct. Levelt (1989) distinguishes between conceptualization and formulation for speech production. Conceptualisation is centered at the message level, whereas formulation involves translating conceptual knowledge into a linguistic representation, necessitating heavy reliance on semantics and syntax. How exactly conceptual knowledge is mapped onto spoken output remains unclear, as is the way in which this mapping develops. Models such as Stackhouse and Wells' (1997, Figure 2.2) and Dodd and McCormack's (1995) differentiate between online processing at a given moment in time, and also in terms of a child's general competence built up over time. Thus, for example in Figure 2.2 it can be seen how there are links between two phonological representations (input and output). But, the model also accounts for *how* motor programmes come to exist as stored representations. The online motor programming device creates new motor programmes based on input. The model is thus able to account for repetition of non-words at a sub lexical level, as well as children's learning of new words and production of familiar words. Similarly, Dodd and McCormack (1995) distinguish between phonological plans, and stored routines. They suggest that high frequency utterances become automated and

are stored as whole units not requiring online effort. The nature of the stored routines reflects the realization rules that were acting at the time the routine was stored. This can account for variability in some children's speech when one compares their production of target words in therapy (i.e. they have been produced online and in isolation using a phonological plan), and the same words spoken spontaneously in connected speech (i.e. they revert to a stored routine that reflects realization rules from an earlier phase of development, cf. Bryan and Howard, 1992).

The main challenge of motor programming or phonological encoding is ensuring that the right elements are put together in the right order. Some authors (e.g. Shattuck-Hufnagel, 1979 in Harley, 2001) describe scan-copier mechanisms of phonological encoding. Such models conceptualise the process as selecting an appropriate word 'frame' and then selecting phonemes in serial order to be inserted into the frame. Thus, for example difficulties with this process might result in phonotactic errors if the incorrect frame is selected, or phoneme substitutions when the incorrect phonemes are chosen, or sequencing difficulties when the correct phonemes are inserted into the wrong slots of the frame. Once again, there is uncertainty as to how motor programmes are stored - as words, morphemes, or larger units of language – and how they interact. Shattuck-Hufnagel's (1979) conceptualization of phonemes as key elements may not be accurate or at least appropriate for children. Dodd and McCormack (1995) suggest that the type of information contained in the phonological plan is both segmental and prosodic. There is also some evidence for the syllable as being the fundamental structure of motor programming (Levelt, 1989, 1999; Gierut, 1999). What does seem clear is that for children, and to some extent for adults, at any given time, there may be fewer and less well-formed motor programmes than there are phonological input representations. We understand and recognize many words that we may not have produced or know exactly how to produce.

Attempts have been made to classify the degree to which a child has internalized a particular phoneme target into their phonological system. Surface speech errors can be used to infer a child's productive phonological knowledge (PPK) of individual phonemes. This notion was introduced in Chapter 1 in the context of complexity accounts of treatment efficacy. Gierut, Elbert and Dinnsen (1987) devised a scale of productive phonological knowledge whereby each phoneme in a child's ambient language can be classified into one of six categories. The categories of productive phonological knowledge are summarized in Table 2.1.

Table 2.1
Description of types of productive phonological knowledge (from Gierut et al., 1987)

Type	Description
1	Produced correctly in all word positions for all morphemes.
2	Produced correctly in nearly all morphemes but alternations between the target and another sound observed for some morphemes (optional rule).
3	Produced correctly in nearly all morphemes but some "fossilized" forms always produced incorrectly.
4	Produced correctly in one or more word positions and consistently incorrect in other word positions.
5	Inconsistently correct in one or more word positions and consistently incorrect in other word positions
6	Produced incorrectly in all word positions and all morphemes.

Gierut et al. (1987) suggest that PPK should be determined by evaluating samples of children's spontaneous speech and single word productions. The PPK categories are based on output, attempting to tap into the phonological output lexicon or motor programmes, to evaluate what they child knows about how to produce particular phonemes in single words and connected speech. PPK does not give an indication of the child's ability to recognize and process phonemes in input. The notion of phonological knowledge as presented by Geirut et al. (1987) may be too broad to characterize the precise level of knowledge. There may be levels of partial knowledge with different categories of knowledge for different children, and the path through these more complex than has been proposed (Williams, 1991). PPK Type 5 has proved to be the most controversial category with some authors (e.g. Flipsen, 2003) considering that this category is a theoretical one only, with examples of the type never seen. However, other authors (e.g. Rvachew and Nowak, 2001) are able to provide examples of Type 5 phonemes in their participants' speech. Nevertheless, PPK is a useful measure with important clinical implications: the authors have shown that the higher up the scale the child is for a particular sound (i.e., the child has no productive phonological knowledge), the greater the generalization that occurs to the rest of the sound system when that particular phoneme is targeted in therapy. This means that it may be more efficient to target phonemes with high PPK. This research relating to PPK and intervention is discussed further in Section 4, which deals with the overlap between theoretical and clinical concerns.

(b) Semantic representations

While authors such as Stackhouse and Wells (1997) and Chiat (2000) consider the semantic lexicon as being intrinsic to speech processing and production, it is beyond the scope of their

models to consider its internal organisation to any great extent. It is viewed as a module common to both input and output processing, and covering a range of modalities. However, some researchers have argued that the semantic system is comprised of several modality-specific subsystems each responsible for processing stimuli in a specific modality (e.g. visual, verbal, auditory-non verbal and tactile). This is contrasted with the view that there is one global, multimodal semantic system responsible for all semantic processing, and used for both input and output processing. In the domain of cognitive neuropsychology several studies with adults have been used to argue both for (e.g. Shallice, 1987) and against (e.g. Hillis, Rapp, Romani and Caramazza, 1990) having several modality specific systems. The matter of a single multi-modality semantic system versus multiple modality-specific systems still needs to be resolved through further research, and has only been investigated in a very superficial way with children.

Questions such as whether or not separate semantic systems exist for concrete as opposed to abstract words have also been debated. There is some evidence from neuropsychological research that factors such as degree of abstractness and imageability affect the way in which words are stored, processed and produced, e.g. Camarata and Leonard (1986) carried out studies which revealed that increased semantic complexity resulted in decreased phonological accuracy. Leonard, Schwartz, Terrell et al. (1982) found that new-word learning involving new phonemes was more challenging than new-word learning involving already acquired sounds. Consistent with these ideas and with Chiat's mapping theories, it is well-established that children universally produce first words about concrete objects or people in their environment. Staying with this developmental perspective, it can thus be assumed that there are words typically acquired at early ages and others typically acquired later. Words which children hear frequently will have representations established early on in the lexicon, whereas unusual words will take longer to become established. Factors such as abstractness, imageability, age of acquisition and spoken language frequency are important to consider in studies of children's language development since variable processing or production of items may reflect differences in these properties of words.

New word learning and word-finding are important skills that need to be accounted for by psycholinguistic models. Chiat's (2000, 2001) mapping theory explains how children must visually extract meaning from the scenes taking place around them everyday. At the same time they must auditorily extract relevant linguistic units from the accompanying sound stream, and then mesh the two together. Initially semantic information may be very broad, but gradually and with appropriate feedback from their productions this comes to be shaped into more specific knowledge (Clark, 1973 in Harley, 2001). Semantic 'bootstrapping' takes place when a child

extracts an aspect of a scene, and uses knowledge about what they observe to seek out the correct phonological label (Pinker, 1984, 1989 in Harley, 2001). Nippold (1990) maintains that every word in the semantic store has both a storage strength (i.e. how well a word is learned) and a retrieval strength (i.e. how easily a word is retrieved). In finding a particular word, links between the semantic system and grammatical, phonological and possibly orthographic knowledge may come in to play.

(c) Grammatical representations

Children do not speak in single words. Grammar and the production of strings of speech is an important area when studying linguistic theory and development (e.g. Clahsen, 1989 in Temple, 1997). However, psycholinguistic models typically focus on one aspect of speech or language processing. Thus, Stackhouse and Wells' model focuses at a single word level of processing, although the authors consent that for each stored lexeme there will be corresponding information stored about the grammatical detail of the word. There are psycholinguistic models that specifically address sentence processing and production. Garrett's (1980, 1988) model contains a number of processing levels: (a) message level, linked to semantics and analogous with Levelt's conceptualization phase, (b) functional, positional and sound levels – similar to the phase which Levelt terms formulation, and (c) articulatory instructions. Other authors (e.g. Levelt, 1989; Pinker, 1989) have devised alternative models placing more emphasis on linguistic considerations. Verbs are thought to be critical to sentence processing (Chiat, 2001).

There is a great deal of evidence for a strong relationship between grammar and phonology (Fey, Cleave, Ravida et al., 1994; Camarata, 1998; Harley, 2001). Both aspects involve resources so that processing of more complex grammar may limit resources available for phonology – and vice versa (Camarata, 1998). It is well known that phonological simplifications in connected speech are often more numerous and qualitatively different to those in single words (e.g. Andrews and Fey, 1986; Morrison and Shriberg, 1992). But more specifically, phonological knowledge and in particular the ability to process prosodic information, is needed in order to "weld together a prosodic arrangement of familiar word forms and a relation observed between the referents of those word forms." (Chiat, 2001, p.122). Similarly, authors such as Hirsch-Pasek and Golinkoff (1996, p.198) describe the development of language comprehension as follows:

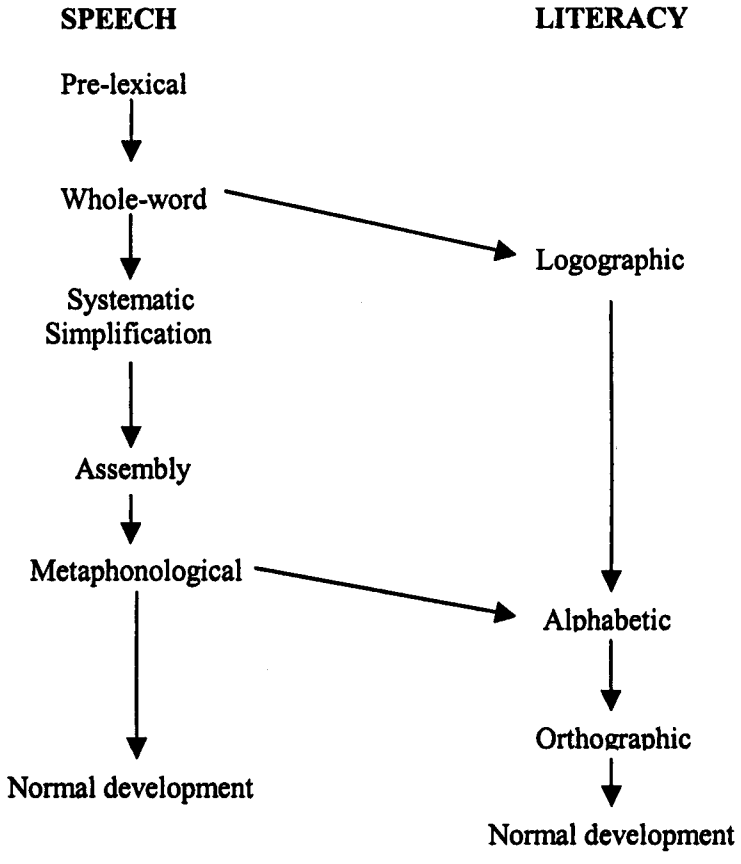
> "Comprehension begins with a strong reliance on acoustics, moves to a reliance on co-ordinated input cues from syntax, prosody, extra-linguistic context, and semantics ... and culminates in a reliance mainly on syntax."

Questions that need to be answered are: How might single word models such as Stackhouse and Wells' include a greater level of detail about grammatical information and connected speech processing, and to what extent are these processes separate or overlapping?

(d) Orthographic representations

Orthographic knowledge is acquired through instruction and at a later age than the other aspects of spoken language. Frith's (1985) model is a developmental model used to conceptualise three stages involved in literacy acquisition: a logographic (whole word recognition) phase, an alphabetic phase (in which grapheme-phoneme conversion is relied upon) and an orthographic phase in which stored representations can be drawn on and irregular orthography has been learnt. This stage-based model has been linked together with Stackhouse and Wells' (1997, 2001) phase model of speech development. Stackhouse and Wells' (1997) psycholinguistic framework consists not only of the box and arrow model but in addition it contains a developmental model mapping stages that children must pass through over time in their development of speech and literacy. This model is presented in Figure 2.4 where it can be seen that children's speech development is thought to progress through successive stages: (1) pre-lexical, (2) whole word, (3) systematic simplification, (4) assembly, (5) metaphonological. These stages fit in well with Frith's (1985) model of literacy development, also shown in Figure 2.4. At the whole-word level of speech, children experience a parallel phase in literacy, being able to visually process words as whole units. They then become increasingly sensitive to the components of words, using simplifying processes as they attempt to master the sound structure of their language and learning to assemble the components into connected speech. This shift from whole units to segments is consistent with notions of lexical restructuring previously presented in this chapter (e.g., Metsala and Walley, 1998). At the metaphonological stage children develop the ability to reflect on the sound structure of their language in an abstract way. This ties in with the alphabetic phase of literacy development in which children learn to link arbitrary orthographic symbols with the phonemes in their language. Mastering these skills means that children will have fully acquired the foundations of speech and literacy, and further stages of development involve refinement of the skills and experience of irregular and unusual forms.

Figure 2.4
The relationship between the phases of speech and literacy development: Developmental model for speech and literacy (from Stackhouse and Wells, 1997; Frith 1985).

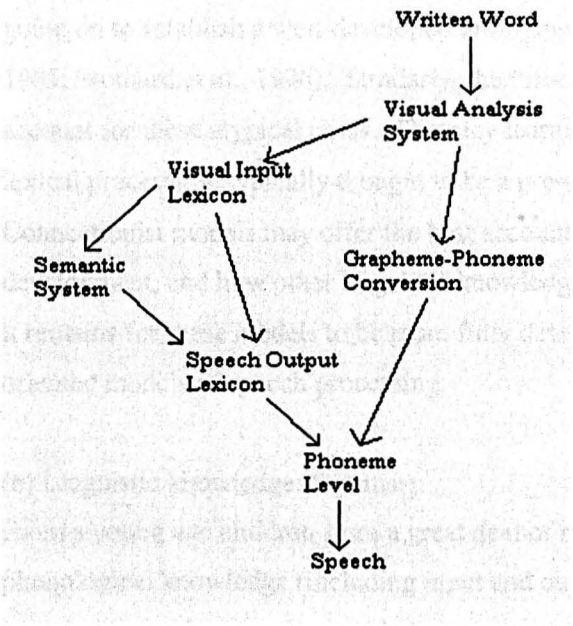


Essentially, reading is about deciphering a code: learning which written symbols represent the particular sounds of a language in the process of grapheme-phoneme conversion. With increased exposure to written material and as reading becomes more practised, mental representations of words are established in the lexicon, enabling readers to bypass the mechanics of grapheme-phoneme conversion. Thus, many researchers have suggested 'dual route' models of reading: on the one hand, grapheme-phoneme conversion can take place using the sub-lexical route, or on the other hand, if a word is familiar it can be retrieved from the lexicon (Harley, 2001). Similarly, for writing, we need to retrieve the written representation from the orthographic lexicon, if we know the word, or alternatively to carry out phoneme-grapheme conversion in order to attempt spelling. In many cases there are no logical rules about how particular words should be written (e.g. consider the rime of words such as <yacht> versus

<pot>), yet adults and children learn how to recognise and write these words through building up their orthographic knowledge.

Figure 2.5 shows a dual-route information processing account of ways in which reading may occur (from Ellis and Young, 1988). Distinct lexical and sub-lexical processing paths can be followed. Such models have been widely applied to children's normal development of literacy, and to understanding those with difficulties (e.g. Patterson, 1994; Broom and Doctor, 1995 a, b).

Figure. 2.5
Ellis and Young's (1988) dual-route model of the reading process



Connectionist, single route models provide another way of understanding reading development (e.g. Seidenberg and McClelland, 1989; Plaut, 1996). In such models information about words is distributed across many processing units, with the system learning by establishing mappings between orthographic input units and phonological output units. Early versions of the model did not include semantics, but more recent forms (e.g. see Snowling, 2000) explicitly acknowledge the 'top-down' contributions of context and semantics. Plaut (1996) acknowledges that the semantic contribution will, in most cases, be secondary to the role of phonology, but suggest that when phonological units are impaired the semantic units could play an important compensatory role. Indeed, more recently researchers have started to consider not only the important role of phonology in literacy development but also the important contribution of other aspects of language such as semantics (e.g. see Norbury and Chiat, 2000; Nation, 2001).

Reading models are useful for conceptualising normal literacy development, yet as with speech processing models they are not without controversy. Information processing models (e.g. Ellis and Young, 1998) can be limited in the static picture they provide of children's dynamic literacy learning. Frith's (1985) stage-based model of literacy development was devised in preference to information processing models which had more typically been used to account for children's literacy difficulties at the time. She emphasized the importance of distinguishing between developmental and acquired difficulties, suggesting that children with literacy difficulties are best understood by considering their development to be arrested at a particular developmental point. Nevertheless, it has been shown that this progression through a series of stages of literacy development does not occur in all cases, with some children omitting the alphabetic phase but going on to establish a well-developed orthographic system (e.g. see Campbell and Butterworth, 1985; Stothard et al., 1996). Similarly, the information processing models are also not able to account for these atypical cases of literacy learning in which children failed to acquire sub lexical processing, typically thought to be a pre-requisite for acquiring the lexical route. Connectionist models may offer the best account of what takes place during literacy development, and how other linguistic knowledge integrates with the reading process. However, it remains for these models to be more fully developed and linked to more detailed, clinically-oriented models of speech processing.

(e) Linguistic knowledge: Summary

From a young age children store a great deal of related but different information about words: phonological knowledge (including input and output aspects), semantic knowledge, grammatical knowledge and later, orthographic knowledge. Although a great deal is known about speech and language development, many questions remain about the processes involved in speech processing and production, and how they are related to each other and to the development of literacy. In each of the sections outlined above there are recurring questions about the 'units' of representations (e.g. syllables, words, morphemes or larger chunks of language) and how these are organised in the lexicon.

2.1.2 Cognition

Children's linguistic knowledge has been described in some detail. However, there are more general cognitive abilities required if children are to acquire language normally. For example, children must be able to attend to stimuli, have a functional memory, have reasoning and referencing skills enabling them to carry out the mapping process, and the ability to integrate

information from a range of sources. Cognitive theories of language development have been influential (e.g. Menn, 1976; Kiparsky and Menn, 1977; Ferguson, 1978). These authors view the child as 'a little linguist' actively engaging with their environment for language learning. Children are thought to use problem solving to gradually acquire language in a series of stages. Strategies are seen as individual for each child and based on external and internal factors.

However, theorists have questioned the extent to which processes of language and cognition should be considered self-contained (i.e. modular) or interacting? Fodor's (1982) ideas about modularity as they apply to language processes are considered in greater detail in subsequent sections. However, a wider question can be asked about modularity: to what extent should language be viewed as a self-contained module, separate and special as compared to cognition more generally (Bates, 1994)? Cognitive theorists (e.g. Piaget, 1923, in Harley, 2001) argue that language, along with aspects like memory and face recognition are all integrated aspects of cognition whereas Chomsky (1980) is a strong advocate of the modular view. To investigate such questions studies have been carried out with children developing language in unusual ways or unusual circumstances. Children with specific language impairment are thought to have deficits limited specifically to language (e.g. Van der Lely, 1998, Botting and Conti-Ramsden, 2001) but with normal cognition. In contrast, children with Williams's syndrome have traditionally been described as having impaired cognitive functioning but normal language skills. This double dissociation has been taken as evidence for a clear demarcation between the two. However, more recent studies of children with William's syndrome and SLI have shown that their language skills may not be as good as previously thought (Stojanovik, Perkins and Howard, 2001).

The role of memory has become increasingly topical in trying to understand speech and language processing. The relationship between working memory and other language abilities has been investigated (Vance, Donlan and Stackhouse, 1999; Botting and Conti Ramsden, 2001). Baddelely and Hitch (1974) carried out research into short-term memory suggesting that it is not a unitary structure. They described working memory as being a set of structures consisting of a central executive, a visuo-spatial sketchpad, and a phonological loop. The central executive is the attentional system responsible for higher level language integration and comprehension; the visuo-spatial sketchpad stores spatial information for short term usage, and the phonological loop ties in with phonological processes of language. The central executive and phonological loop thus are thought to have important roles in speech and language processing. Bocks's (1982) information processing model shows a range of linguistic processing modules (e.g. syntactic processing; phonetic coding and semantic processing etc.) all underpinned by working

memory, thought to mediate resource allocation. Much of Levelt's (e.g. 1989, 1999) work has been focused on understanding the way in which language interfaces with conceptual knowledge more broadly. This has been addressed in broad terms in his models of speech production, but remains an important but difficult area to investigate empirically.

Stackhouse and Wells (1997) have not explicitly incorporated general cognitive abilities in their speech processing model (Figure 2.2). Memory and other executive functions do not appear in their model, although to some extent the lexical representations represent long-term memory stores, and the online skills such as phonetic discrimination and motor programming are analogous to (linguistic) working memory. However, these factors are managed from a clinical viewpoint, by discussions in the text on profiling and the need to understand the complexities of therapy tasks, one aspect of which is memory load. Dodd and McCormack (1995) include non-linguistic factors in their speech processing model, making particular mention of culture, an important factor that will shape the child's worldview and the context in which they communicate.

2.2 Input

2.2.1 What is input processing?

Different models conceptualise input processing in slightly different ways, however the basic elements common to all models are (a) segmenting the speech stream into relevant units (e.g. words, syllables), and (b) recognizing those units. Perception requires detailed decomposition of the acoustic signal in order to perceive the gestures produced and the sequence of these gestures. Stackhouse and Wells' (1997, Figure 2.2) model offers a relatively detailed conceptualization of sub-processes which might occur during input processing. It is suggested that the following stages occur in a bottom-up fashion in the processing of speech :

1. peripheral auditory processing
2. separating speech from non-speech stimuli
3. phonetic discrimination
4. phonological recognition, leading on to
5. retrieval of stored representations if the word is already familiar, or creation of new representations in the case of exposure to new words.

Chiat (2000) conceptualises similar stages in her speech-processing model. The initial stage of auditory processing involves 'discrimination of relevant features of the speech signal', which equates to Stackhouse and Wells' stages 2 *and* 3 above, with the assumption that peripheral

auditory processing has taken place successfully. This is followed by 'identification of word phonology', which equates to 'phonological recognition' in the Stackhouse and Wells model. Ellis and Young's (1988) model for adults indicates simply an 'auditory analysis system' and an 'auditory input lexicon.'

Children's processing of non-words is an aspect that has received increasing attention in recent years (Botting and Conti-Ramdsen, 2001). Difficulties with non-word repetition are thought to be an important diagnostic indicator for SLI (Bishop, Bishop, Bright et al., 1999) and may also be linked to literacy difficulties (Snowling, Bishop and Stothard, 2000). Bird and Bishop (1992) found that the performance of children with speech disorders on a non-word discrimination test was unrelated to severity of speech impairment, but that performance on a real-word test was significantly related, suggesting that these tasks are tapping distinct underlying skills. In terms of input, it remains to be seen whether there is further evidence for a separate non-lexical route of auditory processing, and to what extent there are common aspects in the processing of linguistic and non-linguistic stimuli. It is also unclear whether phonemes are represented directly in the pre-lexical code or whether they are constructed after accessing the lexicon (Harley, 2001). There is some evidence that children do more perceptual processing at syllable level than adults (e.g. Nittrouer and Studdert-Kennedy, 1987).

2.2.2 What is the role of input?

The importance of input for children's speech development has been emphasized by many researchers (e.g. Beckman and Edwards, 2000; Evans, 2001). There is much evidence that children's speech perception starts to develop pre-natally and that they are sensitive to speech input already whilst in utero (e.g. see Aslin, Jusczyk and Pisoni, 1998 for a review of the early development of auditory perception). The hearing infant first encounters language not as strings of word forms and their component subparts but as unsegmented audiovisual signals. The child's task is to map the phonological form of words they hear in ambient speech onto relevant meanings (Chiat 2000, 2001).

There is great variability in the audiovisual patterns corresponding to any given word form. Chomksy (1980) has made much of this 'poverty of stimulus' argument in suggesting that language is more innate than influenced by input. However, while authors such as Edwards et al. (1999) acknowledge that a simple associative model of input and output cannot fully account for the effortless, complexity of language acquisition, they consider the role of input as one which drives speech and language acquisition. They suggest that children are cognitively equipped to carry out stochastic modeling which involves implicit calculations of the statistical

probability of hearing particular combinations of sounds in their languages (Maye, Werker and Gerken, 2002). However, more clear evidence is needed to demonstrate what the initial unit of perception is in normal development (Waterson, 1987; Bird and Bishop, 1992). Although input is undoubtedly important, the degree of robustness of language development in the presence of degraded input is still debated.

2.3. Output

2.3.1 What is output processing?

This section considers output processing from a post-lexical perspective since lexical representations have been dealt with in a previous section. Beyond motor programming, the Stackhouse and Wells (1997) model considers stages of motor planning and motor execution, as shown in Figure 2.2. Motor planning is considered to involve phonetic aspects of speech production, moving beyond the abstract linguistic knowledge of the previous stage. It is at this stage that co-articulation is considered to come into play: how will different phonemes be realized in their different contexts? While motor programming is conceived as being a single word phase, motor planning might involve the connection of words into strings of speech. From these authors' perspective motor execution involves the physical actions required to produce speech which rely on an intact and functional speech mechanism.

Two speech processing models to have focused on speech output in a comprehensive way, are those of Dodd and colleagues (e.g. Dodd and McCormack, 1995; Ozanne, 1995), and Hewlett (1990). Dodd and McCormack (1995) and Ozanne (1995) describe a phonetic planning level, following the generation of the phonological plan. This level, akin to Stackhouse and Wells' motor planning level and Hewlett's (1990) motor processing modules, is thought to involve three sub-processes. These include conversion of the phonological plan into a motor-speech programme, assembly of the phonetic units into appropriate sequences, and concluding with the implementation of the programme. A distinct module then describes the motor execution itself. Again, there is some uncertainty about the linguistic units processed at each point: while Stackhouse and Wells consider motor planning to be the earliest stage at which prosody and connected speech processes are involved, Dodd and McCormack consider that prosodic information is included at the earlier motor programming level.

Hewlett's model specifies two distinct levels of motor planning rather than the one described by Stackhouse and Wells (1997). Hewlett (1990) terms these 'motor processing' modules but the description of the modules is very similar to what is envisaged in Stackhouse and Wells' (1997) motor planning. Hewlett differentiates between his two boxes, with the one

being 'motor processing at a syllabic level', followed at a lower level by 'motor processing at a segmental level', and finally a motor execution level. Hewlett (1990 p.31) notes:

> "The task of the Motor Processing component is to assemble the motor plan of the sequence of gestures involved in pronouncing the word, and determine the precise values of the articulatory parameters involved. The output from the Motor Processing component contains all the information required to achieve the actual muscular contractions (motor execution)."

The division of motor processing into the syllable and segmental level comes from a developmental perspective since it is thought that during development of motor control and when learning new words, there is more reliance at a syllable level. Later, more emphasis is placed on a segmental level. Hewlett conceptualises a great deal of feedback taking place between each of the levels of output, so that if there is sufficient awareness of difficulties at a particular level of processing, then subtle modifications can be made to increase speech production accuracy.

2.3.2 What is the role of output?

There is some evidence that having no functional speech affects auditory perception and auditory memory (Bishop, Brown and Robson, 1990), as well as phonological awareness (Blischak, 1994). This is not hard to understand in the light of the complex relationship posited between input and output (and vice versa) by authors such as Vihman et al. (1985) and Edwards et al. (1999). Guenther, Hampson and Johnson (1998) present a model of speech production in which, during the early babbling of motor speech development, the infant learns systematic mappings between articulatory movements and auditory consequences, thus suggesting that output may drive the language acquisition process.

It is clear that input and output are to some degree mutually dependent – it is the degree and exact nature of the relationship that remains unclear. Studies, which have confronted children with their own erroneously produced speech, have shown a mild relationship between misperception and misproduction (e.g. Locke and Goldstein, 1971; Morgan, 1984). Constable et al. (1997) investigated the severe word-finding difficulties of a 7-year old boy. Using a psycholinguistic framework these authors tapped into the child's phonological and semantic processing. He had good semantic representations, but his phonological processing was pervasively impaired in terms of both input and output. The authors argued for close links between the two, suggesting "imprecise phonological representations inevitably result in inaccurate and or/unstable motor programs." (p.532)

2.4 Discussion of overarching ideas in speech and language development

Modularity is implicitly assumed in neuropsychological and psycholinguistic information processing models. However, such approaches to understanding children's speech and language development have been questioned (Marslen-Wilson and Tyler, 1987) and criticised (Bishop, 1997). Bishop (1997) notes that while cognitive neuropsychology makes assertions about the way an intact, fully developed system is organized, this may not be appropriate when considering the dynamic, developing systems of children. Cognitive neuropsychology relies heavily on dissociations and double dissociations in order to draw conclusions about modular processes. Within the developing language system there is ample evidence for interaction between levels of representation, with modularity emerging in the course of development. This means that one is typically seeking to explain a complex pattern of associated impairments, rather than highly selective deficits. For instance, a selective impairment in auditory processing will have repercussions throughout the language system, and may lead to distinctive syntactic deficits that are seen in written as well as spoken language. Changes in the nature of representations, and in the relationships between components of a developing system mean that cross-sectional data at a single point in development may be misleading indicators of the primary deficit.

Modularity is often assumed in the design of intervention studies, for example in multiple baseline designs which alternately treat and suspend treatment of particular items. However, variables are more likely to be interdependent on one another, thus highlighting a fundamental problem of using multiple baseline designs within the area of language intervention. Because the five components of language (phonology, semantics, syntax, morphology and pragmatics) are so intertwined it is difficult to treat one without the others being affected. Seron (1997) terms this the modularity constraint, and cautions that it is likely to not only apply between the broad language areas outlined, but also within language domains.

Increasingly, emphasis has been placed on the importance of a developmental perspective in processing models for children versus adults. The application of static neuropsychological deficit-based models to children for whom language development is taking place is no longer considered appropriate. Neuroconstructivist theories (Karmiloff-Smith, 1998), theories of emergentism (Evans, 2001) and interactionist theories (Chapman, 2000) all emphasise the dynamic nature of development and have important implications for how research into child language disorders is carried out. This complicating influence of one aspect of language processing on another during development, is one to explore rather than eliminate. Theories of language development must address interactions between different aspects of

linguistic representations in the developmental process. However, it is argued that having a developmental perspective should not preclude the use of information processing models - if the models are applied with an awareness of interaction taking place not only in real time processing, but also in terms of the child's development over time. Models such as Stackhouse and Wells' (1997) take into account both aspects of processing, suggesting that their conceptualisation of children's speech processing is not a static one. In addition, models such as Hewlett's posit feedback throughout the system at almost every level.

It is not the aim of psycholinguists or cognitive neuropsychologists to map normal processes of speech and language onto the brain anatomy and physiology (although Ellis and Young (2002, p.4) note that there are "times when it would be churlish to ignore biological evidence.") Rather, the concern is with considering the processes which might underlie normal speech and language functioning, and then characterizing impairments by pinpointing specific aspects affected. However, it is useful to consider in general terms, the nature of the neurological system and how children might differ from adults. Temple (1997) cautions that:

> "For the truly developmental disorders, where the underlying abnormality predates birth, the mechanisms of plasticity have always been in doubt. If plasticity is operational, why are there children with developmental dyslexia? Why does the brain not reorganize or compensate for the deficit? My own belief is that plasticity, in so far as it exists, may normally be a response to injury or disease... rather to an abnormal developmental process." (p.16)

Nevertheless, we should consider individual differences and the fact that there may not be a single developmental pathway (e.g. as exemplified by the case study of Stothard et al. (1996), cited in section 2.1.1.(a). Although the ultimate goal in speech and language development may be the same, the ways involved in achieving this may differ. Whether or not it is termed 'plasticity', there is evidence of a critical age during which languages are optimally acquired. Lenneberg (1967 in Temple, 1997) suggested that the cut-off point for optimal acquisition is at puberty, but more recent theories suggest that the age is much younger, probably around 5 years (e.g. see Lightbown and Spada, 1999). Similarly, 5;6 years is considered to be a critical age by Bishop and Adams (1990) whose longitudinal studies have suggested that children who have not resolved their speech difficulties by this age, face an increased risk of experiencing literacy problems.

3. PSYCHOLINGUISTIC THEORIES OF DISORDER

In general, the best way to understand children's language impairment is by considering models of normally developing children's speech and language processing. These models allow us to move beyond observation and description of symptoms towards explanation in terms of underlying processing representations and mechanisms. What has gone wrong in a child's development to cause him/her to show a particular profile of difficulties? This section considers some of the dominant theories about speech and language disorders and the underlying causes of such conditions.

Chiat (2000; 2001) considers the child's mapping of forms onto meanings as central to the language acquisition process. Thus, she believes that the 'first place to look' when considering language difficulties is here. This phonological theory considers that specific language impairment arises from impaired phonological processing and the consequent disruption of the mapping process. Chiat's (2000, 2001) mapping theory does predict the effects of phonological impairment at all levels of language, rather than being confined to just one module. From this point of view the theory does take children's development and the dynamic nature of this process into account. Recent research emphasizes the contribution of complex phonological processing not just in the segmentation and representation of lexical phonology but in wider lexical and syntactic development, which accounts for the broad spectrum of linguistic difficulties often seen in these children. This theory stands in contrast to grammatical theories that attribute language impairment to deficits in specific linguistic structures (e.g. Van der Lely, 1998). In terms of psycholinguistic models, grammatical deficit theories would see the impairment as originating in the module/s of grammatical representations.

Another influential theory is the 'auditory hypothesis' (e.g. Tallal et al., 1993; Tallal et al., 1996) which suggests that children have specific speech and language difficulties because of problems in processing auditory input in the usual way. Tallal and colleagues have suggested that these children have fundamental auditory perceptual limitations which affect their processing of transient stimuli, including but not limited to speech sounds. There is some debate regarding Tallal's inclusion of both linguistic and non-linguistic stimuli in her theory and also in the remediation of auditory processing deficits, since it is not certain what is common to the processing of such sounds. Furthermore, her theory has been criticized for confusing cause and effect. Bishop et al. (1999a) agree that many children with speech and language difficulties have auditory processing deficits but that these are more likely to be one part of a range of deficits and

cannot be said to be responsible for the impairments of grammar and phonology. Briscoe, Bishop and Norbury (2001) conclude that although low-level auditory deficits could be at the root of some of the developmental language problems, they do not fully account for the whole range of language and literacy difficulties observed in children.

Other researchers have attempted to account for speech processing difficulties by suggesting that there is a deficit in motor programming, and that this problem then impacts on the entire system (e.g. Aram and Horwitz, 1983). Proponents of this 'motor programming hypothesis' have also used the term 'developmental verbal dyspraxia' to describe the difficulties. While there is some evidence that children who cannot produce certain sounds, may have difficulty in discriminating between them perceptually (e.g. Winitz, 1969), this does not always seem to be the case. In a study by Bird and Bishop (1992) there were not sufficient discrimination errors to account for the production errors observed. These authors concluded their investigation of the motor programming hypotheses – and other theories of speech disorders – by stating:

> "The clinical implications of this study are clear... the individual variation in data from the 14 children in our study suggest caution in proposing one general theory to explain all phonological disorders." (Bird and Bishop, 1992, p.309)

Turning to more general cognitive processing, short term phonological memory has been suggested as the underlying deficit accounting for children's difficulties with speech and language development (Gathercole and Baddeley, 1990; Gathercole, 1995), as well as contributing to literacy difficulties (Snowling et al., 2000). Results of a study by Botting and Conti-Ramsden (2001) suggest that there is a strong short-term memory element which underlies SLI, but that this deficit may not necessarily be causal.

In terms of literacy, it seems clear that having an intact speech processing system is needed for the normal development of literacy, as indicated graphically in Figure 2.4. (Stackhouse and Wells, 1997). Phonological deficits are thought to lie at the heart of dyslexia, and the links between phonological awareness and reading acquisition have been demonstrated and replicated many times (e.g., see Lundberg et al, 1988; Snowling and Stackhouse, 1996). This highlights again the complexity of the causal relationship between different aspects of children's developing systems.

Children's difficulties with speech, language and literacy are likely to be the consequence of a range of factors, and characterised by wide-ranging behavioural manifestations and underlying processing strengths and weaknesses. These points have been emphasized by

both clinicians and researchers, and proven in a range of investigations (e.g. Grunwell, 1981; Bird and Bishop, 1992; Dodd, 1995; Stackhouse and Wells, 1997). Detailed investigations of children with specific speech difficulties suggest that they often have pervasive speech processing problems (e.g. Stackhouse and Snowling, 1992; Chiat and Hunt, 1993) or more specifically problems with auditory discrimination (Crosbie and Dodd, 2001), imprecise storage of words (Bryan and Howard, 1992) or with all areas of output production (Waters et al., 1998) – or various combinations of these areas. Ebbels (2000) cautions that while some reported cases (e.g. Bryan and Howard, 1992; Bryan and North, 1994) show a deficit limited to one module of the processing model, there are more typically multiple levels of breakdown. Profiling approaches such as Stackhouse and Wells' (1997, 2001) allow one to consider each child as an individual with their own unique constellations of strengths and weakness, as well as causal and maintaining factors. Dodd and colleagues (e.g. Dodd, 1995; Ozanne, 1995; Holm and Dodd, 1999; Dodd and Bradford, 2000; Dodd, Hua, Crosbie, Holm and Ozanne, 2002) have approached the heterogeneity challenge from a slightly different perspective. It is argued that differential diagnosis is vital for effective intervention. Dodd's sub-grouping approach to children with speech difficulties was introduced in Chapter 1 from a clinical and intervention planning perspective. These subgroups have a strong theoretical basis: experimental evidence (see for example, Dodd and McCormack, 1995) has proven the existence of the distinct categories. Furthermore, the difficulties faced by each of the groups can be accounted for in terms of Dodd and McCormack's (1995) speech processing model. These authors suggest that children with delayed phonology do not have one particular locus of deficit in their speech processing profile, but rather that they are generally delayed throughout the system as if they were a younger child. Children whose speech is consistent but deviant (i.e. there is evidence of non-developmental processes, see Chapter 1, p.20) are thought to have their locus of difficulty centred at the cognitive–linguistic level: their phonological representations and the realization rules acting upon them are not appropriate for the ambient language. Children with inconsistent, deviant speech are thought to have difficulties at the level of phonological planning: they may not be able to access templates or may have templates which are under-specified or incorrect (Ozanne, 1995). This sub-group is distinguished from children with dyspraxia whose difficulties are thought to affect a wider range of areas including phonological planning, phonetic programme assembly and execution. The fact that so many levels of speech processing are implicated in dyspraxia accounts for why it is often such a challenge to address in intervention (Ozanne, 1995).

Sub-grouping of children into diagnostic categories (following Dodd, 1995), and profiling of children's strengths and weakness (following Stackhouse and Wells, 1997, 2001) are two, complementary ways of dealing with the heterogeneous nature of speech difficulties.

4. CONTRIBUTIONS OF INTERVENTION: CLINICAL AND THEORETICAL IMPLICATIONS

It has been shown how children's patterns of impaired and intact speech and language skills can inform our knowledge about the way in which the normal speech processing system is organised. Observed patterns of symptoms would not be noted if the normally developing speech-language system were not organised in a certain way (Ellis and Young, 2002). Similarly, it can be deduced that children will not respond to intervention in the ways they do, if the speech and language system is not of a particular nature and organised in particular ways.

Much has been made of the difficulties inherent in grouping heterogeneous individuals, and the usefulness – indeed essentialness - of the single case approach has been emphasised. Ellis and Young (1996) note that single clients can serve as separate tests of cognitive theory. However, this does not mean that comparisons between clients are excluded: the latter chapters of this thesis will attempt to highlight similarities between the children studied. The question, might then be asked: how does generalisability of theory come about if all cases are treated separately? Ellis and Young (1988) emphasise that a theory or model of a particular cognitive function is meant to account for all reported cases, so that the model is not a model unique to the individual. The models employed must be able to account for the patterns of deficit observed as well as the child's response to intervention, if it is to be considered valuable. Comparing groups of single cases and their responses to model-based intervention, may lead one to conclude that a particular model is not accurate and suggest ways in which it might be revised.

Therapy and theory are not – or at least should not be - as distinct as is sometimes supposed (Patterson, 2002). Generalisation, an important theme in both this chapter and the previous one, is a good example of an aspect of intervention that is equally important from clinical and theoretical perspectives. From a theoretical point of view, generalization has the potential to be extremely illuminating, since the predictions one makes about generalisation will vary depending on one's views of the way in which speech and language are organized in children's developing brains. Generalisation can be considered at two broad levels:

- *Across-item generalization*: generalisation from treated items (e.g. words) to untreated items. The degree to which the untreated items resemble the treated items is an important variable, i.e. these may range from very closely matched single words, to words with a different phonotactic structure, or sentences.

- *Across-task generalization*: generalization from a treated task (e.g. naming of CVC words) to another task (e.g. spelling of CVC words to dictation). To evaluate across-task generalization a constant wordlist is needed since it enables comparison of task performance between tasks and levels of processing, without confounding the issue by introducing stimulus variability (Stackhouse and Wells, 1997, 2001).

If one believes that each lexical item has discrete, local representations then one would not expect to see across-item generalization. Whereas, if one assumes that words are representations of interconnected micro-features shared by many different words (e.g. Coltheart and Byng, 1989, Patterson, 1994) then one would expect generalization to other untreated words. Furthermore, the pattern of generalization noted post-intervention would inform views about how the lexicon might be organized. Turning one's attention to predictions about generalisation from one task to another, this will depend on whether a chosen theory assumes that, for example there is a common output lexicon for both spoken and written forms. If one supported this idea, then one would be expecting that intervention addressing speech production (or more specifically motor programmes) would result in improved spelling skills on the same set of words. Predictions about reading and writing will depend on whether one's theory assumes, for example, that the orthographic representations underlying word recognition in reading, and word production in writing are the same ones. Evidence regarding this issue, from intervention studies with adults, is conflicting: Carlomagno and Parlato (1989) did find the generalization from reading to writing, whereas Scott and Byng (1989) did not.

The evaluation of generalization holds great potential. However, it is not always a simple matter to investigate or understand. Chapter 1 reviewed what is known about generalization in terms of children's responses to phonological intervention. Although generalization can occur in many ways, it is not always observed and seldom predictable. This highlights again the heterogeneity of children with speech and language difficulties, and also reminds us that the matter is not likely to be as simple as targeting individual modules in therapy and then activating adjacent, or 'downstream' modules. One way of dealing with this issue, is by returning to a psycholinguistic analysis of 'what tasks really tap' as discussed in Chapter 1

(section 3.4). Analysis of intervention tasks and the parts of the profile tapped can be systematically compared with the generalization tasks and the parts of the profile they tap. If, for example, across-task generalization is observed then this may be accounted for by looking at overlapping aspects between the two tasks. If there are additional boxes being invoked by the newly successful generalization task, then the skills linked to this box can be investigated further by carrying out other tasks designed to specifically tap into that level. Section 5.7 in Chapter 1 considered generalization for the small group of psycholinguistic intervention studies reviewed. This showed that across-task generalization is more rarely achieved than across-item generalisation.

Psycholinguistic task analysis is vital in carrying out and interpreting intervention studies from a theoretical perspective. Patterson (2002) observed that some intervention studies describe themselves as being conducted within a psycholinguistic or cognitive neuropsychological framework, yet this may not truly be the case (see Chapter 1, p. 34). One way of ensuring that the psycholinguistic approach is followed is by considering task analysis for assessment, intervention and evaluation tasks in a very explicit way. Although intervention may not always be successful, by adopting a psycholinguistic approach it is possible to isolate the level of the speech processing system that therapy tasks were tapping, and make appropriate revisions. Another way of ensuring that the study will be of theoretical value and truly 'psycholinguistic', is by carrying out pre-intervention assessments that rely on the model or framework to guide this process. Specific hypotheses can then be generated regarding the child's areas of difficulty, and the way in which intervention will affect these specific aspects as well as its effects on the entire system. Again, these hypotheses may not be supported and unexpected patterns of change may occur. However, having carried out the programme in the context of a particular model will enable one to reflect and reconsider initial hypotheses.

The impact one level of speech processing has on another is an important and recurrent theme, both in understanding normal and disordered development and also in intervention. While one problematic component may have negative repercussions on others, the converse may also be true: a strength at one level may be exploited to strengthen the rest of the system. This was demonstrated in the intervention study by Waters et al. (1998). Some studies have shown that children make minimal progress in targeted areas of the speech processing system, but make significant gains in other untreated aspects. Such results need to be interpreted cautiously, but may provide valuable insights into the workings and organisation of children's speech and language. Such insights would be unlikely to result from a purely diagnostic evaluation. Richardson and Klecan-Aker (2000) evaluated the effects of intervention for pragmatic skills

with a group of children with learning disabilities, aged 6;5 to 8;1. Results revealed that the children improved in all targeted pragmatic language areas, and in addition they made progress in areas not targeted in the intervention programme such as expressive and receptive language. The authors reconsidered notions about both development and modularity, and concluded that their findings were *not* in fact as surprising as they may seem on first glance.

Productive phonological knowledge (PPK) is another good example of a construct with great relevance from both clinical and theoretical perspectives. Intervention research has been carried out to evaluate the validity of Gierut et al.s (1987) PPK categories and claims about the differential responses of these to intervention. Williams (1991) studied the use of "least phonological knowledge" (Type 6) by treated nine children (ages 3;8 – 5;9) with similar levels of knowledge on the same error. The level of phonological knowledge did not appear to be related to outcomes. Rvachew and Nowak (2001) investigated generalization in 48 children randomly assigned to two groups. For one group phonemes with most phonological knowledge were treated, and for the other phonemes with least phonological knowledge were addressed. The authors reported significantly more progress for the first group, and no difference between the groups in terms of generalization to untreated phonemes. This is in contrast to what has been predicted by Gierut et al. (1987), although the authors did acknowledge that in a longer study the impact of treating "least knowledge" phonemes may have been seen.

Stimulability is another area that can have important implications for both clinical practice and theory. Work on stimulability (e.g. Powell, Elbert and Dinnsen, 1991; Powell and Miccio, 1996) supports the notion that phonological competence is not 'all or nothing.' The fact that some children with phonological disorders are stimulable for some error sounds – while others are not – suggests that phonological disorder might encompass a considerable range of deficits in any of several representational domains. The child necessarily passes through intermediate states in which knowledge of all aspects of perceiving and producing is built incrementally. Edwards et al. (1999) note that an adequate characterization of the child's knowledge deficit must be able to account for the observation that a child produces a recognizable [g] in 'doggie' but does not do so in 'dog', and this is something which the motor planning boxes in models such as Stackhouse and Wells' and Hewlett's can account for. Tallal's auditory account of SLI (Tallal et al., 1993; Tallal et al., 1996) has been criticized by many researchers (e.g. Bishop, 1998b; Bishop et al., 1999a, b; Briscoe et al., 2001). However, this work provides an excellent example of the way in which intervention can be used to test and build theory. Tallal's intervention work (Merzenich et al., 1996; Tallal et al., 1996) has aimed to improve children's auditory temporal processing skills by means of intensive computer-based

listening therapy. This approach has been successfully used to improve children's auditory discrimination and language comprehension skills, and interpreted by these researchers as supporting their hypothesis. A weakness of these intervention studies is that they measure the same task as is treated. There is further work to be done in looking at the effects of the treatment on more broad-ranging tasks in the speech and language processing system. Nevertheless, it is a good example of how theory has driven a programme of intervention research, the results of which have led to a reconsideration of the theory.

5. SUMMARY

This chapter has selectively reviewed a range of important theoretical issues in the field of speech and language development and disorder. It has aimed to show that intervention studies can address and inform theoretical questions, but also that the distinction between theory and therapy is necessarily a false one. Questions central to the thesis and underpinning the case studies are: What are the processes involved in speech processing and production? How are these processes related to each other and to the development of literacy? Do these processes operate independently or do they overlap? What can be learned from the investigations of children with speech, language and literacy difficulties, and from their responses to intervention? These questions are considered in relation to each individual child in their chapter (Chapters 4-8) together with some discussion of possible answers as they relate specifically to each child. Chapter 10 compares and contrasts the findings for all the children, considering theoretical contributions of the case-series as a whole. The following chapter, Chapter 3, outlines the methods employed in the studies.

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CHAPTER 3: METHODOLOGY

Chapter outline Page

1. INTRODUCTION

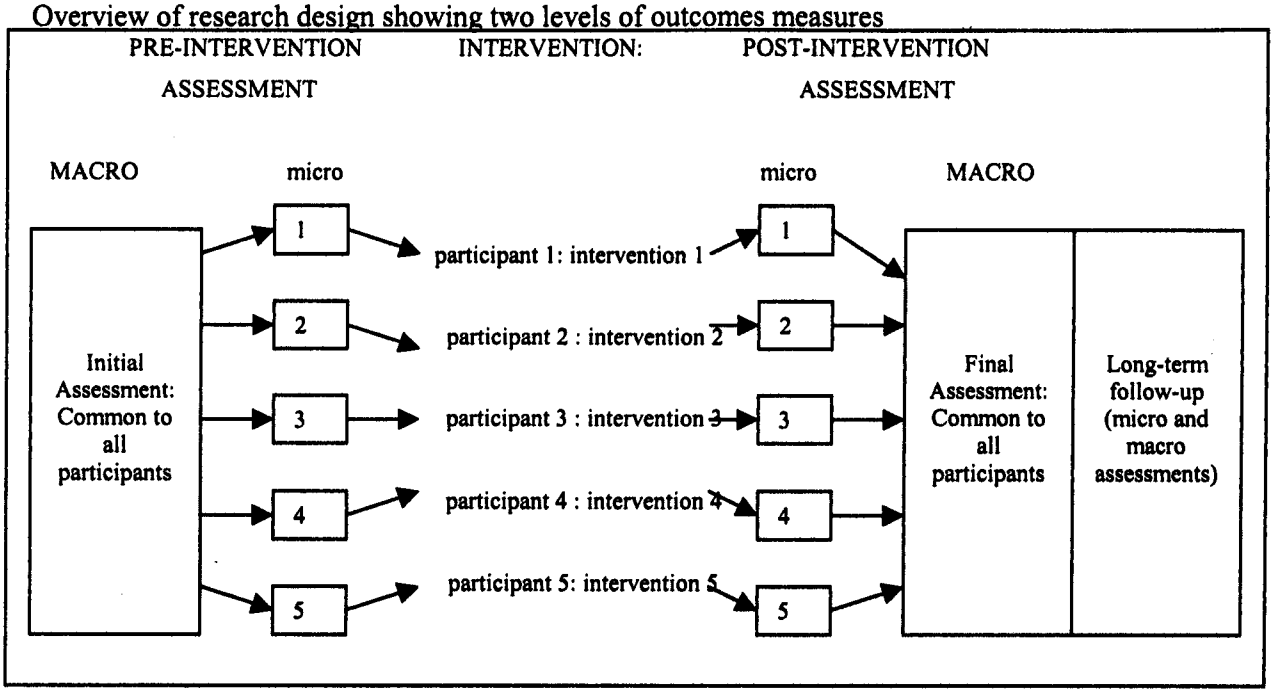
This chapter outlines the methods employed in the intervention case studies. The first part of the chapter provides an overview of the research design. This is followed by an introduction to the five child participants. The procedures employed for each child are then described, including the initial assessment, the intervention planning process that took place for each child, the intervention itself, and the evaluation and analysis that followed thereafter. This

chapter aims to provide an overview of the methods employed for all children, with the subsequent chapters describing this in further detail as appropriate for each individual child.

2. DESIGN OVERVIEW

The research was carried out using a single subject pre/post design with five children. Each child is the focus of a single chapter (chapters 4 – 8), which together form the main body of the thesis. These chapters focus on the children as individuals, considering each one's unique profile of strengths and weaknesses, the intervention that was tailored to their particular needs, and their response to that intervention. In each case, children acted as their own controls, with intervention being carried out by the same research therapist. An overview of the design is presented in Figure 3.1.

Figure 3.1
Overview of research design showing two levels of outcomes measures



Earlier chapters emphasised the importance of employing a wide range of outcomes measures. In order to be both sufficiently sensitive to measure subtle changes, as well as functionally relevant, outcomes measures are grouped into two levels: macro measures and micro measures. The former are measures that were employed for all the children, while the latter are measures that were specifically created for each individual child. The design overview presented in Figure 3.1 shows both macro and micro levels of assessment, before and after the intervention. Pre-intervention assessment took place over several months, so

that comparisons could be made between the accuracy of each child's speech at macro assessment with that at micro assessment to ensure that their speech was stable and not already improving prior to therapy. Speech severity indices (percentage phonemes correct (PPC), percentage consonants correct (PCC) and percentage vowels correct (PVC)) were used for this purpose. Despite the heterogeneity of the participants and the variety in their intervention programmes, there are many commonalities uniting the cases. Assessment at micro and macro levels, as well as intervention planning, was in each case guided by the Stackhouse and Wells (1997) psycholinguistic framework.

Assessment of functional communication skills of children has increasingly been acknowledged to be an essential part of the assessment process (Lees and Urwin, 1997). One of the most important, functional macro measures employed was that of intelligibility: if changes in the children's overall speech intelligibility could be demonstrated following intervention, then intervention could clearly be considered effective. Intelligibility has been defined as the "understandability of speech" (Yorkston, Dowden and Beukelman, 1992), but ways of measuring this differ. For this research a write-down procedure was used with unfamiliar listeners, i.e. a group of listeners unfamiliar with the children were required to listen to recorded samples of the children's speech and to write down what they thought the children were saying. Comparisons were made for each individual child for pre-intervention and post-intervention intelligibility to determine if any changes had occurred. This procedure was carried out following the completion of the intervention programmes using an experimental paradigm that relied on recorded samples of the children's speech and groups of unfamiliar listeners. The background to the intelligibility study, further details of the methods employed and the results for each child, are discussed in Chapter 9.

3. PARTICIPANTS

3.1 Participant selection

Children considered for participation in the study were required to meet the following criteria:

- To be of young school-age, between 5-12 years
- To be attending a mainstream school
- To have current and persisting speech difficulties
- To have received speech and language therapy previously
- To be monolingual English speakers

These criteria were deliberately broad because psycholinguistic models should be applicable to all children, not just specific groups of children. Indeed, Stackhouse and Wells (1997) claim that their framework is not limited in its application to children with particular

difficulties or diagnoses. Many intervention studies have focussed on pre-school children and the study aimed to redress this imbalance by focussing on the older child whose difficulties have not resolved. The criteria were outlined to the local paediatric speech and language therapy agency, who had agreed to collaborate on this project. On the basis of these criteria, six potential children attending the same school in the North of England were identified. The NHS liaison therapist made contact with the children, the school and the children's families and established their interest in the project. One of the children was moving out of the area and thus could no longer be considered as a potential participant. Informed consent was then obtained from the five remaining children and their families, and ethical approval for the study obtained from the local research ethics committee. These documents are included in Appendix 1. The children and their guardians agreed not only to participate in the intervention study but also consented to being audio- and videotaped during intervention and assessment.

3.2 Participant description

Table 3.1 presents a summary of the five child participants[1]. It can be seen that the children ranged in age from 5;6 years to 8;6 years at the start of the study. Three of the children aged between 6;2 and 7;2 (Katie, Rachel and Joshua) were in the same class for the duration of the study. There were two girls and three boys. Initial description of the children's difficulties suggested that problems ranged from being very severe and wide ranging (e.g. Oliver, Katie and Joshua) to being more specific and less severe (e.g. Rachel). Concerns about the oldest child, Ben were centred around both his speech and literacy.

Table 3.1
Description of child participants

Child	Chapter of thesis	Sex	CA at start of project	School year	Summary of difficulties based on case notes, parental and teacher report
Oliver	4	M	5;6	Reception	Wide-ranging speech and language problems; unintelligible speech; history of ear infections; possible developmental verbal dyspraxia
Katie	5	F	6;5	2*	Wide-ranging speech and language problems; unintelligible speech; ataxic cerebral palsy
Joshua	6	M	6;10	2*	Delayed speech and language in the presence of behavioural and social problems; diagnosed with DAMP – deficits of attention, motor-control and perception
Rachel	7	F	7;1	2*	Difficulties largely resolved; some phonological problems remain; academically copes well
Ben	8	M	8;6	5	Mild speech problems remain despite years of therapy; concerns about effect of speech on spelling; possibly dyslexic

* These children were in the same class with the same teacher/s for the duration of the project

[1] The children's real names are not used.

4. PROCEDURES

4.1 Outline of procedures for each child

Each of the five children went through the same seven stages, listed below:

1. Macro assessment
2. Macro intervention planning
3. Micro intervention planning
4. Micro assessment
5. Intervention
6. Micro evaluation
7. Macro evaluation

Initial assessments were carried out in a way which closely informed intervention planning. Corrin (2001a,b) suggests that this should be the case, and describes her conceptualisation of the 'Profile to Programme' process as consisting of six sequential but interlinked steps with the psycholinguistic framework driving each of these. The six steps she suggests are the same as the ones outlined above, although her final step: 'analysing outcomes of intervention' has here been subdivided into two levels, mirroring the macro and micro levels from the initial assessment. Each of these stages is described in greater detail in the sections that follow.

All assessment and intervention sessions took place at the children's school, a small mainstream school in an inner-city area in the North of England. The research therapist visited the school on a twice-weekly basis during the school term for a period of about 18 months in total. All children were seen individually on each visit for approximately one hour each, unless children were absent or unable to leave the classroom for a specific reason on a particular day. Assessment was lengthy and took place over many sessions. All sessions took place in a quiet room with only the therapist and child present. All assessment and intervention sessions were audiotaped using a high quality SONY MZ-R30 portable mini-disc recorder and a SONY condenser microphone 5500.

Transcription

Live transcription of the children's speech took place at each assessment session so that both visual and auditory information from the children could be taken into account. Further listening to the audio-recordings of the children's speech took place immediately following the sessions, and the transcriptions were completed and re-checked. Broad phonetic transcription was carried out using the International Phonetic Alphabet (IPA) symbols (see Stackhouse and Wells, 1997, Appendix 1 on Phonetic Symbols and Diacritics). Reliability

transcriptions of the audio-recorded data (approximately 5% of the total sample) were carried out by three independent listeners with advanced training in phonetics. Agreement of at least 90% was found when comparing the initial transcription with those of the independent raters.

4.2 Macro assessment

The pre-intervention assessment aimed to obtain a clear understanding of each child and their speech, language and literacy abilities. More specifically, this assessment aimed to:

- Obtain measures of each child's speech, language and literacy skills through standardised test procedures
- Evaluate each child's speech processing strengths and weaknesses by using the Stackhouse and Wells (1997) speech processing profile which aims to tap into all aspects involved in speech processing to indicate areas of breakdown or difficulty.
- Evaluate each child's speech production through qualitative linguistic analysis so that phonological data could be combined with psycholinguistic data for intervention planning.
- Obtain data from each child, their parents and teachers about the child and their communication skills to yield a broader picture of their functional communication beyond the therapy room
- Evaluate aspects of the child's non-verbal skills which could be used as a control task, unrelated to intervention.
- Evaluate each child's speech intelligibility as judged by unfamiliar listeners, thus incorporating functional data together with the more impairment-oriented assessment. Details of the intelligibility study appear separately in Chapter 9.

Each of the assessment procedures is outlined in further detail below.

4.2.1 Standardised language assessment

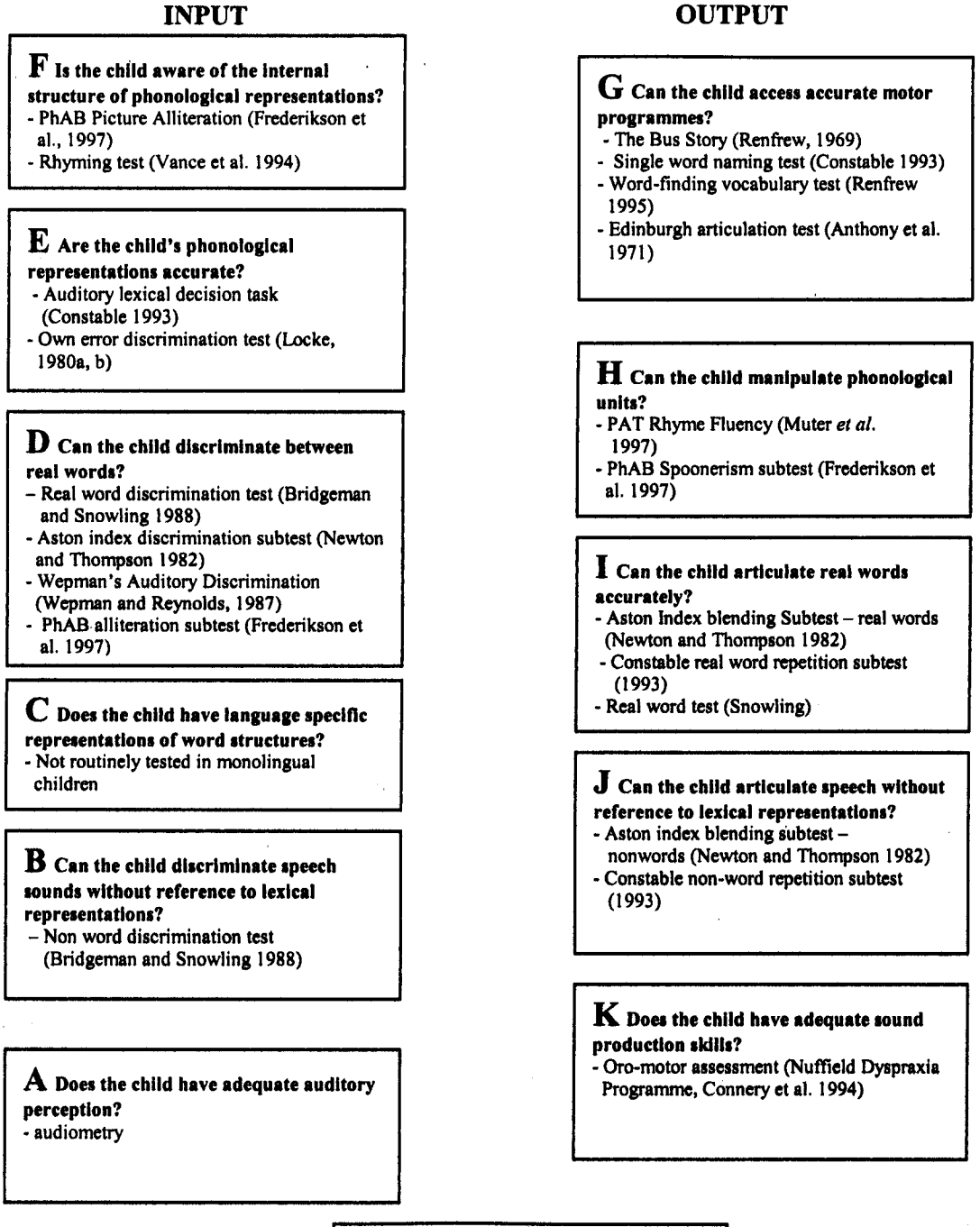
Assessment was grouped into three areas: receptive language, expressive language and literacy assessment. Some of the assessments selected for individual children varied depending on the child's age. In general, the receptive tests used included the Test of reception of grammar (TROG, Bishop, 1989), British Picture Vocabulary Scale (BPVS, Dunn et al., 1997) and Clinical Evaluation of Language Fundamentals (CELF- 3), Receptive Subtests (Semel et al., 1995). For most of the children, expressive tests included the Renfrew Word Finding Vocabulary Test (Renfrew, 1995), the Edinburgh Articulation test (EAT, Anthony et al., 1971) and Clinical Evaluation of Language Fundamentals (CELF- 3) Expressive Subtests (Semel et al., 1995). Literacy tests used were the Schonell Graded

Reading Test (Newton and Thompson, 1982) and the Schonell Spelling Test (Newton and Thompson, 1982). These are both single word tasks.

4.2.2. Speech profiling in a psycholinguistic framework

The speech processing profile of Stackhouse and Wells (1997) (Figure 3.2) was used as a framework for organising the data from this part of the assessment.

Figure 3.2
Speech processing profile from Stackhouse and Wells (1997) used to organise data for each individual child participating in the study. Examples of assessments tapping into of the levels are included at each level.



4.2.3 Speech analysis

Phonological Assessment of Child Speech (PACS, Grunwell, 1985) was carried out to provide information on each child's speech production system. PACS is a structured way of analysing a child's phonology based on their single word naming of pictures. Analysis is focused on the child's phonology at both a segmental and a structural level. The main findings from each child's PACS is presented in the relevant chapter, which includes information on the child's phonetic inventory, stimulability, the phonological contrasts and processes used by the child. For each child, the data gathered in this section was then used to 'subgroup' the child in terms of Dodd's (1995) differential diagnosis framework. For each child speech severity indices were calculated using the PPC, PCC and PVC metrics. This involved randomly selecting a sample of approximately 100 single words for each child, for which the target was known. For PCC (percentage of consonants correct, see Shriberg, Austin, Lewis, McSweeny and Wilson, 1997) counts were made of the number of target consonants in the speech sample. Counts were then made of the number of these consonants which were appropriately realised by the child, to yield a percentage. A similar procedure was employed for each child to yield the percentage of vowels correct. The raw scores for vowels and consonants were then combined to yield a PPC, the percentage of all phonemes correct (see Dodd, 1995). For each child the sample of words used to calculate these metrics differed. For each child, these metrics were compared with the metrics obtained using the same procedure at the micro assessment, carried out approximately two months later. This was done in order to ensure a stable baseline prior to intervention.

4.2.4 Child interview and parent / teacher report

Each child was interviewed in a semi-structured way with the aim of discovering more about the following areas: (1) their experience of speech and language therapy, (2) their perceptions and awareness of their own speech, (3) their perceptions of communication more generally, and (4) their attitudes to literacy. Many of the questions on literacy were based on the work of Francis (1982, in Stackhouse and Wells, 2001, p.286). The interview questions are shown in Appendix 3. Interviews were carried out at two points of the study for each child. The initial interview took place during an early phase of intervention for each child, when it was felt that rapport had been established. The second interview took place at follow-up some time after the completion of intervention and the final assessments.

Impressions were also obtained from each child's class teacher and/or classroom assistant. In some cases, verbal information only was obtained. In other cases this information was supplemented by data gathered using Bishop's (1998) Children's Communication Checklist (CCC). This checklist was developed to assess aspects of

communicative impairment that are not adequately evaluated by contemporary standardised language tests (see Bishop, 1998a for discussion on development of the checklist), and requires individuals familiar with the child to read statements about their communication and rate these by strongly agreeing, agreeing somewhat or disagreeing with the statement. There is also an option of "unable to judge." The checklist consists of 9 scales with 7 of these covering pragmatic aspects (inappropriate initiation, coherence, stereotyped conversation, use of conversational context, conversational rapport, social relationships, interests) but speech and syntax also included. The checklist was scored and interpreted using guidelines supplied by Bishop (2004)[2], which includes clinical guidelines for points at which further investigations are warranted.

Nathan (2002) investigated the social communication skills of children with speech difficulties using the CCC. Results of the study suggested that these children, as a group may have subtle differences in their social communication skills when compared to typically developing controls. Nathan, does however, go on to highlight individual differences between the children suggesting that in any group of children with speech disorders we would expect to find children whose CCC evaluation overlaps with normally developing children.

In addition, class teachers were asked to supply the children's Standard Assessment Tasks (SATs) scores. Schools in England follow a national curriculum which is divided into a series of 'Key Stages.' The Standard Assessment Tasks take place at the end of each key-stage, with many schools carrying out mock SATs towards the end of each school year. In this study the children's numeracy SATs results were used as control measures, unrelated to intervention.

Finally, impressions were also obtained from the children's parents. Contact was established with each child's parent/s. In addition to obtaining specific information about their concerns and perceptions of their child's speech before and after intervention, regular contact was sustained throughout the project either by written, telephonic or face-to-face meetings at the school.

4.2.5 Non-verbal control measures

All children were administered the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999), from which the non-verbal reasoning task was used as a control task unrelated to the intervention. The results from this test and the SATs scores were skills that intervention was thought not to address. If significant gains were found in these skills when comparing a child's pre and post-intervention performance it may have been that they were

[2] http://epwww.psych.ox.ac.uk/oscci/dbhtml/CCC/cccinstruct.htm

maturing in a general way, and that any gains in their speech may have been for this reason rather than because of the intervention.

4.2.6. Summary

A great deal of information was obtained for each child at this first stage, the pre-intervention macro measures. This information was used as baseline data, from which comparisons could be made with the assessment carried out at the completion of the intervention. Another, equally important function of this broad-ranging assessment, was to drive the macro intervention planning process discussed in the following section.

4.3 Macro intervention planning

It is doubtful if a psycholinguistic approach could ever shape the clinical process in isolation. Each of the cases aims to show how a psycholinguistic approach can be combined with a linguistic approach in intervention with school age children with phonological difficulties. Intervention planning focused on three main areas with each one providing an impetus for the work carried out. These areas included (1) a psycholinguistic perspective asking and attempting to address the question: "What aspects of the speech processing system should be worked on?" (2) a phonological perspective which asked and aimed to answer the question: "Which linguistic levels should be targeted and by means of what particular target stimuli?" and, (3) a more general child-centred perspective which aimed to answer the question: "What other aspects important to the child should be taken into account?" Work by Waters, Hawkes and Burnett (1998) has suggested that intervention may not be effective if aspects such as a child's learning style and motivation are not taken into account. The following sections expand on each of these areas in greater detail.

4.3.1 Psycholinguistic rationale

For each child, the psycholinguistic 'rationale' for intervention planning was based on the information organised in the speech processing profile. This is a very practical way of organising data from wide-ranging tests which tap into different speech processing skills. The speech processing profile is closely linked to the Stackhouse and Wells (1997) model of what may take place when children are processing and producing language. This model was introduced in Figure 2.2. The information gathered on each child's speech processing profile was then considered in the light of the speech processing model to yield hypotheses for each child about the strengths and weaknesses of their system. Each child's main deficits were mapped from the speech processing profile (Figure 3.2) onto the Stackhouse and Wells (1997) speech processing model (shown in Figure 2.2) from which the clinical tool was

originally derived. However, this mapping is not necessarily a straightforward 1:1 process since several of the levels of the profile may be incorporated in one 'box' of the model. For each child there was an individual consideration of how their profile might be mapped onto the model, and hypotheses formulated about what strengths and weaknesses characterised their system, together with suggestions for how intervention might address these. Both the speech processing profile and the speech processing model drive intervention in different but integrated ways. The profile focuses attention on specific tasks that a child can or cannot do, whereas the model allows one to extrapolate from task performance to the underlying functional architecture of the system.

Howard and Hatfield (1987 p.5) have stated that "knowing what is wrong does not, in any simple way, determine what to do about it." While being aware of each child's main deficits (and strengths) in terms of the psycholinguistic processing model is helpful for intervention planning, on its own this is not likely to be sufficient. For most children the deficits are likely to be numerous affecting several levels of the profile and parts of the speech processing model. This means that consideration needs to be given to deciding which (or all) of these levels will be addressed. There is limited evidence available for making such decisions in a reasoned way, and thus for some of the intervention planning in this work, when there were no other strong factors dictating the direction treatment should take, the intervention of two children with similar difficulties was contrasted. For example, Oliver (Chapter 4) and Katie (Chapter 5) were both found to have widely-affected speech processing profiles. Katie received treatment focused on her speech output, while Oliver received intervention more focused on input.

In deciding which aspects of the speech processing model should be addressed, the work of Rees (2001a) was drawn upon heavily. Rees (2001a, pp.52-60) describes principles of psycholinguistic intervention which include the following:

- Work on the speech processing system as a whole: although specific areas of weakness have been identified, these should be targeted in the context of the whole system and any strengths used to support this work.
- Strengthen links in the lexicon: consider the lexical representations (e.g. phonological, semantic, orthographic, motor programme) that the child has of a given word, and strengthen the links between these.
- Familiarize: children need repeated exposure and practise in order to develop new skills.
- Include non-word stimuli: Children need to process unfamiliar words as part of new-word learning.
- Make links with literacy: it is thought that activities aimed at improving phonological awareness will not promote literacy skills unless specific links are

made, i.e. explicit consideration of written symbols (Hatcher, Hulme and Ellis, 1994; Stackhouse, 2001). Furthermore, the incorporation of visual information (e.g. written forms) may act as a support for children with weak auditory processing skills or for children who have limited experience in producing certain sounds or sound patterns.

For each of the children, intervention was planned by:

1. Selecting a weak part / parts of the speech processing system as indicated on the speech processing model, which intervention would attempt to change
2. Selecting a part/parts of the speech processing system as indicated on the speech processing model, which were relative strengths for a given child
3. Devising a hierarchy of tasks which tapped into the parts of the system identified in (1) and (2) above. Early tasks in the hierarchy were designed to be easier for a child, tapping heavily into the child's processing strengths as identified in (2) above. These aspects were increasingly reduced in an attempt to scaffold from strong to weak points so that tasks ultimately tapped into (1) above.
4. In order to discern parts (1) and (2), speech processing tasks had to be deconstructed so that the parts of the system they were tapping were clear. In order to devise the hierarchy of part (3), a variety of tasks needed to be constructed so that they would tap the relevant parts of the system.

The psycholinguistic 'rationale' – where to start and what to work on - varied widely between children, but the principles outlined above were common to them all. This process gave a clear idea of the type of activities that would take place in each child's intervention.

4.3.2. Phonological rationale

For each child, a phonological perspective suggested the nature of linguistic stimuli used in the intervention activities. Thus, having first determined a task hierarchy and the activities or games to be carried out, this part of the intervention planning procedure determined what the *content* of those games would be. The important question from an intervention-planning perspective was: "What level of linguistic units (phonemes, words and/or phrases) should be targeted, and which specific exemplars should be selected? Principles outlined by Rees (2001a) were considered. These include:

- Confront the child with their own errors
- Design stimuli that reflect the child's pattern of errors

Rees (2001a,b) and others (e.g. Locke, 1980a, b; Ebbels, 2000) urge that a child's difficulties may not be global across all aspects of a processing task, e.g. auditory discrimination difficulties are likely to be centred around particular phoneme contrasts rather than being a problem with all contrasts of the ambient language. A good example of this is the case of Zoe, a child with very specific auditory discrimination problems limited to voice / voiceless contrasts, described by Stackhouse and Wells (1993). Intervention needs to be tailored to a child's specific difficulties, not just in terms of the particular 'boxes' targeted, but also in terms of the content of those boxes.

In order to make this decision, the information gained from the PACS (Grunwell, 1985) and other speech assessments (e.g. EAT, Anthony et al., 1971) was heavily drawn on. This information was combined with other data used to build the speech processing profile including both input and output tasks. There is a great deal of controversy and uncertainty about target selection procedures in general (e.g. as outlined in Chapter 1), as well as the most efficient way of carrying out therapy to achieve maximum generalisation. Thus, for many of the case studies presented here, target selection procedures were used experimentally. For example the selection of early-acquired phonemes in accordance with a developmental perspective is contrasted with sounds acquired later, in an attempt to advance knowledge in this area. Phonemes which differ in terms of productive phonological knowledge (PPK) are used as targets to allow for contrasts to be made between the different PPK categories. The outcomes of these experiments will be evaluated in each chapter.

4.3.3 Child-centred rationale

Intervention takes place in the real world, and children come to the intervention process with individual personalities, learning styles, likes and dislikes. Older children with a history of longstanding difficulties may be sensitive about their difficulties and the need to have therapy. An attempt was made to take such factors into account in intervention planning. This was not a central focus of the project and was not addressed in any systematic way, but it was incorporated into intervention planning for the children as appropriate.

4.4 Micro intervention planning

Micro intervention planning for each child involved a more detailed level of planning for both intervention itself, and the specific outcome measures used to evaluate the effects of intervention. In terms of intervention itself, specific stimuli sets were created for each child based on the criteria outlined in the macro planning phase. These include a mixture of stimuli: real words, non-words, phrases – as appropriate for each child. A timescale was devised for each child: how many words (or phrases, etc.) would be addressed in each

session; for how long would each task in the hierarchy be addressed; how many phases of intervention were envisaged? In many cases these timescales were guidelines that were modified in the light of children's responses to treatment.

In addition to the detailed treatment planning, lists of control stimuli were devised in order to evaluate the effects of generalisation post-intervention. These varied widely depending on the child and the nature of the stimuli. In all cases there were varying degrees of similarity to the treated stimuli, typically moving from a very similar list of stimuli matched in terms of phonological structure, age of acquisition and spoken language frequency, to more widely varying lists of stimuli such as non-words or words with particular phonemes in a different position. The purpose behind these lists was to allow for the evaluation of the extent of generalisation. In order for valid comparisons to be made across treatment and control wordlists, properties of words such as spoken language frequency and age of acquisition were taken into account and balanced across word lists. The MRC psycholinguistic database[3] was used for this purpose.

For each child, micro intervention planning ended with a detailed formulation of questions specific to the child and their intervention. Typically these questions moved from a very straightforward evaluation of the effectiveness of intervention (e.g. was a significant difference noted in the accuracy of final consonant production of treated words?) to questions regarding the extent of generalisation and generalisation patterns noted.

4.5 Micro assessment

Using the lists of specific stimuli selected for each child, baseline measures were then obtained for the items to be treated and the non-treatment controls. In order to assess generalisation from one task to another, these assessments typically involved a range of tasks including:

- Speech production: naming of items from pictures
- Speech production: repetition of items spoken by the research therapist
- Speech production: insertion of target word into a short carrier phrase
- Auditory discrimination of a stimulus paired with the child's erroneous production
- Spelling of stimuli to dictation

As for the macro measures, assessment took place over several sessions. Presentation of tasks and selection of items from lists was varied so that learning effects were minimized. The speech severity indices (PCC, PVC and PPC) were again calculated for each child using the data gathered at the micro assessments. Again, a sample of single words was randomly

[3] http://www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm

selected for each child. The percentages obtained were used to ensure that each child's speech severity was not changing beyond chance level prior to intervention.

4.6 Intervention

The intervention carried out in this study involved table-top games and activities, and in some cases sessions carried out at a computer. Corrin (2001a, p.143) notes that:

> "In intervention based on the psycholinguistic framework, the tasks themselves do not have to be novel. The emphasis is on the rationale for selecting particular tasks and for presenting them in a particular order."

In the case studies presented, the nature of the activities in each session was strongly dictated by the macro intervention planning at the psycholinguistic level. Typical activities included meaningful minimal pair therapy (following Weiner, 1981); metaphon-type approaches which aim to increase children's explicit awareness of properties of sounds (from Howell and Dean, 1994) and tasks which give children the opportunity to subconsciously reflect on input (e.g. Hodson and Paden, 1991). Each of the children was subgrouped according to Dodd's (1995) criteria. Holm and Dodd (1999) outline therapy approaches most effective for the different subgroups. In some cases principles from the recommended therapy were employed. In cases where they were not, the outcomes are evaluated in the light of these decisions. Overall, the approaches to intervention are eclectic, drawing on many influences, and typical of the type of activities routinely carried out by speech and language therapists working with children. What is different about the therapy carried out, is the rationale underlying the activities, and the way in which these can be deconstructed to show what parts of the speech processing are being tapped and why this is important for a given child based on their profile of strengths and weaknesses.

The nature of the intervention carried out with each of the children varied, as did the timescale. Some of the children received three phases of intervention while others had therapy that involved only one phase. The duration of the intervention varied from four to nine months.

4.7 Micro evaluation

Following the completion of intervention, each child was re-assessed using the specific micro stimuli designed for them, as outlined in section 4.5. Most of the children received more than one phase of intervention, and in such cases this micro assessment was carried out on completion of each intervention phase in order to yield a picture of their progress over time and linked to specific phases.

Results from each child's micro evaluation following intervention was compared with their initial performance on these measures. The purpose of these comparisons was to answer the questions formulated about the child and their intervention. More specifically to evaluate:

- the effectiveness of the intervention.
- generalisation which may have taken place across items.
- generalisation which may have taken place across tasks.
- the effects of intervention on specific targeted stimuli for children whose intervention follows a multiple baseline design, i.e. did accuracy of [s] stimuli significantly increase following phase I which specifically addressed [s] production?

Changes across intervention were statistically analysed by using two-way mixed ANOVAs. This analysis was used to test whether there were main effects for each of the independent variables (therapy and time) and whether the interaction between the two variables was significant. ANOVA was selected as a powerful statistical tool which would enable one to detect significant outcomes arising from the therapy as a whole, and has been employed in other intervention studies with a similar design, e.g. Fletcher, Foorman, Francis, and Schatschneider (1997). However, for most of the participants the raw data was categorical (i.e. target feature noted as present or absent) rather than continuous, which posed problems for the assumptions of normal variance associated with ANOVA. Cone and Foster (1993) assert that this is a fairly common problem faced by researchers, and suggest that ANOVA is robust to minor violations of assumptions particularly when a large sample is used. In the present research, each child had a large number of stimuli and controls and the use of ANOVAs was therefore justified, although carried out with an awareness of possible limitations. Follow-up two-tailed paired sample *t*-tests were then carried out to compare scores at different points in time, ensuring that any differences noted were above chance level. Micro measures were specifically selected for each individual child, and each child acted as their own control. If significant changes were found between these child-specific pre- and post intervention measures, but no significant gains were found on general non-language measures (e.g. non verbal reasoning task, and numeracy SATs scores) then it would be reasonably safe to conclude that the changes observed are the result of the intervention programme.

Longer-term follow-up took place 6-8 months after the completion of the intervention programme to evaluate maintenance of any progress made. This is important in determining that any progress arising from intervention was not temporary, and could be sustained after intervention had ceased. This follow-up assessment is referred to as the 'long-term' follow-up to distinguish it from the immediate post-intervention assessment, and with awareness that 6-8 months does not typically constitute 'long-term' in longitudinal

studies. Children were evaluated as for the previous micro assessments, to determine whether the effects of intervention were long-lasting or more transitory.

4.8 Macro evaluation

The intervention cycle was completed with a return to the macro measures carried out at the start of intervention. All the procedures carried out initially, as described in section 4.2, were carried out again in order to allow for comparisons between pre- and post-intervention at a more global level of functioning. This macro evaluation aimed to determine:

- If the child had made significant gains (in relation to their peer group) on standardised tests of speech, language and literacy
- If the child's speech processing profile had changed from the initial profile
- If the child's speech production had changed from the initial analysis
- If changes in the child's communicative skills had been noted over the course of intervention as perceived by the child and significant individuals in their environment.
- Speech severity indices and intelligibility ratings. The results of these macro evaluations are presented and discussed separately in Chapter 9.

As for the micro measures, long-term follow-up took place 7 - 9 months after the completion of the intervention programme. Children were re-assessed to determine whether the effects of intervention were long-lasting or more transitory.

5. SUMMARY

This chapter described the methodology used in this work, introducing the five child participants and the procedures carried out with each of them. It has been emphasised that although the children form a heterogeneous group and received intervention that differed widely depending on the individual child's profile of strengths and weaknesses, there were principles and procedures common to each of the case studies. This chapter has outlined these and given some examples of how the principles underpin the procedures carried out. The chapter has also highlighted the range of outcomes measures employed, at both macro and child-specific micro levels – to evaluate changes occurring as a result of intervention. The following five chapters each centre around an individual child. The chapters each provide background information about the child, before describing the seven stage procedure outlined in this chapter: (1) Macro assessment, (2) Macro intervention planning, (3) Micro intervention planning, (4) Micro assessment, (5) Intervention, (6) Micro evaluation, and (7)

Macro evaluation. Each chapter concludes with a discussion about the case. The intelligibility evaluation is included as a separate chapter, Chapter 9, which follows after the children's chapters.

CHAPTER 4: OLIVER

Chapter outline Page

The selection of appropriate stimuli for phonological intervention is an important issue. For children with speech difficulties, the psycholinguistic approach is best combined with a phonological approach. While psycholinguistic approaches inform the process of intervention, knowledge from phonology enables one to focus on the content of intervention, answering the question: "What stimuli will be used in the activities?" These issues are crucial since the ultimate aim of intervention is to encourage generalization throughout the speech processing system, and careful selection of targets may maximize the generalization achieved, ultimately increasing the efficiency of intervention. Much has been written about stimuli selection in phonological therapy from a developmental perspective, (Edwards, 1983; Grunwell, 1985, 1987, 1990; Gierut, Morrisette, Hughes and Rowland, 1996), phonological knowledge perspective (Gierut and Dinnsen, 1987; Gierut et al, 1987; Gierut et al., 1996; Rvachew and Novak, 2002) and in terms of oppositions and contrasts between words used in intervention (Gierut, 1989; Gierut, 1990; Williams, 2000a, b; Rvachew and Novak, 2001). While some researchers have suggested that developmental norms should be used to guide stimuli selection, others have suggested that PPK is more important for efficient intervention planning, and others have suggested that the contrasts illustrated between sounds in phonological therapy are key to bringing about change.

Oliver is a 5-year old boy whose intervention forms the focus of this chapter. Intervention planning for Oliver highlighted many of the issues associated with stimuli selection, making stimuli selection a key theme of this chapter. Oliver's severe and wide-ranging speech difficulties made target selection a particular challenge, but also raised issues about diagnosis. This chapter considers issues associated with diagnosis of developmental verbal dyspraxia, in the light of Oliver's speech processing profile, and his response to intervention. Section (1) provides background information about Oliver, while section (2) describes the assessments used to evaluate his speech. Macro intervention planning is discussed in the following section (3), while section (4) considers intervention planning at a

micro level. In section (5), the intervention programme is outlined, and this is followed by section (6) where the intervention is evaluated. Section 7 concludes with a discussion of the intervention, and in particular reflects on issues related to stimuli selection and diagnoses central to the chapter.

1. BACKGROUND INFORMATION

Oliver was 5;6 at the start of the study and in the reception class of a mainstream school. His involvement in the study continued until he was 7;3 and in year 2.

1.1. Developmental

Oliver's birth and early developmental history was normal in all aspects with the exception of his persisting speech difficulties and language delay. He was born at full term after a normal delivery, with no neonatal problems. There is no family history of communication impairment. His mother reported that he spoke his first words late. When Oliver did speak at approximately 3 years of age, his speech sounded 'unclear' and the sounds were not recognisable. Since this time, his mother has learnt to 'tune in' to his speech, but she reports that unfamiliar people – and also many familiar ones – find him hard to understand.

No feeding difficulties have been noted at any time, and Oliver was quick to develop independence in the areas of feeding and dressing. His toileting was slightly delayed for his age: he still wore nappies when starting nursery at age 3;0. Motor milestones were normal: Oliver walked at 12 months and has always enjoyed physical activities. He is right-handed and has good fine motor co-ordination.

1.2 Educational

Oliver attended the nursery attached to his present school, from the age of 3;0. Towards the end of his time in nursery, there was much discussion about his future educational placement. While it was agreed that Oliver would benefit from attending a special school with specialist help available on a daily basis, there were other advantages associated with remaining at the same school. Oliver has remained at the mainstream school which is situated conveniently close to his home, and has small classes. He has a Statement of Special Educational Needs because of his considerable communication difficulties, and receives support in the mainstream environment. He has an LSA who works with him in school for four mornings a week. She spends approximately one hour each day with Oliver outside of the classroom environment in a one-to-one situation. This time is used to carry out speech activities provided by the NHS speech and language therapist and to support

Oliver with his classwork – particularly his reading and writing. In the classroom, the LSA acts as an interpreter for Oliver when he is not understood, and gives him support with independent work or classroom activities.

Oliver is not always able to sustain his attention for long periods of time in the classroom. However, he is a co-operative, popular boy who always tries his best. His strengths lie with his numeracy and his social skills; his literacy work is weaker and he has difficulty making himself understood in all activities involving speech even though he tries to contribute. IQ results (WASI, Wechsler, 1999) suggest a verbal IQ of 77 (borderline range), a performance IQ of 86 (low average) and a full-scale score of 79 (low average).

1.3 Medical

Oliver failed his first hearing test as a baby and although he passed the following one, has had recurring problems with both middle ears and his hearing until recently. In November 1999 (CA 3;3), Oliver was found to have a moderate bilateral hearing loss (50-65dB) and was referred to ENT for grommet insertion. These were thought to make a difference in that Oliver suffered less discomfort with his ears, but his speech did not improve as had been hoped. This led to speculation that Oliver's speech difficulties were the result of factors additional to his hearing difficulties. Oliver has remained on ENT and audiology caseloads for monitoring. At the start of this project Oliver's hearing was thought to be within the normal range with no ear infections reported for some time.

Oliver's case notes frequently describe him as having 'generally poor health.' He has suffered from recurring kidney infections, frequent colds and asthma. Oliver has a high level of absenteeism from school, and this continues to be a cause for concern.

1.4 Speech and language therapy

Oliver has had speech and language therapy in a variety of forms from the age of 2;0. An account of this input is summarised in Table 4.1. Oliver was referred to Speech and Language Therapy by his health visitor in 1998 at CA 2;2. His mother reported that he babbled but seemed to only produce vowel sounds. She was concerned that his speech development seemed far behind that of his brothers at a similar age. At the initial assessment, it was noted that Oliver had delayed verbal communication skills. He was only able to make some vowel sounds, and relied on pointing and gesture to make his needs known. Oliver was seen for several sessions of language intervention where his mother was given advice and activities to encourage him to produce single words.

Table 4.1
Summary of Oliver's speech and language therapy history

CA	Description of intervention	Comments
2;2	Initial referral and assessment	Concerns about delayed speech
2;2	~ 4 sessions of general language intervention with advice given to his mother	
3;0	Review appointment	Little progress noted since previous contact. Oliver described as severely delayed and at risk for phonological disorder
3;0	~6 clinic sessions focusing on sound production, and nursery visits	Concerns about lack of speech, limited progress and middle ear infections
3;2-3;6	Makaton signs introduced and encouraged at home and nursery	Oliver's speech still characterised by single words, lacking in consonants and with distorted vowels
3;6	Bigmouth Phonology Pack (Hughes and Ramsay, 1999) introduced in an attempt to encourage oral movements	Grommets inserted
3;8	Initiation of process to obtain statement of Special Educational Needs for Oliver; Probable diagnosis of dyspraxia mentioned.	
3;8-4;0	Continuation of weekly input at home and at nursery	Aims to introduce new consonants and vowels, more Makaton signs and cued articulation. Some discrimination work also carried out
4;0	Assessment using CELF-Preschool (Clinical Evaluation of Language Fundamentals – Preschool, UK Edition, Wiig et al., 2001).	Indicates Oliver has severe delay in expressive language and mild delay in comprehension of language
4;0-5;0	Continuation of weekly input at home and at nursery	Aims as above
5;0-6;0	Oliver in Year 1 in mainstream school. SLT directing LSA for daily sessions of speech work.	Aims are mainly to introduce more consonants, encourage sequencing of sounds, discrimination skills and phoneme-grapheme links

Oliver attended a review appointment at CA 3;0 at his mother's request. At this time, he was described as a non-talker having 'severe verbal communication difficulties' and at risk for phonological disorder. Oliver continued to make certain vowel sounds ("squeaks and exclamations") to convey his wishes and respond to his mother. The SLT noted that little progress had been made since he was last seen. In terms of understanding, it was initially thought that Oliver had language comprehension appropriate for his age. His comprehension has remained an area of secondary concern, as it is relatively strong in comparison to his expressive language, although more recent assessments suggest that it is mildly delayed for his age.

Following this review of Oliver's progress, he was seen for a block of 6 sessions in the clinic together with SLT visits to his nursery. SLT notes for this period around CA 3;0

record his mother's frequent concern about his ears: she often remarked that he was not hearing clearly and had sore, wet ears.

Concern about Oliver's expressive language remained high, and intervention was continued on a relatively intensive basis with the focus shifting towards use of Makaton signs, and improving Oliver's ability to discriminate between vowel sounds such as [ɑ] and [i]. Oliver's aunt is a nursing sister familiar with Makaton, and she was involved in working with him and the family to develop his signing. At CA 3;4, one month after being introduced to Makaton, Oliver was able to produce signs for CAR, DRINK, DINNER, BISCUIT and PIG. His mother reported that Oliver enjoyed signing and was keen to learn more. At this time it was noted that Oliver still produced few consonants although he was now saying [m] and [b] regularly and attempted to say DADDY producing [d] for the first time. Oliver's phonology was characterised at CA 3;5 as lacking in consonants and with distorted vowels.

At CA 3;6 Oliver's SLT aims were for him to produce selected long and short vowels together with the bilabial consonants [p] and [b] and to signal 2 syllables. The 'Bigmouth' sound pack (Hughes and Ramsay, 1999), which uses visual cues to support oral movements, was used in an attempt to achieve this aim and was introduced to the nursery staff at the same time. It was noted that Oliver's expressive language problems are most likely not caused solely by his hearing problems although these may well be a contributing factor. It was felt that Oliver should have made more progress with his speech following the insertion of the grommets if this was the case. At a review meeting in May 2000 (CA 3;8) with Oliver's nursery teacher, SLT, mother, LSA and school's special educational needs co-ordinator (SENCO), the statementing process was explained and a diagnosis of verbal dyspraxia mentioned by the SLT. It was noted that Oliver's difficulty with performing voluntary speech movements, in the absence of any physical difficulties with his speech musculature indicated that he may have verbal dyspraxia.

Pre-school CELF results (CA 4;0) show a standard score of 82 for his comprehension (age equivalent 2;10) and a standard score of 59 for his expression (age equivalent 1;6). He was described as very communicative during testing using gesture, pointing, vocalisation and symbolic noise. Oliver continued with intervention focusing on his production of new consonants and vowels, Makaton signs and cued articulation. Some limited work was also carried out on Oliver's ability to discriminate between single sounds in isolation (e.g. [b] ~ [p]). Oliver was seen by SLTs for one-to-one work in nursery and at home, as well as daily work from the LSA carried out in close liaison with the SLTs.

Oliver started Year 1 of his formal schooling in September 2001, and a new SLT became responsible for his needs at that time. His first block of therapy (5 sessions with SLT and LSA, and follow-up by LSA) took place from September to December 2001, in

school. The aims of the intervention were (a) to improve his listening skills so that he could carry out a one-part instruction; (b) to encourage oral movement from one sound to another with consonants [k], [g], [s], [m], [t] and [h] forming the focus of the sound work; (c) to be able to discriminate between these sounds; (d) to develop phoneme-grapheme links for these sounds, and (e) to improve awareness of rhyme in nursery rhymes. The rationale for the selection of these phonemes was not made explicit. His second block of therapy followed these same aims and it was noted that Oliver had made good progress in each of the areas addressed although he had lost some of the skills over the Christmas break. The SLT noted that Oliver does not seem to be emotionally affected by his communication difficulties, although at times he becomes disgruntled when not understood and his facial expression registers frustration and impatience.

1.5 Family

Oliver lives with his mother and two older male siblings. His parents separated when Oliver was 4;0 and he has had minimal contact with his father from that time. His mother understands his speech and reports that she is not overly concerned by his difficulties, believing that he will "grow out of them." She is keen for Oliver to have therapy at school but finds it difficult to carry out extra work with him at home. She was happy for him to participate in this project and receive the extra intervention.

1.6 Social

Oliver is a popular boy who has many friends and is well-liked by teachers and peers. In the one-to-one situation with an adult, he is talkative and friendly. Oliver enjoys playing games, but finds it hard to sit still and concentrate on an activity for an extended period of time. He particularly enjoys physical games and playing with toy-weapons and cars. He is an effective communicator who is normally able to get his message across via facial expression, gesture or showing the person what he is referring to. Despite his speech difficulties, he is a very verbal child, often producing long, unintelligible utterances or singing happily to himself.

1.7 Summary of background information

Oliver has a severe expressive language impairment, and a mild impairment of comprehension of language. He is already showing some difficulties with literacy acquisition. Subjectively Oliver's speech intelligibility is limited, and he is not understood by many people, including those familiar with him such as his class teacher. At CA 6;5 he has an extremely limited repertoire of vowels and consonants. A history of middle ear

infections and fluctuating hearing loss has almost certainly contributed to this, but he has also been labelled as dyspraxic.

Oliver is a socially-skilled child who, at this stage, is able to make most of his needs known and who is not sensitive about his speech problem. In the classroom situation, he is popular and copes adequately with numeracy. He is not able to fully contribute to oral language activities. Oliver has received a relatively large amount of therapy in the past and continues to receive intensive input delivered primarily by his LSA. He has made some progress but has a way to go in producing intelligible speech appropriate for a child his age.

2. ASSESSMENT

Assessment was carried out at the start of the study when Oliver was in the school's reception class (CA 5;6 –5;8). The entire assessment procedure was re-administered on completion of the intervention, when Oliver was in Year 1 (CA 6;6 – 6;7) and at long-term follow-up in Year 2 (CA 7;2 - 7;3). Assessment was divided into five main areas: (1) standardised language assessment, (2) speech profiling carried out within the psycholinguistic framework, (3) phonological analysis, and (4) child interview and parent / teacher report. Results of the standardised assessments are presented in section 2.1, followed by a discussion of the speech profiling (2.2), speech analysis (2.3) and child interview and parent / teacher report (2.4). The re-assessments are discussed in the evaluation section of the chapter (section 6).

2.1 Standardised language assessment

The results of the standardised assessment are summarised in Table 4.2. These revealed that Oliver has delayed language skills in addition to his speech impairment. Oliver performed substantially below age on all the assessments carried out. This is not surprising given the severe nature of his speech difficulties (e.g. see Whitehurst et al., 1988; Paul and Elwood, 1991). Blischak (1994) notes that children with severe speech difficulties typically have problems with all aspects of their language and with literacy acquisition. Oliver's comprehension delay is mild in comparison to his expressive language delay.

Oliver's unintelligible speech made scoring the expressive language tests challenging. The results presented are a conservative estimate of his skills. In terms of literacy, it has already been mentioned that Oliver finds it hard to recognise and produce simple words. He was able to write his name and parts of his address that he has been taught. His phoneme-grapheme links were found to be limited at the end of reception year with Oliver only able to write <t> and <s> in response to dictation. He was able to write some single words from

memory such as <cat>. On one occasion he wrote this word correctly, but later in the session he attempted it again and reversed the consonants to produce <tac>. The standardised literacy tests were not carried out as these were too hard for Oliver.

Table 4.2
Summary of Oliver's standardised speech, language and literacy assessment results at CA 5;6

Assessment	Area tapped	Standard score	Centile	Age equivalent
Receptive language				
Test of reception of grammar (TROG, Bishop, 1989)	Receptive grammar	81	10	4;6
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive vocabulary	75	5	3;0
Receptive Subtests* of CELF-Preschool (Clinical Evaluation of Language Fundamentals – Preschool, UK Edition, Wiig et al., 2001).	Receptive language	6	1	
Expressive language				
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive vocabulary	Z Score: 2.89	1	3;7
Expressive Subtests* of CELF-Preschool (Clinical Evaluation of Language Fundamentals – Preschool, UK Edition, Wiig et al., 2001).	Expressive language	1	1	
Edinburgh Articulation Test (EAT, Anthony et al., 1971)	Articulation	10	2	1-2 years of age
Literacy measures				
Schonell Graded Reading Test (Subtest of Aston Index, Newton and Thompson, 1982).	Reading single words			Not attempted
Schonell Spelling Test (Subtest of Aston Index, Newton and Thompson, 1982).	Writing single words from dictation			Not attempted

2.2 Speech profiling in a psycholinguistic framework

The speech processing profile of Stackhouse and Wells (1997, 2001) was used as a framework for organising the data from this part of the assessment. At each level of the

profile[4], at least one assessment was carried out. In some cases these were standardised measures, and in other cases consisted of unpublished and non-standardised materials (see Appendix 2). The ticks and crosses used on the profile indicate Oliver's performance in relation to other children of his chronological age: with a tick indicating age-appropriate skills, and further ticks or crosses showing the number of standard deviations above or below the mean. The completed profile is presented in Figure 4.1.

2.2.1 Overview of psycholinguistic speech processing profile

Oliver's speech processing profile showed difficulties throughout the system. On the input side, he had some strengths towards the top parts of the profile, e.g. he performed well on the alliteration task which involved no speech but only picture identification (level F). On the output side, the pattern seems to be reversed with Oliver having relative strengths towards the lower reaches, at level K.

2.2.2 Strengths

Oliver has some isolated strengths at level F and scored age-appropriately on the task which tapped his knowledge of onsets using pictures (PhAB picture alliteration subtest, Frederikson, Frith and Reason, 1997). Oliver was aided by pictures and found having semantic knowledge to draw on, useful. In terms of output, motor execution (level K) is a relative strength for Oliver. He can produce almost all sounds in isolation with the exception of [v], [z], [θ], [ð] and [ʒ].

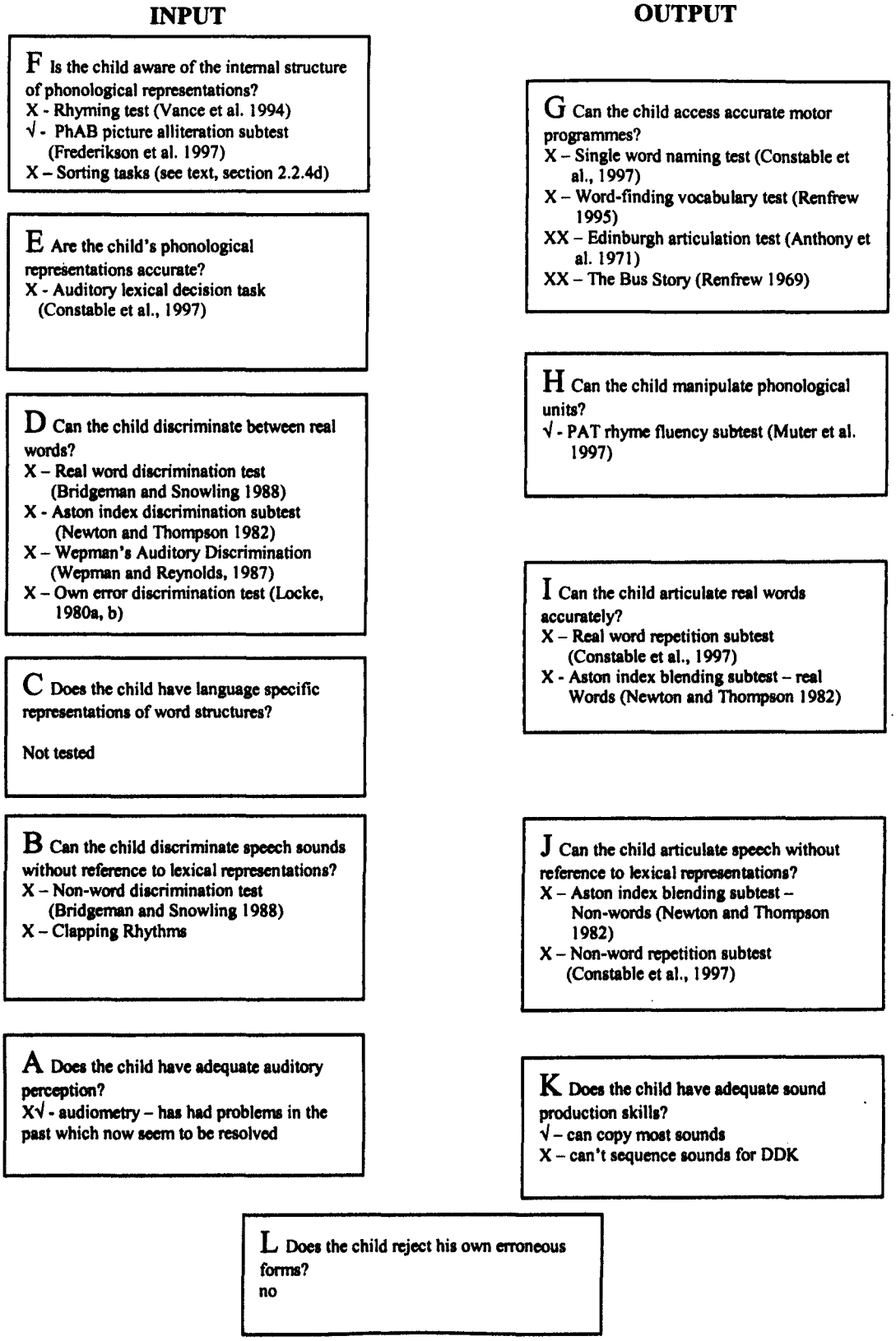
2.2.3 Weaknesses

In terms of input, discrimination of non-words was the most challenging task for Oliver. The lower parts of the input side of the profile are more challenging for Oliver, and this may give some indication of the way in which his middle ear problems and his speech output difficulties are likely to have impacted on the entire speech processing system.

For output, Oliver's problems increase as one moves up the output side. He finds repetition of real and non-word tasks difficult (levels I and J), and has major difficulty in accessing the accurate motor programmes (level G) required in naming tasks and spontaneous speech. The fact that his performance did not improve from spontaneous naming to repetition suggested that he has difficulties with stored motor programmes as well as with online motor programming. His phonological manipulation skills (level H) are surprisingly good – and this may be due to the effects of training and previous therapy.

[4] with the exception of level C not routinely assessed in monolingual children (Stackhouse and Wells, 1997)

Figure 4.1.
Oliver's speech processing profile at CA 5;6 (from Stackhouse and Wells, 1997)
√ = age appropriate performance
X = 1 s.d below the expected mean for his age
XX = 2 s.d below the expected mean for his age



2.2.4 Further investigations

The speech processing profile yielded a clear picture of Oliver's strengths and weaknesses but it also raised questions. These were investigated using tasks designed specifically for the purpose and based on psycholinguistic principles (e.g. Rees, 2001a).

(a) Oliver performed poorly on many of the auditory discrimination tasks which required him to make same / different judgements. This may have been due to the nature of the task rather than to his discrimination abilities themselves. The Locke Procedure (Locke, 1980a, b, see Appendix 2a) was carried out. This is based on the child's own errors and a simple format with low short-term memory demands. Oliver's score on such tasks was not significantly different to that for the same /different paradigm, suggesting that his discrimination itself is problematic and was not greatly affected by the nature of the task.

(b) Is there a link between Oliver's speech output problems and his auditory discrimination difficulties? Comparison of Oliver's speech with his discrimination errors was carried out. Links between the two were limited: phonemes which Oliver has acquired (e.g. [m], [n] and [b] are not sounds that he is more readily able to discriminate between than phonemes which he has yet to acquire. His discrimination skills were generally poor. This is not surprising given his history of hearing difficulties.

(c) Is there a link between Oliver's written knowledge and his speech? Oliver is able to reliably link the phonemes /s/ and /t/ to written symbols. Both these phonemes have been included in Oliver's most recent therapy programme and he may have consolidated the links through this intervention. In terms of speech, Oliver is able to produce [s] on some occasions and is certainly in the process of acquiring the phoneme. /t/ is harder for him to produce, and is typically deleted or realised as a glottal stop. Oliver has a range of well-acquired and consistently used phonemes which, as yet, show little evidence of emergence in terms of graphemic knowledge. From the evidence gathered, no direct link could be shown between Oliver's speech and his spelling.

(d) Is there a link between the accuracy of Oliver's phonological representations and his speech output skills? Oliver's phonological representations were tapped by means of a sorting task in which he was required to look at pictures and sort them according to the initial phoneme. This task involved no speech, thus ensuring that Oliver's phonological *representations* rather than his auditory discrimination ability was tapped. Oliver found such sorting tasks (level F) difficult and contrary to what had been expected, he was not

able to sort out his favoured phonemes from others yet to be acquired. Oliver's phonological representations seem to be 'fuzzy' for all phoneme categories.

(e) Does Oliver have developmental verbal dyspraxia and how would this diagnosis inform intervention? Developmental verbal dyspraxia (DVD) has been defined as a disorder of the performance of actions required for speech production, resulting in severely unintelligible speech (Ozanne, 1995). Velleman and Strand (1994) note that the condition is better described by what it is *not*: it is not a disorder affecting the muscles of speech, or cognition, but rather the motor planning required for speech. Detailed descriptions of the symptoms associated with the condition can be found in Stackhouse (1992). DVD is a controversial diagnosis for a number of reasons. Some authors have questioned its very existence suggesting that children with DVD represent the severe end of the continuum of phonological difficulties, rather than having a specific, identifiable condition (Panagos and Bobkoff, 1984). Others argue that the term dyspraxia has been inappropriately applied to children with developmental speech difficulties and cannot be equated to the acquired difficulties faced by adults with the condition. Apraxia was a term originally applied to limb movements that could be executed involuntarily but not on command. In the case of speech, involuntary movements are not so easily identified since speech movements are very different in nature to limb movements. There is also uncertainty about the underlying deficit in the speech processing system that brings about the symptoms of DVD: is this limited to planning at articulatory levels (i.e. a phonetically-based disorder) or are linguistic planning levels implicated too (i.e. a phonologically-based disorder)? If language is implicated is this part of the core problem of dyspraxia or an effect (Milloy, 1991) of the primary speech difficulties? Aram and Nation (1982) and Edwards (1984) provide examples of early multi-deficit disorder models, hypothesising that both phonetic and phonological planning levels are involved.

Whilst motor programming and motor planning are frequently used as synonyms in the DVD literature, authors adopting a psycholinguistic approach typically link these terms to specific levels of the speech processing system (e.g. Hewlett, 1990; Ozanne, 1995; Stackhouse and Wells, 1997, 2001). Stackhouse and Wells consider that motor planning is invoked in connected speech production, while motor programming can be conceptualised as a higher level of linguistic processing, at a single word level. These authors (and see also Stackhouse, 1992) suggest that children diagnosed with DVD have a multi-deficit disorder: they are likely to have difficulties in devising new motor programmes, but they may well also experience difficulties with other aspects of speech processing such as motor planning and auditory discrimination. Ozanne (1995) accounts

for DVD in a similar way, again suggesting that children with typical DVD symptoms have deficits at three levels of speech processing: (1) in creating a phonological plan or template, (2) in assembling the phonetic programme, and (3) in implementing the programme. These multi-deficit conceptualisations can account for the fact that children with DVD always present with severe difficulties, and also the fact that intervention typically yields slow results, since intervention is unlikely to tap into all deficit areas at one time in what Ozanne (1995, p.109) terms a 'sabotaging effect.' From these theoretical perspectives, Oliver may well have DVD: his difficulties as shown in his speech processing profile (Fig 4.1) are certainly widespread enough to warrant this diagnosis.

Diagnoses of DVD do not necessarily inform intervention planning: in many cases, only when children fail to respond to 'traditional' phonological intervention, are they labelled as 'dyspraxic' thus intervention leads to diagnosis, rather than vice versa. Psycholinguistic profiling approaches allow one to devise hypotheses about the underlying causes of the child's difficulties. In Oliver's case these have been outlined in Figure 4.1 and intervention will need to tap into these in a way that brings about change. From a theoretical perspective it is interesting to consider whether the cluster of deficits observed in Figure 4.1 is characteristic of DVD. From a clinical, intervention-planning perspective, this diagnosis is less important than the way in which these deficits will be addressed. There remains very limited research into the treatment of DVD: when treating children with multiple deficits in their speech production how can we make intervention as efficient and effective as possible in order to minimise the 'sabotaging effect?' A medline search was carried out for intervention studies with children diagnosed with DVD. The search was limited to papers written in English and carried out within the last 10 years. Only 4 papers were found, revealing the paucity of research into intervention with this group of children. Rosenthal (1994) and Helfrich-Miller (1994) evaluated the efficacy of rate control and melodic intonation therapy respectively, both with young pre-school children. Bornman, Alant and Meiring (2001) focused on the effect of an AAC device on the language of an older pre-school child. Velleman's (1994) paper focuses most specifically on speech, with descriptions of a bridging strategy for linking phonemes in two pre-school children, aged 2;4 and 3;11. This last paper emphasizes the difficulties common to the two children, as well as the differences between the two children and how these idiosyncracies were used to drive the intervention process.

Questions about DVD and its response to intervention are returned to in the discussion section of this chapter.

2.3 Speech analysis

PACS (Grunwell, 1985) was carried out to provide information on Oliver's speech production system. A summary of the findings from the assessment is presented in Table 4.3.

Table 4.3
Summary of Oliver's speech data at CA 5;6

Assessment	Comments	
Severity indices	PCC 23.4 % PVC 68.2 % PPC 39.7 %	
Phonetic inventory	Word initial position: [m, n, b, d, g, w, j] Word medial position: [m, n, b, w] Word final position: [m n, ŋ, dʒ]	
Stimulability	All phonemes except [v], [z] [θ],[ð], [ʒ]	
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (94%); final consonant deletion (43%); prevocalic voicing (39%); stopping of fricatives and affricates (32%); reduplication (12%) Non-developmental processes: Vowel distortion (27%); initial consonant deletion (34%)	
Single word speech sample	[aɪ] for DICE [da] for DUCK [ki] for KEY [a] for CAR [aɪs] for ICE [benu] for PENCIL [u] for BLUE [æ] for CROCODILE	[ba] for BATH [wa'wu] for WATER [bu] for SPOON [it] for LEAF [wa] for WATCH [fi] for FEATHER. [i] for TEA [e.a.a] for HELICOPTER
Connected speech sample	[ba.ɛwɛ] for RUN AWAY [aɪwænu] for I WANT TO [maɪbed] for MY BED [wa.æ.u] for WHAT'S THAT NOISE? [ubu.ɛm] for WHO BOUGHT THEM?	

The severity of Oliver's speech difficulties was estimated at two points before the intervention: at the start of the macro-assessment, and at the micro-assessment. PCC (percentage of consonants correct), PVC (percentage of vowels correct) and PPC (percentage phonemes correct) indices were used[5]. The difference between these scores at the two pre-intervention points was not a significant one indicating a stable pre-intervention baseline. However, these indices reveal severe difficulties with Oliver's speech. The phonemes most

5 following guidelines from Dodd (1995) and Shriberg et al. (1997c) and discussed in greater detail in Chapter 9 on intelligibility

well-established in Oliver's consonant inventory were the voiced plosives ([b], [d] and [g]) and nasals ([m], [n] and [ŋ]). He was able to use these in all appropriate word positions, although not consistently, e.g. [dɑ] for DUCK, and [ɑɪ] for DICE. Voiceless plosives were starting to emerge but remain inconsistently used, e.g. [ki] for KEY, [ɑ] for CAR. Fricatives [s] and [f] were used on occasion, e.g. [ɑɪs] for ICE, [fi] for FEATHER. Oliver used a range of systematic simplifications in his speech, including processes such as final consonant deletion (43% of possible instances, e.g. [bɑ] for BATH), reduplication (12% of possible instances, e.g. [wɑ'wʊ] for WATER), cluster reduction (94% of possible instances, e.g. [bʊ] for SPOON), stopping (32% of possible instances, e.g. [it] for LEAF) and pre-vocalic voicing (39% of possible instances, e.g. [bɛnu] for PENCIL). These are all processes that one would expect to find in the speech of a younger child. Oliver used initial consonant deletion (e.g. [u] for BLUE, [i] for TEA) in 34% of possible instances, a process considered atypical or unusual by many authors (e.g. Dodd et al., 2002). Some vowel distortion was also noted. At a syllable structure level, Oliver generally managed to preserve the correct number of syllables. He favoured syllable structure types of V, CV, VC, and CVCV. Some isolated instances of closed CVC syllables are noted. [w] is well established in his phonetic inventory (e.g. [wɑ] for WATCH, [wɑ'wʊ] for WATER) with other approximants being used in an inconsistent way. Clusters do not yet occur in Oliver's inventory with the exception of [bw] for [br] and [fw] for [fr] which were noted in two isolated instances (e.g. [bwɪdʒ] for BRIDGE).

2.4 Child interview and parent / teacher report

This part of the assessment aimed to gain impressions of Oliver's speech from Oliver himself, his teachers, and parent. Information gathered was used to assist with intervention planning and to evaluate the outcome of the intervention programme.

2.4.1 Child interview

An attempt was made to interview Oliver in a semi-structured way in order to investigate: (1) his experience of speech and language therapy, (2) his perception and awareness of his own speech, (3) his perceptions of communication more generally, and (4) his attitudes to literacy (see Appendix 3). Oliver, however did not understand all of the questions and found it hard to concentrate on this task, preferring to play with the microphone and sing songs. His few responses were unintelligible. For these reasons the data from the interview procedure was not used, and the procedure was not attempted a second time on completion of intervention, as it was for the other children.

2.4.2 Teacher report

Oliver's class teacher was unable to complete Bishop's (1998a) Children's Communication Checklist (CCC) due to time constraints. However, informal discussion with the class teacher and LSA provided insights into Oliver and his communication difficulties. There is a great deal of concern about Oliver's speech and the fact that his mother is unconcerned about his speech difficulties. His teacher observed that Oliver has made slow progress despite ongoing intervention. The LSA described feeling "responsible for Oliver and his lack of speech" and although she acknowledged the support of the NHS SLT, she emphasised that she has limited background and skills to cope with what she describes as a "very complicated problem." Concerns about Oliver's receptive language and his progress with literacy were also evident at these discussions, but these seem to be secondary to his speech problems. Both LSA and class teacher hope that Oliver's speech will improve to such an extent that he is intelligible to his peers and teachers. In order to provide further information about Oliver's academic progress over the course of the intervention, his numeracy results were obtained from the school's assessments carried out at the end of reception (prior to starting intervention, CA 5;6). Oliver obtained a grade of 1C for numeracy, suggesting that he is at the lowest level of ability.

2.4.3 Parent report

Oliver's mother is glad for him to have speech and language therapy at school, and hopes that this will have a positive effect on his speech. Contact with her was limited, and so no further insights can be added regarding her point of view.

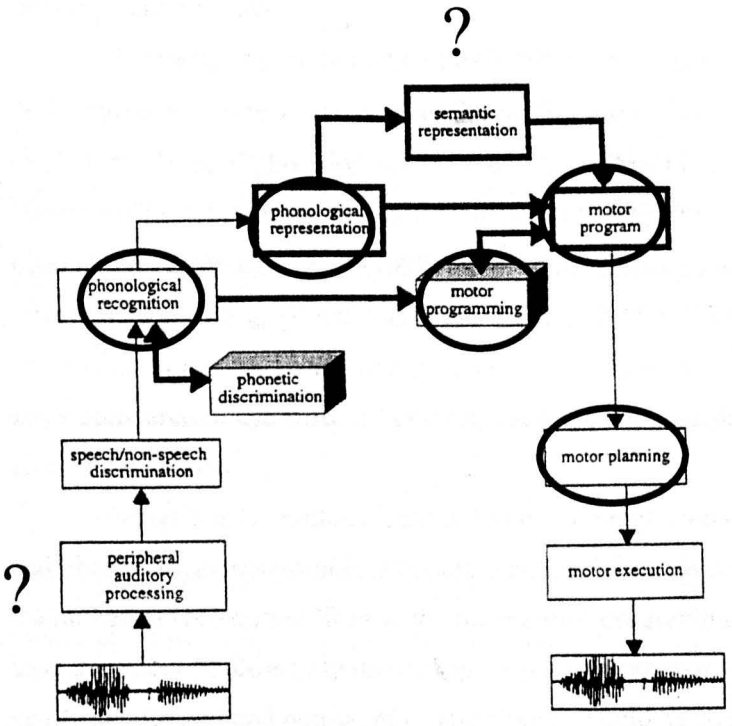
3. MACRO INTERVENTION PLANNING

Intervention planning focused on three main areas with each one giving direction to the work carried out. These included (1) a psycholinguistic rationale that aimed to answer the question: "What aspects of his speech processing system should be worked on?" (2) a phonological rationale which aimed to answer the question: "Which aspects of the sound system should be targeted?" and (3) a more general child-centred rationale which aimed to answer the question: "What other aspects important to the child should be taken into account? Each of these are discussed in the sections that follow.

3.1 Psycholinguistic rationale – What aspects of the speech processing profile should be worked on?

Oliver's main deficits were mapped from the speech processing profile onto the related speech-processing model. Oliver has widespread difficulties at almost all levels of the profile. These difficulties are indicated by the circled areas in Figure 4.2, which shows that there are difficulties with phonological recognition and representations, motor programmes and motor-programming and motor planning. In addition, there is some uncertainty about Oliver's auditory perception skills, given his history of middle ear infections, and his semantic representations due to difficulties in tapping into Oliver's expressive vocabulary because of his severe speech problems.

Figure 4.2
Speech processing model (from Stackhouse and Wells, 1997, 2001) showing Oliver's main areas of difficulty at CA 5;6



It is a principle of psycholinguistically-based therapy to use strengths in an individual's profile to build-up or scaffold weaknesses (Rees, 2001a). A psycholinguistic approach aims to separate out levels for assessment, but in therapy to maximise overlap between areas to scaffold from stronger to weaker skills. It has been noted previously that Oliver's main areas of *relative* strength were at the top part of the input side of the profile (i.e., level F) and at the bottom part of the output side (i.e., level K). Waters, Hawkes and Burnett (1998) and Waters (2001) used input work successfully with a child with severe speech output problems in the

presence of relatively good input skills. The child's strengths were used as a way of modifying the speech processing system as a whole. The relationship between input and output is a controversial one. Some authors have advocated that input should be addressed prior to output (e.g. Evershed Martin, 1991; Jamieson and Rvachew, 1992). Corrin (2001a, b) notes that as a general principle input should be addressed first, and this used to strengthen output skills. Authors such as Williams and McReynolds (1975) have questioned the value of input therapy. Input work may be irrelevant in cases where, following a detailed assessment no input problems can be found, or in cases where the input stimuli are not carefully chosen to reflect the child's specific problems. A tenet of the psycholinguistic approach is that one should target specific underlying difficulties, and that whatever aspects are targeted should be done by means of appropriate stimuli that reflect a child's errors (Rees, 2001a). For some children both input and output therapy may be appropriate but the issue may be one of 'readiness' with input / output work appropriate at different developmental phases.

Oliver had multiple difficulties in his speech processing system making it challenging to decide which parts of the profile should be addressed. Evidence of some skills at the level of phonological representations (level F in the speech processing profile shown in Fig. 4.1) suggested that this might be a 'way into' his speech processing system. Case studies by Waters et al. (1998) and Corrin (2001a, b) were used as a basis for intervention planning. It must be noted that the child in Waters' paper had very good input skills when compared to age-matched peers, in contrast to Oliver whose input skills were weak compared to age-matched peers but showed *relative* ability in terms of his own speech processing profile.

Oliver's intervention aimed to target the input levels of phonological representation and phonological recognition. Phonological representations map onto motor programs, and phonological recognition links with online motor programming. Modifying input should have the effect of ultimately modifying output as input maps onto output. The intervention involved both real and non-words. The effects should be equal for real, familiar words which already have a stored motor programme and will be updated, and for non-words which require creation of accurate motor programmes online

A task hierarchy was devised which aimed to tap the deficit areas shown in Fig 4.2 in a systematic way moving from tasks that Oliver was likely to find relatively easy to those that will be more challenging for him. The task hierarchy is outlined in Table 4.4.

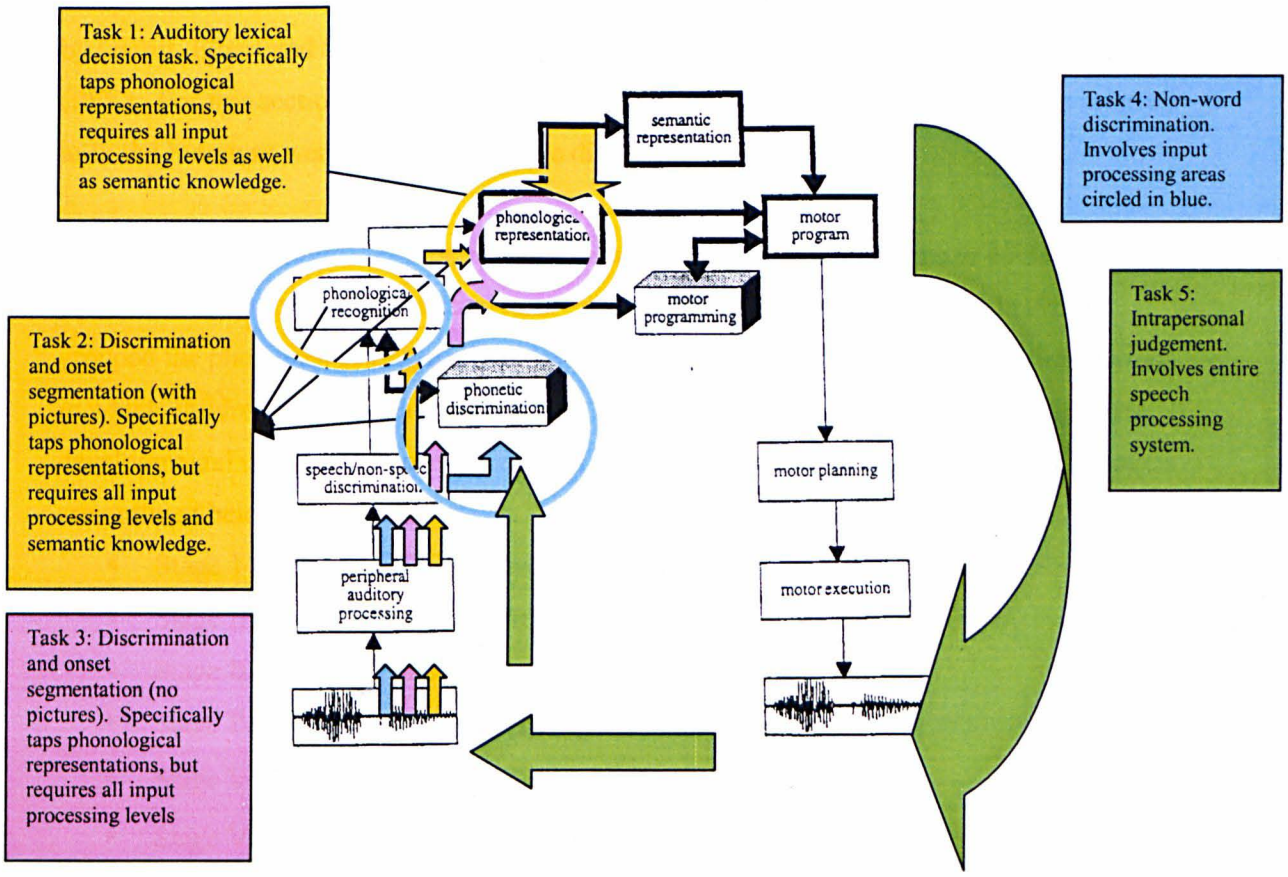
Table 4.4
Outline of Oliver's intervention task hierarchy

Task (1 easy, 5 hard)	Description	Example	Levels of speech processing tapped
1	Auditory lexical decision task	Oliver is presented with a picture (e.g. COW) and asked to respond 'yes' or 'no' to questions such as: Is it a [zau]? Is it a COW?	Primarily phonological representations but can access top-down support of semantic knowledge. Involves all levels of input as he hears the stimuli
2	Discrimination and onset segmentation (with picture)	Oliver is given a picture of a COW and hears the therapist produce that word at the same time. He is required to post the item into the relevant [k] post box.	Phonological representations, phonological recognition and phonetic discrimination. Can access top-down semantic support, and involves all levels of input as he listens to the stimuli word.
3	Discrimination and onset segmentation (no picture)	As for Task 2, but for this task Oliver is not given the picture. He listens to the word and then, depending on the initial phoneme perceived (e.g. DOG or LOG) posts a token into the appropriate box (e.g. [d] or [l] box)	As for task 2 but semantic support is no longer top-down.
4	Non-word discrimination	As for Task 3 but uses non-words	Primarily phonological recognition, but will also involve peripheral auditory processing.
5	Intrapersonal judgement	Oliver names a picture. He then listens to an audio-recording of himself and judges whether what he hears is correct or incorrect.	Taps entire system starting from semantic representation and placing demands on both output and input.

Tasks outlined in the hierarchy were designed to tap one particular area, e.g. Task 1, the auditory lexical decision task was designed to primarily tap phonological representations. However, it is important to consider that all tasks will involve the stimulation of other related areas, e.g. Task 1 also allows for the 'downward flow' of semantic knowledge and the bottom-up flow of auditory input. This is the principle of the therapy programme and allows for transitions to be made from one task in the hierarchy to the next. Task 1 and 2 give Oliver the optional support of semantic knowledge, while tapping his phonological knowledge (Task 1) and his auditory discrimination abilities (Task 2). It has been noted previously that Oliver benefits from presentation of visual material. Tasks 3-5 are more demanding, requiring careful listening as he moves from real word to non-word tasks. The final task was considered to be the most challenging for Oliver. This intra-personal judgement task required him to listen carefully to his own speech – as opposed to the therapist's- and to make judgements regarding the accuracy of his own speech. Evershed-Martin (1991) notes that perception of others' speech seems to be ahead of self-perception, and this is thus considered a final but important stage of the hierarchy.

The task hierarchy outlined in Table 4.4 was applied to the speech processing model shown in Figure 4.2. Figure 4.3 shows the way in which the tasks outlined in Table 4.4 tap into various levels of the speech processing system.

Figure 4.3
Representation of the parts of the speech processing model tapped by intervention tasks presented in Table 4.4.



3.2. Phonological rationale - Which aspects of the sound system should be targeted?

PACS (Grunwell, 1985) analysis was carried out to give a detailed picture of Oliver's phonological output skills. Oliver's speech is very delayed for his age and faced with the PACS data, it was difficult to select targets to be addressed. The previous section has focused on the psycholinguistic model, giving a clear outline of activities to be carried out in the intervention programme. This section suggested that intervention focus mainly on Oliver's input skills.

Corrin (2001a, b) describes a therapy programme in which individual phonemes are taken 'on tour' through the speech processing system, in a systematic, cyclical way. This approach was successful in the case of the child described, a 7-year-old girl with severe speech processing problems throughout her profile. A similar principle was adopted for Oliver: Individual phonemes would be selected and moved through the task hierarchy as previously described in Table 4.4. The question, however, still remained: Which phonemes to address?

Stimuli selection issues are controversial. Corrin (2001a,b) notes that this decision should be informed by normal phonological development, and knowledge of speech sounds that the child can already produce accurately. This latter factor has been described in further detail by Gierut, Elbert and Dinnsen (1987), referred to as 'productive phonological knowledge' (PPK). For this section of Oliver's intervention planning, these and other principles referred to in the literature were drawn on, and are discussed in turn.

(a) Normal phonological development. The use of developmental norms to guide the process of stimuli selection for therapy is a commonly used one, e.g. Grunwell (1987) grouped the phonemes of English into developmental stages, broadly delineated time periods in which children with normally-developing speech typically acquire the phonemes. These developmental norms are frequently used as guidelines for intervention planning. The stages are outlined below:

- Stage 1 - 0;9-1;6 years: Protoword and first word stage
- Stage II - 1;6-2;0 years: e.g. [m], [p], [b]
- Stage III - 2;0-2;6 years: e.g. [n], [t], [d]
- Stage IV - 2;6-3;0 years: e.g. [f], [s]
- Stage V - 3;0–3;6 years: e.g. [k], [g]
- Stage VI - 3;6-4;0 years: e.g. [v], [z]
- Stage VII – 4;6 years: e.g. [r], [θ]

However, using developmental norms for therapy planning is not without controversy: many researchers suggest that therapy need not be restricted by developmental hierarchies and, indeed may be more *efficient* in bringing about widespread changes when more advanced developmental targets are followed (e.g. Gierut et al., 1987; Gierut et al., 1996). A recent response to these 'CATE' accounts (complexity accounts of treatment efficacy) by Rvachew and Nowak (2001) suggested that the traditional approach to target selection (i.e. based on developmental norms) may indeed be more *effective*, once motivational issues are taken into account. For Oliver's programme a range of targets at different levels of the developmental hierarchy were chosen to investigate this issue. Guidelines in Rvachew and Novak (2001) using 90th percentile norms for age of acquisition of each phoneme were used. Would early acquired sounds be easier for Oliver to acquire than the later ones?

The principle of normal phonological development can be applied in other more complex ways. Hodson and Paden (1991) devised a cyclical approach to therapy suggesting that a small number of 'error sounds' be targeted in therapy in a way which closely resembles the way in which children naturally acquire phonemes. Target sounds (or processes) are individually addressed, in terms of both input and output, in a successive way

with each of the targets worked on for a limited amount of time, before moving on to another target. When all targets have been addressed, the cycle begins again and continues for as many rotations as needed until a given phoneme has been acquired at which point it 'drops out' of the cycle. In this way, the child is exposed to more than one isolated sound over the course of intervention and has the opportunity for making rapid progress with some sounds and slower progress with more challenging phonemes. It is considered a particularly useful approach for children with severely disordered phonology, and thus appropriate for Oliver. In addition, working on a small set of sounds successively would be compatible with the 'phonemes on tour' approach described by Corrin (2001a, b).

(b) Productive phonological knowledge (PPK) was determined for all Oliver's phonemes using the procedures described by Gierut et al. (1987). Phonemes were classified into the categories delineated by these authors:

- Type 1: Produced correctly in all word positions
- Type 2: Produced correctly in nearly all morphemes, but alternations between the target and another sound observed for some morphemes
- Type 3: Produced correctly in nearly all morphemes but some fossilised forms always incorrect
- Type 4: Produced correctly in one or more word positions and consistently in error in others
- Type 5: Inconsistently correct in one or more word positions and consistently incorrect in all other word positions
- Type 6: Produced incorrectly in all word positions

Therapy stimuli are typically selected from PPK types 4-6 since phonemes in the other categories are essentially already acquired. Some authors (e.g. Flipsen, 2002) consider that type 5 phonemes, the set of phonemes characterised by consistent errors on some morphemes and a positional constraint elsewhere are a purely theoretical construct and never seen. It has been suggested (Rvachew and Nowak, 2001) that phonemes selected from categories with a greater degree of knowledge (e.g., from type 4) rather than type 6 are more appropriate therapy targets and will result in more rapid change. However, other authors (e.g. Gierut et al., 1996) have suggested that type 6 targets are preferable, as they will result in more widespread generalisation throughout the system, ultimately making intervention using these targets more efficient. Since research regarding PPK is inconclusive, stimuli for Oliver were selected from a range of categories including types 3, 4 and 6, so that the outcome of intervention for a range of PPK types could be investigated. PPK has typically been considered in studies which focus directly on remediation of speech output. Oliver's

intervention programme is centred on input but aims to ultimately improve the entire speech processing system and Oliver's speech intelligibility. It was thus felt that the concept of PPK could be usefully invoked in the target selection for his intervention programme.

(c) Perception difficulties. It has been shown that speech perception training is beneficial in its effects on both input and output only for children who have difficulties with discrimination and production of the particular sounds in question. In other words, perception training programmes need to be specific in targeting the problem areas if they are to be effective (e.g. Locke, 1980a, b). General perception work may not necessarily carryover into speech. Oliver has widespread discrimination difficulties in addition to his many speech problems. Each of the stimuli selected for intervention was required to need intervention at both input and output levels.

(d) Effects of word-position. It is important to consider the effects of word position since some children will find it easier to produce certain phonemes in certain positions. Research (e.g. Ferguson, 1978; Edwards, 1983; Grunwell, 1985; Redford, MacNeilage and Davis, 1997) has suggested that some phonemes emerge first in word-final position before becoming established in word-initial position, and in other cases the reverse is true. In Oliver's case there was no major difference in terms of contrasts / phonemes available in different word positions. Phonemes in word-initial position were targeted and the positional focus of all work – both input and output – was on this position. Generalisation to other word-positions was monitored by means of control probes.

Phonemes in PPK type 4 are defined as being produced correctly in one or more word positions and consistently in error in others. For the purposes of this project, phonemes that were correct in WI position but not in other positions were excluded, so that therapy could focus on WI phonemes in a consistent way.

(e) Multiple oppositions. Most clinicians are familiar with the concept of minimal pairs where words are selected to highlight contrasts between relevant phonemes and their features. The selection of such stimuli may be based on one, or a combination, of at least five different theories, and these are listed by Flipsen (2002) as (a) distinctive feature theory, (b) a minimal opposition approach, (c) a maximal opposition approach, (d) a natural processes approach or (e) a multiple oppositions approach. Not all minimal pairs are the same: some will differ in terms of one feature only (e.g. [k] and [g] in COAT and GOAT differ only in terms of voicing) and others will differ in three ways (e.g. PIN and GIN differ in the WI consonants in terms of place, manner and voicing). The selection of such stimuli words

and the extent to which phonemes in these words differ has become an increasingly important issue in phonological intervention.

Recent work into multiple oppositions (e.g. Williams 2000a,b) has shown that this may be an effective and efficient way of bringing about cognitive reorganisation of children's phonological systems. The principle of "multiple oppositions" therapy is to create a set of contrasting words and to focus on these all at one time. It has been noted (Flipsen, 2002) in particular that this may be an effective way of remediating the phonology of children with very limited repertoires. This principle of multiple oppositions has been adopted for Oliver but is incorporated with two of the other theoretical approaches mentioned by Flipsen, maximal and minimal opposition approaches which are discussed below.

(f) Moving from maximal to minimal oppositions. A traditional minimal opposition approach targets contrasts with the fewest differences between target and error (e.g. [f] and [v] differ only on voicing in FAN and VAN). A maximal oppositions approach, on the other hand, is based on the idea that error sounds should be contrasted with very different sounds as this makes the error phoneme more noticeable. Some studies (e.g. Gierut, 1989) have suggested that generalisation may be faster with this approach where the child's attention is focused on more than one distinction along the broad multiple dimensions of voice, place, and manner. Flipsen (2002) describes two different versions of the maximal opposition approach and notes that while the original version focused on articulatory features as described, the more recent version creates oppositions based on distinctive features.

Research into the effectiveness of these various approaches is in its infancy. The approach adopted with Oliver is structured using a combination of the two. A hierarchy has been composed moving from maximal oppositions to minimal ones.

(g) Confront child with own errors wherever possible. Modified versions of the minimal opposition approach see therapists contrasting the child's own substitution, e.g. [p] for [f], with the target sound, e.g. PAN and FAN. Children such as Oliver with inaccurate phonological representations are more likely to respond to presentation of their own errors and error words than to words for which they have accurate representations. It may be easy for them to distinguish between the non-error words, after all that is why they are producing them correctly. This is a point emphasised by Rees (2001a) and by other authors (e.g. Locke, 1980a, b; Jamieson and Rvachew, 1992; Rvachew, 1994) who suggest that auditory perception as a general approach to intervention is not successful: only if stimuli relevant to the child are used, will change occur.

3.3. Child-centred rationale - What other aspects important to the child should be taken into account?

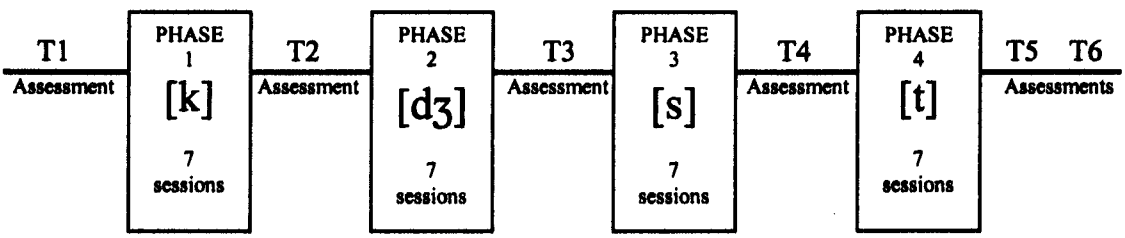
Oliver has had a considerable amount of intervention focusing on his speech production. This therapy has brought about some improvements although many difficulties remain. It is possible that intervention to date has not been tapping the underlying cause of his speech difficulties. Oliver's auditory input skills are weak and the current approach to intervention aimed to address these. He has been under some pressure to 'speak clearly' and this approach to intervention will remove some of that pressure (cf. Waters, 2001). Oliver does not always find it easy to maintain his attention for extended periods of time, and for this reason a cycles-type approach and its inherent variability was thought to be a practical way of approaching intervention.

4. MICRO INTERVENTION PLANNING

4.1 Research design

Oliver received a total of 28 hours of intervention, carried out over four phases. The intervention followed a multiple baseline design with each phase addressing a specific phoneme. The phonemes addressed in intervention were [k], [dʒ], [s] and [t]. The way in which these were selected is outlined in detail in the following section. Each phase was followed by a reassessment of all items. Baselines were obtained prior to the intervention. Figure 4.4 shows the design of the intervention.

Figure 4.4
The design of Oliver's intervention programme



4.2 Treatment stimuli

The approach taken to stimuli selection for Oliver's intervention drew on many influences, outlined in the previous section. Multiple oppositions were favoured with the aim being for Oliver to produce four target phoneme stimuli in words contrasted with a range of similar word forms. The principle of maximal oppositions was applied in the selection of the four

targets which vary widely in place, manner and voicing *from each other*, and which in their individual intervention phases were contrasted initially with maximally different sounds, moving into more minimal contrasts as Oliver became more skilled. Using the principles discussed in section 3.2, the targets selected are summarised in Table 4.5.

Table 4.5
Summary of Oliver's target selection process

PHONEME	GENERAL PRINCIPLES FOR STIMULI SELECTION RATIONALE	Developmental norms: mean age of acquisition*	Productive phonological knowledge ** Choose targets that reflect a variety of categories	Word position Exclude types 1-3 which are already acquired	Perception Exclude where WI is best position	Multiple oppositions Choose targets which Oliver finds hard to perceive	Stimuli selected and comments Choose targets from different sound classes where possible
[p]		Stage II	Type 4			Stop	
[b]		Stage II	Type 2			Stop	
[t]		Stage II	Type 6			Stop	[t]: early developing stop with no PPK
[d]		Stage II	Type 3			Stop	
[k]		Stage IV	Type 3			Stop	[k]: later developing stop with more PPK
[g]		Stage IV	Type 4			Stop	
[m]		Stage II	Type 3			Nasal	
[n]		Stage II	Type 3			Nasal	
[ŋ]		Stage IV	Type 3			Nasal	
[f]		Stage V	Type 4			Fricative	
[v]		Stage VI	Type 6			Fricative	
[θ]		Stage VII	Type 6			Fricative	
[ð]		Stage VII	Type 6			Fricative	
[s]		Stage V	Type 4			Fricative	[s]: representative from fricative class; later developing than stops and with some PPK
[z]		Stage VI	Type 6			Fricative	
[ʃ]		Stage VI	Type 6			Fricative	
[ʒ]		Stage VII	Type 6			Fricative	
[tʃ]		Stage VI	Type 6			Affricate	
[dʒ]		Stage VI	Type 4			Affricate	[dʒ]: represents additional sound class (affricates), some PPK and latest developmental stage
[l]		Stage VI	Type 4			Approximant	
[r]		Stage VII	Type 4			Approximant	
[w]		Stage II	Type 2			Approximant	
[j]		Stage V	Type 2			Approximant	
[h]		Stage III	Type 4			Fricative	

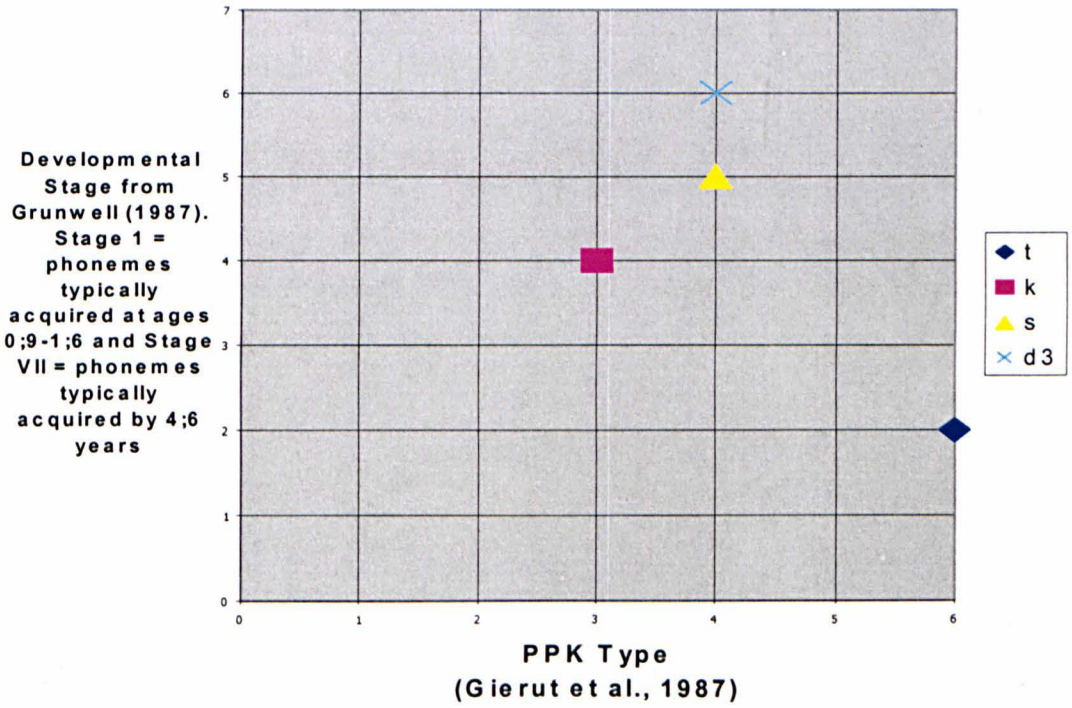
excluded from target selection

* From Grunwell (1987). Stage I = 0;9-1;6. Stage II = 1;6-2;0. Stage III = 2;0-2;6. Stage IV = 2;6-3;0. Stage V = 3;0–3;6. Stage VI = 3;6-4;0, Stage VII = 4;6+

** From Gierut et al., (1987). Type 1= produced correctly in all word positions; Type 2 = produced correctly in nearly all morphemes but alternations between the target and another sound observed for some morphemes; Type 3 = produced correctly in nearly all morphemes but some fossilised forms always incorrect; Type 4 = produced correctly in one or more word positions and consistently in error in others; Type 5 = Inconsistently correct in one or more word positions and consistently incorrect in all other word positions; Type 6 = produced incorrectly in all word positions

Table 4.5 shows how all the consonant phonemes in English were considered in the light of principles for stimuli selection as outlined above, i.e. each phoneme was considered from a developmental perspective, in terms of productive phonological knowledge, word position, perception skills and phoneme oppositions. For each of these areas, a particular rationale was adopted, e.g. for normal development each phoneme was grouped into categories of acquisition (from Grunwell, 1987) and the rationale adopted was that stimuli selected should cover a range of these to allow comparison of therapy outcomes. For PPK, phonemes needed to be in the categories (4-6) not yet acquired. In terms of position, phonemes which were not yet used in WI position, were favoured. For perception, phonemes were sought which were hard for Oliver to perceive – and this was simple since he had such widespread auditory perception difficulties. In terms of oppositions, targets were sought to represent a range of different sound classes. It can be seen in Table 4.5 (right hand column) that the phonemes selected using this process were [k] [dʒ], [s] and [t]. Figure 4.5 contrasts the four target phonemes selected in terms of PPK, and developmental phase. It can be seen that the four phonemes selected cover a range of developmental stages, and PPK types, so that Oliver's response to intervention could be monitored and compared for each of these aspects.

Figure 4.5.
Oliver's intervention stimuli showing contrasting positions in terms of a developmental hierarchy and productive phonological knowledge (PPK).



Sets of stimuli words were then created for each of the four phonemes. These lists were devised using the following criteria:

1. For each phoneme, 5 CV and 5 CVC words with the target phonemes in WI position were created.
2. When selecting the target CVC words to be used in intervention, an attempt was made to avoid having the target phoneme stimuli ([k], [dʒ], [s], [t]) in word final position as well. This proved impossible, but an attempt was made to balance this effect so that each phoneme stimulus appeared in word final position twice across the categories, e.g. [s] appears as coda in JUICE, and SAUCE. A challenge was presented by [dʒ] which appears seldom in coda position in high frequency words. Its voiceless counterpart [tʃ] was used instead.
3. Words were selected which were familiar to Oliver, as determined by picture naming tasks.
4. The words were matched across phoneme sets in terms of age of acquisition and spoken language frequency using the MRC psycholinguistic database[6].

Table 4.6 shows these four target wordlists, in the first column. Moving across the table the columns shows the way in which the stimuli words were contrasted with phonemes in other words moving from maximal to minimal contrasts, as well as making contrasts with Oliver's own errors.

[6] http://www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm

Table 4.6
Oliver's stimuli phonemes with contrasts used in the intervention

Wordlists for each phoneme	Contrast phonemes Maximal → Minimal Opposition					
	Differs on 3 features	Differs on 2 features	Differs on 1 feature	Own errors		
[k]	**[z]**	**[d]**	**[g]**	**[b]**	**[p]**	**#**
COW	[zaʊ]	[daʊ]	[gaʊ]	[baʊ]	[paʊ]	[aʊ]
CAR	[zɑ]	[dɑ]	[gɑ]	[bɑ]	[pɑ]	[ɑ]
KEY	[zi]	[di]	[gi]	[bi]	[pi]	[i]
KAY	[zɑ]	[deɪ]	[geɪ]	[beɪ]	[peɪ]	[eɪ]
CORE	[zɔ]	[dɔ]	[gɔ]	[bɔ]	[pɔ]	[ɔ]
CAGE	[zeɪdʒ]	[deɪdʒ]	[geɪdʒ]	[beɪdʒ]	[peɪdʒ]	[eɪdʒ]
CAT	[zæt]	[dæt]	[gæt]	[bæt]	[pæt]	[æt]
CALL	[zɔl]	[dɔl]	[gɔl]	[bɔl]	[pɔl]	[ɔl]
CARD	[zɑd]	[dɑd]	[gɑd]	[bɑd]	[pɑd]	[ɑd]
CAKE	[zeɪk]	[deɪk]	[geɪk]	[beɪk]	[peɪk]	[eɪk]
[dʒ]	**[p]**	**[m]**	**[tʃ]**	**[b]**	N/a	**#**
JAR	[pɑ]	[mɑ]	[tʃɑ]	[bɑ]		[ɑ]
JOE	[pəʊ]	[məʊ]	[tʃəʊ]	[bəʊ]		[əʊ]
JAW	[pɔ]	[mɔ]	[tʃɔ]	[bɔ]		[ɔ]
JAY	[peɪ]	[deɪ]	[tʃeɪ]	[beɪ]		[eɪ]
JEE	[pi]	[mi]	[tʃi]	[bi]		[i]
JAYNE	[peɪn]	[meɪn]	[tʃeɪn]	[beɪn]		[eɪn]
JEEP	[pip]	[mip]	[tʃip]	[bip]		[ip]
JET	[pɛt]	[mɛt]	[tʃɛt]	[bɛt]		[ɛt]
JAIL	[peɪl]	[meɪl]	[tʃeɪl]	[beɪl]		[eɪl]
JUICE	[pus]	[mus]	[tʃus]	[bus]		[us]
[s]	**[m]**	**[v]**	**[z]**	**[b]**	N/a	**#**
SEA	[mi]	[vi]	[zi]	[bi]		[i]
SAW	[mɔ]	[vɔ]	[zɔ]	[bɔ]		[ɔ]
SEW	[məʊ]	[vəʊ]	[zəʊ]	[bəʊ]		[əʊ]
SUE	[mu]	[vu]	[zu]	[bu]		[u]
SIR	[mɜ]	[vɜ]	[zɜ]	[bɜ]		[ɜ]
SAD	[mæd]	[væd]	[zæd]	[bæd]		[æd]
SWORD	[mɔd]	[vɔd]	[zɔd]	[bɔd]		[ɔd]
SEAL	[mil]	[vil]	[zil]	[bil]		[il]
SAUCE	[mɔs]	[vɔs]	[zɔs]	[bɔs]		[ɔs]
SOCK	[mɒk]	[vɒk]	[zɒk]	[bɒk]		[ɒk]
[t]	**[m]**	**[g]**	**[d]**	**[b]**	N/a	**#**
TOE	[məʊ]	[gəʊ]	[dəʊ]	[bəʊ]		[əʊ]
TWO	[mu]	[gu]	[du]	[bu]		[u]
TIE	[maɪ]	[gaɪ]	[daɪ]	[baɪ]		[aɪ]
TAR	[mɑ]	[gɑ]	[dɑ]	[bɑ]		[ɑ]
TEA	[mi]	[gi]	[di]	[bi]		[i]
TEACH	[mitʃ]	[gitʃ]	[ditʃ]	[bitʃ]		[itʃ]
TALK	[mɔk]	[gɔk]	[dɔk]	[bɔk]		[ɔk]
TAIL	[eɪl]	[geɪl]	[deɪl]	[beɪl]		[eɪl]
TART	[mɑt]	[gɑt]	[dɑt]	[bɑt]		[ɑt]
TOUGH	[mʌf]	[gʌf]	[dʌf]	[bʌf]		[ʌf]

4.3 Control stimuli

To examine generalisation from the treated wordlist to matched untreated words, a control list was devised. These lists were based on the following requirements:

1. A set of 15 CVC words with the relevant phoneme (i.e. either [s], [t], [dʒ] or [k]) in the word initial position. These words were familiar to Oliver and matched with the treatment stimuli in terms of age of acquisition and spoken language frequency.
2. A set of 5 CVC words with the relevant phoneme (i.e. either [s], [t], [dʒ] or [k]) in the word initial position. These words were unfamiliar to Oliver as determined by a picture-naming task, and approximately matched for each of the 4 lists in terms of age of acquisition and spoken language frequency.
3. A set of 5 CVC words with the relevant phoneme (i.e. either [s], [t], [dʒ] or [k]) in the word final position. These words were familiar to Oliver and approximately matched across each of the 4 lists in terms of age of acquisition and spoken language frequency.

Table 4.7 presents the control stimuli.

Table 4.7
Oliver's control stimuli

CVC Words	/k/	/s/	/dʒ/	/t/
Matched to treatment items, with target phoneme used word initially	COT	SAT	JADE	TIGHT
	CUT	SUIT	JILL	TEETH
	CASE	SAIL	JEWEL	TALL
	CART	SUN	JEAN	TAN
	COUGH	SIZE	JOHN	TILE
	CALF	SEED	JESS	TOSS
	CASH	SIDE	JOIN	TOUCH
	KING	SAID	JUDGE	TOWN
	CURL	SELL	JUNE	TURF
	CAVE	SIGN	JEFF	TED
	CAP	SOUP	JOG	TAPE
	CUP	SICK	JAM	TAKE
	KIM	SUM	JAB	TOM
	KICK	SACK	JACK	TAP
	CORK	SAME	JOB	TICK
Unfamiliar words with target phoneme used word initially	COACH	SAG	GIN	TIFF
	CODE	SOUTH	JOT	TINE
	CORD	SOIL	GELL	TOAD
	COIL	SITE	GEM	TOIL
	CARVE	SURF	JIG	TIDE
Familiar words with phoneme used word finally	ROCK	DICE	AGE	BOAT
	PICK	HORSE	CAGE	HAT
	DUCK	HOUSE	BADGE	CAT
	HOOK	MOUSE	FUDGE	MEAT
	MAKE	RACE	JUDGE	DOT

4.4. Questions

Questions posed in relation to Oliver and his programme of intervention included the following:

(a) Will the intervention, focused mainly on Oliver's input, improve his speech production to result in an increased count of targeted word-initial consonants, i.e. increased accuracy in treated word production?

(b) Will Oliver's speech production accuracy for the matched, untreated control set of CVC words also improve beyond chance level?

(c) Will training predominantly word-initial phonemes result in generalisation of those phonemes to other word positions, i.e. will increased accuracy be noted for the control set of words with the target phonemes in word-final position?

(d) Will there be a difference in the progress observed for each of the 4 target phonemes, i.e. are PPK, developmental norms or phonetic category good indicators of success in intervention?

(e) Will Oliver's written representations of the treated words and untreated control items improve, without specific literacy intervention but linked to changes in his speech processing?

(f) Oliver's intervention focused mainly on his input skills. Will his ability to discriminate between pairs of closely related (treated) words improve as a result of the intervention?

(g) Will Oliver's phonological representations improve as a result of the intervention for the treated words? These representations were considered to be important pre-cursors to any changes that might ultimately be brought about in his speech output.

(h) Will Oliver's speech, auditory discrimination and spelling skills improve in more global terms as a result of the intervention?

5. INTERVENTION

5.1 Overview of intervention

Intervention consisted of four consecutive phases with each phase consisting of seven sessions: A total of 28 hours of intervention took place. The sessions were carried out on a twice-weekly basis in Oliver's school in a quiet room with only Oliver and the therapist present. Oliver was 5;11 at the start of the intervention itself and was 6;5 on completion of the final phase of intervention.

5.2 Detailed intervention report

Each phase centred round one phoneme. Sessions are outlined in Table 4.8 with examples of activities from each session. The intervention programme followed the hierarchy of tasks outlined in Table 4.4 using each of the selected stimuli in turn. A range of motivating materials (e.g. stickers, toy cars, action people) and supports (e.g. tape recorder, computer activities) were used to make the activities exciting and enjoyable for Oliver.

Table 4.8
Overview of Oliver's intervention programme

Session	Task from task hierarchy	Examples of activity
PHASE I: [k]		
1	1: Auditory lexical decision task	Oliver was presented with a picture of COW and asked to respond 'yes' or 'no' to questions such as: Is it a [zaʊ]? Is it a COW?'
2	2: Discrimination and onset segmentation (with picture)	Oliver was given a picture of COW. He heard the therapist produce that word at the same time. He was required to post the item into the relevant [k] post-box.
3	3: Discrimination and onset segmentation (no picture	As for Task 2, but for this task Oliver was not given the picture. He listened to the word and then, depending on the initial phoneme perceived (e.g. COW or [zow] or BOW) posts a token into the appropriate box (e.g. [k] or [z] or [b] box).
4	4: Non-word discrimination	As for Task 3 but using non-words
5	4: Non-word discrimination	As for Task 3 but using non-words
6	5: Intrapersonal judgement	Oliver named a pictured item. He then listened to an audio-recording of himself, and made a judgment regarding whether he had said the word correctly or incorrectly.
7	5: Intrapersonal judgement	Oliver named a pictured item. He then listened to an audio-recording of himself, and made a judgment about his own accuracy.
PHASE II: [dʒ]		
8	1: Auditory lexical decision task	Oliver was presented with a picture of JAR. He was asked to respond 'yes' or 'no' to questions such as: Is it a [mɑ]? Is it a JAR?
9	2: Discrimination and onset segmentation (with picture)	Oliver was given a picture of JAR and heard the therapist produce that word at the same time. He was required to post the item into the relevant [dʒ] post-box.
10	3: Discrimination and onset segmentation (no picture)	As for Task 2, but for this task Oliver was not given the picture. He listened to the word and then, depending on the initial phoneme perceived (e.g. [mɑ], JAR, [bɑ]) posted a token into the appropriate box (e.g. [dʒ] or [m] or [b] box)
11	4: Non-word discrimination	As for Task 3 but with non-words
12	4: Non-word discrimination	As for Task 3 but with non-words
13	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself, judging the accuracy of his own production.

Table 4.8 ***Cont.*** Overview of Oliver's intervention programme

14	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself, and made a judgment about the accuracy of his own production.
PHASE III: [s]		
15	1: Auditory lexical decision task	Oliver was presented with a picture of SEA and asked to respond 'yes' or 'no' to questions such as: Is it the SEA? Is it a BEE?
16	2: Discrimination and onset segmentation (with picture)	Oliver was given a picture of SEA and heard the therapist produce that word at the same time. He posted the item into the relevant [s] post-box.
17	3: Discrimination and onset segmentation (no picture)	As for Task 2, but for this task Oliver was not given the picture. He listened to the word and then, depending on the initial phoneme perceived (e.g. SEA or BEE or ME) posted a token into the appropriate box (e.g. [s], [m] or [b] box).
18	4: Non-word discrimination	As for Task 3 but with non-words
19	4: Non-word discrimination	As for Task 3 but with non-words
20	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself and made a judgment regarding whether what he heard was correct or incorrect.
21	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself, judging if what he heard was correct or incorrect
PHASE IV: [t]		
22	1: Auditory lexical decision task	Oliver was presented with a picture of TOE and asked to respond 'yes' or 'no' to questions such as: Is it a TOE? Is it a [məʊ]?
23	2: Discrimination and onset segmentation (with picture)	Oliver was given a picture of a toe and heard the therapist produce that word at the same time. He was required to post the item into the relevant [t] post-box.
24	3: Discrimination and onset segmentation (no picture)	As for Task 2, but for this task Oliver was not given the picture. He listened to the word and then, depending on the initial phoneme perceived (e.g. TOE, BOW, or [məʊ]) posted a token into the appropriate box (e.g. [t], [m] or [b] box).
25	4: Non-word discrimination	As for Task 3 but with non-words
26	4: Non-word discrimination	As for Task 3 but with non-words
27	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself and made a judgment regarding whether he was correct or incorrect
28	5: Intrapersonal judgement	Oliver named an item in a picture. He then listened to an audio-recording of himself and made a judgment regarding whether he was correct or incorrect

6. EVALUATION

This section focuses on the outcome of Oliver's intervention programme. Section 6.1. is a micro evaluation of the intervention, aiming to look at the specific changes in treated stimuli and untreated control items outlined in Section 4. The section starts with an overview of the micro evaluation (6.1.1), before considering speech (6.1.2), spelling (6.1.3) auditory discrimination (6.1.4) and phonological representations (6.1.5) in turn. This is then followed by a summary of micro evaluation in section 6.1.6, and a reconsideration of the questions posed initially in section 6.1.7. Section 6.2 provides a macro analysis of the intervention, aiming to outline broader benefits in the following areas: standardised language assessment (6.2.1), speech profiling in a psycholinguistic framework (6.2.2), speech analysis (6.2.3), and child interview and teacher / parent report (6.2.4). The evaluation section is concluded with a summary of evaluation at the macro level.

6.1 Micro evaluation

Oliver was reassessed at periodic intervals during the intervention study. Figure 4.4 shows the six points (T1 – T6) at which he was assessed. The micro evaluation involved the following tasks:

1. single word naming of each of the treated stimuli (Table 4.6)
2. single word naming or repetition of each of the control items (Table 4.7)
3. written productions of each of these stimuli items
4. auditory discrimination of targeted words and closely related words using same / different paradigm (e.g. are these words the same or different, [ɑd] [kɑd]?)
5. Posting task tapping Oliver's phonological representations, i.e. sorting of pictured items into appropriate boxes by initial phoneme.

The results from these evaluations are described below.

6.1.1 Overview

Table 4.9 gives an overview of Oliver's progress on treated and untreated stimuli by comparing the percentage of target phonemes correct in his speech, spelling, auditory discrimination and phonological representations at pre-intervention assessment (T1) with scores obtained on completion of the programme at T5 (short-term follow-up), and at T6 (long-term follow-up).

The scoring procedure focussed specifically on the target phonemes ([k], [dʒ], [s], and [t]), not on the remainder of the word. Scoring was carried out for both speech and spelling by awarding a maximum of 3 points per item, for a correct phoneme /

grapheme in the correct word position; 2 points were awarded for a correct phoneme / grapheme in the incorrect word position, or a closely related phoneme /grapheme (e.g. voiced / voiceless counterparts) in the correct word position. 1 point was awarded for a closely related item in the incorrect word position. Raw scores were converted to percentage. Auditory discrimination and phonological representation tasks were scored as percentage total items correct, using a binary system.

Table 4.9
Overview of Oliver's performance pre- and post-intervention

	T1 Pre-Intervention % items correct*	T5 Short term follow up % items correct*	T6 Long term follow up % items correct*
SPEECH – mean for all items	**2.5**	**18.3****	**21.6****
Treated CVC words	2.5	43.75**	37.5**
Untreated matched CVC words	2.5	17.5**	21.25 **
Untreated new CVC words	0	10	10
Untreated CVC words with phonemes in word final position	5	5	7.5
SPELLING - mean for all items	**1.66**	**53.3****	**37.5****
Treated CVC words	2.5	70**	70**
Untreated matched CVC words	0	40**	30**, #
Untreated new CVC words	0	35**	30
Untreated CVC with phonemes in word final position	5	65**	45**, #
AUDITORY DISCRIMINATION	**62.5**	**82.8****	**75**, #**
PHONOLOGICAL REPRESENTATIONS	**61.1**	**100****	**95.83****

* Scoring was carried out for both speech and spelling by awarding a maximum of 3 points per item, for a correct phoneme / grapheme in the correct word position; 2 points were awarded for a correct phoneme / grapheme in the incorrect word position, or a closely related phoneme /grapheme (e.g. voiced / voiceless counterparts) in the correct word position. 1 point was awarded for a closely related item in the incorrect word position. Raw scores were converted to %. Auditory discrimination and phonological representation tasks are scored as % total items correct, using a binary system.
** paired with T1 results ($p<.05$)
# paired with T5 results ($p<.05$)

A two-way mixed between-within subjects ANOVA was conducted. There was a statistically significant main effect for time for both speech [$F(2, 115) = 13.844$, $p< .001$] and spelling [$F(2, 115) = 25.068$, $p< .001$]. Both Oliver's written and spoken production of the targeted phonemes had improved over the time course of the intervention programme. The effect size for spelling (eta squared = .304) was slightly greater than that for speech (eta squared = .194), but according to Cohen (1988) both are large effects.

Paired samples t-tests were carried out to compare performance on stimuli lists at two points in time. In terms of speech, it was found that Oliver's spoken production of the treated stimuli had improved significantly from T1 to T5 ($t(119) = -6.248$, $p<.001$) and from T1 to T6 ($t(119) = -6.234$, $p<.001$), although not from T5 to T6 after intervention ceased.

Looking more specifically at the subgroups for speech, it was found that there were significant improvements for the treated words when comparing T1 with T5 ($t(39) = -6.418$, $p<.001$), and T1 with T6 ($t(39) = -5.188$, $p<.001$) showing that overall the intervention was effective for these treated words. The difference between T5 and T6 was not a significant one. For the untreated matched words, a similar pattern of improvement was noted: there were significant gains from T1 to T5 ($t(39) = -3.34$, $p<.005$) and T1 to T6 ($t(39) = -4$, $p<.001$). Significant gains extended to the closely matched words. However, significant gains were not noted in terms of Oliver's improvement on the untreated new words, or on the untreated words with the target phonemes occurring word-finally.

Overall Oliver's spelling showed a significant improvement from T1 to T5 ($t(119)=-7.489$, $p<.001$), and T1 to T6 ($t(119)=-6.725$, $p<.001$), but not from T5 to T6 after intervention had ceased. This is the same pattern of change noted for speech. Looking more specifically at the subgroups for spelling, it was found that there were significant improvements for the treated words when comparing T1 with T5, and T1 with T6 ($t(39) = -5.152$, $p<.001$) showing that overall the intervention was effective for these treated words. The difference between T5 and T6 was not a significant one. For the untreated matched words, a similar pattern of improvement was noted: there were significant gains from T1 to T5 ($t(39) = -4$, $p<.001$) and T1 to T6 $t(39) = -3.365$, $p<.005$). There was however a significant decline for items in this set from T5 immediately after intervention to long-term follow-up at T6 ($t(39) = 2.082$, $p<.05$). Significant gains were noted for Oliver's written production of untreated new words, when comparing scores at T1 with those at T5 ($t(19)=-2.333$, $p<.05$), and for the untreated words with the target phonemes occurring word-finally when comparing T1 and T5 ($t(19)=-3.04$, $p<.05$), and T5 and T6 ($t(19)=-2.373$, $p<.05$). For the word-final items, the effects of intervention seemed temporary, and a significant decline was noted from T5 after intervention to long-term follow-up at T6 ($t(19) = 1.282$, $p<.005$). For spelling, generalisation extended not only to the matched words but also to the other untreated wordlists. Generalisation for spelling was more widespread than the generalisation occurring for speech. Intervention addressed speech only, not spelling. This pattern may reflect the fact that Oliver's speech difficulties represent a core deficit, resistant to generalisation and requiring a great deal of further input. This point is considered further in the discussion. It may also reflect the fact that Oliver was exposed to written language and writing tasks in the classroom during the intervention period which would have supported his developing skills in these areas, whereas his speech was only directly addressed in intervention.

Oliver's auditory discrimination performance showed significant improvement when comparing scores from T1 with those obtained at T5 ($t(63)=-4.007$, $p<.001$) and T6 ($t(63)=-2.049$, $p<.05$). Comparing scores at T5 with those at T6 showed a significant decline in

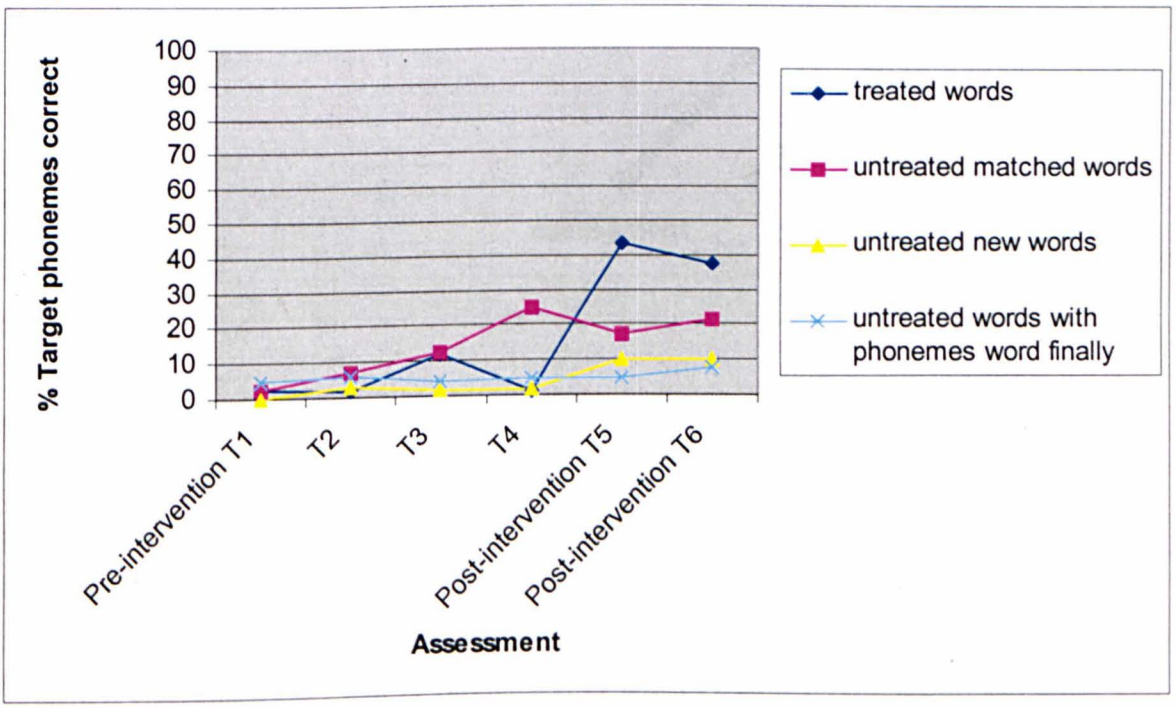
performance once intervention had ceased ($t(63)=2.311$, $p<.05$). Measures of the accuracy of Oliver's phonological representations showed a similar pattern of change: A significant increase was noted from T1 to T5 ($t(89)=-6.671$, $p<.001$) and T1 to T6 ($t(89)=-4.87$, $p<.001$). Comparing scores at T5 with those at T6 showed a significant decline in performance once intervention had ceased ($t(89)=2.288$, $p<.05$). It was suggested that these input skills are prerequisites to Oliver improving his speech. Oliver's input skills, both auditory discrimination and phonological representations, improved significantly over the course of intervention, suggesting that the intervention worked in a way similar to what was outlined.

Subsequent sections focus more specifically on the change that occurred during the intervention programme, as measured by the micro assessments following each phase of intervention.

6.1.2 Speech

Overall, Oliver made significant gains in his speech when comparing pre- and post intervention scores. This section focuses on the change that occurred for each of the different stimuli lists and phoneme groups over the course of intervention. An investigation of the qualitative changes occurring in Oliver's speech was also undertaken. Figure 4.6 compares the progress between the different stimuli lists collapsed across phonemes.

Figure 4.6.
Comparison of Oliver's stimuli lists over the course of intervention: speech

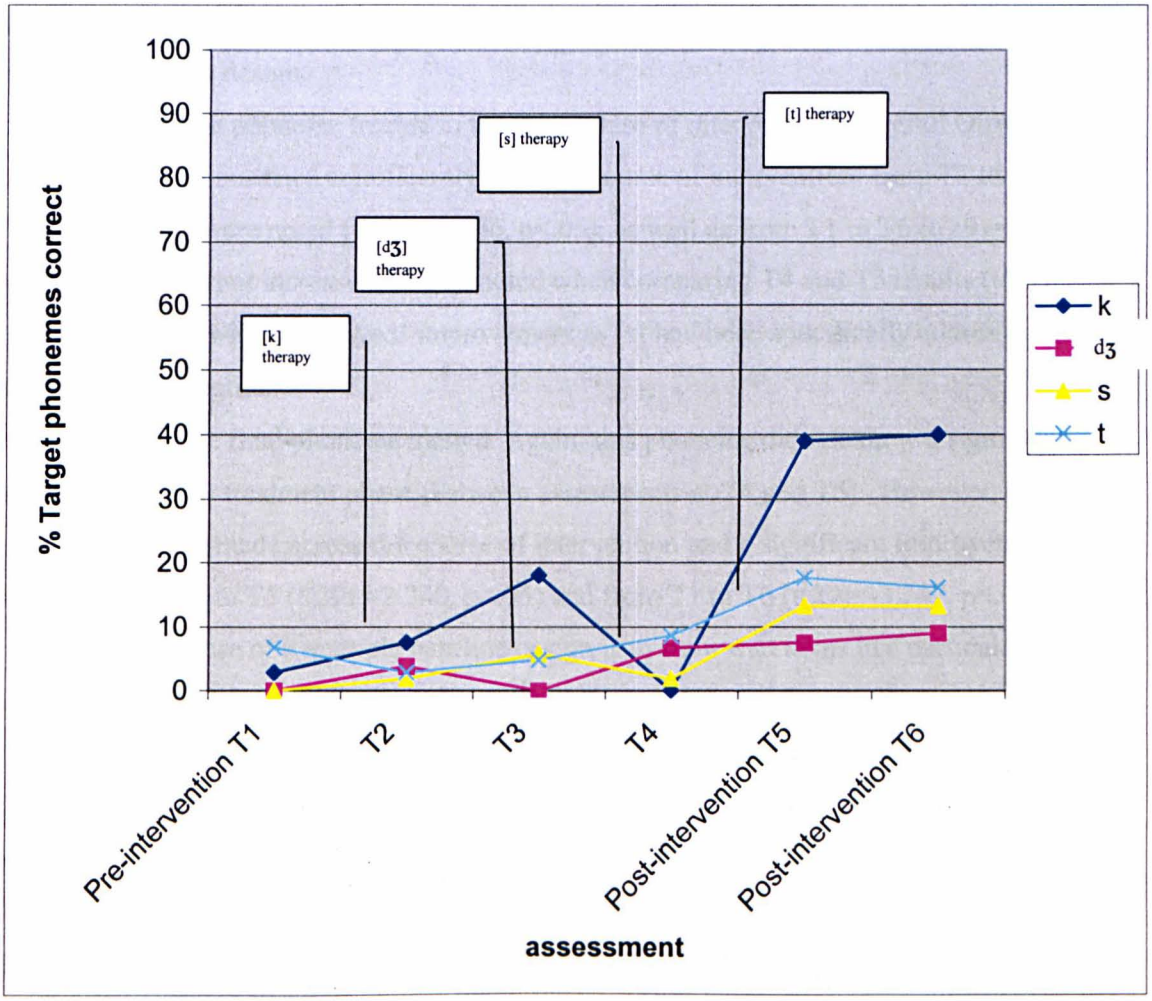


At the initial assessment (T1), there was no significant difference in Oliver's performance on the different stimuli lists. Over the course of intervention significant change was noted for

the treated items and the untreated, matched set. Change for the other two untreated lists, the new words and the words which had the stimuli in word final position, was not significant.

Figure 4.7 shows speech results by phoneme category. Data for each phoneme include all the stimuli, both treated and untreated.

Figure 4.7
Comparison of Oliver's phoneme stimuli lists over the course of intervention: speech



The general trend shown in Figure 4.7 is a positive one with an increase across the sessions for each phoneme. [k] was treated in the first phase of therapy, but showed no significant change in production at the early assessments. When comparing T3 and T4 results, a significant decline in the accuracy of this sound's production was noted ($t(29)=-2.693$, $p<.05$). A significant increase was then noted from T4 to T5 ($t(29)=-4.709$, $p<.001$). Overall, if one compares T1 and T5 results, and T1 and T6 results for [k], significant gains were found ($t(29)=-4.397$, $p<.001$) showing that intervention was effective for this phoneme,

although it did not respond in a neat way in terms of the multiple baselines design and its response to the specific intervention phase targeting [k].

[dʒ] was treated in the second phase of intervention. Few significant changes were noted from evaluation to evaluation, and Oliver found this phoneme challenging to produce. A significant difference was however found when comparing T1 and T6 scores ($t(29)= -2.112$, $p<.05$) showing that overall Oliver had improved in his ability to produce this phoneme, making small changes that did not reach significance from one assessment to the next. As for [k], this phoneme did not show a pattern of response that fitted in with the multiple baselines design.

[s] was the phoneme treated in the third phase of intervention. Overall Oliver's production of [s] increased significantly over the course of intervention: from T1 to T5 significant gains were noted ($t(29)=-2.626$, $p<.05$), as well as from T1 to T6 ($t(29)=-2.693$, $p<.05$). A significant increase was also noted when comparing T4 and T5 results ($t(29)=-2.276$, $p<.05$) showing a 'delayed' improvement as [s] had been specifically addressed in phase 3 of intervention.

[t] was the final phoneme treated. Again, this phoneme did not show a significant increase during its treatment phase (between assessments at T4 and T5). However, overall steady gains were made across the course of intervention and a significant improvement occurred from T1 to T5 ($t(29)=-2.340$, $p<.05$) and from T1 to T6 ($t(29)=-3.247$, $p<.005$).

The purpose of a multiple baseline design is to show that items in a particular sub-set are affected only subsequent to treatment. This was not the case for Oliver. It can be seen that he made improvements irrespective of the particular phonemes being targeted. Oliver's auditory input skills were targeted in intervention, and this may have meant that the intervention carried out in the first phase had general effects of improving Oliver's speech processing system rather than only one discrete phoneme. This 'unlocking effect' is discussed in further detail in the discussion section. For each of the phonemes, Oliver's speech production accuracy at T4 was low. No illness or family disturbance was noted at this time that might account for the reduced scores. He may have been overloaded at this point in the intervention programme, although this cannot fully account for the pattern of change since he recovered and went on to make significant increases at T5.

Table 4.10 provides a breakdown of results for each of the phoneme lists ([k], [dʒ], [s] and [t]) in terms of the type of stimuli (treated and untreated words) for T1 – T6 assessments.

Table 4.10
Breakdown of Oliver's speech results by stimuli type and phoneme category:

		T1 Assessment % items correct	T2 Assessment % items correct	T3 Assessment % items correct	T4 Assessment % items correct	T5 Assessment % items correct	T6 Assessment % items correct
Treated CVC words							
	[k]	0	3.3	26.6	0	60	53.3
	[dʒ]	0	0	0	0	10	6.6
	[s]	0	3.3	10	0	36.6	33.3
	[t]	10	0	10	3.3	70	56.6
Untreated matched CVC words	[k]	0	13.3	36.6	0	36.6	46.6
	[dʒ]	0	6.6	0	6.6	20	23.3
	[s]	0	3.3	6.6	6.6	16.6	20
	[t]	10	0	6.6	26.6	0	0
Untreated new CVC words							
	[k]	0	0	0	0	40	40
	[dʒ]	0	0	0	0	0	0
	[s]	0	0	6.6	0	0	0
	[t]	0	10	0	0	0	0
Untreated CVC with phonemes in word final position	[k]	13.3	13.3	10	0	20	20
	[dʒ]	0	6.6	0	16.6	0	6.6
	[s]	0	0	0	0	0	0
	[t]	3.3	0	0	0	0	6.6

In terms of treated items, [k] and [t] seem to fare equally well. However, when looking at the untreated items, it can be seen that generalisation for [k] is pleasing in the untreated lists, but very limited for [t] and the other phoneme lists. [k] differed in the way it responded to treatment. This is interesting, considering there was no evidence of velar placement developing in the pre-intervention data.

Qualitatively, Oliver's speech changed over the course of the intervention. Table 4.11 gives examples of the different patterns of change noted in Oliver's speech for the treated and untreated wordlists.

Table 4.11
Examples of qualitative changes in Oliver's speech production

Item	Description	T1 assessment	T2 assessment	T3 assessment	T4 assessment	T5 assessment	T6 assessment
No change							
CAT	treated	[æ]	[æ]	[æt]	[æ]	[æ]	[æ]
COUGH	untreated	[ɒ]	[ɒkt]	[ɒf]	[ɒ]	[ɒ]	[ɒ]
JOT	untreated	[ɒ]	[ɒk]	[ɒ]	[ɒ]	[ɒ]	[ɒ]
JEEP	treated	[ɪ]	[ip]	[ip]	[ip]	[ɪ]	[ɪ]
SOUP	untreated	[u]	[up]	[up]	[up]	[u]	[u]
TAP	untreated	[æp]	[æp]	[æp]	[æp]	[æp]	[æp]
BOAT	untreated	[bɔ]	[bəu]	[bəu]	[bəu]	[bəu]	[bəu]
Inconsistent change							
COW	treated	[au]	[aug]	[au]	[au]	[kau]	[kau]
CODE	untreated	[əu]	[əug]	[dəu]	[əu]	[kəu]	[kəu]
JOE	treated	[əu]	[əu]	[dəu]	[əu]	[gəu]	[gəu]
SOCK	treated	[ɒ]	[ɒk]	[s. ɒ]	[ɒ]	[dɒ]	[dɒ]
TAIL	treated	[teɪ]	[ɛl]	[æ.ɪl]	[eɪjɪl]	[taɪjɪl]	[taɪjɪl]
Delayed approximation							
JEWEL	untreated	[u]	[ul]	[u]	[ul]	[dul]	[dul]
SAT	untreated	[æ]	[æt]	[æ]	[æ]	[sæ]	[sæ]
Delayed success							
SEA	treated	[ɪ]	[ɪ]	[ɪ]	[ɪ]	[si]	[si]
TEA	treated	[ɪ]	[ɪ]	[ɪ]	[ɪ]	[ti]	[ti]

Four distinctive patterns of change were noted. These were:

(1) ***No change.*** Over intervention Oliver's production of these words did not change in terms of the target consonant, e.g. CAT is produced as [æ] or [æt] at each assessment. In some cases the words did change, but the change was not related to the target consonant, e.g. consider COUGH in Table 4.11.

(2) ***Inconsistent change.*** Items in this category were in a state of flux with Oliver using 'trial and error' in his realisation of the targets. Consider COW in Table 4.11, which shows introduction of a velar plosive in the word-final position at T2, [aug], suggesting that Oliver has awareness of the consonant [k] but is still grappling with the exact phonetic realisation and sequencing of phonemes into the correct position.

(3) ***Delayed approximation.*** Items in this set were characterised by a belated response to intervention. The target phoneme was never achieved but is closer to target when compared to previous productions. JEWEL, in Table 4.11 is an example of this type of pattern.

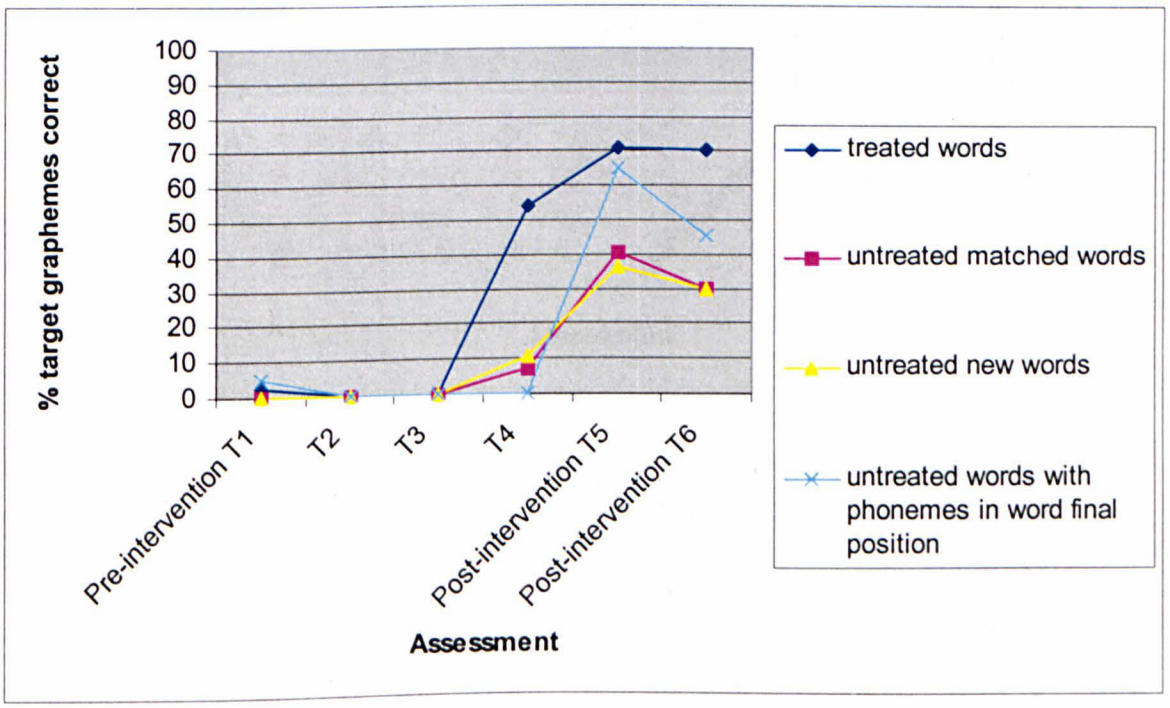
(4) ***Delayed success.*** These words were ones which were slow to change. However, change did occur, and intervention was successful with Oliver realising the target consonant correctly. SEA and TEA in Table 4.11 illustrate this pattern of change.

6.1.3 Spelling

Overall, Oliver made significant gains in his spelling when comparing pre- and post-intervention scores, despite the fact that intervention did not specifically address spelling. The change noted for spelling was greater and more widespread for spelling than for speech: unlike speech, significant gains were noted when comparing scores at T1 with those at T5 for each of the stimuli lists, suggesting that generalisation was more widespread for spelling than speech. Strengthening his representations resulted in output gains, but only significantly so in terms of spelling since speech output was 'blocked' by articulation difficulties. This section focuses on the change which occurred for each of the different stimuli lists, as well as the pattern of change that occurred over the course of intervention. An investigation of the qualitative changes occurring in Oliver's spelling was also undertaken.

Figure 4.8 compares the progress between the different stimuli types collapsed across phonemes.

Figure 4.8
Comparison of Oliver's stimuli types over the course of intervention: spelling

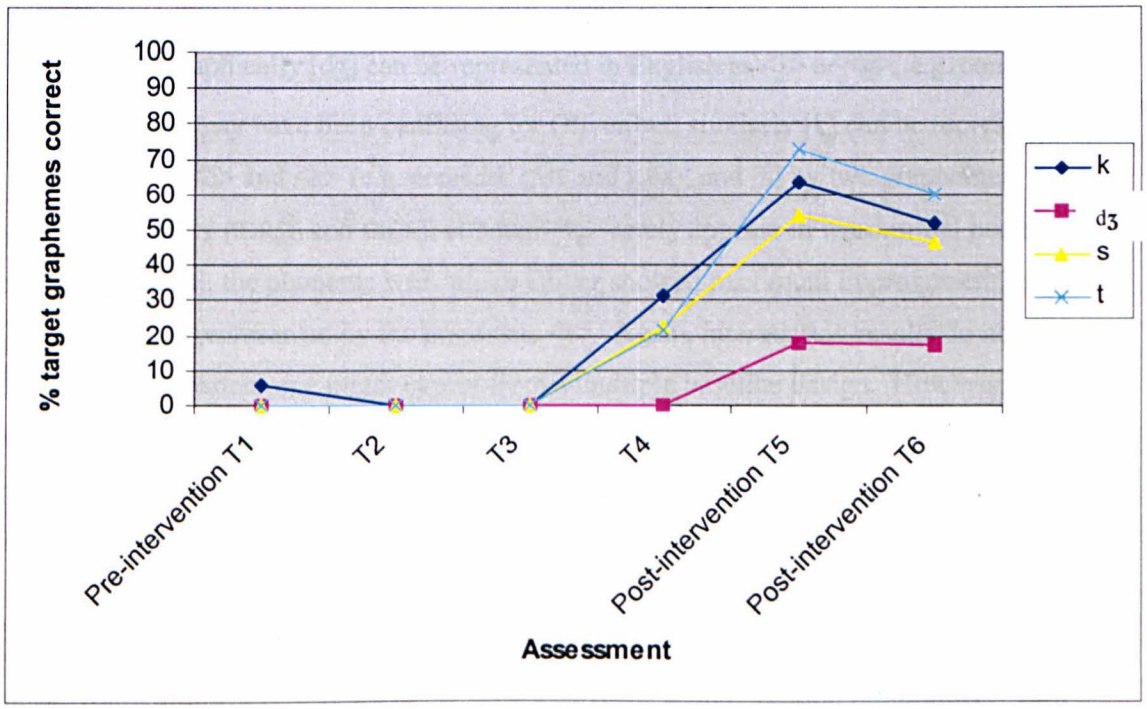


There was no significant difference in Oliver's spelling performance for the different stimuli groups at the initial assessment. Oliver made minimal progress with his spelling over the

first two phases of intervention. However, during the third phase of intervention in which [s] was targeted, Oliver made significant gains with his treated words ($t(39)=-4.188$, $p<.001$) and with the untreated new words ($t(19)=-2.666$, $p<.05$) and untreated matched words ($t(39)=-.1282$, $p<.005$). When comparing the T4 and T5 result, the remaining stimuli groups, untreated words with the target phonemes in word final position made significant gains ($t(19)=-3.322$, $p<.005$). Some of these gains were however temporary: a significant decline was noted from T5 to T6 after intervention ceased for the untreated matched controls ($t(39) = 2.082$, $p<.05$) and the words with the phonemes in word-final position ($t(19) = 1.282$, $p<.005$). Intervention did not involve written stimuli.

Figure 4.9 compares the progress for each of the four treated phonemes. The results shown in Figure 4.9 include the results for all stimuli (treated and untreated) linked to each phoneme.

Figure 4.9
Comparison of Oliver's phoneme lists over the course of intervention: spelling



As noted for Figure 4.8, Oliver's spelling accuracy for the target phonemes was extremely limited at the first three evaluations, but from T4 significant changes were noticed. [k] was the phoneme addressed in the first phase of intervention, and evidenced significant changes when comparing spelling performance from T3 with that at T4 ($t(29)=-4.097$, $p<.001$), and T4 with T5 ($t(29)=-4.397$, $p<.001$). From T5 to T6 a significant decline in his spelling performance for this phoneme was noted ($t(29)=3.181$, $p<.005$). Overall there was a significant improvement in Oliver's written representation of this phoneme from T1 to T5 ($t(29)=-3.808$, $p=.001$) and T6 ($t(29)=-4.397$, $p<.001$).

[dʒ] was addressed in the second phase of intervention, but the first significant gains are noted when comparing results from T4 with those from T5 ($t(29)=-2.626$, $p<.05$). There were no further significant changes at T6, but overall there was a significant improvement in Oliver's written representation of this phoneme from T1 to T5 ($t(29)=-2.626$, $p<.05$) and T1 to T6 ($t(29)=-2.971$, $p<.01$).

The third phase of intervention targeted spoken production of [s]. For this phoneme, significant improvement was noted from T3 to T4 assessment ($t(29)=-3.247$, $p<.005$), with further significant gains from T4 to T5 ($t(29)=-2.536$, $p<.05$). As for the other phonemes there was a significant improvement in Oliver's written representation of this phoneme overall from T1 to T5 and T6 ($t(29)=-5.385$, $p<.001$).

The final phase of intervention addressed [t]. This phoneme showed significant gains from T3 to T4 ($t(29)=-3.181$, $p<.005$) and from T4 to T5 ($t(29)=-7.346$, $p<.001$), but a significant decrease was noted from T5 to T6 ($t(29)=3.181$, $p<.005$). Overall significant gains were made from T1 to T5 ($t(29)=-15.456$, $p<.001$) and T1 to T6 ($t(29)=-7.077$, $p<.001$).

Orthographically [dʒ] can be represented in English as <j> or <g>, e.g. consider JOB and GELL. This may have been confusing for Oliver but, similarly [k] can be represented by two graphemes <c> and <k> (e.g. consider CUT and KIM), and [s] by two graphemes, <s> or <c> (e.g. consider HORSE and DICE), although <c> rarely appears in word initial position, e.g. CEILING). [t], the phoneme with which Oliver showed maximum improvement, is one that can *only* be represented by the grapheme <t>. Again, intervention results do not fit in neatly with the pattern one might expect from a multiple baseline design. However, this is not surprising since intervention did not focus specifically on spelling, and Oliver was being exposed in the classroom to all phonemes and their written equivalents throughout intervention.

Table 4.12 gives a breakdown of results for each of the phoneme lists in terms of the type of stimuli for assessments T1 to T6. These results show how spelling progress was only noted from T4 onwards, and not in the earlier parts of the intervention programme. They also show how Oliver's written representation of [dʒ] improved for the treated CVC word set, but did not generalise to the other stimuli lists.

Table 4.12
Breakdown of Oliver's spelling results by stimuli type and phoneme category

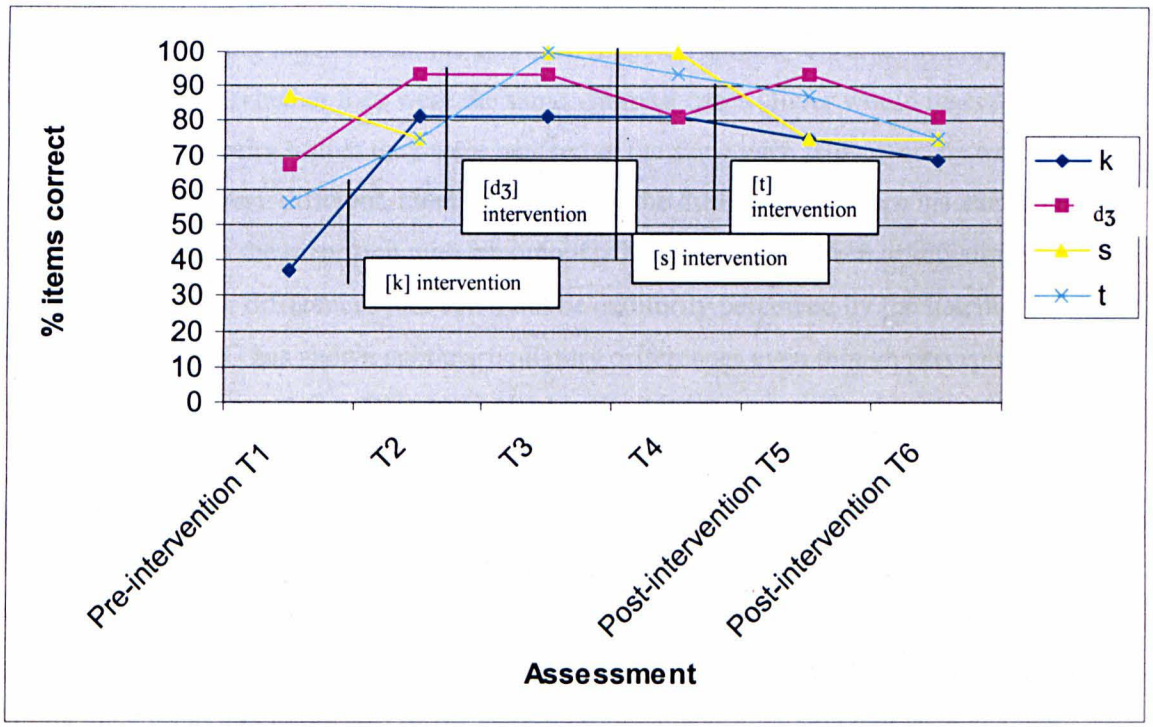
		T1 Assessment % items correct	T2 Assessment % items correct	T3 Assessment % items correct	T4 Assessment % items correct	T5 Assessment % items correct	T6 Assessment % items correct
Treated CVC words	[k]	10	0	0	46.6	56.6	56.6
	[dʒ]	0	0	0	0	56.6	56.6
	[s]	0	0	0	90	70	70
	[t]	0	0	0	80	100	100
Untreated matched CVC words	[k]	0	0	0	40	76.6	70
	[dʒ]	0	0	0	0	3.3	0
	[s]	0	0	0	0	53.3	46.6
	[t]	0	0	0	3.3	33	13.2
Untreated new CVC words	[k]	0	0	0	40	40	33.3
	[dʒ]	0	0	0	0	13.2	13.2
	[s]	0	0	0	0	23.3	20
	[t]	0	0	0	3.3	56.6	50
Untreated CVC with phonemes in word final position							
	[k]	20	0	0	0	80	50
	[dʒ]	0	0	0	0	0	0
	[s]	0	0	0	0	70	50
	[t]	0	0	0	0	100	76.6

6.1.4 Auditory discrimination

The intervention programme focussed on Oliver's auditory discrimination skills. Oliver's auditory discrimination was assessed by presenting him with pairs of closely related words. He was asked to say if they were the same or different. Each of the 10 treated words was paired with a closely related item based on Oliver's pattern of errors (e.g. TEA from the [t] list presented with BEE, Oliver's own production of TEA.) Six foils consisting of the same items repeated twice were also included for each of the stimuli lists. A total of sixteen word pairs was created for each of the stimuli lists, including foils. These were then randomised and presented to Oliver. His performance on auditory discrimination tasks using the intervention stimuli and related items improved significantly over the course of intervention. Oliver's auditory discrimination performance showed significant improvement when comparing scores from T1 with those obtained at T5 ($t(63)=-4.007$, $p<.001$) and T6 ($t(63)=-2.049$, $p<.05$). Again, comparing scores at T5 with those at T6 showed a significant decline in performance once intervention had ceased ($t(63)=2.311$, $p<.05$). What was the pattern of change observed over the entire intervention programme, for individual phonemes, and did this fit in with the multiple baselines design?

Figure 4.10 shows the changes in Oliver's auditory discrimination for words linked to each of the four phoneme lists over the course of intervention.

Figure 4.10
Changes in Oliver's auditory discrimination for each of the phoneme lists



[k] and [t] were the phonemes with which the most significant gains were made over the course of intervention. Significant improvement was noted when comparing Oliver's auditory discrimination scores for [k] at T1 with T5 ($t(15)=-3$, $p<.05$) and T6 ($t(15)=-2.611$, $p<.05$). Similarly auditory discrimination of [t] improved from T1 to T5 ($t(15)=-4.392$, $p<.001$) and from T1 to T6 ($t(15)=-3.416$, $p<.005$). Oliver found auditory discrimination tasks involving these phonemes ([t], [k]) the most challenging at T1 assessment. His performance on the auditory discrimination tasks for the other phonemes ([dʒ] and [s]) was significantly better ($t(62)=-3.869$, $p<.001$), almost approaching ceiling in the case of [s] (87.5% correct). Thus it is not surprising that changes for these phonemes across the intervention did not reach significance.

The multiple baselines design did not clearly reveal the effect of treatment on specific stimuli. As mentioned previously this may be because the same skill – auditory discrimination – underlies each of these tasks. This notion is supported by the fact that after the first phase of intervention significant gains were already seen for three of the four stimuli lists: [k], the specifically targeted phoneme improved from T1 to T2 ($t(15)=-3.416$, $p<.005$), as well as for [dʒ] ($t(15)=-2.236$, $p<.05$), and [t] ($t(15)=-3.416$, $p<.005$). From evaluation at

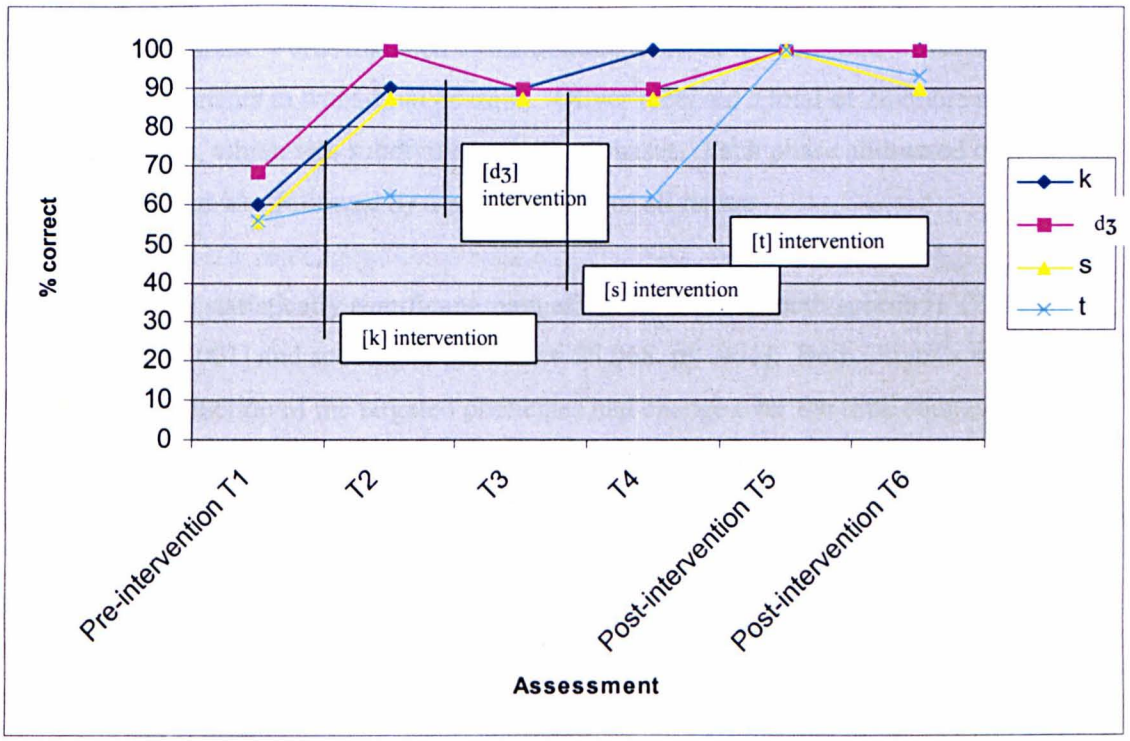
T2 to evaluation at T3, further gains were noted for [t] and [s] ($t(15)=-2.236$, $p<.05$), despite the fact that these phonemes had not yet been specifically addressed in the intervention.

From a qualitative point of view, changes were noted in Oliver's approach to the discrimination task. At the second assessment, after one phase of intervention, Oliver's approach to the auditory discrimination task had changed. Initially he had listened and then responded. Following intervention, his approach involved spoken rehearsal of the word pairs before deciding on whether they were the same. In most cases Oliver would inaccurately produce the word pairs so that they were realised in the same way. However, he would then indicate that they *were* different, thereby illustrating the difference between his stored input representations and the mismatch with his output. Oliver may have been articulating them with slight phonetic differences that could not be auditorily perceived by the listener. Research using EPG has shown subtle articulatory differences even though perceptual differences are not noted (e.g. Wood and Hardcastle, 2000).

6.1.5 Phonological representations

Oliver's phonological representations were considered a key focus of intervention and an important part of each micro assessment. The rationale behind the intervention was that changing inaccurate phonological representations will result in more accurate information for mapping on to the output part of the speech processing system, and that such changes should also be observed in spelling. Any changes noted in phonological representations were considered a good indication of the change resulting from work focused on input. Figure 4.11 shows the changes which occurred in the accuracy of Oliver's phonological representations for each of the stimuli lists. The phonological representation task required Oliver to post pictures into boxes depending on the initial phoneme in the pictured items. The therapist did not name the items since the aim was to 'bypass' Oliver's weak auditory discrimination skills.

Figure 4.11
Changes in Oliver's phonological representations for each of the phoneme lists



ANOVA indicated a significant main effect of time ($F(5, 112)=19.407$, $p<.001$) for Oliver's phonological representations. His phonological representations improved significantly for each of the phoneme lists over the course of intervention. For [k], significant gains were not only noted when comparing results with T1 and T5, and T1 and T6 ($t(29)=-4.397$, $p<.001$), but also when comparing T1 and T2 ($t(29)= 2.757$, $p<.05$). [k] was specifically addressed in this first phase of intervention. However, [k] was not the only phoneme to make significant gains after the first phase of intervention: [s] also improved significantly following this phase ($t(29)=-3.071$, $p<.01$). Further gains were not noted for [s] following its specific phase of intervention, but between T4 and T5 further significant gains were made ($t(29)=-2.112$, $p<.05$). Overall [s] made significant gains from pre- to post-intervention ($t(29)=-3.340$, $p<.005$). [t] was a phoneme which showed significant changes when comparing results before and after the specific intervention that addressed it ($t(29)=-4.097$, $p<.001$). Overall this phoneme made significant gains from pre to post-intervention ($t(29)=-3.612$, $p<.001$) as did [dʒ] ($t(29)=-3.808$, $p=.001$).

6.1.6 Summary of micro evaluation

(a) This evaluation focussed on the specific results of Oliver's intervention by looking at changes in his processing of single words containing the phonemes [k], [dʒ], [s] and [t].

Intervention focused on Oliver's input processing with him being required to discriminate and make phonological judgements about treatment words. Control stimuli included familiar words matched to the treatment set, new words and words with the target consonants in word-final position. Oliver received a total of 28 hours of intervention, which was subdivided into four phases. Each phase addressed one phoneme and was followed by a reassessment of all items.

(b) There was a statistically significant main effect for time for both speech [$F(2, 115) = 13.844$, $p < .001$] and spelling [$F(2, 115) = 25.068$, $p < .001$]. Both Oliver's written and spoken production of the targeted phonemes had change over the time course of the intervention programme. The effect size for spelling (eta squared = .304) was slightly greater than that for speech (eta squared = .194), but both are large effects.

(c) For speech, significant improvements were noted from pre- (T1) to post-intervention (T6) assessment for the treated words and the untreated matched control words. However, significant gains were not noted in Oliver's production of the untreated new words, or the untreated words with the target phonemes occurring word-finally. Focussing separately on the four targeted phonemes, it was found that Oliver's ability to produce all individual phonemes had improved over the course of intervention.

(d) For spelling, Oliver made significant improvements from T1 to T6 for the treated words. In addition, significant improvements were made with all the untreated wordlists. Oliver made minimal progress with his spelling over the first two phases of intervention. However, during the third phase of intervention, he made significant gains with his treated words and with the untreated new words. When comparing the T3 and T4 results, and the T4 and T5 results significant gains were noted for each of the four wordlists. Some of these gains were temporary with significant declines noted from T5 to T6 after intervention ceased. Intervention did not involve written stimuli, but it is suggested that the improved written forms reflect improved underlying phonological representations.

(e) The intervention programme tapped Oliver's auditory discrimination skills. Oliver's auditory discrimination improved significantly from T1 to T5 ($t(63)=-4.007$, $p<.001$) and T6 ($t(63)=-2.049$, $p<.05$). Comparing scores at T5 with those at T6 showed a significant decline once intervention had ceased ($t(63)=2.311$, $p<.05$). [k] and [t] were the phonemes which made the most significant gains over the course of intervention. Oliver found auditory discrimination tasks involving these phonemes the most challenging at T1 assessment. His performance on the auditory discrimination tasks for the other

phonemes ([dʒ] and [s]) was significantly better and significant gains could not be demonstrated across the intervention for these phonemes.

(f) The intervention programme specifically tapped Oliver's phonological representations. Accuracy of Oliver's phonological representations showed a similar pattern of change: A significant increase was noted from T1 to T5 ($t(89)=-6.671$, $p<.001$) and T1 to T6 ($t(89)=-4.87$, $p<.001$). His phonological representations improved significantly for each of the phoneme lists over the course of intervention. These input changes, and his spelling gains, may be precursors to Oliver improving his speech.

6.1.7 Questions revisited

The following questions related to Oliver and his intervention were asked:

(a) Will the intervention, focused mainly on Oliver's input, improve his speech productionto result in an increased count of targeted word-initial consonants, i.e. increased accuracy in treated word production? Yes, working on Oliver's input in a specific way (i.e. rather than auditory discrimination in general) resulted in significant changes in his speech.

(b) Will Oliver's speech production accuracy for the matched, untreated control set of CVC words also improve beyond chance level? Yes, significant speech production gains extended to this list of words.

(c) Will training predominantly word-initial phonemes result in generalisation of those phonemes to other word positions, i.e. will increased accuracy be noted for the control set of words with the target phonemes in word-final position? No, generalisation of the phonemes targeted in word-initial position did not extend in a significant way to the phonemes in word-final position.

(d) - Will there be a difference in the progress observed for each of the 4 target phonemes? Yes, different patterns of change emerged for each of the phonemes. Overall, [k] and [t] were the phonemes most effectively treated. [k] made the most gains in speech, followed by [t]. In terms of spelling, [t] made the most significant changes overall, followed by [k]. For auditory discrimination, [k] and [t] made the most significant changes, but these were phonemes that were initially harder for Oliver to perceive than

the other two targeted phonemes. There was no significant difference from phoneme to phoneme for the phonological representations.

- Are developmental norms / phonetic category good indicators of success in intervention?

[t] and [k] are both plosives and were the two most early acquired phonemes from a developmental point of view. However, velars are typically acquired later than alveolars (Grunwell, 1987) and it is interesting that Oliver did not show this distinction, and made the most speech gains with [k].

- Is PPK a good indicator of success in intervention?

Consideration of the PPK categories for each of the phonemes is inconclusive: [k] represented type 3, the category in which Oliver had the most phonological knowledge. [t], on the other hand, was classed as type 6, the phoneme category about which Oliver knew the least. The other two phonemes were both classed as representatives from type 5. Results from this case study suggest that PPK may be a less relevant index of treatment effectiveness than developmental norms.

These findings suggest that the traditional developmental hierarchy may be the best one since children may not be ready to acquire phonemes that are typically acquired later in the developmental hierarchy. However, the findings may have been different if different phonemes had been chosen to represent the different categories. It may also be that some children require developmental targets, whereas for others PPK is more important in selecting stimuli. These issues of stimuli selection are returned to in the discussion.

(e) *Will Oliver's written representations of the treated words and untreated control items improve without specific literacy intervention but linked to changes in his speech processing?* Yes, significant gains were made with Oliver's spelling of the treated words. Significant generalisation occurred to each of the untreated stimuli lists for all the phonemes.

(f) *Oliver's intervention focused mainly on his input skills. Will his ability to discriminate between pairs of closely related (treated) words improve as a result of the intervention?* Yes, Oliver's ability to discriminate between closely related words improved overall, from T1 to T5, and T1 toT6.

(g) *Will Oliver's phonological representations improve as a result of the intervention for the treated words? These representations were considered to be very important pre-cursors to any changes that might ultimately be brought about in his speech output.* Yes, Oliver's phonological representations improved overall, from T1 to T5, and T1 to T6.

(h) *Will Oliver's speech, auditory discrimination and spelling skills improve in more global terms as a result of the intervention?* This question remains to be answered in the following section.

6.2 Macro evaluation

Oliver was followed up in March 2003, approximately one month after the completion of his intervention programme. Long-term follow-up took place some 7 months later at CA 7;2. The same assessment procedures as carried out initially were repeated in order to assess his more general progress in terms of speech, language and literacy. Assessment is grouped into four main areas: (6.2.1) Standardised language assessments, (6.2.2) Speech profiling carried out within a psycholinguistic framework, (6.2.3) speech analysis, and (6.2.4) child interview and parent / teacher report.

6.2.1 Standardised language assessment

Standardised tests administered at the start of the intervention, were re-administered. The results are shown in Table 4.13. Oliver's results show little change from the first assessment. In terms of receptive language, there was no significant change. His CELF score remained stable in relation to his peers. There was a slight increase in his BPVS score relative to his peers, and a slight decrease in his TROG performance relative to his peers. In terms of expressive language, Oliver's performance did not change in a significant way. It was with literacy that most change was observed. At the initial assessment Oliver had been unable to attempt reading or spelling on the single word tasks required for the Schonell Tests. At the follow-up assessment, he was able to attempt these. His reading age at long-term follow-up (CA 7;2) was 6;2, delayed by one year. His spelling age was more delayed (5;7 years at CA 7;2) but he was able to tackle many of the words in a way that would not have happened prior to intervention. Oliver had received some additional support for literacy during this time (~ 20 minutes with the LSA each week). Although the results show evidence of change, they also show that the gap between Oliver and his peers is widening in reading and spelling: At CA 6;6 his reading age was 7 months behind that of his peers, and at 7;2 this had increased to 12 months. A similar picture occurs for spelling with the gap widening from a delay of 17 to 19 months.

Table 4.13
Comparison of Oliver's standardised speech, language and literacy assessments at CA 5;6 (pre-intervention) and CA 6;6 and 7;2 (post-intervention)

Assessment	Area tapped	PRE-INTERVENTION CA 5;6 Score	PRE-INTERVENTION CA 5;6 Age-Equivalent	POST-INTERVENTION CA 6;6 Score	POST-INTERVENTION CA 6;6 Age Equivalent	POST-INTERVENTION CA 7;2 Score	POST-INTERVENTION CA 7;2 Age Equivalen
Receptive Language							
Test of reception of grammar (TROG, Bishop, 1989)	Receptive grammar	Std Score:81 Centile: 10	4;6	Std Score: 82 Centile: 10	5;0	Std Score: 77 Centile: 5	5;0
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive vocabulary	Std Score: 71 Centile: 2	3;0	Std Score: 81 Centile: 10	4;2	Std Score: 89 Centile: 20	5;8
Receptive Subtests* of CELF-Preschool (Clinical Evaluation of Language Fundamentals – Preschool, UK Edition, Wiig et al., 2001).	Receptive language	Std Score: 1 Centile: 1		Std Score: 1 Centile: 1		Std Score: 1 Centile: 1	
Expressive language							
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive vocabulary	Z Score: -2.89 Centile:1	3,7	Z score: -2.19 Centile: 2	4;0	Z Score: -2.89 Centile: 1	3;7
Clinical Evaluation of Language Fundamentals (CELF- 3), Expressive Subtests (Semel et al.,1995)	Expressive grammar	Std Score: 6 Centile: 9		Std Score: 6 Centile: 9		Std Score: 7 Centile 16	
Edinburgh Articulation Test (EAT, Anthony et al., 1971)	Articulation	Std Score: 1		Std Score:2*		Std score: 2*	
Literacy measures							
Schonell Reading Test (Newton and Thompson, 1982)	Reading single words	Unable to do		Reading Age = 5;11		Reading Age = 6;2	
Schonell Spelling Test (Newton and Thompson, 1982)	Writing single words from dictation	Unable to do		Spelling Age= 5;1		Spelling Age= 5;7	

*EAT is designed for use with children up to the age of 6;0. Oliver's scores were calculated using this upper age limit although he was 6;6 and 7;2 at the time of the assessment

6.2.2 Speech profiling in a psycholinguistic framework

Tests used to build Oliver's initial speech processing profile (Figure 4.1) were carried out again in order to determine if any changes in his profile had occurred. The updated profile is presented in Figure 4.12. Few changes were noted in the profile. Oliver still exhibited widespread difficulties with a range of input and output tasks. The one part of the profile on which change was noted was that of level F, which asks: 'Is the child aware of the internal structure of phonological representations?' This level had previously been noted as an area of relative strength for Oliver. At the final re-assessment, Oliver scored not only age-appropriately for the PhAB picture alliteration subtest, which he had previously managed, but also on the rhyme test (Vance et al., 1994, see Appendix 2a). Rhyme was not worked on in the intervention, but Oliver's class were doing a great deal of work on rhyming and this may have boosted his score in this area, or reflected his increasing strengths in this area as a result of intervention.

Figure 4.12
Oliver's speech processing profile at age 6;6 and 7;2 (from Stackhouse and Wells, 1997, 2001). Changes when compared to the profile at CA 5;6 (Figure 4.1) are highlighted.
√ = age appropriate performance
X = 1 s.d below the expected mean for her age
XX = 2 s.d below the expected mean for her age

INPUT

F Is the child aware of the internal structure of phonological representations?
√ - Rhyming test (Vance et al. 1994)
√ - PhAB picture alliteration subtest (Frederikson et al. 1997)

E Are the child's phonological representations accurate?
X - Auditory lexical decision task (Constable et al., 1997)

D Can the child discriminate between real words?
X – Real word discrimination test (Bridgeman and Snowling 1988)
X - Aston index discrimination subtest (Newton and Thompson 1982)
X – Wepman's Auditory Discrimination (Wepman and Reynolds, 1987)

C Does the child have language specific representations of word structures?

Not tested

B Can the child discriminate speech sounds without reference to lexical representations?
X – Non-word discrimination test (Bridgeman and Snowling 1988)
X – Clapping Rhythms

A Does the child have adequate auditory perception?
X√ - audiometry – has had problems in the past which now seem to be resolved

OUTPUT

G Can the child access accurate motor programmes?
X – Single word naming test (Constable et al., 1997)
X – Word-finding vocabulary test (Renfrew 1995)
XX – Edinburgh articulation test (Anthony et al. 1971)
XX – The Bus Story (Renfrew 1969)

H Can the child manipulate phonological units?
√ - PAT rhyme fluency subtest (Muter et al. 1997)

I Can the child articulate real words accurately?
X – Real word repetition subtest (Constable et al., 1997)
X - Aston index blending subtest – real Words (Newton and Thompson 1982)

J Can the child articulate speech without reference to lexical representations?
X – Aston index blending subtest – nonwords (Newton and Thompson 1982)
X –Non-word repetition subtest (Constable et al., 1997)

K Does the child have adequate sound production skills?
√ – can copy most sounds
X – can't sequence sounds for DDK

L Does the child reject his own erroneous forms?
no

6.2.3 Speech analysis

A post-intervention PACS (Grunwell, 1985) was carried out to provide information on Oliver's speech production system. This was compared with the findings from the initial assessment (Table 4.15). Many of the findings were the same as for the initial assessment. A significant change in Oliver's speech severity was not noted. Oliver's speech remains characterised by many vowels and a limited repertoire of consonants. The voiced plosives ([b], [d] and [g]) and nasals ([m], [n] and [ŋ]) are used more consistently. A greater number of [p] and [t] productions were noted at the final assessment than at the initial one: 12 productions of the former in contrast to 6 productions initially; and 9 productions of the latter in contrast to 3 previously. The fricatives [s] and [f] were used on occasion but showed no difference overall in the frequency of appearance in Oliver's phonetic repertoire, despite the fact that [s] was one of the phonemes addressed in intervention[1]. No significant changes were noted when comparing the percentage frequency of Oliver's phonological simplifying patterns, before and after intervention, although there were however, no instances of reduplication noted in the final speech analysis. Clusters do not yet occur in Oliver's inventory with the exception of [bw] for /br/ and [kw] for /kr/ which were noted in two isolated instances, the same as prior to intervention.

[1] Grunwell (1987) notes that phonemes which are used less than three times in a representative sample should not be included as established in the phonetic inventory, although they are useful indicators of incipient change in the child's phonological system.

Table 4.15
Comparison of Oliver's speech data at CA 5;6 (pre-intervention) with CA 7;2 (post-intervention)

Assessment	Pre-intervention CA 5:6		Post-intervention CA 7:2	
Severity indices	PCC 23.4 % PVC 68.2 % PPC 39.7 %		PCC 27.3 % PVC 84.1 % PPC 48 %	
Phonetic inventory	Word initial position: [m, n, b, d, g, w, j] Word medial position: [m, n, b, w] Word final position: [m n, ŋ, dʒ]		Word initial position: [m, n, p, b, t; d, g, w, j] Word medial position: [m, n, b, w] Word final position: [m n, ŋ, p; dʒ]	
Stimulability	All phonemes except [v], [z], [θ], [ð], [ʒ]		[v], [z], [θ], [ð], [ʒ]	
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (94%); final consonant deletion (43%); prevocalic voicing (39%); stopping of fricatives and affricates (32%); reduplication (12%) Non-developmental processes: Vowel distortion (27%); initial consonant deletion (34%)		Developmental processes: Cluster reduction (95%); final consonant deletion (39%); prevocalic voicing (22%); stopping of fricatives and affricates (32%); reduplication (0%) Non-developmental processes: Vowel distortion (23%); initial consonant deletion (50%)	
Single word speech sample	[aɪ] for DICE [da] for DUCK [ki] for KEY [a] for CAR [aɪs] for ICE [bɛnu] for PENCIL [u] for BLUE [æ] for CROCODILE	[ba] for BATH [wa'wu] for WATER [bu] for SPOON [it] for LEAF) [wa] for WATCH [fɪ] for FEATHER. [i] for TEA [e.a.a] for HELICOPTER	[daɪ.ɛ] for DICE [da] for DUCK [i] for KEY [a] for CAR [aɪs] for ICE [pɛnʊl] for PENCIL [bu] for BLUE [kwa.æ.daɪ] for CROCODILE	[ba] for BATH [waʔʊ] for WATER [bʊm] for SPOON [it] for LEAF) [wa] for WATCH [fɪ] for FEATHER. [i] for TEA [e.ɪ.ap] for HELICOPTER
Connected speech sample	[ba.ɛwɛ] for RUN AWAY [aɪwænu] for I WANT TO [maɪbɛd] for MY BED [wa.æ.ʊ] for WHAT'S THAT NOISE? [ʊbʊ.ɛm] for WHO BOUGHT THEM?		[i.dɔnɔ.wɛə.ɪ.mʊmɪ] for HE DON'T KNOW WHERE HIS MUMMY [wɛə.dædɪ] for WHERE'S DADDY? [mɪ.dʊ.ɔ] for ME DO ALL [wa.æ.] for WHAT THAT SAY? [mɪ.nɒ.wumpɛ] for ME NOT GRUMPY	

6.2.4 Child interview and parent / teacher report

The subjective assessment aimed to obtain impressions of Oliver's speech from Oliver himself, his class teacher, LSA and parents. It was not possible to interview Oliver in the same way as for the other participants in this study. His spontaneous speech remained very difficult to understand. For this reason there is no data from Oliver to include in this section.

6.2.4.1 Teacher report

Oliver's class teachers and LSA were both pleased with his progress. They felt that Oliver had become more intelligible, and would "surprise them with sudden strings of clear speech." They were pleased with the way his concentration had improved and the fact that he continued to try hard. These staff members and the head teacher remained very concerned about his speech, and the fact that they do not understand him for much of the time. They remain anxious to know what his prognosis is and what can be done to overcome his difficulties. Another major concern is Oliver's literacy and academic success. He requires a great deal of extra support in the classroom with his literacy – and more recently with his numeracy - one of his strengths described initially.

In order to provide further information about Oliver's academic progress over the course of the intervention, his numeracy results were obtained from the school's assessments carried out at the end of reception (prior to starting intervention, CA 5;6) and at the end of Year 1 (at the completion of intervention, CA 6;9). These results are shown in Table 4.14 and indicate that Oliver has made some progress in his general academic work, although it is not greater than might be expected over the course of this time period.

Table 4.14
Oliver's school assessment results from pre-intervention (reception) to post-intervention (Year 1)

Area	Reception: CA 5;6	Year 1: CA 6;9	Comment*
Numeracy	1C	1B	Improved 1 grade

* the numbers indicate the child's level of ability which moves from 1 upwards through to a target of 4 by the end of key stage 2. An A symbol indicates the child is almost ready to progress to the following level, whereas C or B suggests that they need further consolidation at that level. Here changes are reported in 'grades' which are derived from the number of 'letter' changes occurring, i.e. 1B to 1A constitutes an improvement of 1 grade. One would expect an average child to move 2-3 grades in the course of a year.

6.2.4.2 Parent report

Oliver's mother was pleased with the intervention and the fact that Oliver had co-operated and worked hard. She felt that his speech had improved.

Summary of macro evaluation

(a) On the standardised tests, Oliver showed no significant gains in relation to his peers and given the amount of time that had elapsed. His literacy had improved considerably: initially he had been unable to attempt the reading and spelling tests, and on completion of the intervention he was able to attempt these. However, his score was still ~1-2 years behind his chronological age.

(b) The speech processing profile revealed few changes at the macro level of assessment. His phonological representations (level F) had improved relative to his peers, and this was pleasing since phonological representations were specifically targeted in intervention, although classroom work may have also contributed to his progress.

(c) Speech analysis similarly revealed few gains at the macro level. Although there was evidence of an increasing repertoire of consonants and a reduction of phonological processes, many difficulties remained and there was little evidence of the specific sounds addressed in intervention being incorporated into more spontaneous speech.

(d) Some changes were noted by Oliver's parent and class teachers, but in general there was widespread concern about his speech – in addition to growing concerns about his ability to cope academically.

7. DISCUSSION

Oliver's speech processing profile revealed widespread difficulties. While the diagnosis of developmental verbal dyspraxia remains a controversial one (Ozanne, 1995), Oliver's speech difficulties and the multiple deficits underpinning his psycholinguistic profile are consistent with this disorder. His limited response to intervention is further evidence of DVD, since it is well documented that such children typically respond extremely slowly to intervention (Shriberg et al., 1997a, b).

There is a paucity of research that has addressed itself to evaluating intervention for children with DVD. This small group of studies include papers by Helfrich-Miller (1994) Velleman (1994); Rosenthal (1994) and Bornman et al. (2001). The case described in the present chapter can contribute to this body of work in several ways. Firstly, it has been demonstrated that Oliver made significant gains in his speech production (as well as in three other speech processing areas) at a micro level, i.e. for the targeted stimuli words as well as matched control lists of words. These findings suggest that while children with DVD may make slow progress, intervention can be effective in bringing about change to a wide-range of speech processing skills. Oliver made no significant gains at the macro level and this may be for one of, at least, three reasons:

(a) the intervention was not effective in fully 'unlocking' Oliver's speech processing skills. Ozanne (1995) cautions that children with DVD are 'hard to treat' because their multi-deficits sabotage intervention attempts. Intervention typically targets a specific skill, and although this may improve, the effects may be lost because of the remaining deficits not adequately tapped in intervention. This caution, together with a conceptualisation of DVD as a multiple deficit disorder, was important in Oliver's intervention planning. It was hoped that the task hierarchy would tap into slightly different parts of the speech processing system, treating the system as a whole and thus minimising these sabotaging effects. This may not have been the case. The intervention focused mainly on input, although speech output skills were addressed in the final stages of the task hierarchy. This is an unusual approach to intervention for children with DVD since traditionally 'drills' and output work have been used (e.g. The Nuffield Dyspraxia Programme, Connery, 1992). This is a program of graded sessions to teach basic articulatory placement and co-ordination of motor speech sequences.

Oliver's intervention was inspired largely by the work of Waters et al (1998), as well as concerns about Oliver's self-esteem and the fact that he was under increasing pressure to talk and had had little success in previous speech therapy focusing on production. However, the child described by Waters was very different to Oliver, with many positive strengths in input processing that could be successfully brought to bear in intervention. Oliver showed one limited example of age-appropriate input processing in his speech processing profile. The intervention aimed to boost his input processing and phonological representations, enabling him to map representations from input to output. However, he may have benefited from a programme more balanced in terms of input and output, giving him more opportunity to put the mapping skills into practise. Gillon (2000) carried out programmes of phonological awareness in the hopes of improving the speech of children (ages 5;6-7;6) with spoken language impairments and matched controls. Children with spoken language impairment were allocated to three different treatment groups: a) an integrated phonological awareness program, b) a 'traditional' program that focused on improving articulation and language skills, and c) a minimal intervention control group. The phonological awareness tasks in this study aimed generally to improve children's awareness of sound structure in spoken language and to develop explicit knowledge of the links between spoken word forms and written representations. The 'traditional' therapy involved a phoneme-oriented, articulatory approach and, in some severe cases, activities from the Nuffield Dyspraxia Program (NDP, Connery, 1992) were used. The study found that children who received phonological awareness training obtained age-appropriate levels of literacy performance, and *in addition* their speech articulation improved, suggesting that speech output can be addressed by targeting other areas of the speech processing system. Thus, now we might

question the traditional 'drillwork' approach and focus more on input or at least input and output together.

(b) On the other hand, intervention may have been appropriately targeted from a psycholinguistic perspective, but have been less effective from a phonological point of view. Stimuli were selected for treatment based on a variety of rationales. An attempt was made to incorporate wide-ranging phonemes so that response to these could be contrasted. Oliver's response to intervention supported the use of traditional developmental hierarchies (e.g. Grunwell, 1985) and showed that in his case PPK was not an important consideration for intervention planning. Oliver made the most significant gains for sounds that are early acquired, and with the later developing sounds he made less progress. If all targets had been selected according to this developmental perspective, the gains overall may have been greater. Nevertheless, this is another contribution of the intervention study: psycholinguistic and phonological approaches can be combined when planning intervention for children with DVD. Our knowledge of the way in which these approaches interlink and the intervention outcomes achieved needs to be developed, both to assist individual children and to advance our understanding of normal speech and language development and complex conditions such as DVD.

Generalisation remains an important but puzzling clinical phenomenon. In Oliver's case statistically significant change occurred for single word speech production, spelling, auditory discrimination and phonological representations. For speech, significant gains were made in treated CVC word production, untreated but matched CVC production and untreated new CVC production. The effect was greater for the treated word lists but generalisation occurred to these other lists of words. Generalisation did not however extend to the words, which had the target phonemes in word final position. For spelling, there was a statistically significant increase in accuracy for each of the untreated stimuli lists, including the words that had the target phonemes in word final position. The effect size was greatest for the treated words but generalisation occurred for all the control stimuli. The extent of the generalisation in spelling was greater than that which occurred for Oliver's speech.

(c) Another reason to account for the lack of significant gains at the macro-level is that the intervention dosage was insufficient. Intervention may have been effective in terms of process and content – and this must be the case to some extent, or micro changes would not have been noted – but it was not sufficient to result in widespread changes at a macro-level in terms of, for example, Oliver's intelligibility (discussed in Chapter 9) or his performance on standardised speech tests. In any event, it is clear that Oliver does require further intervention, with possible modifications to the content and process of this.

Bishop and Adams' (1990) Critical Age hypothesis describes how children who do not resolve their speech difficulties by the age of 5;6 are at increased risk of experiencing difficulties with their normal literacy acquisition. Oliver was aged 5;6 at the start of the intervention and had a range of severe and persisting speech difficulties at that time. Now, beyond the critical age, his speech problems remain and investigating his literacy reveals some interesting insights. Oliver's speech was not directly addressed in the intervention. However his spelling was monitored at each of the micro evaluations in addition to his speech. Significant improvement was noted in this area with an effect greater than that for speech. Spelling and reading improved over the intervention, but the gap between Oliver and his peers is increasing. Long-term follow-up would be valuable in determining the relationship between his speech and literacy, and literacy may still prove to be a *relative* strength that might be exploited in future intervention.

Oliver's intervention challenged traditional speech therapy approaches for children with developmental verbal dyspraxia by working on input (phonological representations) rather than output. The intervention was successful in bringing about change in his phonological representations, although widespread change was not noted in his speech at a macro level. There is a great need for further intervention studies to add to the evidence base for this complex group of children. Stimuli selection has been emphasised throughout the chapter with Oliver's differential responses to each target noted. Given that dyspraxia may be a multi-component disorder (Ozanne, 1995), it may be that different stimuli should be addressed in different ways to target different levels of breakdown. The evidence base for intervention with children with DVD requires further detailed approaches which integrate linguistic (phonological) knowledge with psycholinguistic knowledge.

CHAPTER 5: KATIE

Chapter outline

There are many children referred for speech and language therapy who present with age appropriate speech at a segmental or single word level. However, connected speech proves specifically challenging for these children, and intelligibility of spontaneous speech is markedly lower than their single word production (e.g. see Stackhouse and Wells, 1991; Stackhouse and Snowling, 1992; Wells, 1994; Stackhouse and Wells, 1997; Camarata, 1998; Newton, 1999). Clinicians are often at a loss as to how such difficulties can be explained or should be addressed, because our theoretical knowledge of the relationship between connected and single word speech is limited. It is known that connected speech consists of specific phonetic and phonological features arising from the particular sequences of sounds that occur at word junctions. Stackhouse and Wells (2001) list examples of these such as assimilation of alveolar stops to following bilabials or velars; elision of the middle of three consonants, and liaison of one vowel to a following vowel by using a glide. These connected speech processes are used appropriately by children from approximately four years of age (Newton and Wells, 1999).

Speech and language therapy typically focuses on children's production of specific speech sounds or production of single words (e.g. Bowen and Cupples, 1998; Forrest, Elbert and Dinnsen, 2000). Many children are able to apply what they have learnt at a segmental or whole-word level to conversational speech (Wright, Shelton and Arndt, 1969; Elbert, Dinnsen, Swartzlander and Chin, 1990; Almost and Rosenbaum, 1998). However, this is not always the case, and there is little research addressing the relationship between connected speech and single word speech production in intervention. Connected speech has important implications from a functional point of view and in terms of intervention efficiency.

This chapter has connected speech as a main focus. The intervention that took place with a 6-year-old child called Katie is described. Katie is an example of a child with severe speech difficulties, who benefited from specific intervention aimed at one of her most persistent speech patterns: final consonant deletion. Spontaneous generalisation into her connected speech was not noted, until a further phase of intervention specifically targeted

this aspect. Katie's response to the intervention offers some insights into the relationship between single words and connected speech, and how this may be conceptualised within a psycholinguistic model. The chapter starts with a description of Katie's (1) background, followed by discussion of the (2) assessment, (3) macro intervention planning, (4) micro intervention planning, and (5) implementation of her intervention programme. The chapter concludes with (6) an evaluation of the intervention and, (7) discussion of the intervention and the way it informs the key theme of connected speech.

1. BACKGROUND INFORMATION

Katie was 6;5 at the start of the study and in Year 2 in a mainstream school. Her involvement in the study continued until she was 8;2 and in Year 4.

1.1 Developmental

Katie was born following a normal pregnancy and delivery at full term. Early development was normal but concerns were raised at around 18 months about abnormal movements and low muscle tone. At a physiotherapy assessment, Katie's limited communication was noted and she was referred for a multi-disciplinary developmental assessment at CA 2;3. Results of the assessment showed that Katie was delayed in many spheres of her development in addition to her speech and language, e.g. in her gross and fine motor skills. Katie was diagnosed with congenital ataxic cerebral palsy at this time. At CA 6;5 Katie was independently mobile but still receiving physiotherapy. Katie has a history of expressive speech delay, and relied on pointing and gestures as a younger child. No hearing difficulties or middle-ear infections have been reported at any stage. Katie is right-handed.

1.2 Educational

Katie is in the weaker ability group for all her subjects, and requires extra support in order to cope with the academic and physical demands of the classroom. Her class teacher describes her as academically below average, but she responds well to extra input. Katie has good attention in a 1:1 situation and can generally sustain her attention in the classroom, although at times she needs to be re-focussed on the task at hand.

Katie has a statement of special educational needs with speech and language considered to be her primary areas of difficulty and requiring intensive, ongoing intervention. Her teacher notes that her speech and language difficulties affect her ability to follow instructions, work independently to finish tasks, as well as her literacy. On the WASI

(Wechsler, 1999) Katie obtained a verbal IQ score of 83 (low average), a performance IQ of 78 (borderline) and a full scale IQ of 78.

1.3 Medical

Katie has ataxic cerebral palsy and shows the classic features associated with this condition, thought to occur as a result of peri-natal cerebellar trauma: diplegia, tremors of the upper limb, incoordination of movement and difficulties with balance, nystagmus and disordered speech and voice (Milloy and Morgan-Barry, 1990). Katie is a generally healthy child with no history of hospitalisation or long-term illness. She has suffered from some urinary tract infections, and had surgery to correct a squint.

1.4. Speech and language therapy

Katie was first referred to her local NHS speech and language therapy agency at CA 2;3 by her health visitor who noted abnormal patterns of speech development. Katie was described as a child who favoured pointing and vocalisation rather than using words. She used hand signs to convey her needs (e.g. signs for toilet, drink and food). Katie's understanding of language was thought to be in the normal range for her age.

Katie's first episode of speech and language therapy consisted of weekly home-visits with general advice on language development given to Katie's parents and ongoing observation. At CA 2;8 a delay in Katie's understanding and concept knowledge was noted, in addition to the marked delay in the development of her expressive language skills. Katie was starting to babble at this time, using strings of vowels together with the bilabial consonants [b] and [m]. She found it hard to copy sounds, but both the SLT and her parents noted that she was motivated to communicate.

From CA 3;0 Katie attended 'non-directive' therapy sessions at the local child development centre. It was noted at CA 3;3 that the only word produced by Katie that her parents could understand was 'yes.' To expand her communicative repertoire, signing and gestural skills were encouraged and some Makaton signs introduced. Katie received several sessions of neuro-developmental therapy (NDT) that was carried out together with the occupational therapist and physiotherapist, and aimed to increase Katie's muscle tone both generally and for speech production purposes. Katie's attention was described as limited for her age, making both therapy and follow-up work at home challenging.

From CA 4;2 Katie attended the university clinic, receiving 10 sessions of intervention using Speech Viewer, a computer-based therapy tool which aims to increase a speaker's awareness of their output by giving visual feedback of their speech. Katie was encouraged to combine consonants and vowels into CV segments (e.g. [mɑ], [bɑ]) and made

good progress. Later targets that Katie found more challenging included CVCV production and differentiation between vowels. A nursery visit was made following completion of this block of therapy. It was noted that Katie had settled in well, and was showing increased sociability. Pointing and gestures were used a great deal, and the staff were given advice on how to encourage and respond to this appropriately. Katie has been able to remain in the same school environment moving from the school's nursery into the reception class, and then the primary school classes. The school is a small, mainstream school situated close to Katie's home.

Katie entered Year 1 in September 2000 with a Statement of Special Educational Needs, and the support of a part-time learning support assistant (LSA). In October 2000 at CA 5;2, Katie was visited in school by the NHS Mainstream Schools SLT for the first time. At this visit it was noted that Katie showed a range of phonological processes affecting her intelligibility, predominantly final consonant deletion and stopping of fricatives and affricates. An intervention programme was devised with the focus on expanding Katie's range of consonants – particularly those used in the word final position, as well as improving her awareness of word length and timing by clapping out syllables. The more specific speech target from Katie's annual review (at CA 5;5) was for her to produce the final consonants [p, m, b, d, n, g]. The SLT demonstrated the programme of intervention, based on Hodson and Paden's (1991) programme, to the LSA. The LSA was responsible for carrying out speech sessions with Katie on a daily basis – sometimes individually and at other times with a small group of children with similar needs. The SLT has been visiting the school approximately twice each term in order to update the programme, monitor progress and support the LSA in carrying out the programme. At the end of Year 1 (CA 5;10) it was noted that Katie was able to use some of the targeted final consonants when cued, and in addition she was starting to use some of the targeted consonants in other word positions.

A new block of school-based therapy was started in October 2001 as Katie was starting in Year 2. The programme continued to focus on syllable clapping, and expanding Katie's range of available consonants and their use in word final position. The programme continued to be carried out on a daily basis by the LSA with support and bi-termly visits from the SLT. In Year 2, Katie's class teacher expressed concern about the effect of her disordered speech on her spelling: Her literacy progress was slow. At CA 6;5 Katie had made some progress with her speech, but beyond the single word level it was noted that she was still very hard to understand. Katie seems to have difficulty applying what she has learnt at the single word level to phrase and sentence levels. It was noted however, that Katie had become more aware of her listener's needs and was able to preserve the number of syllables in words, sometimes rephrasing utterances in appropriate ways when not

understood. Katie's history of speech and language therapy intervention is summarised in Table 5.1.

Table 5.1
Summary of Katie's speech and language intervention history

CA	Description	Duration	Comments
~2;3	General advice on language development given in home	6 x Weekly visits	Concerns about delayed speech
~3;0	Non-directive, multi-disciplinary therapy at child development centre	Unknown	Focus on signing, Makaton and NDT therapy
~3;6	Therapy block focusing on use of Rebus symbols as well as oral-motor exercises 'to address articulation problems.'	6 x Weekly	No comments re progress; Katie thought to be more confident
~4;2	Instrumentation to provide increased feedback used in university clinic	10 x Weekly sessions	Good improvement noted in CV production. CVCV remains more challenging
Nursery	Observation and advice given to nursery staff	One visit	Increased used of gesture and pointing; increasingly sociable
Reception / year 1	Syllable clapping to improve awareness of length and timing; expand repertoire of consonants to include [p, m, b, d, n, g] in word final position	2-3 termly visits from SLT. SLT's programme carried out on daily basis by LSA in 1:1 sessions or small groups	Increased awareness of word final consonants; within word consonants beginning to emerge
Year 2	Continuation of programme from Year 1	As for Year 1	Concerns emerging re influence of speech on spelling; improved production of final consonants at single word level but limited generalisation to sentence level; increased awareness of listener's needs; intelligibility remains poor

Katie remained on the NHS caseload at the time of the study and her assessment and intervention was carried out in close collaboration with the NHS therapist responsible for her. The LSA remained involved, continuing with the speech programme given by the NHS therapist usually with a small group of children and focusing on phonological awareness skills such as rhyming and syllable clapping, listening skills and production of final consonants and consonant clusters.

1.5 Family

Katie lives with both parents and her older brother. They are a close-knit family and Katie and her brother are good friends. Katie's parents run a business and both have flexibility in

terms of the time they spend with her. Her family have been very concerned about her speech and remain eager to assist with therapy programmes in whatever way they can. English is the only language spoken in the home. There is no family history of speech and language difficulties.

1.6 Social

Katie is a sociable girl who has many friends at school. In the one-to-one situation with an adult, she was initially shy but once she gained confidence was talkative and friendly. At times her behaviour was manipulative and controlling. She seems to enjoy communicating despite her severe speech problems: she enjoys telling stories and watching herself on a video recording. She enjoys singing and dancing. In the classroom situation she contributes to discussions readily, but gives up when not understood. Katie forms bonds easily with children and adults, and has a kind and caring personality.

Katie seems to have some insights into her speech difficulties but she expects her listeners to adapt to her patterns of speech. Her speech is consistent and most people familiar with her will soon 'tune in' to her way of talking. She expects this from all listeners, and as a result is not very motivated to change.

1.7 Summary of background information

Katie is a child with a severe and complex communication disorder. She has been diagnosed with ataxic cerebral palsy, and evidences associated delays in all aspects of her motor development including speech. There were no other significant medical or social factors to report. Katie's family is a happy and supportive one.

Academically Katie was coping in the classroom but requires additional one-to-one support. Her speech and language difficulties were widespread and severe, affecting all aspects of her academic work. These include her speech production problems, delays in receptive language and literacy delays. Katie has received SLT from the age of 2;3. She requires ongoing classroom support, and speech and language therapy. Her speech remained the primary area of concern as at age 6;5 it was still very hard for unfamiliar listeners to understand her.

2. ASSESSMENT

Assessment was carried out at the start of the study when Katie was in Year 2 (CA 6;5 –6;7). The entire assessment procedure was revisited on completion of the intervention, when she was in Year 3 (CA 7;6 – 7;8) and at long-term follow-up in Year 4 (CA 8;2 - 8;3).

Assessment was grouped into four main areas: (1) standardised language assessment, (2) speech profiling carried out within the psycholinguistic framework, (3) phonological analysis, and (4) child interview and parent / teacher report. Results of the standardised assessments are presented in section 2.1, followed by a discussion of the speech profiling (2.2), speech analysis (2.3) and child interview and parent / teacher report (2.4). The re-assessments are discussed in the evaluation sections of the chapter.

2.1 Standardised language assessment

Katie's standardised test results are presented in Table 5.2.

Table 5.2
Summary of Katie's standardised speech, language and literacy assessment at CA 6;5

Assessment	Area tapped	Standard score	Centile	Age equivalent
Receptive Language				
Test for the reception of grammar (TROG, Bishop, 1989)	Receptive grammar	95	40	6;0
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive vocabulary	80	10	4;6
Receptive Subtests* of CELF-Preschool (Clinical Evaluation of Language Fundamentals – Preschool, UK Edition, Wiig et al., (2001).	Receptive language	1	1	
Expressive Language				
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive vocabulary		8	4;8
Renfrew Action Picture test* (RAPT, Renfrew, 1989)	Information Grammar			5;0 3;0
Edinburgh Articulation test** (EAT, Anthony et al., 1971)	Naming and articulation	41		3;0
Literacy Measures				
Schonell Graded Reading Test (Subtest of Aston Index, Newton and Thompson, 1982).	Reading single words			Reading Age = 6;8 years
Schonell Spelling Test (Subtest of Aston Index, Newton and Thompson, 1982).	Writing single words from dictation			Spelling Age=5;9

* administered at CA 6;0
** EAT is designed for use with children up to the age of 6;0. Katie's scores were calculated using this upper age limit although she was 6;5 at the time of the assessment. Results are discussed in more detail in the speech analysis section

Katie had widespread speech and language difficulties. She was in the low-average range in her understanding of language as evidenced by the TROG (Bishop, 1989), where she found more complex sentence structures (e.g. those involving plurals, comparatives and reversible passives) hard to understand. Her performance on the receptive tests of the Clinical Evaluation of Language Fundamentals – Preschool (Wiig, Secord.and Semel, 2001) showed significantly delayed understanding and specific difficulties with understanding more complex sentence structures and linguistic concepts. Both her expressive and receptive vocabulary scores suggested that Katie knows significantly fewer words than one might expect for a child her age.

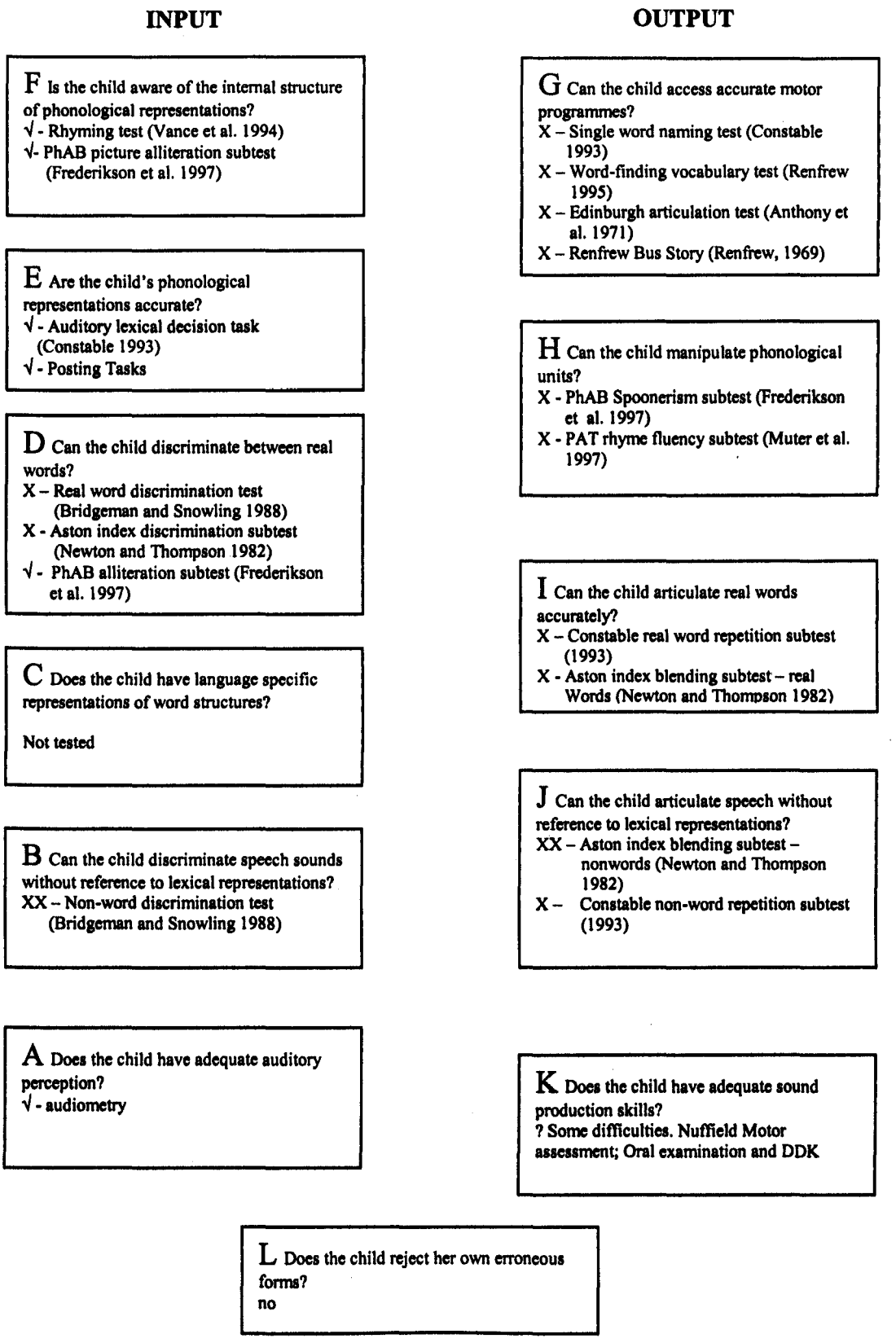
Katie was able to convey some information on the Renfrew Action Picture test (Renfrew, 1989), scoring in the low average range, but her use of grammatical structures on this same test was significantly delayed. This fits with the receptive grammatical difficulties described. Katie performed poorly on the Edinburgh Articulation Test (Anthony, Bogle, Ingram and McIsaac, 1971) with an age-equivalent score of 3;0 being obtained. In contrast, Katie performed above-age on the single word reading test (age equivalent = 6;8 at CA 6;5). Her single word reading may age-appropriate due to extra input at both home and school. Katie's speech is often unintelligible, and this made scoring for any of the speech output tasks difficult. Results in Table 5.2 represent conservative estimates of her skills. Her spelling test result was slightly below her chronological age (age equivalent = 5;9 at chronological age 6;5) but surprisingly good given the concerns that have been voiced about her literacy skills. Again, this may be due to the extra input that she has received and the fact that this is a single word task not involving meaning or context.

2.2 Speech profiling in a psycholinguistic framework

The speech processing profile from Stackhouse and Wells (1997) was used as a framework for this part of the assessment. At each level of the profile, with the exception of level C,[7] at least one assessment was carried out. In some cases these were standardised measures, and in other cases consisted of unpublished and non-standardised materials. The ticks and crosses used on the profile indicate Katie's performance in relation to other children of her chronological age: with one tick indicating age-appropriate skills, and further ticks or crosses showing the number of standard deviations above or below the mean for her age-matched peers. The completed profile is presented in Figure 5.1 with a discussion of these results following.

[7] not routinely assessed in monolingual children (Stackhouse and Wells, 1997)

Figure 5.1
Katie's speech processing profile at age 6;5 (from Stackhouse and Wells, 1997)
√ = age appropriate performance
X = 1 s.d below the expected mean for her age
XX = 2 s.d below the expected mean for her age



2.2.1 Overview of speech processing profile

Katie had weaknesses throughout her speech processing profile, on both the input and output sides. Her speech processing system was widely affected. The entire output side, from levels G to K, was affected. The input side showed some more specific difficulties, with discrimination of both real words (level D, Fig 5.1) and non-words (level B, Fig 5.1) proving problematic. Non-word discrimination was relatively harder for Katie than real-word discrimination. Bishop, Brown and Robson (1990) found that children with cerebral palsy, as a group, typically perform poorly on discrimination tasks that require them to hold unfamiliar phonological strings in memory. This is accounted for by the fact that their pervasive output problems give limited opportunity for rehearsal of such strings.

2.2.2 Strengths

Katie has built up good stores of phonological and semantic knowledge, and these aspects were her *relative* strengths. Building up such representations may have taken her longer than for normally developing children, because of difficulties in speech production and obtaining kinaesthetic feedback. Katie had some good phonological awareness skills (e.g. rhyme and alliteration identification from pictures, level F, Fig 5.1) and good input phonological representations, as evidenced by the posting tasks and auditory lexical decision test (level E, Fig. 5.1). Her strengths seemed to lie on the input side of the profile with bodies of phonological and semantic knowledge that have been built up over time.

2.2.3 Weaknesses

On the input side of the profile Katie had difficulties with discrimination tasks - with both real and non-words - and made errors when discriminating between closely related phoneme sequences (e.g. [ts] and [st] in VOST ~ VOTS) and individual segments (e.g. [s] and [t] in VOS ~ VOT).

In terms of output she had widespread weaknesses in her accessing of motor programmes, as well as her repetition of real and non-words, and her manipulation of phonological units. Non-words were, again, particularly challenging for Katie who seemed to find these harder to process and produce than real words. Her difficulties with phonological manipulation were not surprising given the fact that Katie will have had little opportunity to experiment with sound production in the way that normally developing children do. Katie's output constraints are likely to have resulted in limited feedback to the rest of the system, and created widespread problems throughout the rest of the profile. Although many of the motor difficulties may have resolved – or been adapted to – the overflow from phonetic difficulties into phonological difficulties is clearly illustrated (e.g. see Hewlett (1990) for further discussion of this overlap).

2.3 Speech analysis

PACS (Grunwell, 1985) was used to provide information on Katie's speech production. A summary of the findings is presented in Table 5.3.

Table 5.3
Summary of Katie's speech data at CA 6;5

Assessment	Comments	
Severity indices	PCC 22 % PVC 74,1 % PPC 41,9 %	
Phonetic inventory	Word initial position: [m, n, p, b, d, t, k, g, f, w, j, r, dʒ] Word medial position: [m, b, d, t, k, g, w] Word final position:	
Stimulability	All phonemes except [v, ð, ʃ, ʒ, tʃ]	
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (100%); final consonant deletion (96%); prevocalic voicing (40%); stopping of fricatives and affricates (21%); gliding (21%) Non-developmental processes: Vowel distortion (25%)	
Single word speech sample	[bæ] for BAG [wɛ] for WEB [vɪ] for FISH [gɪ'mɛ] for CHRISTMAS [bæ] for PRAM [ɛ] for EGGS [bɪ] for BEES	[æbə] for APPLE [gæ'wɪ] for GARAGE [vɛ'bɛ] for VEGETABLES [dɪ] for SINK [jɑɪ] for LIGHT [ki] for QUEEN [gæ] for CLASS
Connected speech sample	[jɪlɪtə.gɜ.ɪmɪdæ] for THE LITTLE GIRL IS MICHELLE [də.fi.lɪ.ə.bɪ] for THE THREE LITTLE PIGS [ɑɪ bɪbæ wʊ] for I'M (THE) BIG BAD WOLF [jə.tudɛ.ɑ.nɔdɪ] for THE CHILDREN ARE NAUGHTY [fɪŋgə.pʊpɛ] for FINGER PUPPET	

Katie's speech was delayed for her age with some deviant sound substitutions also noted. Syllable structure is typically open. Her speech is laboured and staccato, typical characteristics of ataxic speech[8].

Katie was asked to imitate single consonant sounds in order to assess her stimulability. She was able to produce the majority of sounds, although some of the fricatives proved difficult for her. In particular voiced fricatives such as [v], [ð] and [z] required some encouragement as she tended to de-voice them. Fricatives and affricates were

[8] Milloy and Morgan-Barry (1990) and Kent, Kent, Duffy, Thomas, Weismer and Stuntebeck (2000) provide detailed descriptions of typical ataxic speech.

also hard for her with [ʃ] and [ʒ] both realised as [s]; and [tʃ] and [dʒ] produced as [t] and [d] respectively.

In terms of phoneme realisations, Katie had a good – albeit incomplete – repertoire of phonemes in the SIWI position, where she is able to indicate contrasts between plosives ([b, t, d, k, g]), nasals ([m]) and approximants ([w, j]). In SIWW position she was able to mark some of these contrasts although with less regularity ([b, d, g, m]). In the SFWW and SFWF positions, Katie realised few consonants: the PACS analysis sheet for this section shows that for the vast majority of instances zero realisations were made (e.g. [bæ] for BAG; [wɛ] for WEB; [vɪ] for FISH). In the case of SFWW position 21 of 24 realisations were zero (87.5%, e.g. [gɪ'mɛ] for CHRISTMAS) and for SFWF position 70 of 75 realisations were zero (93.3%). The remaining realisations were either correct (12.5% (SFWW) and 5.3% (SFWF)) or incorrect phonemic substitutions (1.3% (SFWF)). Katie was not able to produce any of the consonant clusters in an adult-like way. In SIWI position, she attempted these, but reduced them in the manner of a much younger child (e.g. [bæ] for PRAM). In all other word positions zero realisations occurred. At a phonotactic level, it was noted that Katie typically had open syllable structure favouring V and CV syllable structure for monosyllables (e.g., [ɛ] for EGGS, [wɛ] for WEB), and VCV and CVCV structure for disyllables (e.g. [æbə] for APPLE; [gæ'wɪ] for GARAGE). A phonological process analysis revealed a range of processes which included final consonant deletion (e.g. [bɪ] for BEES), cluster reduction ([bæ] for PRAM), weak syllable deletion (e.g. [vɛ'bɛ] for VEGETABLES), stopping ([dɪ] for SINK), gliding (e.g. [jɑɪ] for LIGHT) and voicing (e.g. [vɪ] for FISH). Final consonant deletion is consistently carried out on all consonants (95.3%) in this position. Syllable initial cluster reduction is also consistently carried out (100%). The other processes are less pervasive: weak syllable deletion (15%), stopping (21%), gliding of liquids (21%), WI voicing (45%) and WW voicing (37.5%), but act together to reduce Katie's speech intelligibility.

Based on the results from the Edinburgh Articulation Test (Anthony et al. 1971) and using the PACS chart of normal phonological development, Katie was judged to have speech approximately equivalent to a normally developing 3;0 year old child. However, her speech evidenced more than a simple delay and included some deviant substitutions characteristic of phonological disorder such as vowel distortions. Since the vowel distortions were the only example of a deviant process and are likely due to her motor difficulties, she was considered to be a child with delayed rather than deviant speech (Dodd and McCormack, 1995). Qualitative classification of single words in this assessment revealed that Katie had acquired

some of the adult forms: mostly plosives and nasals in word initial positions (e.g. [d] in DESK; [m] in MILK) but also some stops within words (e.g. [p] in SLEEPING). Her errors were classified mostly as 'very immature' (e.g. stopping [s] -> [d] in SCISSORS; reduction of [kw] cluster in QUEEN to [k].

The severity of Katie's speech difficulties was estimated at two points before the intervention: at the start of the macro-assessment, and at the micro-assessment, carried out ~6 weeks later. PCC (percentage of consonants correct), PVC (percentage of vowels correct) and PPC (percentage phonemes correct) were used[9]. The difference between these scores at the two pre-intervention points was not a significant one indicating a stable pre-intervention baseline.

2.4 Child interview and parent / teacher report

This part of the assessment aimed to gain impressions of Katie's speech from Katie herself, her teachers, and parents. This information was used to assist with intervention planning and to evaluate the outcome of the intervention programme.

2.4.1 Child interview

Katie was interviewed in a semi-structured way with the aim of discovering more about the following areas: (1) her experience of speech and language therapy, (2) her perception and awareness of her own speech, (3) her perceptions of communication more generally, and (4) her attitudes to literacy. This interview procedure was carried out at two points in the study, following the completion of phase I, when a rapport was established, and at the completion of the intervention study at long-term follow-up. A summary of the first interview is presented in Table 5.4

[9] following guidelines from Dodd (1995) and Shriberg et al. (1997c) and discussed in greater detail in Chapter 9 on intelligibility.

Table 5.4
Summary of findings from Katie's first semi-structured interview following Phase I of intervention

Area of questioning	Main findings	Examples of Katie's responses
Katie's experience of SLT • Present (comments on phase I)	Enjoyed therapy despite initial reservations	"when I met you I said to myself I don't really want to go to her. And now I really want to go to you."
	Particularly enjoys games, stickers, toys, and being video/ audio-taped	"I don't want to go… back to class"
	Does not enjoy hard work, e.g. writing things and practising words	"hard work… I don't really like hard work"
	Therapy helps children to improve their speech through hard work	(do you know how their speech gets better?) Because it all hard work
• Past	Remembers previous therapy and therapists	"drawing, doing painting"
Katie's perception and awareness of own speech	Speech has improved a lot as she has grown older	"at first… no. And then, got better because I'm a big girl."
	Talking is fun and easy when she talks to certain people (e.g. her mom, her teacher) but is hard and makes her frustrated when people don't understand	"If my mommy were here I can talk to her then. (You like talking to her) "yeah" (And who don't you like talking to?) "other people, horrid people… sometimes I go away. I say I don't want to talk to you"
	A lot of the time people don't understand her and she feels frustrated	"it happens to me over and over again" "(I feel) a bit grumpy…. because I might go away, and other people say come back. And I won't come back because they won't listen to me"
	Wishes that she had more control of volume of voice so that she could whisper to her friends in class	(And would you like to do more talking in your classroom?) "yeah but I talk quietly… more quiet…don't let anybody else hear"
Katie's perceptions of communication more generally	Talking and listening are generally positive. She likes listening to her teacher, therapists and mother	"talking is nice; listening is nice"
	When communication breaks down you should just walk away	"I just walk away"
	Most people in England talk the same language but people in other countries talk different languages	"Some people in different countries talk a different language"
Katie's attitudes to literacy	Reading and writing can be fun if she is doing something easy at home but is harder and less enjoyable at school	"I don't like reading books. I like reading my own books but not the school's books because its hard work"
	Did not know why reading and writing are important for children to learn.	"(I like writing) a bit but don't like writing lots of words."

It can be seen that Katie enjoys therapy, but finds many activities in therapy and at school hard. She has had both positive and negative experiences of communication, and has some awareness of her difficulties and strategies for coping with these. The full transcripts of the

interviews are presented in Appendix 3, with a summary of the second interview presented in the evaluation section for comparison.

2.4.2 Teacher report

Katie's class teacher and LSA jointly completed Bishop's (1998a) Children's Communication Checklist (CCC). The results of the checklist are presented in Table 5.5.

Table 5.5
Summary of the Children's Communication Checklist (Bishop, 1998) and Katie's performance on subscales

CCC subscale	Example of behaviours in each subscale	Katie's score	Comments*
A. Speech output: intelligibility and fluency	Intelligibility; use of immature speech sounds; rate and fluency	26	Scores of 27 or below require further investigation; Katie's speech is her greatest area of difficulty
B. Syntax	Grammatical errors, phrase length	32	Acceptable: Scores below 29 require further investigation
C. Inappropriate initiation	Ability to talk appropriately to different people; whether amount and nature of communication is appropriate for the situation	27	Acceptable: Katie's composite score for the Pragmatic subscales C-G = 146. Scores below 132 are considered indicative of pragmatic impairment.
D. Coherence	Ability to talk logically; make explicit information when needed	29	
E. Stereotyped conversation	Use of favoured phrases and topics; over-precise manner	27	
F. Use of conversational context	Understanding conversational rules; social appropriacy	29	
G. Conversational Rapport	Appropriacy of initiation and response to initiation of conversation; understanding and use of facial expression, gesture and eye-contact	34	
H. Social relationships	Friendships; interactions with children and adults	33	Acceptable: Scores of 24 or less require further investigation
I. Interests	Having very focused interests; prefers to do things alone or with others; interests in factual information	33	Acceptable: Scores of 28 or less require further investigation

* based on clinical guidelines from http://epwww.psych.ox.ac.uk/oscci/dbhtml/CCC/cccinstruct.htm

Katie's pragmatic skills were found to be good and her syntactic skills to be at the lower end of the acceptable range. It was only on the speech scale in which Katie fared poorly: Bishop suggests for clinical purposes that children scoring less than 27 on the speech scale should be

followed up with further investigations. Katie's score fell within this range, at 26. Many of the items on the pragmatic scales will necessarily involve speech production, but Katie's communication was sufficiently skilled for her speech problems to be overlooked.

2.4.3 Parent report

Katie's parents remain concerned about her speech. They acknowledge that her speech and language have improved greatly, and attribute this to the large amount of speech and language therapy she has had together with extra input in the classroom. They are positive about SLT in general and eager to accept any additional sessions offered, and assist in any way they can. However, Katie's mother reports that Katie can be manipulative and is reluctant to do speech therapy activities at home, quickly becoming impatient and annoyed. Katie's family have a very good understanding of her condition and realistic expectations in that she will most probably never achieve 'normal' speech. However, they would like to see her intelligibility maximised, and to see her achieving academic success.

2.5 Further investigations

The assessments combined to reveal a clear picture of Katie's strengths and weaknesses in speech, language, literacy and communication. However, questions were raised about Katie's speech processing skills. These questions are discussed below and were investigated using tasks designed specifically for the purpose and based on psycholinguistic principles.

1. *What is the nature and extent of Katie's 'pure' motor problems (i.e. level K, fig. 5.1)?* It was initially assumed that because Katie has cerebral palsy, a motor condition, she would experience difficulties with level K, which asks: Does the child have adequate sound production skills? If there were difficulties at this level then treatment should focus here (e.g. using PROMPT therapy (Hayden and Square, 1994) or early stages of the Nuffield Dyspraxia Programme (NDP) (Connery, 1992). If there were no specific difficulties at this level, then oral-motor work would have dubious benefits and would not be appropriate (Forrest, 2002).

   Initial observations had suggested that Katie indeed had difficulties at Level K: Lip closure seemed possible but effortful for Katie and she was frequently observed to stabilise her tongue by resting it on the bottom of her mouth. However, a more considered motor evaluation, using the NDP assessment revealed that Katie, was infact stimulable for all sounds, was able to make co-ordinated moves with her articulators from sound to sound and had the basic motor skills necessary for functional speech (e.g. could imitate jaw, lip and tongue movements in a sustained and accurate way). Her motor problems unquestionably affected her eyes, her whole body posture and to a lesser

extent her respiration for speech. However, it has been noted by Forrest (2002) that there is a huge range of variability and adaptation that allows a wide range of individuals to articulate clearly. There was little that could be addressed in a programme of intervention targeted at level K. Psycholinguistic approaches suggest that a child's diagnostic label is not sufficient to plan intervention, and this was well demonstrated in Katie's case.

2. *Is there a difference in Katie's performance when a different procedure for discrimination is used?* Bishop et al. (1990) hypothesised that children with cerebral palsy have discrimination difficulties because their memory for unfamiliar phonological strings is weak due to limited opportunities for practice with their own speech. Comparing auditory tasks with different memory loads would support or refute Bishop's hypothesis. Katie's auditory discrimination was tested initially using a same/different paradigm. If Katie faced similar problems with a different task then one may suspect that memory is not the critical factor, although limited verbal rehearsal could be an implicating factor. Locke's (1980a,b) auditory lexical decision task was followed in a series of exercises specifically designed for Katie (see appendix 2a). This task involves presenting the child with a picture and asking them to respond with 'yes' or 'no' to questions concerning the name of the object (e.g. a picture of a LEG was shown; Katie was asked if it was a [jɛg]). The speech processing system was tapped on two levels in this task: First, Katie was required to discriminate between subtle sound differences between the target and distracters. Second, and presuming she was able to discern the auditory differences, the accuracy of her phonological representations was tapped. Katie was thought to have adequate phonological representations (level E, fig. 5.1) and using this procedure is an alternative way of tapping her auditory discrimination abilities.

   Katie performed better with the Locke procedure, obtaining 90% accuracy but still evidencing some difficulties in discriminating between [b] and [v]; [v] and [ð], and [f] and [θ] in single words. Bishop's hypothesis was supported in that Katie coped better with discrimination tasks where memory load was reduced, but it remains likely that her limited opportunities for accurate verbal rehearsal may have affected her processing skills. It is also important to note that Bishop et al.'s theory was particularly concerned with children's memory for *unfamiliar* phonological strings, and these by their very nature cannot be tested using the Locke procedure.

3. *Which sounds are difficult for Katie to discriminate, and how are these input errors related to her speech output?* Initial testing showed that Katie found it harder to

discriminate between non-words than real words. Her scores on standardised tests of discrimination (e.g. the Aston Index sound discrimination subtest, Newton and Thompson, 1982) were below the norm for her age. Further discrimination testing was carried out to determine which individual sounds or sound groups were affected. The Wepman (1958) Auditory Discrimination Test revealed that her discrimination of words which have segments that differ in their place of articulation (e.g. PET ~ PECK) is below the norm for her age. The greatest number of errors (n=5) were noted when WF segments were contrasted, also evidenced by her poor performance on the Bridgeman and Snowling (1988) tasks. Other errors arose with vowels and WI consonants. Her difficulties with vowel discrimination could be partly due to accent interference since the therapist's accent was different to Katie's. In the WF group, all contrasts were problematic.

A task was designed for Katie based on her own speech production errors, and in addition tapping other contrasts not yet tested. She made 4 errors: 3 on WF items (1 involving [b] ~ [p] contrast, confusing the voicing contrast in ROPE and ROBE; two with CVC ~ CV (e.g. BEES/BEE) and one with a word-initial [j] ~ [l] contrast (e.g. [jɛg] ~ [lɛg]). Table 5.6. presents a summary of Katie's results from the discrimination tests carried out.

Table 5.6
Katie's auditory discrimination skills: summary of errors from all discrimination tests

Contrast	Word Initial	Medial	Word Final
CV ~ CVC	-	-	2 errors: BEE ~ BEES [jɛ] ~ YES
[s] ~ [t]	nil	nil	8 errors, e.g. GUESS ~ GET
[b] ~ [g]	nil	nil	1 error: TUB ~ TUG
[b] ~ [p]	nil	nil	1 error: ROPE ~ ROBE
[k] ~ [p]	nil	nil	1 error: SHAKE ~ SHAPE
[t] ~ [p]	1 error: TIN ~ PIN	nil	nil
[t] ~ [k]	nil	nil	1 error: PAT ~ PACK
[ð] ~ [v]	nil	nil	1 error: CLOVE ~ CLOTHE
[m] ~ [n]	1 error: MOON / NOON	nil	1 error: DIM ~ DIN
[ʊ] v. [ɒ]	nil	1 error: bum / bomb	nil
[j] ~ [l]	1 error: [jɛg] ~ LEG	nil	nil
[st] ~ [ts]	-	-	8 errors, e.g. [kest] v. [kets]
[eʊ] ~ [ɔ]	nil	1 error: SHOAL / SHAWL	-
[ae] v. [ɛ]	nil	1 error: PAT /PET	-

The assessments aimed to cover all possible contrasts, focusing mainly on singleton consonant segments. Katie had most errors in WF position, and these covered a range of differences, e.g. some voicing confusion, as well as place and manner of articulation. Previous research (e.g. de Montfort Supple, 1983) has suggested that there is no direct relationship between children's auditory discrimination abilities and their surface speech

error patterns but this has long been a controversial issue (Evershed-Martin, 1991; Bishop et al., 1999a). It was noted that the most difficult word position for Katie to discern differences was word-final contrasts, and that in her speech she makes no contrasts here. However, when considering a phoneme such as [s] that Katie did not have in her inventory, it was seen that no errors were made in discriminating between [s] and other phonemes. Thus, while there were some clear links between input and output, there were other aspects of asymmetry between the two areas.

4. *How does Katie's spelling relate to her input and output problems? Is she able to represent phonemes that she is unable to produce or discriminate? (e.g. [s], all clusters, WF phonemes).* According to Bishop et al. (1990), a child like Katie with a diagnosis of cerebral palsy, should have no specific difficulty in writing and decoding sounds she cannot produce. However, Stackhouse and Wells (1997, 2001) and Bishop and Adams (1990) suggest that if a child's speech problems are the result of more than motor output constraints, then s/he may be at risk for literacy difficulties.

   Standardised spelling measures were used as a starting point for qualitative examination, followed by a high-frequency word spelling test (Griffiths, 2002). Katie used <s> appropriately in her spelling although she did not have this sound in her phonetic inventory. She found it very hard to spell words with clusters and typically wrote the first sound of the cluster only, e.g. <sem> for SLIDE. The only cluster she managed to write was <fr> in FROM. She cannot say [fr] but would typically say [f] or [fw]. Katie *did* however show some irregular, bizarre spelling patterns which suggest confusion over final consonants and final consonant clusters, e.g. SPOON = <sut>. Katie typically represented the first sound-letter correspondence accurately but the remainder of the spelling showed little evidence of such knowledge. She favoured <n> and <m> as graphemes in the final position, e.g. writing BED as <bin>, DOT as <don>, SLIDE as <sem>, SAUCE as <som> and PURSE as <pem>. [m] is a phoneme well established in her inventory – although not actually used in the WF position - and it is thus logical that this was her favoured choice for ending. [n] however, was less well established and used inconsistently in her speech.

5. *How do real word and non-word spelling compare? And how does real and non-word discrimination compare?* Previous research has shown that children with severe speech output difficulties such as dysarthria or anarthria, have no specific difficulty with non-word spelling, although this is usually expected to prove harder than the spelling of real words (Bishop, 1989). Katie found discrimination of non-words harder than for real words although she did experience some problems with the latter. Like the real word

spelling task, Katie found the non-word task harder, scoring 49% for the non-words as opposed to 70% for the real words, using a phoneme-by-phoneme scoring system. The difference between these scores is a significant one ($t(104) = -2.205$, $p < .05$).

6. *Do Katie's phonological representations differ from phoneme to phoneme?* Previous tests suggested that Katie's input phonological representations were a relative strength: Katie performed well with picture rhyming, alliteration and the Locke (1980) auditory task. Specially devised 'posting tasks' were carried out to provide information about Katie's phonological representations and the sound contrasts involved. The format of these tasks was to introduce the child to two post-boxes, each one used for posting of a different sound, e.g. pictures of [b] words (e.g. BAT, BEE) into a green box, and pictures of [s] words (e.g. SAT, SEE) into the red box. The child picks up picture cards and puts them into the relevant box. The therapist does not name the items for the child. Some children will perform the task silently and other rely on their own verbal rehearsal to make the decision. Katie was largely silent in her completion of the task although she did name some of the items initially. The results of the posting task are presented in Table 5.7.

Table 5.7
Summary of Katie's performance on silent 'posting' tasks used to assess her phonological representations

Task	Phonemes Contrasted	Word position	Example	Scores % correct
1	[m] ~ [f]	WI	MAN ~ FAN	100%
2	[p] ~ [b]	WI	PEA ~ BEE	75%
3	CV ~ CVC	WF	BEE ~ BEAD	80%
4	[s] ~ [n]	WF	RAIN ~ RACE	100%
5	[p] ~ [t]	WF	CAP ~ CAT	87.5%

In general Katie performed well on these tasks: most challenging for her was the voicing contrast of [p] and [b] where she favoured the [b] box and scored correctly on only 75% of items. Katie did have voicing errors in her speech and typically voiced plosives pre-vocalically. It was concluded that in general Katie had accurate representations of words.

7. *Is spelling more challenging when the word is not spoken and Katie must access the lexical item using visual input only? What does this tell us about Katie's speech processing system*? There are several possible processing routes that might be used in carrying out a spelling task. Spelling to dictation involves the entire auditory input route with the child either recognising already learnt forms and producing these as output, or listening to unfamiliar items and carrying out a phoneme-grapheme conversion to

produce the output, i.e. a bottom-up process. Alternatively, a dictation spelling task might include picture presentation so that the child does not only need to rely on auditory information in accessing the correct form but also is supplied with some visual, semantic information, i.e. a combination of bottom-up and top-down processing can be used. The final approach to the task would involve top-down processing only with the child given a picture of the target item but not accompanying auditory input.
Top-down and bottom-up spelling tasks were compared in this section of the assessment with the aim of revealing more about the integrity of Katie's higher level, phonological representations. The Schonell Spelling Test (Newton and Thompson, 1982) was carried out for a second time, two weeks after the original administration, in a modified format using pictures only as stimuli. The therapist did not name the items for Katie. Again, Katie's written productions were scored phoneme-by-phoneme, but no significant difference was found between the two tasks.

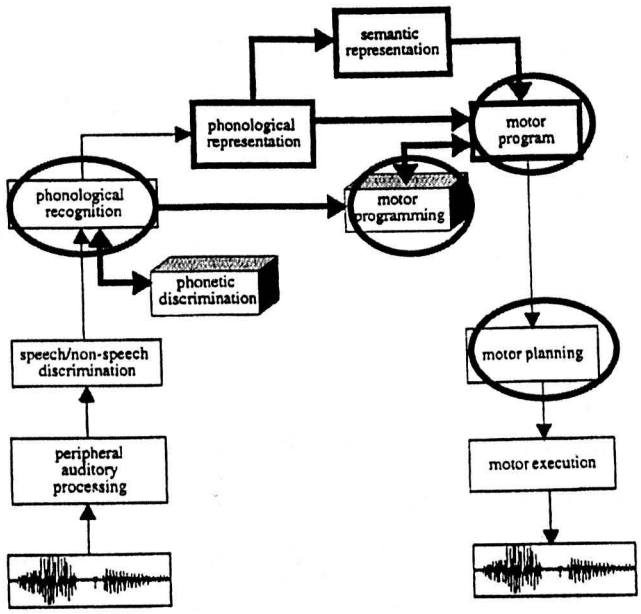
3. MACRO INTERVENTION PLANNING

Intervention planning focused on three main areas with each one giving direction to the work carried out. These included (1) a psycholinguistic rationale that aimed to answer the question: "What aspects of her speech processing system should be worked on?" (2) a phonological rationale which aimed to answer the question: "Which aspects of the sound system should be targeted?" and (3) a more general child-centred rationale which aimed to answer the question: "What other aspects important to the child should be taken into account? Each of these is discussed in the sections that follow.

3.1 Psycholinguistic rationale – What aspects of the speech processing profile should be worked on?

Katie's main deficits were mapped from the speech processing profile onto the Stackhouse and Wells (1997) speech processing model. Katie's main areas of deficit are presented in Figure 5.2.

Figure 5.2
Stackhouse and Wells' (1997) speech processing model indicating Katie's main areas of difficulty



Katie has widespread difficulties throughout her speech processing system with both input and output affected. There was a range of possible weaknesses that might be addressed: phonological recognition, stored motor-programs and her online motor programming skills and motor planning. Her strengths lay in her stored knowledge of words: she had good phonological and semantic representations. As for all the children, Katie's intervention needed to bring about positive change in the areas of weakness, using the stronger areas to gently 'scaffold' change (Rees, 2001b; Corrin, 2001a).

The first question that arose was: Should one aim to address input, output or a combination of these? Williams and McReynolds (1975) stated that production training affects both perception and production, while discrimination training affects perception only with no accompanying improvement in production ability. However, in their study the training contrasted sounds that did not reflect the child's substitution errors. It has also been hypothesised that severe speech difficulties are the *cause* of auditory discrimination difficulties (Bishop et al., 1999a). If intervention focuses on speech output difficulties, then one might expect to see corresponding improvement in discrimination as speech improves.

Focusing on Katie's range of output difficulties, which level of processing should intervention target? Katie has been diagnosed with ataxic dysarthria and clearly had some muscular weakness (level K of the speech processing profile, fig.5.1). However, detailed assessment at this level revealed that Katie's sound production skills were adequate for speech: she was able to produce all speech sounds in isolation and had no specific difficulties

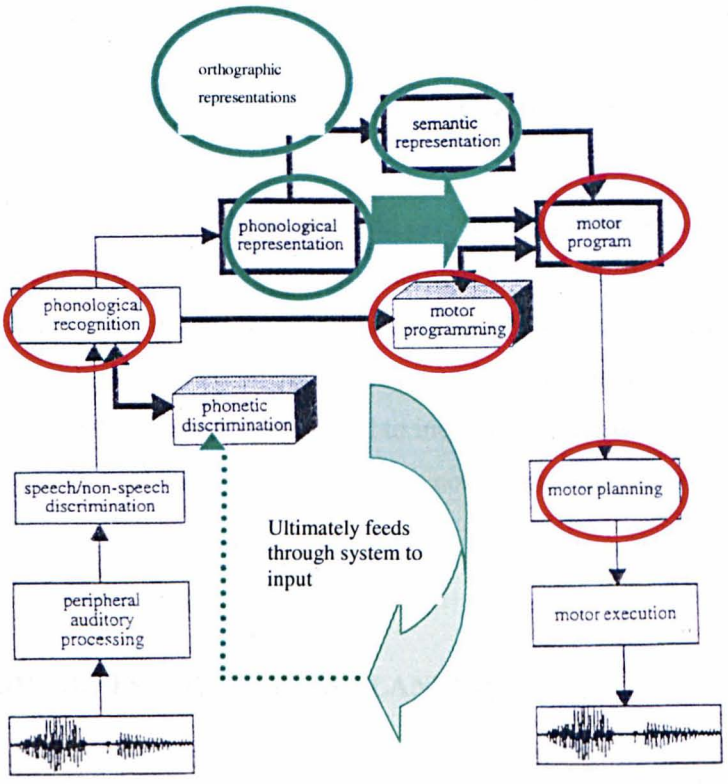
in terms of the strength, range of movement or co-ordination exhibited during speech (and non-speech tasks). Katie's difficulties begin at the single word level of speech, and her difficulties are concentrated towards the higher reaches (level G, fig.5.1: Can the child access accurate motor programs?) of the output side of the profile. It was hypothesised that Katie had the incorrect phonotactic 'frame' for words in her online motor programmer, and a set of stored motor programmes which also reflect the incorrect, immature, simplified frame, typically with open syllable structure such as CVCV or CV. The intervention aimed to use Katie's good phonological and semantic representations as well as her orthographic knowledge to highlight the difference between her simplified productions and the correct adult targets. Intervention involved activities that gave Katie explicit opportunities to use her strengths. These activities included:

- reading - drawing on her orthographic decoding skills.
- meaningful minimal pair work (following Weiner, 1981) - drawing on her semantic knowledge.
- tasks involving picture naming which give Katie the opportunity to access her own (accurate) phonological representation and relate it to the (inaccurate) stored motor programme, giving her the opportunity to revise the latter.

Figure 5.2 shows that Katie also experienced difficulties with motor planning. Motor planning is considered to involve phonetic aspects of speech production, moving beyond the abstract linguistic knowledge of the previous stage. It is at this stage that co-articulation comes into play. While motor programming is conceived as being a single word phase, motor planning involves the connection of words into strings of speech. Once motor programmes have been revised, motor planning may need to be more specifically addressed so that Katie is able to use the new words with their coda segments in connected speech.

The intervention strategy is presented graphically in Figure 5.3. Katie's relative strengths are circled in green, and it is these three areas that will be used in the intervention programme to facilitate change in the output areas of weakness (circled in red): motor programming, the store of motor programmes and motor planning. It is hypothesised that the effects of improvement on the output side will flow through the system to bring about improved discrimination on the input side.

Figure 5.3
Graphical representation of Katie's intervention strategy: Katie's relative strengths are circled in green, and it is these three areas that will be used in the intervention programme to facilitate change in the output areas of weakness (circled in red)



3.2. Phonological rationale - Which aspects of the sound system should be targeted?

'Whole word phonology' is a widely accepted way of conceptualising children's early phonological patterns (e.g. Ferguson and Farwell, 1975; Macken, 1979; Velleman and Vihman, 2002). In recent years this theory has been applied to clinical settings. Velleman (2002) describes 'phonotactic therapy' as an intervention for unintelligible children which focuses on building up accurate phonotactic frames, before focusing on 'filling up' the phoneme slots within the frames with accurate phonetic realisations. Along similar lines, Stackhouse and Wells' (1997) psycholinguistic framework includes a developmental model of speech and literacy in which the 'whole word' phase is one of the earliest phases of speech development, preceding the 'systematic simplification' phase in which systemic substitutions dominate (1997, p.197; 2001, p.410). Katie's speech output showed characteristics of the whole word phase: she relied heavily on CV syllable structure and would benefit from expanding her potential syllable structures to include CVC, thereby enabling her to make a much greater range of lexical contrasts. Although she had some patterns (e.g. stopping) characteristic of the systemic simplification phase, it was developmentally appropriate to focus intervention on the earlier whole word phase.

Katie's intervention aimed to alter her habitual open syllable structure, and get her producing *any* phoneme in the SFWF position. Katie's intervention programme concentrated on a range of phonemes typically occurring in SFWF position and aimed to increase her awareness of the fact that consonants are needed here to make important meaning contrasts.

3.3. Child-centred rationale – What other aspects important to the child should be taken into account?

Results from the child interview, and parent / teacher report showed that Katie is a good communicator but has low speech intelligibility. Because her speech is very consistent, those familiar with her are able to attune themselves to her speech. Katie becomes impatient with people who do not understand her, and often feels that it is their fault for not listening. A successful intervention will need to increase her motivation and make her aware that by changing her speech she may be able to communicate more readily with a wider range of people.

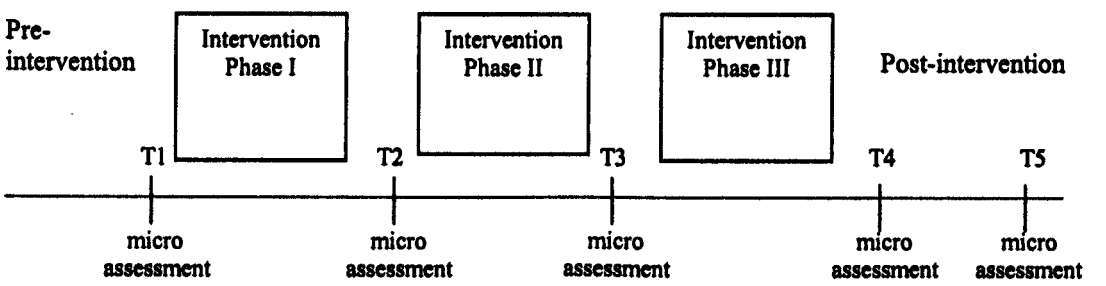
4. MICRO INTERVENTION PLANNING

Katie received a total of 30 hours of intervention. This was subdivided into 3 phases, as follows with each phase involving a different treatment:

- Phase I: therapy on a specific set of single words
- Phase II: therapy on a wider range of single words
- Phase III: therapy on connected speech

Re-assessment was carried out following each intervention phase in order to evaluate the effects of therapy over the course of the programme. The research design is shown in Figure 5.4

Figure 5.4.
The design of Katie's intervention programme



Phase I aimed to increase Katie's awareness of final consonants and encourage her to produce CVC stimuli items from a small set of targeted words. Phase II aimed to encourage generalisation of CVC production to a broader range of single words. Intervention in this phase was guided by broad themes (e.g. animals, numbers, household objects). Sessions gave Katie the opportunity to produce CVC words in a wider and more natural range of contexts. Written forms of the words were used to remind Katie about her final consonant production in some instances, together with silent posting tasks and 'meaningful minimal pair' activities (following Weiner, 1981). Phase III aimed to facilitate production of CVC targeted words from Phase I, putting these in sentences graded in terms of phonetic difficulty. Intervention in this phase revolved around literacy as Katie was required to read the stimuli sentences written below illustrations of the items, as well as matching sentences with appropriate pictures.

Three lists (lists A, B and C) of stimuli were devised, and are shown in Table 5.8. Lists A and B were designated as treatment lists. In phase I, lists A and B were treated in different ways. Words in list A were used in speech production tasks that included explicit consideration of spelling. List B was used in speech production tasks that did not involve written forms. In order to avoid confusion between the two types of intervention, odd-numbered sessions addressed list A stimuli with the speech-spelling treatment, and even-numbered sessions worked on stimuli from list B. In subsequent intervention phases, list A and B were not differentiated. List C was randomly selected as a non-treatment control list.

Table 5.8
Katie's matched stimuli lists

Item No.	LIST A TREATMENT: SPEECH & SPELLING	LIST B TREATMENT: SPEECH ONLY	GROUP C UNTREATED
1	NOTE	BOAT	GOAT
2	PLANE	RAIN	TRAIN
3	HEART	CART	PART
4	NAIL	WHALE	HAIL
5	CAGE	AGE	PAGE
6	SLIDE	HIDE	LIED
7	WHEEL	SEAL	KNEEL
8	RAKE	CAKE	STEAK
9	STORK	FORK	WALK
10	LEAF	HALF	HOOF
11	SAUCE	FLEECE	PURSE
12	ICE	SLICE	DICE
13	SOAP	ROPE	GRAPE
14	PIPE	PEEP	SHEEP
15	BARN	DAWN	LINE
16	ROAD	SWORD	TOAD

The selection criteria for stimuli are listed below:

1. Each list consisted of 16 monosyllabic words.
2. CVC words were favoured, although in some instances CCVC words had to be used since all requirements for matched items could not be met. Where CCVC words were selected they were matched across the three lists.
3. Items were matched in terms of rime across the three lists. Where rime could not be matched, items were matched by coda segment.
4. Items were matched across the lists for age of acquisition and spoken language frequency using the MRC psycholinguistic database (http://www.psy.uwa.edu.au/mrcdatabase).
5. Irregular orthographic forms were weighted in terms of their complexity and balanced across the lists
6. Items were chosen to highlight the functional importance of final consonants and, thus were words that, with the final consonant removed, made another real-word minimal pair (e.g. BOAT / BOW). The vowel nucleus was therefore either a long vowel or a dipthong.

Details of stimuli for the single word phases of intervention have been provided. Stimuli for the connected speech phase of treatment (phase III) were also chosen according to phonological criteria. A graded hierarchy of sentences was devised around each of the target single words shown in Table 5.8, moving from a facilitatory context to a more demanding one. For example, in the case of the target word ROPE the facilitatory sentence used as a starting point was: THIS ROPE PULLED THE CAR, where the onset consonant of the following word PULLED is the same as the coda consonant of the target word ROPE. Given her phonological abilities at the beginning of the study, it was thought that Katie would be able to produce the initial [p] in PULLED even if she omitted the final [p] in ROPE. In order to achieve an acceptable realisation of this final consonant, she would merely have to lengthen the closure phase for the (single) consonant articulation. At the next level, Katie would be required to produce a sentence such as THERE'S ROPE ON THE ROAD with the target ROPE being followed by a vowel. Most challenging was a sentence such as THIS ROPE GOT FRAYED where she was required to change her place of articulation (and voicing) between the final [p] in ROPE and the following consonant [g]. However, it was noted that hetero-organic adjacent consonants such as those selected for the most challenging sentences are not necessarily the articulatory challenge one might suppose, since assimilation occurs across word boundaries. Assimilation refers to the way in which neighbouring phonemes affect each other in connected speech. Thus, for example, in a sentence such as: THIS NOTE COST £2 it would be inappropriate to encourage Katie to produce the final [t] in NOTE since this phoneme would typically be absent in normal English speech. Nevertheless, it was thought

to be interesting to observe the assimilation occurring in Katie's connected speech, and the most challenging sentences of the hierarchy were split into two subgroups with the former being instances where no assimilation was expected, and thus considered to be very challenging items for Katie to produce with subsequent phonemes having a different place of articulation. The latter group were those sentences where assimilation was expected and these were monitored in the pre and post-intervention baselines, but not directly worked on. These stimuli are shown in Appendix 4.

At each of the micro evaluation points (T1-T5) shown in Figure 5.4 a set of tasks was carried out to evaluate Katie's progress. These tasks constituted the micro assessment. For each of the items in lists A, B and C (Table 5.8), Katie was required to:

(a) name pictures of each of the target single words
(b) produce the target single word in a short phrase ('the TARGET in the picture')
(c) write the target single words to dictation
(d) discriminate between the target single word and a closely related item that differed only in terms of the final segment in spoken production (e.g. are these word pairs the same or different: ROPE and ROW? ROPE and ROTE?).
(e) discriminate between closely related non-words matched to the target stimuli, that differed only in terms of the final segment in spoken production (e.g. are these word pairs the same or different: [pəʊt] and [pəʊd]?

This research aimed to determine whether Katie could make significant progress in speech production when given intensive phonological therapy structured within a framework of psycholinguistic assessment. More specific questions were formulated regarding her progress in a range of areas including speech at a single word and connected level, spelling, and auditory discrimination. Table 5.9 summarises these questions.

Table 5.9
Questions about Katie's intervention

Area	Question
Single Word Speech	- Will phase I intervention result in an increased count of final consonants in the treated word lists A and B? - After intervention phases I and II, will Katie's final consonant count (FCC) for list C (untreated controls) also improve beyond chance level?
Connected Speech	- Will Katie's FCC for target words used in a short carrier phrase improve in phase I and II, as Katie's speech processing system is modified? - Phase III specifically addresses connected speech. Will it result in significantly increased FCC's in connected speech productions in the treatment lists A and B? - After intervention phase III, will Katie's FCC for list C items (untreated controls) in connected speech also improve beyond chance level?
Spelling	- Will exposure to orthographic forms promote faster learning, i.e. after phase I will list A (speech and spelling treatment) show more improvement than list B (speech only treatment)? - Will Katie's ability to indicate final segments in spelling improve following three phases of intervention for speech?
Auditory discrimination	- Will improved speech production result in improved ability to discriminate between treatment stimuli and phonetically similar words? - Will increased experience with production of final consonants result in improved discrimination of non-words that differ in terms of final segments?

5. INTERVENTION

5.1 Intervention overview

Intervention consisted of three consecutive phases with each phase involving different therapy. Each phase consisted of 10 sessions of approximately one-hour duration. There was thus a total of 30 hours of intervention. The sessions were carried out on a twice-weekly basis in Katie's school in a quiet room with only her and the therapist present. Katie was 6;8 at the start of the intervention itself and was 7;5 on completion of the final phase of intervention.

5.2 Intervention report: Phase I

In the first phase of intervention, items from list A and list B (Table 5.8) were treated in different ways. Items from list C were not treated. In order to minimise confusion between the two different treatment types, the first session of the week would involve speech and spelling work with selected items from list A. The second session of the week would involve the matched items from list B, addressing these using the same speech activities but incorporating no written forms. The amount of input for each group was balanced as closely as possible so that if four items from list A were addressed, then the matched four items from list B were addressed later in that week. Similarly, the overall length of sessions were kept as constant as possible (~1 hour). Both sessions relied heavily on 'meaningful minimal contrast therapy' (Weiner, 1981). Table 5.10 presents a summary of the sessions carried out

in the first phase of intervention. The comments column in Table 5.10 contains excerpts from the case notes following each session and gives some indication of the type of activities carried out each week, as well as qualitative comments about Katie's progress.

Table 5.10
Summary of Katie's intervention sessions: Phase I

Session No.	Activities	targets	Comments
1	SPEECH AND SPELLING Katie was introduced to items for sale in an imaginary shop: the 5 target words as well as their contrasting minimal pairs. Taking turns, we wrote lists of items to buy from the shop and then requested these from the shopkeeper.	List A words: NOTE SAUCE PIPE CAGE LEAF	Katie is aware of the differences between the words (e.g. NO and NOTE). She tended to over-emphasise the coda segments, frequently making the words disyllabic (e.g. leaf = [lɪ'fə]. I encouraged her to make the final sound softly as if kissing one of the toy animals.
2	SPEECH ONLY We played the same shopping game as for session 1, but did not use the lists. Also played a 'barrier game' with Katie having to create a pattern of pictures / objects behind a barrier and then describe the pattern so that I could replicate the pattern on my side of the barrier.	List B words: BOAT FLEECE PEEP AGE HALF	Katie needed much reminding to attempt final sounds. She can do it! FLEECE is the most challenging word for Katie: the final fricative and the initial cluster are hard for her. Barrier game resulted in great confusion with Katie quite surprised at the mistakes I made when following her instructions.
3	SPEECH AND SPELLING Katie and I read a story which had been made using the target words from session 1. We played a game which involved reading cards with 4 new target words on them, and also some picture naming.	List A words: NOTE SAUCE PIPE CAGE LEAF BARN PLANE WHEEL NAIL	The story was useful in revising the words learnt in session 1. She has made progress, with fewer reminders needed and more 'gentle' final sounds. Katie did well with the 4 new words – especially those ending with [n] such as BARN and PLANE.
4	SPEECH ONLY Played game which involved picture naming. Revision of items from Session 2. Sticker game used to introduce 4 new items: Katie was given stickers to put on different target and foil items on picture cards.	List B words: BOAT FLEECE PEEP AGE HALF	Katie is starting to spontaneously use final consonants for the target words. She still tends to over-emphasise but with reminding is able to do it well.
5	SPEECH AND SPELLING Katie and I used stickers, paints, pens and folded paper to make pictures of the various target words, and also wrote the name of each one for a discussion on spelling.	List A words: HEART SLIDE RAKE SOAP	Katie writes well and using writing feels like a natural tool to be using with her. She is using the final consonants more appropriately and regularly now.
6	SPEECH ONLY Introduced 4 new words today. First spoke about them and made pictures of them. Then played barrier game as played in Session 2 using these pictures.	List B words: FORK CART SEAL SWORD	Some excellent production of final consonants. Katie needs less reminding each session, but does get annoyed when reminded. Some confusion in barrier game between SWORD (target) and SAW (minimal pair foil) as conceptually they are quite similar.
7	SPEECH AND SPELLING Played a lotto game with game boards (picture and written form) and matching letter cards which needed to be picked up and place on relevant part of board to gradually spell the complete words.	List A words: FORK ICE ROAD NOTE PLANE HEART	Katie was not as accurate in her final sound production as in previous sessions. In response to my prompts for final sounds, she said: "You know it!" She knows that I understand what she is saying and therefore does not see the point in making the effort to change her production.

Table 5.10 *cont.* Summary of Katie's intervention sessions: Phase I

8	SPEECH ONLY "Big Brother" session based on the Television Programme which Katie has been watching. Katie was required to select a Big Brother participant, each pictured on a different envelope, and then name the picture/s inside.	List B words: RAIN WHALE HIDE CAKE SLICE ROPE DAWN	She seemed motivated today and tried hard to remember the final consonants. She still needs some gentle reminding at times – as soon as she moves beyond a very structured therapy task she tends to forget. In the session she gets into 'speech mode', but forgets as soon as she leave the room.
9*	SPEECH AND SPELLING Played a fishing game where Katie had to catch paper fish using a magnet, and then name items attached to fish.	All list A words	Katie tried hard to remember the final consonants today, and also to say these in the gentle 'kissing' way we practised. Katie was encouraged to think before she speaks and this seemed to really help as she had a chance to remind herself to use the new speech patterns not her old habitual ones. Had a good chat with Katie's mother about words to practise at home. Katie's mom feels she has improved and is more confident especially to talk to strangers.
10*	SPEECH ONLY Played shopping game with minimal pairs, a board game and drew pictures on etch-a-sketch board	All list B words	At times she was reluctant to name the words. She feels we know them all and have done so much work with them. She is able to say all words with end sounds indicated. Generalisation remains questionable.

** Katie was seen at the University Clinic and not in school for these sessions, carried out in the summer holidays*

Summary of intervention phase I

Katie progressed in her ability to produce final consonants for the specific stimuli words. The section on evaluation will provide objective evidence of this progress. The intervention programme aimed to help Katie set-up a new phonological frame in her motor-programming system which would take into account the need for some words to be closed with a final consonant. Katie learnt this for the specific subset of words treated, but she did so inconsistently and generalisation to other words was limited.

Katie was very enthusiastic about the activities, but at times she was lacking in motivation to change her speech. She often produced final consonants to please the therapist rather than because she believed it would improve her speech! She seemed to switch into 'speech mode' for the sessions, but on returning to the classroom went into her normal 'everyday' speech mode where the work carried out in therapy was forgotten. The nature of the intervention has to date been focused on a set of 32 words, and Katie became quite tired of working on these same items each week.

5.3 Intervention report: Phase II

Table 5.11 presents a summary of the sessions carried out in the second phase of intervention. A wide range of target words was worked on, and the sessions attempted to maximise opportunities for naturalistic use of language rather than adhering to a limited target set in a more structured format. Intervention in this phase was guided by broad themes (e.g. animals, numbers, household objects). The comments column in Table 5.11 shows excerpts from the case notes following each session and gives some indication of the type of activities carried out each week, as well as the therapist's views on Katie's progress.

Table 5.11
Summary of Katie's intervention sessions: Phase II

Session No.	Activities	Targets	Comments
11	Computer session: Searching for pictures, and making cards	Range of animal names, e.g. CAT, DOG, PIG, FROG, RABBIT, SNAKE	Katie has a new kitten so we discussed cats and kittens. Katie needed some reminding about her final sounds at the start of the session, but was using a lot of good codas by the end.
12	Computer Session: Making more cards and stories	Range of animal names, names of children in her class	Katie did well with several instances of spontaneous final consonant's appearing in her speech, e.g. [kæ'wɪn] for KAREN, AND [beɪd] for PAIGE.
13	Building games with blocks: had to build objects for each other to name. In the second part of the session we drew pictures of household items and look in some magazines for other pictures.	Household Items e.g. JUICE, TOAST, BED, FRIDGE, BIKE, BATH, LIGHT	Again, several instances of spontaneous final consonants appearing in her speech (e.g. BIKE). But the % of these occurrences is still low (estimated at about 15%).
14	Computer session: Katie's class has been to the library and heard stories about animals. We talked about the stories, revising animal names with end sounds and Katie wrote a story about the outing on the computer.	More animal names; children in her class's names	Katie used final consonants more extensively today (45%). She was over generalising too, using final consonants inappropriately, e.g. [kɑ.tə] for CAR.
15	Teaching game with white-board	Numbers, animals.	Katie responded well to being in the teacher's role. She still needs reminding about her final consonants especially in connected speech.
16	Completion of class work (animal story): Katie had to write a few sentences on a wild animal.	Wild animals and body parts	Had lots of opportunities for talking in an unstructured way, and encouraging Katie to use her end sounds. She did well and I had to remind her less.
17	Teaching game with white board	Numbers, animals	Katie needed minimal reminding about her final consonants. She was able to write some of the animal names on the board and to group these according to their different end sounds.
18	Story reading: Katie read a story about Spain and going on holiday.	Holiday words, numbers, opposites e.g. BLACK and WHITE; NIGHT and DAY; LOUD and SOFT	The book was useful in that it gave many opportunities to say common everyday words and to talk about them. Katie has been unwell, and was quiet today.
19	Colouring and drawing	Words ending in [p] and [d], e.g. STOP, SHOP, RED	Noted that Katie was not using any final consonants today. When I reminded her, she got very annoyed, saying she was tired of 'end sounds' and just wanted to play. We had a long chat about her speech. Unsure if I have been pushing Katie too hard, or is she just manipulating me to get what she wants?
20	Teaching game with white board. Following Katie's outburst in the previous session, I aimed to have a 'freeplay' session today with Katie and a classmate* playing and talking.	No specific theme areas – anything that the children raise	Katie spent most of the session, teaching me and Rachel. Katie gave us a spelling test, and in giving the words there was some confusion on Rachel's (and my) part as to what the words were. Rachel questioned Katie on several occasions, e.g. Katie is it CAR or CARD or CART we must write? This may have highlighted for Katie the importance of final consonants. She was able to repeat the words and make them clearer. The session was effective in highlighting communicative importance of the end sounds in a natural way.

* Rachel, the child described in Chapter 7, joined us for this session.

Summary of intervention phase II

Katie made progress in her ability to produce final consonants for a wider range of words. Some generalisation was noted, but Katie seemed lacking in motivation to change these patterns beyond the therapy room. She remained inconsistent in her usage of the final sounds. The section on evaluation will provide objective evidence of her progress.

The final session in Phase II was useful in underlining some of the points which intervention has aimed to convey to Katie: another child from Katie's class was able to pinpoint her confusion as a listener to the final segment, and to question Katie in a naturalistic setting about what meaning she intended.

5.4 Intervention report: Phase III

Table 5.12 presents a summary of the sessions carried out in the third phase of intervention.

Table 5.12
Summary of Katie's intervention sessions: Phase III

Session No.	Activities	Targets	Comments
21	Played a 'stepping stones' game with Katie having to move from one picture to the next, and read the sentence describing the picture.	All facilitatory sentences, e.g. THIS ROPE PULLED THE CAR	She was able to produce all stimuli words with their final consonants in the sentences (100% accuracy).
22	Teaching game: Katie required to read sentences and show pictures to the imaginary 'pupils' in her class.	All facilitatory sentences	As above, she achieved 100% success.
23	Teaching game as above.	Intermediate sentences, e.g. THERE'S ROPE ON THE ROAD	These are harder sentences for Katie to produce. She needed more encouragement and reminding, but ultimately achieved some success (approximately 50% target words with final consonants).
24	Used Dictaphone today to record Katie's speech and listen to together to evaluate final consonant usage.	Intermediate sentences	She enjoys listening to the tape and was able to make accurate judgements about final consonant production.
25	Dictaphone session combined with teaching game	Intermediate sentences	She is making progress with these sentences, and getting more used to remembering the final consonants at this level. Estimated 70% accuracy achieved with these targets.
26	Dictaphone session combined with teaching game	Most challenging sentences, e.g. THIS ROPE GOT FRAYED	Katie coped better than expected with these most challenging sentences. She got some of the target words right at the first attempt. Because her speech rate is slow, she did not seem that affected by the change in place of articulation because she pauses between words for a fairly long time. Little assimilation seems to occur in her speech.
27	Dictaphone session combined with teaching game	Most challenging sentences	Getting most of these items correct (80%).
28	Dictaphone session combined with teaching game	Most challenging sentences	Getting most of these items correct (80%).
29	Dictaphone session combined with teaching game	Intermediate and most challenging sentences	Getting most of these items correct (80%).
30	Dictaphone session combined with teaching game	All sentences	Getting most of these items correct (80%).

These sessions aimed to encourage Katie to use her stimulus words from the first phase of intervention (i.e. List A and B words, Table 5.8) with their coda segments in connected speech. A carefully structured hierarchy of sentences was designed to scaffold Katie's progression from simple sentences with facilitatory phonetic contexts to more challenging sentences with more complex phonetic demands (see Appendix 4). The comments column in Table 5.12 shows excerpts from the case notes following each session and outlines activities carried out each week, as well as the therapist's views on Katie's progress.

Summary of intervention Phase III

Katie made pleasing progress in the final phase of intervention. Her speech seemed to improve from session to session, as she got used to the demands of the task. She was more motivated in this phase of intervention than the preceding phases. This may have been because she perceived tasks that involved reading and sentences to be more 'grown up' and relevant to her life, than the single word tasks. Micro evaluation will investigate these impressions more objectively in the following section.

6. EVALUATION

This section focuses on the outcome of Katie's intervention programme. Section 6.1. is a micro evaluation of the intervention study, aiming to look at the specific changes in treated stimuli and untreated control items outlined in Section 4. The section starts with an overview of the micro evaluation (6.1.1), before considering single word speech (6.1.2), connected speech (6.1.3), spelling (6.1.4) and auditory discrimination (6.1.5) in turn. The section concludes with a summary of micro evaluation (6.1.6), and returns to the questions posed previously about Katie's intervention (6.1.7). Section 6.2 provides a macro analysis of the intervention, aiming to outline broader changes in the following areas: standardised language assessment (6.2.1), speech profiling in a psycholinguistic framework (6.2.2), speech analysis (6.2.3), and child interview and teacher / parent report (6.2.4). This section concludes with a summary of the macro evaluation.

6.1 Micro evaluation

Katie was reassessed at periodic intervals during the intervention study. Figure 5.4 shows the five points (T1 – T5) at which she was assessed. The micro evaluation required Katie to carry out the following tasks:

1. name pictures of each of the stimuli words (from Table 5.8)
2. produce each stimuli word in a short phrase ('the TARGET in the picture')

3. write the target single words to dictation
4. discriminate between each stimuli word and a closely related item that differed only in terms of the final segment in spoken production (e.g. are these word pairs the same or different: ROPE and ROW? ROPE and ROTE?).

The results for these micro assessments are described in the sections that follow.

6.1.1 Overview

Table 5.13 gives an overview of Katie's progress on treated (lists A and B) and untreated (list C) stimuli by comparing the percentage of target phonemes correct in her speech, spelling and auditory discrimination at pre-intervention assessment (T1) with scores obtained on completion of the programme at T4 (short-term follow-up), and at T5 (long-term follow-up). The scoring procedure focussed specifically on the target final consonants, not on the remainder of the word. Two points were awarded for each correct target phoneme (i.e. producing [bəʊt̲] for BOAT). One point was awarded for producing a final consonant, albeit not an accurate one (e.g. producing [bəʊd̲] or [bəʊn̲] for BOAT). The same rules applied for spelling with correct representations of final consonants being awarded 2 points and incorrect graphemes or distorted but recognisable graphemes, receiving 1 point. Raw scores were converted into %.

Table 5.13
Overview of Katie's changes in speech, spelling and auditory discrimination over the course of the intervention

	T1 Pre-intervention % of target phonemes correct**		T4 Post-intervention % of target phonemes correct**		T5 Post-intervention % of target phonemes correct**	
	Treated	Untreated matched controls	Treated	Untreated matched controls	Treated	Untreated matched controls
Speech						
Single words	6.25	6.00	43.75*	50*	60.9*+	62.5*
Connected	0	0	65.75*	37.5*	68.75*	71.8*+
Spelling	45.5	37.5	81*	84*	75*	84*
Auditory discrimination	80	77	91.5	93	91.5	90

** The scoring procedure focussed specifically on the final consonants, not on the remainder of the word. Each final consonant correctly spoken or written was awarded 2 points. One point was awarded for each inaccurate final consonant used, e.g. in speech: phonetic distortion of a final consonant or phonological substitution; in spelling: incorrect grapheme or distorted but recognisable grapheme. Raw scores were converted into %.
* paired with T1 results ($p<.05$)
+ paired with T4 results ($p<.05$)

A two-way mixed between-within subjects ANOVA was conducted. There was a statistically significant main effect for time for single word speech [$F(2, 44) = 38.310$, $p < .001$], connected speech [$F(2, 44) = 108.477$, $p < .001$] and spelling [$F(2,44) = 14.083$, $p<.001$]. Both Katie's written and spoken production of final consonants had improved over the course of the intervention programme. The effect size for connected speech was greatest (eta squared = .831), followed by that of single word speech (eta squared = .635) and then that of spelling (eta squared = .390). However, these are all large effect sizes (Cohen, 1988). Katie's auditory discrimination did not change significantly over the intervention.

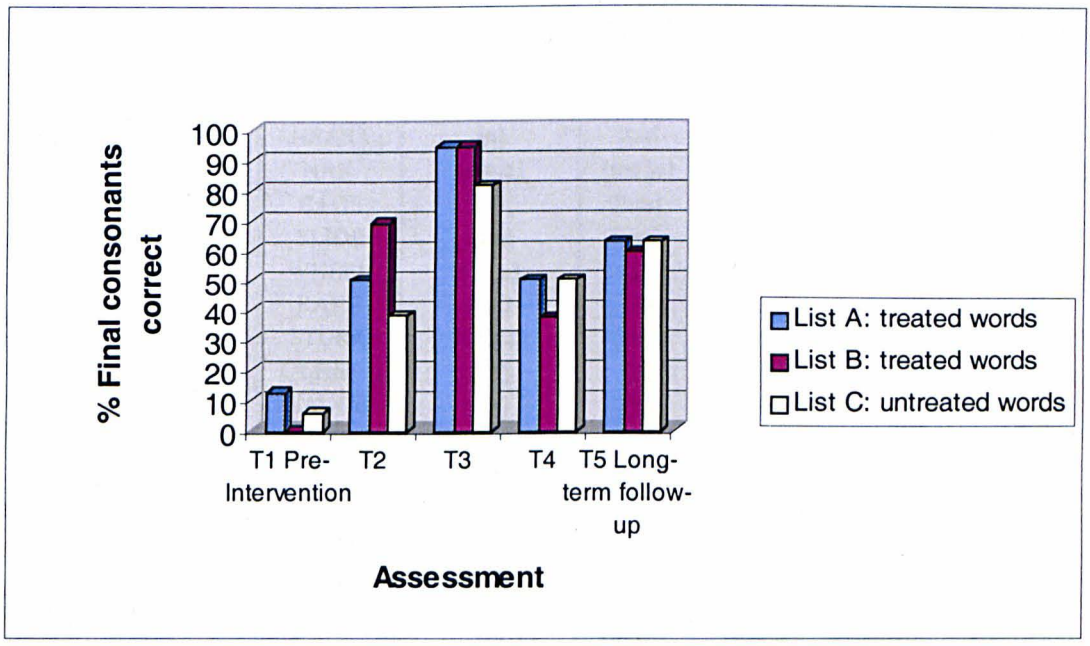
Paired samples t-tests were carried out to compare performance on stimuli lists at two points in time. In terms of single word speech, it was found that Katie had made significant gains when comparing treated word scores from T1 with scores at T4 ($t(31) = -4.822$, $p<.001$) and T5 ($t(31) = -6.929$, $p<.001$). Her score continued to improve significantly from T4 to T5 ($t(31) = -2.47$, $p<.05$) after intervention had ceased. For the matched untreated controls, significant gains were similarly made from T1 to T4 ($t(15) = -4.341$, $p<.001$), and T1 to T5 ($t(15) = -5.582$, $p<.001$), although there was no significant change after intervention ceased from T4 to T5. The treated items went on to change after intervention whereas no further generalisation occurred for the untreated items.
For connected speech, Katie made significant gains when comparing treated word scores from T1 with scores at T4 ($t(31) = -9.515$, $p<.001$) and T5 ($t(31) = -11.171$, $p<.001$). Her treated word performance for connected speech did not change significantly after intervention ceased between T4 and T5. For the matched untreated controls, significant gains were similarly made from T1 to T4 ($t(15) = -3.656$, $p<.01$), and T1 to T5 ($t(15) = -9.139$, $p<.001$), although there was further significant increase after intervention ceased from T4 to T5 ($t(15) = -3.093$, $p<.01$) for this set of stimuli.

For spelling, Katie made significant gains when comparing treated word scores from T1 with scores at T4 ($t(31) = -3.8$, $p<.001$) and T5 ($t(31) = -2.6$, $p<.05$). Her treated word scores for spelling did not change significantly after intervention ceased between T4 and T5. For the matched untreated controls, significant gains were similarly made from T1 to T4 ($t(15) = -4.038$, $p<.001$), and T1 to T5 ($t(15) = -3.758$, $p<.01$), again with no further gains made after intervention ceased from T4 to T5. These results for each of the different areas (single word speech, connected speech, spelling and auditory discrimination) are discussed in great detail in the subsequent sections.

6.1.2 Single word speech

The results for Katie's single word speech production over the course of the intervention are presented in Figure 5.5.

Figure 5.5
Katie's single word speech production



Overall, it has been noted that a statistically significant main effect for intervention was found using two-way mixed ANOVA [F (2, 44) = 38.310, p< .001]. Two-tailed paired samples *t*-tests showed significant gains for each of the stimuli lists following the first phase of intervention (list A treated words, t(15)=-4.392, p=.001; list B treated words, t(15)=-7.652, p<.001; list C untreated words, t(15)-4.038, p=.001). Further significant gains were made with treated items in list A and the untreated items in list C at T3 (t(15)=-3.955, p=.001), following phase II, with the treated items now approaching ceiling at 94%. However, at T4 reassessment, following the intervention phase that targeted connected speech, there was a significant *decrease* in performance on final consonant production in CVC words for each of the three lists (list A treated words, t(15)=3.416, p<.005; list B treated words, t(15)=4.392, p=.001; list C untreated words, t(15)=3.101, p<.05). At long-term follow-up (T5) following a period with no intervention, gains were made for each of the lists, although these did not reach significance for any of the wordlists in isolation. When combining the two treated wordlists A and B, a significant increase was noted from T4 to T5 (t (31) = -2.47, p<.05).

Table 5.14 provides further qualitative information about the changes that occurred in Katie's speech over the course of intervention.

Table 5.14
Qualitative changes in Katie's single word speech production

		Stimulus	T1	T2	T3	T4	T5
List A Treated words	1	NOTE	[nəu]	[nəut]	[nəut]	[nəut]	[nəut]
	2	PLANE	[peɪ]	[peɪnə]	[penə]	[pweɪ]	[pleɪn]
	3	HEART	[ɑ]	[hɑ]	[hɑt]	[ɑt]	[hɑt]
	4	NAIL	[neɪ.ə]	[neɪ.jə]	[ni.jə]	[neɪ.ə]	[neɪ.jə]
	5	CAGE	[keɪ]	[keɪ]	[keɪt]	[keɪt]	[keɪk]
	6	SLIDE	[daɪ]	[taɪt]	[tsaɪd]	[taɪt]	[daɪd]
	7	WHEEL	[wi.ə]	[wi.ə]	[wi.ə]	[wi.ə]	[wi.jə]
	8	RAKE	[reɪ]	[jeɪk]	[weɪk]	[weɪk]	[weɪ]
	9	STORK	[dɔ.gə]	[tɔk]	[tɔk]	[dɔkə]	[dɔk]
	10	LEAF	[jif]	[lɪ]	[livə]	[lif]	[ji]
	11	SAUCE	[dɔ]	[dɔ]	[dɔ]	[dɔ]	[dɔ]
	12	ICE	[aɪ]	[aɪ]	[aɪt]	[aɪ]	[aɪt]
	13	SOAP	[dɔ]	[dəup]	[dəup]	[dəu]	[dəup]
	14	PIPE	[paɪ]	[baɪp]	[paɪp]	[paɪ]	[paɪp]
	15	BARN	[bɑ]	[bɑ]	[bɑn]	[bɑn]	[bɑn]
	16	ROAD	[wɔ]	[wɔ]	[wəuvə]	[wəu]	[wəud]
List B Treated words	1	BOAT	[bɔ]	[bəud]	[bəudə]	[bəut]	[bəut]
	2	RAIN	[weɪ]	[weɪt]	[reɪnə]	[weɪn]	[weɪnə]
	3	CART	[kɑ]	[kɑt]	[kɑt]	[kɑ]	[kɑ]
	4	WHALE	[weɪ.ə]	[weɪ.jə]	[wɪ.əl]	[weɪ.ə]	[weɪ]
	5	AGE	[eɪ]	[eɪ]	[eɪd]	[eɪd]	[eɪ]
	6	HIDE	[aɪ]	[aɪt]	[eɪd]	[aɪ]	[aɪ]
	7	SEAL	[si]	[dɪ.ə]	[si.ə]	[di.ə]	[si.jə]
	8	CAKE	[keɪ]	[jeɪk]	[keɪkə]	[keɪk]	[keɪk]
	9	FORK	[fɔ]	[fɔ]	[fɔk]	[fɔ]	[fɔk]
	10	HALF	[ɑ]	[ɑ]	[ɑf]	[ɑ]	[ɑf]
	11	FLEECE	[fi]	[fit]	[fit]	[fwi]	[fit]
	12	SLICE	[daɪ]	[tslaɪt]	[saɪ]	[daɪ]	[daɪt]
	13	ROPE	[wɔ]	[wəup]	[wəupə]	[wəup]	[wəupə]
	14	PEEP	[pi]	[pɪp]	[pɪk]	[pɪp]	[bɪp]
	15	DAWN	[dɔ]	[dɔ]	[dɔnə]	[dəu]	[dɔn]
	16	SWORD	[dɔ]	[dɔd]	[dɔd]	[dɔ]	[sɔd]
List C Untreated words	1	GOAT	[gəu]	[kəut]	[gəut]	[gəut]	[gəu]
	2	TRAIN	[teɪ]	[teɪ]	[teɪ]	[tʃeɪ]	[teɪn]
	3	PART	[bɑ]	[pɑ]	[pɑt]	[bɑ]	[bɑ]
	4	HAIL	[eɪ.ə]	[eɪ.jə]	[eɪ.ɪl]	[eɪ.ə]	[eɪ.jə]
	5	PAGE	[peɪ]	[bɛdə]	[peɪd]	[beɪ]	[beɪt]
	6	LIED	[laɪ]	[jaɪ]	[laɪd]	[laɪf]	[jaɪd]
	7	KNEEL	[ni]	[nijə]	[ni.ə]	[ni.ə]	[ni.ə]
	8	STEAK	[deɪ]	[teɪ]	[steɪk]	[deɪk]	[deɪk]
	9	WALK	[wɔ]	[wɔg]	[wɔkə]	[wɔk]	[wɔk]
	10	HOOF	[u]	[uf]	[hufə]	[uf]	[uf]
	11	PURSE	[bɜ]	[pɜ]	[pɜ]	[pɜt]	[pɜdə]
	12	DICE	[daɪ]	[daɪ]	[daɪ]	[daɪ.ə]	[daɪt]
	13	GRAPE	[keɪ]	[geɪ]	[geɪp]	[geɪp]	[geɪp]
	14	SHEEP	[dʒi]	[ti]	[sip]	[ʃip]	[sɪp]
	15	LINE	j[aɪn]	[jaɪ]	[laɪn]	[laɪ]	[jaɪn]
	16	TOAD	[təu]	[təu]	[təud]	[dəu]	[dəu]

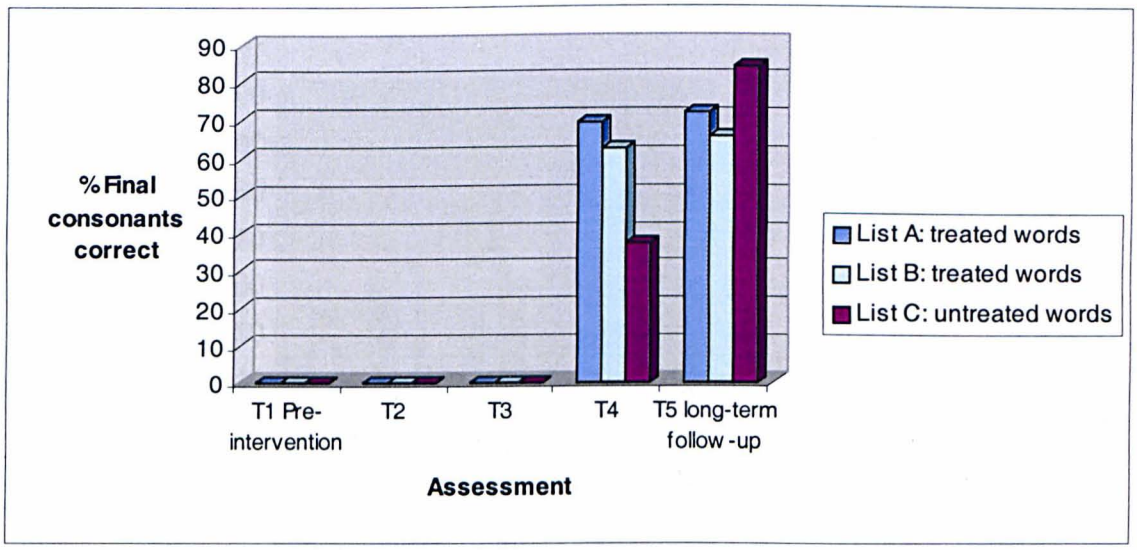
Five main patterns of changes were noted. These included:

1. ***No final consonant:*** These were words that Katie was never able to produce with a final consonant. Examples from Table 5.14 include NAIL (list A, item 4), SAUCE (list A, item 11), and SEAL (list B, item 7). Many of these items were words with [l] in the final position.
2. ***Rapid change from T2***: These were words, that Katie could not produce with a final segment at T1, but that she used with accurate final consonants at T2 and at all subsequent assessments. In some cases schwa was used in addition to the final consonant at early assessments, and in some cases these consonants were not appropriately voiced. Examples from Table 5.14 include NOTE (list A, item 1), SLIDE (list A, item 6), BOAT (list B, item 1) and WALK (list C, item 9). All of these items that Katie experienced success with, were plosives with the exception of [f] in HOOF (list C, item 10).
3. ***Slower change from T3 with accurate final phoneme produced:*** These were words that did not change immediately in the early phases of intervention, but did change by T3 or one of the subsequent assessments. The words were then all produced with an accurate final consonant. Examples include HEART (list A, item 3), BARN (list A, item 15) and TRAIN (list C, item 2). The final consonants appearing in these words were all voiceless plosives, and the nasal [n].
4. ***Slower change from T4 with inaccurate final phoneme produced:*** These words also changed later in the intervention from T3, but were distinguished from the previous category in that the final consonants emerged inaccurately. Examples include CAGE (list A, item 5), RAIN (list B, item 2) and DICE (list C, item 12). Items in this category included [n], and affricates and fricatives which were largely lacking from Katie's phonemic inventory.

6.1.3 Connected speech

Katie's ability to produce CVC words in connected speech was assessed by asking her to repeat the stimuli items in a short carrier phrase, i.e. the WORD in the picture. As for the single word speech assessment, the focus was on Katie's final segment production of the stimuli words: she was awarded two points for final consonants that were accurately realised, one point for using an inaccurate final consonant, and no points for omission of a final consonant. Raw scores were converted to %. Results are shown in Figure 5.6.

Figure 5.6
Katie's CVC production in connected speech

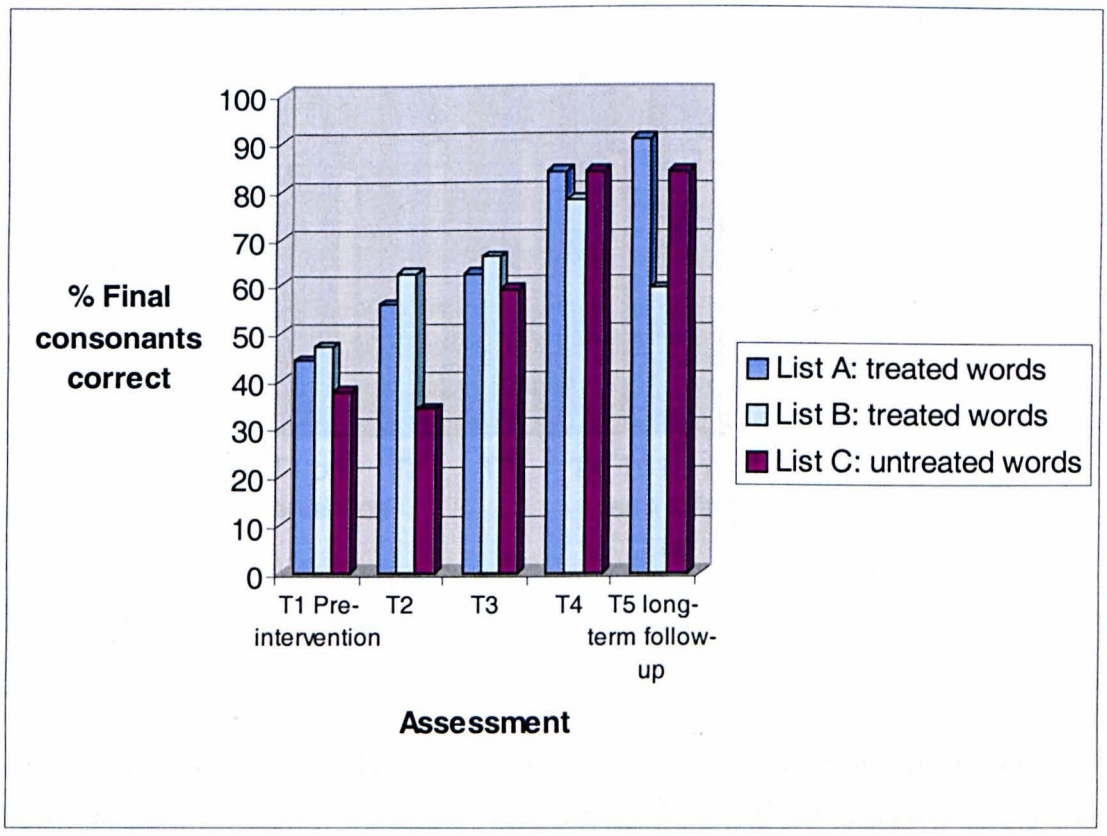


A statistically significant main effect for intervention was found using two-way mixed ANOVA [F (2, 44) = 108.477, p< .001]. Initially, Katie found this a very challenging task and did not use any final consonants in connected speech at the T1 pre-intervention assessment, or T2 or T3 assessments. However, following intervention phase III which specifically targeted connected speech at the T4 assessment, there was a significant change (F (2, 45) =67.623, p<.001 for each of the three stimuli lists. Her treated word performance for connected speech did not change significantly after intervention ceased between T4 and T5. For the matched untreated controls (list C), further significant gains were made from T4 to T5 (t (15) = -3.093, p<.01) for this set of stimuli.

6.1.4. Spelling

Results of Katie's written representations of the CVC targets are shown in Figure 5.7 for each of the three stimuli lists over the course of the intervention programme.

Figure 5.7
Katie's written production of CVC stimuli



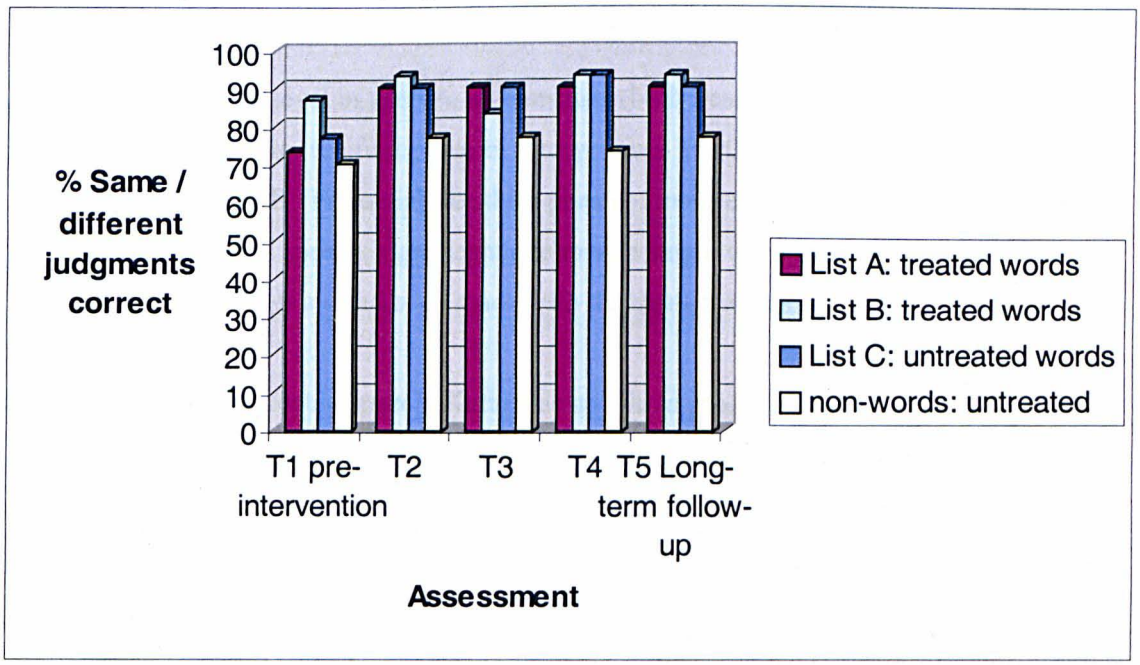
Katie's written representations of the targets were significantly more accurate than her spoken representations pre-intervention ($t(47) = 5.657$, $p<.001$) and at long-term follow-up (T5) ($t(47)=3.483$, $p=.001$). However, the effect size for single word speech (eta squared = .635) was greater than that for spelling (eta squared = .390). Overall, a statistically significant main effect for intervention was found using two-way mixed ANOVA [$F(2,44) = 14.083$, $p<.001$].

For the list A and B treated items, steady but not significant increases were noted at each assessment when compared to the previous evaluation. The change overall from T1 to T5 was a significant one ($t(31) = -2.6$, $p<.05$). For the untreated items in list C, a significant increase was noted when comparing scores from T3 with those at T4 ($t(15)=-2.739$, $p<.05$). Untreated items improved significantly after the final phase of intervention and these gains were maintained at the long-term follow-up at T5.

6.1.5 Auditory discrimination

Katie's auditory discrimination skills were investigated by asking her to make same / different judgments about pairs of closely related words (e.g. ROPE / ROTE). Results of Katie's performance on this task are presented in Figure 5.8.

Figure 5.8
Katie's auditory discrimination judgments of closely related CVC word pairs



At T1 assessment, Katie found the task relatively easy with scores between 70 and 90% for the wordlists A, B and C. Overall there was not a significant main effect of time. However, some significant changes were made on the list A items: when comparing Katie's performance at T1 with T2 ($t(15)=-2.782$, $p<.05$) and when comparing her overall discrimination performance on the list A words from T1 with T5 ($t(15)=-2.150$, $p<.05$). No significant changes were noted for the untreated non-word items.

6.1.6 Summary of micro evaluation

(a) Micro evaluation focussed on the specific results of Katie's intervention by looking at changes in her processing and production of final consonants, in single word speech, connected speech, spelling and auditory discrimination tasks. Intervention aimed to revise Katie's existing motor programmes (in phase I and II) by drawing her attention to written and spoken CVC words, and emphasising the importance of meaning contrasts using final consonants. A further phase of intervention aimed to target her motor planning by encouraging her to use the new motor programmes in carefully graded phrases. Katie received a total of 30 hours of intervention over the three phases.

(b) A statistically significant main effect of time for single word speech [$F(2, 44) = 38.310$, $p< .001$], connected speech [$F(2, 44) = 108.477$, $p< .001$] and spelling [$F(2,44) = 14.083$, $p<.001$] was found. Katie's written and spoken production of the targeted words

improved over the course of the programme. The effect size for connected speech was larger than that for single word speech and spelling, but all were large effects.

(c) At the single word level of speech, all wordlists (both treated and untreated) showed significant gains after the first phase of intervention. Further gains were made after intervention phase II. Following the third phase of intervention that addressed the target words in connected speech, significant declines in single word production were noted. Further significant gains had been made with the treated words at long-term follow-up.

(d) At the level of connected speech, Katie was unable to produce final consonants in the target stimuli in short phrases at the T1, T2 and T3 assessments. Following phase III of intervention that specifically addressed connected speech, significant gains were noted for each of the three wordlists. Further gains were noted for the untreated items at long-term follow up.

(e) Katie's single word spelling performance was significantly better than her speech performance both before (T1) and after intervention (T5). The gains in spelling across the intervention programme were gradual, but significant overall when comparing T1 with T5.

(f) Overall, Katie's auditory discrimination scores did not change significantly over the course of intervention. However, for list A items significant gains were made from T1 to T2 after the first phase of intervention, and overall when comparing scores at T1 with T5 for these items. Katie's auditory discrimination scores were approaching ceiling for some of the stimuli lists at the start of intervention. No changes were noted on her non-word auditory discrimination performance across the intervention.

6.1.7 Questions revisited

Results from the micro evaluation showed significant improvements in Katie's speech – as well as other areas such as spelling and auditory discrimination between real words. Katie's response to the intervention programme is summarised in Table 5.15, which returns to the specific questions posed earlier, with some discussion of each point following.

Table 5.15
Questions revisited: some answers about Katie's intervention

Area	Question	Answers
Single word speech	- Will phase I intervention result in an increased count of final consonants in the treated word lists (A and B)?	Yes
	- After intervention phases I and II, will Katie's final consonant count (FCC) for list C (untreated controls) also improve beyond chance level?	Yes
Connected speech	- Will Katie's FCC for target words used in a short carrier phrase improve in phase I and II, as Katie's speech processing system is modified?	No
	- Phase III specifically addressed connected speech. Will it result in significantly increased FCCs in connected speech productions in the treatment lists A and B?	Yes
	- After intervention phase III, will Katie's FCC for list C items (untreated controls) in connected speech also improve beyond chance level?	Yes
Spelling	- Will exposure to orthographic forms promote faster learning, i.e. after phase I will list A (speech and spelling treatment) show more improvement than list B (speech only treatment)?	No
	- Will Katie's ability to indicate final segments in spelling improve following three phases of intervention for speech?	Yes
Auditory discrimination	- Will improved speech production result in improved ability to discriminate between treatment stimuli and phonetically similar words?	Yes
	- Will increased experience with production of final consonants result in improved discrimination of novel words that differ in terms of final segments?	No

Single word speech

In terms of speech at the single word level, the following questions were asked: Will phase I intervention result in an increased count of final consonants in the treated wordlists (A and B)? After intervention phases I and II, will Katie's final consonant count (FCC) for list C (untreated controls) also improve beyond chance level?

After the first phase of intervention, Katie's use of final consonants in single words increased significantly not only for the treatment lists but also for the untreated, matched control set. This suggests that generalised change had been brought about, rather than being limited to the specific items that she had been introduced to in the intervention. After the second phase of intervention, further significant gains were made in terms of single word speech production. Again, this change was not limited to the treatment lists but also for the untreated, matched control sets suggesting that generalised change had been brought about. Following the third phase of intervention, which focused on connected speech, Katie showed a decrease in her use of CVC stimuli in single word naming tasks. This decrease can be explained by considering the focus of the intervention in each of the phases: phase I and II focused on single word production and had an effect at this level for each of the three matched stimuli lists. Phase III involved work on connected speech, and no work was done

directly on single word production. The single word task may have been perceived as less important communicatively, than tasks involving connected speech.

Connected speech

It was asked: Will Katie's final consonant count for target words used in a short carrier phrase improve in phase I and II, as Katie's speech processing system is modified? Katie was not able to make improvement in her connected speech until phase III when connected speech was specifically addressed. In terms of the speech processing model, the first two phase of intervention may have been focused on motor programmes, but it is likely that the third phase was targeting motor planning. Generalisation of single words into connected speech may be dependent on the specific incorporation of this level. The intervention in phase III was very successful in getting her to use the CVC stimuli in sentences, something which she had been completely unable to achieve before. It is likely that Katie's attention had shifted to larger units of speech and motor planning rather than being focused at the single word level.

Again, this change was not limited to the treatment lists but also for the untreated, matched control lists suggesting that generalised change had been brought about. It seems that improvement in connected speech was only brought about by specifically addressing connected speech in a carefully structured way. An interesting question to consider in future research is whether the single word intervention phases were necessary prior to the connected speech phase, or whether one might have started intervention with the connected speech work.

Spelling

Intervention phase I offered different treatments for the stimuli lists A and B, with A items being given a treatment that explicitly utilised written forms to promote speech, and B items focusing solely on speech. The following question was posed: Will exposure to orthographic forms promote faster learning, i.e. after phase I will list A (speech and spelling treatment) show more improvement than list B (speech only treatment)? There was no significant difference in the outcomes from these two different treatments. This result is surprising on the basis of general theories suggesting that spelling ought to promote speech (e.g. Foorman, Francis, Novy and Liberman 1991; Gillon 2002), and also in terms of the initial identification of Katie's strengths that included decoding.

Further it was asked if Katie's ability to indicate final segments in spelling would improve following three phases of intervention for speech? Katie's spelling did improve significantly. It may be that in therapy, the effects of working on speech and spelling are uni-directional: working on speech improves spelling, but working on spelling does not

necessarily improve speech. Alternatively, there may have been no difference between the progress made on the two stimuli lists because the inclusion of spelling – albeit only for one of the groups – was sufficient to highlight conceptual issues for Katie and have resulting influence on the other list.

Auditory discrimination

In terms of auditory discrimination it was asked: Will improved speech production result in improved ability to discriminate between treatment stimuli and phonetically similar words? Will increased experience with production of final consonants result in improved discrimination of novel words that differ in terms of final segments? Overall, Katie's auditory discrimination scores did not change significantly over the course of intervention. However, when focusing on list A items it was seen that significant gains were made from T1 to T2 after the first phase of intervention, and overall when comparing scores at T1 with T5 for these items. Katie's auditory discrimination scores were approaching ceiling for some of the stimuli lists at the start of intervention. No changes were noted on her non-word auditory discrimination performance across the intervention. These results are considered in further detail in the light of the macro evaluation described in the following sections.

6.2 Macro evaluation

Short-term follow-up took place in March 2003, approximately one month after the completion of Katie's intervention programme at CA 7;7. Long-term follow-up took place some 7 months later at CA 8;2. The complete assessment as described initially in Section 2, was repeated in order to assess her progress in terms of speech, language and literacy. Assessment was again grouped into four main areas: (6.2.1) standardised language assessments, (6.2.2) speech profiling carried out within a psycholinguistic framework, (6.2.3) speech analysis, and (6.2.4) child interview and parent / teacher report.

6.2.1 Standardised language assessment

Standardised tests administered at the start of the intervention, were re-administered. Results are summarised in Table 5.16.

Table 5.16
Comparison of Katie's standardised speech, language and literacy assessments at CA 6;5 (pre-intervention) and CA 7;7 and 8;2 (post-intervention)

Assessment	Area tapped	PRE INTERVENTION CA 6;5 Score	PRE INTERVENTION CA 6;5 Age-equivalent	POST INTERVENTION CA 7;7 Score	POST INTERVENTION CA 7;7 Age equivalent	POST INTERVENTION CA 8;2 Score	POST INTERVENTION CA 8;2 Age equivalent
Receptive Language							
Test of reception of grammar (TROG, Bishop, 1989)	Receptive grammar	Centile: 40 Standard score: 95	6;0	Centile: 5 Standard score: 75	4;9	Centile: 5 Standard score: 77	5;6
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive vocabulary	Centile: 10 Standard score: 80	4;6	Centile: 11 Standard score: 82	5;04	Centile: 15 Standard score: 86	6;5
Receptive Subtests of CELF (Clinical Evaluation of Language Fundamentals – UK Edition, Wiig et al., (2001)	Receptive language	Centile: 1 Standard Score: 1		Centile: 35 Std Score: 8		Centile: 35 Std Score: 8	
Expressive language							
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive vocabulary	Z score = 1.4	4;8	Z score:-2.2	4;10	Z score: -2.8	5;1
Renfrew Action Picture test (RAPT, Renfrew, 1989)	Information Grammar		5;0 3;0		5;5 4;0		6;0 4;6
Edinburgh Articulation Test (EAT, Anthony et al., 1971)*	Articulation and naming	Standard score: 41	3;0	Standard score: 46	3;6	Standard score: 46	3;6
Literacy measures							
Schonell Reading Test (Newton and Thompson, 1982)	Reading single words	6;8 years		7;9 years		8;0 years	
Schonell Spelling Test (Newton and Thompson, 1982)	Writing single words from dictation	5;9 years		6;5 years		7;3 years	

* EAT is designed for use with children up to the age of 6;0. Katie's scores were calculated using this upper age limit although she was 6;5 at the time of the assessment. Results are discussed in more detail in the speech analysis section

In terms of receptive language, a decline in Katie's receptive grammar (as measured by the TROG, Bishop, 1983) was noted. This may suggest that the gap between Katie and her chronologically matched peers is increasing. Her scores on the BPVS (Dunn et al, 1997), on the other hand are more stable, showing increased performance in line with the amount of time that had elapsed between assessments. Her delay in receptive vocabulary remains about

2 years behind her peers. Her CELF score (Wiig et al., 2001) increased significantly from the initial assessment to post-intervention with Katie now performing in the borderline range.

In terms of expressive language, few changes were noted. Her performance on the Renfrew Word-finding Vocabulary scales (Renfrew, 1995) shows very minimal increases given the amount of time that has passed, and that her delay in expressive language is increasing relative to her peers. Her performance on the other two expressive language tests, the Renfrew Action Pictures Test (Renfrew, 1989) and the Edinburgh Articulation test (Anthony et al., 1971) show small but insignificant gains.

Her literacy performances were re-evaluated using the Schonell single word reading and spelling tests from the Aston Index (Newton and Thompson, 1982). Her reading score remained slightly ahead of her age at the first follow-up assessment, and at the long-term follow-up was found to be just 2 months behind her chronological age. Her spelling is delayed by approximately one year, with this delay remained constant over the course of intervention. Given that Katie was being exposed to new words and literacy teaching over the course of the intervention project, it may not be surprising that her spelling skills improved on the micro evaluation. However, the macro measures presented here show that her spelling skills had not increased more than one might expect given the amount of time that had elapsed. Therefore, her improvements in spelling on the micro assessment stimuli can be regarded as specific and significant, and most likely due to the effects of the intervention.

6.2.2 Speech profiling in a psycholinguistic framework

Tests used to build up Katie's initial speech processing profile (fig 5.1) were re-administered in order to determine if any changes in her profile had occurred. Few changes were noted in the profile. Only one of the blocks revealed changes: that of level D, which poses the question: 'Can the child discriminate between real words?' Katie showed improvement on three assessments carried out in order to tap this level (Wepman 1958, Newton and Thompson 1982, Bridgeman and Snowling 1988). She now performed at an age appropriate level for each of these tasks. However, at level B ('Can the child distinguish between non-words?') no improvement was noted. On the output side of the profile no significant gains were made at any level.

Katie's profile from the short-term follow-up at CA 7;7 is presented in Figure 5.9 with the differences from the original profile highlighted.

Figure 5.9
Katie's speech processing profile at CA 7;7 (from Stackhouse and Wells, 1997)
√ = age appropriate performance
X = 1 s.d below the expected mean for her age
XX = 2 s.d below the expected mean for her age

INPUT

F Is the child aware of the internal structure of phonological representations?
√ - Rhyming test (Vance et al. 1994)
√- PhAB picture alliteration subtest (Frederikson et al. 1997)

E Are the child's phonological representations accurate?
√ - Auditory lexical decision task (Constable 1993)
√ - Posting Tasks

D Can the child discriminate between real words?
√ – Real word discrimination test (Bridgeman and Snowling 1988)
√ - Aston index discrimination subtest (Newton and Thompson 1982)
√ - PhAB alliteration subtest (Frederikson et al. 1997)

C Does the child have language specific representations of word structures?

Not tested

B Can the child discriminate speech sounds without reference to lexical representations?
XX – Non-word discrimination test (Bridgeman and Snowling 1988)

A Does the child have adequate auditory perception?
√ - audiometry

OUTPUT

G Can the child access accurate motor programmes?
X – Single word naming test (Constable 1993)
X – Word-finding vocabulary test (Renfrew 1995)
X – Edinburgh articulation test (Anthony et al. 1971)
X – Renfrew Bus Story (Renfrew, 1969)

H Can the child manipulate phonological units?
X - PhAB Spoonerism subtest (Frederikson et al. 1997)
X - PAT rhyme fluency subtest (Muter et al. 1997)

I Can the child articulate real words accurately?
X – Constable real word repetition subtest (1993)
X - Aston index blending subtest – real Words (Newton and Thompson 1982)

J Can the child articulate speech without reference to lexical representations?
XX – Aston index blending subtest – nonwords (Newton and Thompson 1982)
X – Constable non-word repetition subtest (1993)

K Does the child have adequate sound production skills?
? Some difficulties. Nuffield Motor assessment; Oral examination and DDK

L Does the child reject her own erroneous forms?
no

Katie improved at both the micro and macro level in her ability to discriminate between real words. In terms of the speech processing model (Figure 5.2), her phonological recognition had improved. How does this improvement relate to Bishop et al.'s (1990) theory that children with motor output problems are likely to experience auditory discrimination difficulties secondary to these output difficulties? Katie may have made sufficient improvement in her speech to bring about changes in her auditory discrimination. However, the fact that she improved in her real word discrimination and not in her non-word discrimination suggests that this is not the case and that there may be other mechanisms at play. Real word discrimination was not directly addressed in the intervention, but Katie's real word discrimination ability was re-assessed several times between the intervention phases. She may have improved in this area due to the exposure and practice afforded by the re-assessments. The fact that she improved in her real word discrimination but not in her ability to discriminate between non-words (at even a micro level) suggests that these are distinct abilities using different processing routes.

6.2.3 Speech analysis

A post-intervention PACS (Grunwell, 1985) was carried out at CA 8;2 to provide information on Katie's phonological system (Table 5.17). This was compared with the summary of findings at the initial assessment (section 2.3.1). Many of the findings were the same as for the initial assessment. At CA 8;2 Katie was judged to be using patterns of phonological simplification in an approximately equivalent way to a normally developing 4;5 year old, using the PACS chart of normal phonological development. However, as mentioned previously her speech evidences more than a simple delay, and deviant patterns – most notably vowel distortions - remained in her speech. Her syllable structures remained predominantly CV and reduplicated CVCV, although there was now more evidence of the CVC phonotactic structure. Katie had acquired more adult forms: all plosives and nasals now appeared in all word positions, and she was using more fricatives in the word initial position. The incidence of major phonological simplifications in her speech had decreased for cluster reduction (from 100% to 70%); final consonant deletion (from 96% to 54%); and voicing errors (from 40% to 12%).

Table 5.17
Comparison of Katie's speech data at CA 6;5 (pre-intervention) with CA 8;2 (post-intervention)

Assessment	CA 6;5 Pre-intervention	CA 8;2 Post-intervention
Severity indices	PCC 22 % PVC 74,1 % PPC 41,9 %	PCC 49 % PVC 73,2 % PPC 58,2 %
Phonetic inventory	Word initial position: [m, n, p, b, d, t, k, g, f, w, j, r, dʒ] Word medial position: [m, b, d, t, k, g, w] Word final position:	Word initial position: [m, n, p, b, d, t, k, g, f, s, w, j, r, l, dʒ] Word medial position: [m, n, p, b, d, t, k, g, f, w, l] Word final position: [m n, ŋ, p, b, t, d, k, g]
Stimulability	All phonemes except [v, ð, ʃ, ʒ, tʃ]	All phonemes except [v, ð, ʃ, ʒ, tʃ]
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (100%); final consonant deletion (96%); prevocalic voicing (40%); stopping of fricatives and affricates (21%); gliding (21%) Non-developmental processes: Vowel distortion (25%)	Developmental processes: Cluster reduction (70%); final consonant deletion (54%); prevocalic voicing (12%); stopping of fricatives and affricates (20%); gliding (21%) Non-developmental processes: Vowel distortion (25%)
Single word speech sample	[bæ] for BAG [wɛ] for WEB [vɪ] for FISH [gɪ'mɛ] for CHRISTMAS [bæ] for PRAM [ɛ] for EGGS [bɪ] for BEES	[bæg] for BAG [wɛb] for WEB [vɪ] for FISH [gɪ'mɛ] for CHRISTMAS [pæm] for PRAM [ɛ] for EGGS [bɪ] for BEES
Connected speech sample	[jɪlɪtə.gɜ.ɪmɪdæ] for THE LITTLE GIRL IS MICHELLE [də.fi.lɪ.ə.bɪ] for THE THREE LITTLE PIGS [ɑɪ bɪbæ wu] for I'M (THE) BIG BAD WOLF [jə.tʊdɛ.ɑ.nɔdɪ] for THE CHILDREN ARE NAUGHTY [fɪŋgə.pʊpɛ] for FINGER PUPPET	[ɑɪ lu?maɪgæ] for I LOVE MY CAT [maɪ.neɪ.mɪsɪpagə] for MY NAME IS MRS PARKER [ɪdɪnə.tɑmaʊ]for IT'S DINNER TIME NOW [jə.tʊdɛ.mɛmɪmæ] for THE CHILDREN MAKE ME MAD [fɪŋgə.pʊpɛ] for FINGER PUPPET

It is clear that Katie made significant gains in her speech production at the micro level. Results from the macro evaluation were less clear-cut. Qualitative insights from the PACS suggested that while Katie's speech is still deviant both at a structural and a segmental level, she is using phonological simplifications in a way that is now characteristic of a slightly older child. Her final consonant deletion is less evident, and some other immature patterns (e.g. cluster reduction and voicing) have also decreased. However, the assessments (e.g. Word-finding vocabulary test, Renfrew 1995, Edinburgh articulation test, Anthony et al. 1971) used at level G of the speech processing profile, showed that Katie had not improved in relation to her peers.

Her speech difficulties require more intervention to bring about change at a global level, suggesting that her motor programming difficulties, targeted in intervention, are a core deficit in her speech processing system. The notions of whole-word phonology and

phonotactic therapy (Velleman and Vihman 2002; Velleman 2002) were central to this intervention. They may account to some extent for the specific speech improvements noted at a micro level, and not at the macro level. Intervention aimed to establish a new phonotactic frame in Katie's motor programming system, but has not *yet* focused on the accurate insertion of phonemes into the template. In terms of the developmental phase model (Stackhouse and Wells 1997, 2001) Katie's speech may now be more characteristic of the systematic simplification phase, having been helped to progress from the earlier whole word phase. If systemic simplifications (e.g. stopping) were addressed in future intervention, more global changes in her speech may be observed.

6.2.4 Child interview and parental / teacher report

The child interview, and evaluation from significant others was carried out again at CA 8;2 to provide further impressions of changes in Katie's speech.

6.2.4.1 Child interview

The same interview procedure as described in section 2.4.1 and Table 5.4 was carried out at the long-term follow-up assessment. Katie re-iterated much of what she had said initially: she continued to enjoy school and mentioned subjects such as art and PE as her favourite. She admitted that she doesn't like 'hard work... any work.' She thought that her speech had improved because of her hard work, an also because she was getting older. She greatly enjoyed the teaching games that we had played in the sessions, and had decided that she would like to be a teacher when she is older. She reported that reading and spelling were hard for her, but that she still enjoyed reading her own easier books at home. Katie remained positive about her speech and communication in general.

6.2.4.2 Teacher report

Katie's class teacher and LSA were again asked to complete Bishop's (1998) CCC. The same LSA was involved in both of these evaluations, but different teachers (Year 2 and Year 3) took part at the different times. The results of the checklist are presented in Table 5.18.

Table 5.18
Comparison of Katie's ratings on the Children's Communication Checklist (CCC, Bishop, 1998) pre- and post intervention

CCC subscale	Example of behaviours in each subscale	Katie's score (pre-intervention	Katie's score (post-intervention	Comments*
A. Speech output: intelligibility and fluency	Intelligibility; use of immature speech sounds; rate and fluency	26	22	Scores of 27 or below require further investigation
B. Syntax	Grammatical errors, phrase length	32	32	Scores below 29 require further investigation
C. Inappropriate initiation	Ability to talk appropriately to different people; whether amount and nature of communication is appropriate for the situation	27	30	Katie's composite score for the Pragmatic subscales C-G was 146 initially, and 154 post-intervention. Scores below 132 are considered indicative of pragmatic impairment.
D. Coherence	Ability to talk logically; make explicit information when needed	29	34	
E. Stereotyped conversation	Use of favoured phrases and topics; over-precise manner	27	30	
F. Use of conversational context	Understanding conversational rules; social appropriacy	29	28	
G. Conversational Rapport	Appropriacy of initiation and response to initiation of conversation; understanding and use of facial expression, gesture and eye-contact	34	32	
H. Social relationships	Friendships; interactions with children and adults	33	34	Scores of 24 or less require further investigation
I. Interests	Having very focused interests; prefers to do things alone or with others; interests in factual information	33	32	Acceptable: Scores of 28 or less require further investigation

* based on clinical guidelines from http://epwww.psych.ox.ac.uk/oscci/dbhtml/CCC/cccinstruct.htm

Once again, it is clear from the information obtained from the checklist that Katie's main difficulties are with her speech. Her speech score was lower than at the initial assessment which may be due to increasingly noticeable difficulties in comparison to her peers, or due to the different raters used. Both these scores fall within Bishop's (1998) 'danger zone.' Katie's score for syntax remained the same, and her pragmatic score had improved, placing her well above the 'danger zone' for this area.

In order to provide further information about Katie's academic progress over the course of the intervention, SATs results were obtained from the assessments carried out at the end of Year 2 (prior to starting intervention) and at the end of Year 3 (at the completion of intervention). These results are shown in Table 5.19 and indicate that Katie has made

some progress in her general academic work, but it is not greater than might be expected over the course of this time period.

Table 5.19
Katie's SATs results from pre-intervention (Year 2, CA 6;9) to post-intervention (Year 3, CA 7;10)

Area	Year 2: CA 7;3	Year 3: CA 8;3	Comment*
Reading	1B	2C	Improved 2 grades
Writing (includes spelling and handwriting)	1C	1B	Improved 1 grade
Numeracy	1C	1B	Improved 1 grade

* the numbers indicate the child's level of ability which moves from 1 upwards through to a target of 4 by the end of key stage 2. An A symbol indicates the child is almost ready to progress to the following level, whereas C or B suggests that they need further consolidation at that level. Here changes are reported in 'grades' which are derived from the number of 'letter' changes occurring, i.e. 1B to 1A constitutes an improvement of 1 grade. One would expect an average child to move 2-3 grades in the course of a year.

6.2.4.3 Parent report

Katie's parents were pleased with the intervention and noted that her speech seemed easier to understand. They also commented that she was more confident to communicate with strangers. They remain anxious about her speech and want her to continue receiving therapy to further improve her intelligibility.

6.2.5 Summary of macro evaluation

1. The macro assessment procedures carried out at the start of the project were re-administered on completion of the entire intervention programme in order to evaluate the intervention from a global perspective.

2. Standardised tests of speech, language and literacy showed little change over the course of intervention with Katie's performance decreasing in many cases when compared to her age-matched peers. Her reading performance remained age-appropriate, while her spelling remains delayed by approximately one year.

3. Katie's speech processing profile was largely unchanged with just one of the levels showing improvement: level D, which poses the question: 'Can the child discriminate between real words?'

4. Phonological analyses showed Katie to be using patterns of phonological simplification in an approximately equivalent way to a normally developing 4;5 year old. However, as mentioned previously her speech evidences more than a simple delay, and deviant patterns remained prominent in her speech. The incidence of major phonological simplifications in her speech had reduced form the initial assessment.

5. Katie's teachers expressed more concern about her speech difficulties than at the initial evaluation. Katie and her parents were positive about the outcomes of the intervention, but her parents remained anxious that she receive more intensive therapy.

7. DISCUSSION

Connected speech can pose particular problems for children with speech difficulties. In Katie's case, much of the assessment and the early phases of intervention focused on her single word speech production. However, spoken language consists mainly of connected speech, and the ultimate aim of intervention is for children to have increased intelligibility in their spontaneous, connected speech. For these reasons, Katie's connected speech was monitored throughout the intervention and specifically addressed in the final phase of therapy. Katie made significant gains with her connected speech, only following the intervention phase that had targeted this level of speech processing. The intervention hierarchy moved from specific lists of single words to more general single words, and finally to single words in sentences.

Most research into children's connected speech has concerned itself with monitoring normal development. However, Newton (1999) considered the junctions used in connected speech by three 11-year old children with persisting speech difficulties. She found that these children were able to use adult-like junctions on occasion, but would also use junctions that were simplified from an articulatory point of view, and atypical in terms of normal development. Such studies are vital for increasing our understanding of children with persisting speech difficulties and how best intervention may help them. Katie was different to the children described by Newton: not only was she younger, but she also experienced difficulties with speech at both the single word and connected level. If one returns to theories of productive phonological knowledge (Gierut et al., 1987) and complexity accounts of treatment, then one may consider that addressing connected speech initially would have

been a more efficient way of bringing about phonological change. This rests on the assumption that connected speech represents a more complex linguistic level than the single word level. This may not be the case since very young children (e.g. CA 2;4, Newton, 1999) show awareness of connected speech patterns.

Connected speech is a more natural phenomenon than communicating in single words: Katie seemed to enjoy the connected speech activities more than the intervention targeting single words. Children's motivation may increase when communicative relevance seems greater. Furthermore, in connected speech, processes such as assimilation provide natural support, for example for children such as Katie attempting to realise final sounds. The careful selection of hierarchically graded connected speech stimuli for this part of the intervention was useful in building on Katie's strengths and gently leading her to more challenging steps. Intervention approaches which use connected speech stimuli in this way are seldom used, yet potentially valuable for many children with severe difficulties. Example of facilitative phonetic contexts can be found in the speech therapy literature (e.g. see Kent, 1982; Grundy, 1989; Grunwell, 1992), but it is interesting that these facilitative contexts do not extend across word boundaries.

Stackhouse and Wells' (1997, 2001) speech processing model considers that connected speech is brought into play at the level of motor planning. Here motor programmes for individual words are assembled into one overall plan for speech production in a particular grammatical framework. This was the rationale behind the planning of three successive intervention phases moving from single word to connected speech. However, it has been noted (Stackhouse and Wells, 2001) that input processing and phonological representations may also be involved in connected speech. Loucas and Marslen-Wilson (2000) have shown age-related changes in children's connected speech processing.

Camarata (1998) emphasises the importance of connected speech within an intervention context, in his argument about a speech-language overlap. He suggests that single word speech assessments are likely to represent children's highest level of speech competence, and that children's speech should routinely be investigated in syntactic contexts and 'running speech.' From a clinical perspective, this is by no means a new suggestion. However, what is new is the suggestion made by Camarata (1993, 1995; 1998) and others (e.g. Stackhouse and Wells, 2001), and re-emphasised here, that intervention planning should explicitly consider connected speech. Camarata (1998) questions whether 'the conventional wisdom regarding treating speech disorders is in fact true,' i.e. the 'traditional' hierarchies for speech intervention which move form single sounds to single words and finally to connected speech may be inappropriate for intervention planning. A search of the literature reveals few intervention papers addressed primarily to improving children's speech at a connected speech level. Intervention papers emphasising connected speech are typically

concerned with client groups such as children with dysfluent speech (Ingham et al, 2001), hearing impairment (Allen et al, 1998) and Down syndrome (Stoel-Gammon, 2001) rather than children with persisting speech problems. A paper by Fazio (1997) focussed on intervention with low-income children with and without specific language impairment. The children were required to learn a poem, and evaluated in terms of their ability to remember the poem and produce the poem. Although the main theoretical concerns of the paper are with phonological awareness and memory, the paper does provide interesting insights into the challenges of connected speech production.

It has been shown how Katie's written representations improved in line with her speech production: as Katie learnt to indicate the coda segments in final words in her speech production, she also showed improvement in realising these in written forms. However, it is interesting that her written representations were significantly more accurate than her spoken representations both initially and at the completion of intervention. Katie's difficulties arose at the level of motor programmes for speech. The fact that her spelling was significantly better than her speech suggests that these representations may be coming from discrete stores: her (visual) orthographic representations were significantly better than her (verbal) motor programmes. However, her motor programmes did improve more significantly than her spelling over the course of intervention, suggesting that the inaccurate motor programmes were not intractable.

Psycholinguistic approaches can be applied to a wide-range of individuals: individuals with normally developing speech, children with specific diagnoses and children with more subtle speech and language difficulties. The speech processing profile from Stackhouse and Wells (1997,2001) does not exclude children with particular diagnoses: it offers an approach to intervention planning that is not solely dictated by a child's diagnosis. Previous research has aimed to investigate the speech processing skills of children with cerebral palsy. Corkett (1997) investigated the auditory processing skills of two children aged 9;10 and 10;9 with severe dysarthria and cerebral palsy. It was noted, as in Katie's case, that both children had input difficulties in addition to speech output problems. The children varied in many ways (e.g. in their literacy and auditory discrimination) although both had inaccurate phonological representations. This work, together with the case presented in this chapter, highlights the fact that the same intervention programme is not likely to be suitable for children grouped under one diagnostic label. Another contribution arising from Katie's case is that children with ataxic cerebral palsy *can* make significant progress in terms of speech, discrimination and literacy when given carefully focused and intensive intervention, although a caution to consider is that this conclusion is based on evidence from just one child. If one were to only consider - or indeed administer - the macro measures, one might conclude that intervention had brought about very limited changes in

Katie's speech processing and perhaps even the decision to not continue with therapy. Given that speech was the main focus of intervention, one might conclude that the intervention had failed. The micro assessment yields a much more positive picture of changes that have been brought about. Clearly, we need to consider the two levels of change as closely interlinked. Ongoing and intensive intervention brings about micro changes that may ultimately result in macro changes.

Again, returning to the overlap between speech and language, it has been suggested that language learning is a transactional process (Yoder and Warren, 1992). Children who produce unintelligible messages at risk for difficulties with language development since their speech is the focus of the parent's response and "the learning transaction is disrupted when the adult cannot understand the child's communicative act." (p.315). This emphasises the point that speech difficulties should be examined in the light of language development beyond a narrow conceptualisation of a particular diagnosis. Katie was regarded as a child with delayed phonological development (Dodd and McCormack, 1995). Bradford and Dodd (2000) have suggested that children with phonological delays will benefit the most from a 'whole language approach.' From this point of view, the single word stimuli used in the first phase of intervention may have been less than optimal for Katie. More long-lasting gains made have been made at this level if high frequency words specific to Katie were used. Similarly such words could have been incorporated into the phrases to maximise carryover.

Recent randomised control studies (Glogowska et al. 2000) suggest that interventions for children with speech and language impairments do not work. However, in evaluating such studies we need to consider the dosage and nature of therapy that is given, and how 'progress' is assessed. Clearly, in the case of children with severe, specific and persisting speech difficulties, intervention *can* be successful when the intervention is specific and intensive. The case presented here provides evidence of the value of direct and specific intervention for a child with severely disordered speech. Law and Conti-Ramsden (2000) urge practitioners and managers to offer a more flexible package of interventions, suggesting that the results of a body of evidence-based practice should be acted upon. Studies such as the one presented here contribute to that body of evidence.

CHAPTER 6: JOSHUA

Chapter outline Page

Much of the research into children's phonological development has centred on the production of individual segments, and many intervention programmes have individual phonemes as their focus. Yet consonant clusters[10] are an important aspect of speech development for English-speaking children, and a frequent source of difficulty (e.g. Smit, 1993; McLeod, van Doorn and Reid, 1997). Gierut (1999 p.709) describes onset clusters as being "extremely vulnerable in the acquisition course." This vulnerability makes clusters theoretically interesting, and practically important in terms of intervention.

There are relatively few studies that have investigated children's development of onset consonant clusters. Some researchers have focused on the phonetic properties and substitution errors made by children with phonological difficulties, contrasting them with those developing normally (e.g. Allerton, 1976; Smit, 1993; McLeod et al., 1997). Others have explored children's underlying knowledge about consonant clusters without requiring explicit productions (Lance, Swanson and Peterson, 1997). There is also a small group of studies that has investigated children's cluster development by manipulating clusters in intervention for children with phonological difficulties. These studies have contributed to the body of knowledge about consonant clusters, specifically with regard to theories about learning (e.g. within-class generalisation, Elbert and McReynolds, 1975; Williams, 2000a,b) and language (e.g. sequential markedness, Powell and Elbert, 1984; Clements and Hume, 1995; and sonority sequencing, e.g. Gierut, 1999; Pater and Gierut, 2003). However, there remains a great deal of uncertainty regarding consonant clusters and their acquisition both by children with normal phonological development and those with difficulties. This chapter considers the changing production of word-initial consonant clusters by a 6-year-old boy, Joshua, over the course of intervention.

Section 1 considers Joshua's background, showing how his speech difficulties are one aspect of a more general developmental delay. Joshua's assessment is described in section 2, followed by sections on macro (section 3) and micro (section 4) intervention

[10] For the remainder of this chapter the term 'cluster' is used to refer to adjacent consonant phonemes in word initial position, thus covering both clusters and adjuncts unless specified otherwise.

planning. These sections outline the rationale underpinning the intervention, both in terms of the psycholinguistic focus and the phonological analysis which led to the selection of consonant clusters as targets for intervention. Section 5 describes Joshua's intervention programme. Section 6 is an evaluation of the intervention outcomes, and this is followed by a discussion of the intervention and associated themes in section 7.

1. BACKGROUND INFORMATION

Joshua was 6;10 at the start of the study and in Year 2 in a mainstream school. His involvement in the study continued until he was 8;8 and in Year 4.

1.1. Developmental

Joshua has a history of general developmental delays and behavioural difficulties. He was a breech baby born by emergency caesarean section. Shortly after birth Joshua was hospitalised for pneumonia. Research by Fox, Dodd and Howard (2002) into factors that may put children at risk for having speech difficulties, suggests that pre- and peri-natal difficulties are a risk factor. Joshua was not affected by other risk factors cited by these authors (e.g. middle ear infections, and a family history of speech difficulties). Motor milestones were achieved later than normal with Joshua sitting at 1;0 and walking at 1;7. His fine motor skills and communication also developed slowly but in a normal sequence. Joshua started to babble repetitively at 1;2. He had no recognisable single words at 1;3, relying on pointing and gesture, making noises and producing jargon to signal his needs. He was referred for speech and language assessment at this time.

Joshua's first multi-disciplinary assessment took place at 1;9. It was found that his speech and language, attention and motor skills were delayed. Joshua and his mother received support from speech and language therapy, occupational therapy, physiotherapy and psychologists /social workers from that time. While he has compensated for some of his motor weaknesses, difficulties remain in many domains with Joshua described as a child with a complex pattern of neuropsychological deficits. He has been identified as having an autistic spectrum disorder and/or deficits of attention, motor control and perception (DAMP[11]) which combines elements of Asperger's syndrome and Attention Deficit Hyperactivity Disorder (ADHD). Joshua presents differently on different occasions: at times

[11] While diagnoses of DAMP are seldom given in the United Kingdom, the term is one that originated in Scandinavia some twenty years ago and is widely used in parts of Northern Europe. Gillberg (2003) suggests that about 1.5% of the general population of school age children in Sweden are affected by the condition. Gillberg (2003) provides a review of the condition, and notes that the diagnosis is typically made by psychiatrists or paediatricians.

showing a good degree of sociability and imaginary play, and at other times being described as obsessive, rigid, and repetitive in his play sequences. He exhibits features associated with autism including marked resistance to change, difficulty forming relationships and delayed communication. Throughout his development to date, the major concerns have been about his delayed communication and his limited attention.

Joshua's handedness was late to develop. He increasingly used his left-hand from 4;0 and is now left-handed. No hearing difficulties have been noted at any time and he has passed all hearing tests.

1.2 Educational

Joshua started nursery at 3;6 and settled in well, making some progress with his language. He observed other children to see what he should be doing as he did not always understand the teacher's instructions. Joshua enjoyed nursery and many aspects of the associated routine. He made some friends and enjoyed playtime, but found it hard to face and copy a partner in class activities. Joshua's mother was keen for him to attend a mainstream school, but was aware that he would need support to cope in this environment. Joshua obtained a statement of Special Educational Needs on entering Year 1 and this provides access to 25 hours of learning support assistant (LSA) time per week.

In Year 1, Joshua's behaviour was regarded as increasingly problematic by his teachers as the learning and social demands of school increased. He found it hard to sit still for the necessary amount of time. His teacher described him as disruptive to the other children as he frequently knelt on the floor and made loud, animal noises. It was noted that Joshua had a good sight vocabulary but poor comprehension. In Year 2, Joshua's behavioural difficulties remained. The LSA provides support in the classroom, as well as individual and small group lessons away from the larger class group. Joshua is in the weaker ability group in his class for all subjects, and relies on the LSA for support. He is a slow worker, lacking independence and initiative. He finds it hard to organise himself to carry out basic tasks on his own. However, he enjoys reading and writing and tries hard with these activities. Joshua finds it difficult to listen and follow instructions. He is able to sustain his attention on a task if it interests him, but he is easily distracted by other children. He finds that humming loudly to himself while working helps him to concentrate, although this is distracting for his classmates and teacher. Joshua's behaviour is impulsive and he is often in trouble for shouting and upsetting other children.

IQ results (WASI, Wechsler, 1999) suggest a verbal IQ of 70, a performance IQ of 76 and a full-scale score of 70, which falls in the borderline range.

1.3 Medical

Joshua has been hospitalised on several occasions and has some on-going health problems. He has scoliosis that affects his muscle development and requires physiotherapy. He also has problems with his joints, which require ongoing medical attention. He has asthma and is prone to upper respiratory tract infections. Nevertheless he is an active child who enjoys physical activity. His level of absenteeism from school is high.

1.4 Speech and language therapy

At 1;3 Joshua was able to babble repetitively but had no recognisable single words. His mother and health visitor were concerned, and he was referred for speech and language assessment where it was confirmed that his language was delayed for his age. Both his receptive and expressive language were considered delayed, and in line with his generally delayed development.

Speech and language intervention initially focused on basic communication such as turn-taking, listening and play. Joshua's mother found him hard to understand, as he would become frustrated and angry when he wanted something. Rebus and Makaton signs were introduced to overcome some of Joshua's expressive language difficulties. It was difficult for his mother to carry out many of the activities at home, and SLTs found him challenging to work with.

A nursery visit at CA 3;6 found Joshua's comprehension to have improved so that he was now able to understand 2 and 3 word utterances. Joshua was also starting to join two words together, although these were not clearly produced. The CELF-Preschool (Wiig et al., 2001) was administered at CA 3;11 with standard scores of 6 (receptive) and 7 (expressive) obtained, and an age equivalent of 2;09 years. Turn-taking remained hard for Joshua and there was little improvement in his pretend play.

By Year 1, Joshua was using 2, 3 and 4 word combinations and it was clear that his phonology was severely delayed. His attention and listening skills were still a cause of concern, and intervention encouraged Joshua to listen and copy isolated speech sounds, which he was able to do with some success. The Reynell Developmental Language Scales (RDLS III, Edwards, Fletcher, Garman, Hughes, Letts and Sinka, 1997) was carried out at CA 4;8 with an age equivalent score of 3;0 obtained. The CELF-Preschool (Wiig et al., 2001) was re-administered at CA 5;4 with standard scores of 3 (expressive) and 5 (receptive) obtained, suggesting that Joshua remained delayed by about 1;0 – 1;6 years in his language.

From Year 1, Joshua has been visited in school by an SLT on a termly basis. The SLT programme has been carried out by the LSA daily. At the start of Year 1, Joshua could produce a limited range of consonants, and phonological processes such as final consonant

deletion and cluster reduction were pervasive. Intervention in Year 1 aimed to expand his consonant repertoire. Phonological awareness, listening and social skills were also addressed. By the end of Year 1, it was noted that Joshua's speech and language had improved, although many difficulties remained. In Year 2, at the start of this project, Joshua's teacher described his speech as 'babyish' and noted that he does not always talk in well-formed sentences, although he is intelligible most of the time. Joshua's SLT expressed concerns about his pragmatic language use, describing him as follows:

> "well motivated to use his language skills but always on his terms: he likes to dominate conversation and finds it hard to listen to others and take their needs and contributions into account."

At this point, his expressive language was delayed by ~2 years, and his general development delayed by ~1 year. Although Joshua's speech is immature and inappropriately loud for much of the time, familiar and unfamiliar listeners understand him. Cluster reduction is pervasive in his speech. Joshua remained on the NHS caseload at the time of the study and his assessment and intervention was carried out in close collaboration with his NHS SLT. Table 6.1 summarises Joshua's intervention history. It can be seen that he has received speech and language support from the local service in a variety of forms from CA 1;3.

Table 6.1
Summary of Joshua's speech and language therapy history

Education	CA	Intervention	Frequency	Comments from case notes
	1;3 – 3;5	General language intervention, e.g. work on turn-taking, attention and play	Seen fortnightly at child development centre or at home	Joshua's behaviour is challenging. He likes to direct activities and is resistant to change. He is hard to understand.
Nursery	3;6 – 4;5	Nursery visits: Observation and advice to nursery staff about Joshua's social and communication skills.	Fortnightly	Comprehension has improved and Joshua understands 2 and 3 word utterances. He is starting to join 2 words together. Turn-taking and pretend play is minimal.
Reception	4;6 – 5;5	Aimed to improve Joshua's auditory attention and listening skills; he was encouraged to copy speech sounds in isolation	Seen in school by SLT on ~ monthly basis with programmes carried out by LSA and teachers	He uses longer sentences now that are hard to understand. His speech is severely delayed with many immature processes noted (e.g. final consonant deletion, cluster reduction, reduplication, stopping). He can copy most phonemes and this is where he has achieved success in intervention.
Year 1	5;6 – 6;5	Listening programme with clapping out of syllables. Letter-sound games to promote phonological awareness; work on word final consonants.	Small group sessions with other children, carried out by LSA on a twice weekly basis, under direction of SLT	Joshua tries to listen but is distracted by other children and often gets into fights. His syllable clapping has improved. He is able to produce [k] and [p] word-finally.
Year 2	6;6 – 7;5	Working on [s] in CV segments, words and phrases.	Individual and small group sessions with LSA twice weekly, under direction of SLT	Production of [s] is improving but he still relies heavily on copying from models and verbal reminders.

1.5 Family

Joshua has one brother who is a year older than him, and does well at school both academically and socially. They live with their mother, who separated from their father shortly after Joshua was born. Joshua's mother works at nights and the grandparents care for the children. The children have some limited contact with their father. Joshua's mother has been extremely concerned about his delayed development and unusual behaviours from the time Joshua was approximately one year of age.

1.6 Social

Joshua has behavioural difficulties that have been noted from his earliest development and have continued to the present time. Psychologists and social workers have seen him for assessments and intervention on a regular basis. Joshua finds it hard to relate to other children and adults, and this is reflected in his limited conversational and listening skills. His inappropriate behaviours affect his ability to learn: He is frequently out of the classroom being punished, and as he has got older his dislike for school has increased. Joshua has little control over his impulses, and is an easy target for bullying and provoking. His mother prefers him to remain in a mainstream school, but it has been suggested by school staff that a specialised school may ultimately be more appropriate for Joshua.

Joshua's mother reports a range of difficulties in his behaviour at home, with problems increasing as he gets older. He frequently fights with his brother, has tantrums and aggressive outbursts when he cannot get what he wants, and is upset by small changes to routine. In the one to one situation, Joshua is co-operative and enthusiastic. He is a talkative boy who seems eager to please. He has some insights into his difficulties – both his communication difficulties and his behavioural problems. Joshua has some friends of his age but prefers adult company. He thrives when praised and enjoys structure and routine.

1.7 Summary of background information

Joshua is generally delayed in his development, and evidences associated delays in his speech and language. He has been diagnosed as mildly autistic, and having deficits of attention, motor control and perception. He presents with challenging behaviours in addition to speech, language and academic delays. He attends a mainstream school and requires individual support in order to cope with the demands of this environment. Joshua was first referred for speech and language therapy at CA 1;3 as he had failed to attain normal communicative milestones by this age and was not yet using single words. He has received regular intervention from this time and has made slow progress in his use and understanding

of language. His speech still evidences many immaturities, but is understood by most listeners. Joshua's social skills and behaviour are a concern for his teachers and family.

2. ASSESSMENT

Assessment was carried out at the start of the study when Joshua was in Year 2 (CA 6;10-7;2). The entire assessment procedure was re-administered on completion of the intervention, when Joshua was in Year 3 (CA 8;0 - 8;2) and at long-term follow-up when Joshua was in Year 4 (CA 8;7 – 8;8). Assessment was divided into four main areas: (2.1) standardised language assessment, (2.2) speech profiling carried out within the psycholinguistic framework, (2.3) phonological analysis, and (2.4) child interview and parent / teacher report. Results of these assessments are presented in the following sections.

2.1 Standardised language assessment

The results of the standardised assessment are summarised in Table 6.2.

Table 6.2
Joshua's standardised speech, language and literacy assessment results at CA 7;2

Assessment	Area tapped	Std score	Centile	Age equivalent
Receptive language				
Test for the reception of grammar (TROG, Bishop, 1989)	Receptive grammar	72	2	4;6
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive vocabulary	84	1	5;1
Expressive language				
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive vocabulary		1	3;8
Expressive Subtests of Clinical Evaluation of Language Fundamentals (CELF- 3), (Semel et al., 1995).	Expressive language	9	40	
Edinburgh Articulation test* (EAT, Anthony et al., 1971)	Articulation and naming	74	45	~5;0
Renfrew Bus Story (Renfrew, 1969)	Information and grammar		2 2	4;6 4;6
Literacy measures				
Schonell Graded Reading Test (Subtest of Aston Index, Newton and Thompson, 1982).	Reading single words			Reading Age = 6;11 years
Schonell Spelling Test (Subtest of Aston Index, Newton and Thompson, 1982).	Writing single words from dictation			Spelling Age = 6;4

* EAT is designed for use with children up to the age of 6;0. Joshua's scores were calculated using this upper age limit although he was 7;2 at the time of the assessment.

The standardised assessment revealed that Joshua has delayed speech and language development. He showed difficulties with his understanding of language both in terms of

syntax and vocabulary. His expressive language and articulation are similarly delayed. This is consistent with a general developmental delay, although slightly more so than might be expected given his borderline IQ. In terms of literacy, Joshua's ability to visually recognise single words is age-appropriate, and his spelling is only slightly delayed for his age. However, Joshua's ability to comprehend sentences and larger pieces of text may be more delayed since this was not measured by the single word reading task.

2.2 Speech profiling in a psycholinguistic framework

The speech processing profile of Stackhouse and Wells (1997) was used as a framework for organising the data from this part of the assessment. At each level of the profile at least one assessment was carried out[12]. In some cases results obtained from the standardised tests were incorporated into the profile, and in other cases unpublished, non-standardised tests or subtests from standardised materials were used (see Appendix 2). The ticks and crosses on the profile indicate Joshua's performance in relation to children of his chronological age, with one tick indicating age-appropriate skills, and further ticks or crosses showing the number of standard deviations above or below the mean. The completed profile is presented in Figure 6.1.

2.2.1 Overview of psycholinguistic speech processing profile

Joshua has more difficulties with output than with input. Within each of the different levels, Joshua performed variably: his difficulties were often item-specific rather than being a general problem with a particular level of processing. This accords with Dodd's (1995) account of children with phonological delay. She considers that children with phonological delay do not have a specific locus of deficit in terms of a speech processing model, but rather that the entire system is like that of a younger child. Although this is generally the case for Joshua, he does nevertheless have clear areas of relative strength and weakness on his profile.

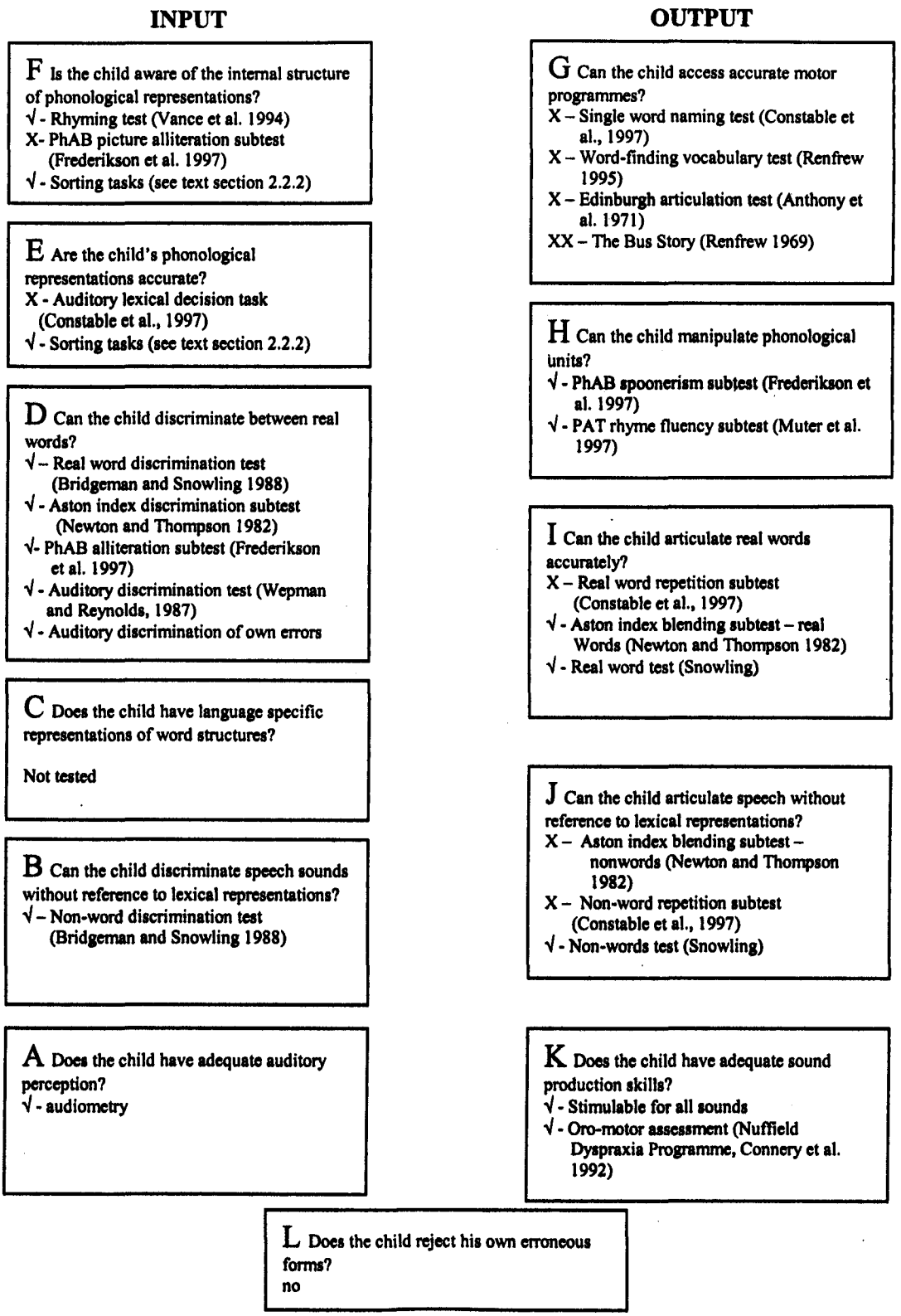
2.2.2 Strengths

In terms of input, Joshua has strengths towards the lower part of the profile: he was able to discriminate between speech and non-speech sounds with ease. His phonological representations were found to be generally accurate - a relative strength – although for some of the longer, less familiar words they were less clear. He has knowledge of the internal structure of phonological representations of CVC and CCVC words, as tested by sorting tasks and rhyme pictures (see Appendix 2). He performed less well on the alliteration

[12] With the exception of level C which is not routinely assessed in monolingual children (Stackhouse and Wells, 1997).

picture subtest of the PhAB (Frederikson et al., 1997), suggesting that he was not aided by the visual information contained in the pictures.

Figure 6.1
Joshua's Speech Processing Profile at age 7;2 (from Stackhouse and Wells, 1997)
√ = age appropriate performance
X = 1 s.d below the expected mean for his age
XX = 2 s.d below the expected mean for his age



2.2.3 Weaknesses

Joshua had widespread difficulties on the output side of the profile. These were weighted to the top of the profile with Joshua having adequate sound production skills, although he lateralises [s] on occasion. He produces consistent speech errors in his repetition and naming. Joshua's speech errors are generally like those of a younger child rather than being unusual or symptomatic of deviant development. His speech delay is in line with his language levels and cognitive skills. As one would expect, longer words that Joshua found hard to recognise from the Constable et al. (1997, see Appendix 2) recognition task, were also harder for Joshua to produce in an accurate way.

2.3 Speech analysis

PACS (Grunwell, 1985) was used to provide information on Joshua's speech production. A summary of the findings is presented in Table 6.3.

Table 6.3
Summary of Joshua's speech data at CA 7;2

Assessment	Comments	
Severity indices	PCC 78 % PVC 100 % PPC 86.7 %	
Phonetic inventory	Word initial position: [m, n, p, b, t, d, k, g, f, v, s, z, ʃ, tʃ, dʒ, j, l, w] Word medial position: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w] Word final position: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w]	
Stimulability	All phonemes	
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (87.7%); consonant harmony (9%)	
Single word speech sample	[dʒeɪpɪb] for JACOB [lɛləʊ] for YELLOW [tætikɪlə] for CATERPILLAR [hɒsbɪkɪl] for HOSPITAL [ɒ.ə.bɪl] for HOSPITAL [bʊvə] for BROTHER [kɑf] for SCARF [kʊtə] for SCOOTER	[bun] for SPOON [kul] for SCHOOL [gændæd] for GRANDDAD [wɒps] for WASP [dɛsk] for DESK [vɛst] for VEST [klæs] for CLASS [kɒk] for CLOCK
Connected speech sample	[ʃi.gɒ. ə. bækwʊn] for SHE GOT A BLACK ONE [də. fwi. lɪtə. pɪg] for THE THREE LITTLE PIGS [ɑɪm. və. bɪgbæd wʊf] for I'M THE BIG BAD WOLF [nɑʊ.də.tʊlɛf] for NOW THE TWO (ARE) LEFT [fɪŋgə.pʊpɛ] for FINGER PUPPET	

The severity of Joshua's speech difficulties was estimated at two points before the intervention: at the start of the macro-assessment, and at the micro-assessment, carried out ~6 weeks later. PCC (percentage of consonants correct), PVC (percentage of vowels

correct) and PPC (percentage phonemes correct) were used[13]. The difference between these scores at the two pre-intervention points was not a significant one indicating a stable pre-intervention baseline. The most noticeable process in his speech was cluster reduction, frequently observed for all clusters in word initial position, e.g. [bun] for SPOON, [kul] for SCHOOL; [gændæd] for GRANDDAD. Joshua reduced clusters in 43 of a possible 49 instances (87.7%). On some occasions elements of the [s] cluster were used in a reversed order in the word final position (e.g. [wɒps] for WASP). Joshua's productive phonological knowledge (PPK) varied from cluster to cluster. Further examples of Joshua's cluster realisations and PPK classification for clusters as outlined by Gierut and Dinnsen (1987, and see Table 2.1) are presented in Table 6.4.

Table 6.4
Summary of Joshua's productive phonological knowledge (PPK) for all consonant clusters

Consonant cluster	Examples	Productive phonological knowledge (PPK)* 1 – maximum PPK; 6 – no PPK
[tw]	[tælv] for TWELVE; [twenty] for TWENTY	3
[kw]	[kin] and [kwin] for QUEEN	3
[sp]	[bun] for SPOON	6
[st]	[dɑ] for STAR; [vest] for VEST	4
[sk]	[kɑf] for SCARF; [desk] for DESK	4
[sm]	[məuk] for SMOKE	6
[sn]	[nəɪk] for SNAKE, [nɔ] for SNORE	6
[sw]	[sɒp] for SWOP	6
[sl]	[sip] for SLEEP	6
[pl]	[piz] for PLEASE	6
[bl]	[bæk] for BLACK	6
[kl]	[klæs] for CLASS; [kɒk] for CLOCK	3
[gl]	[glaɪd] for GLIDE; [gʊv] for GLOVE	3
[fl]	[faʊwə] for FLOWER	6
[pr]	[pæm] for PRAM	6
[br]	[breɪk] for BREAK; [bʊvə] for BROTHER	3
[tr]	[tʃeɪn] for TRAIN; [twi] for TREE	6
[dr]	[daɪv] for DRIVE	6
[kr]	[kwɒs] for CROSS; [kɒkədaɪl] for CROCODILE	3
[gr]	[gændæd] for GRANDDAD	6
[fr]	[fʊt] for FRUIT	6
[θr]	[fwi] for THREE	6
[skw]	[gɛə] for SQUARE	6
[spl]	[pætʃ] for SPLASH	6
[spr]	[pɪŋg] for SPRING	6
[str]	[tɪŋg], [tʃɪŋg] for STRING	6
[skr]	kædʒ	6

* from Gierut et al. (1987) and Gierut and Dinnsen (1987), see Table 2.1.
PPK type 3: can produce on occasion but has fossilised forms for some words
PPK type 4: positional constraints - uses in final position only
PPK type 6: no knowledge - never uses

[13] following guidelines from Dodd (1995) and Shriberg et al. (1997c) and discussed in greater detail in Chapter 9 on intelligibility.

Nineteen of the 27 word initial consonant clusters were Type 6: phonemes about which the child has no productive phonological knowledge and is thus never able to use correctly. Two of the clusters, [sk] and [st] were considered to be Type 4 'positional constraint' clusters since Joshua was able to use these correctly in the word final position but not word initially, e.g. he accurately produced the targets DESK and VEST. The remaining 6 clusters, [kl], [kw], [kr], [br], [gl] and [tw] were Type 3 clusters, about which Joshua had the most phonological knowledge. He was able to accurately produce these clusters in the word initial position in some words (e.g. CLASS) but seemed to have 'frozen' forms for other lexical items (e.g.[kɒk] for CLOCK). Joshua also had immature or 'frozen' forms of non-cluster words which he produced like a younger child, e.g. [dʒeɪpɪb] for JACOB, and [lɛləʊ] for YELLOW. His production of these words alternated with accurate productions. Joshua found it hard to produce longer, multi-syllabic words. Sequencing errors (e.g. [tætikɪlə] for CATERPILLAR) and other sound confusions (e.g. [hɒsbɪkɪl] for HOSPITAL) were frequently noted in words with 3 or more syllables.

Joshua did not meet Dodd's (1995) criteria for inconsistency since he showed only 10% inconsistency in tasks requiring him to name items on more than one occasion over the course of a session. Dodd (1995) and Dodd, Hua, Crosbie, Holm and Ozanne (2002) suggest that 40% or more inconsistent productions are required over the course of a single session in order to consider a child in the inconsistent group. Inconsistencies are defined as variable erroneous productions. In most cases Joshua alternates his inaccurate productions with accurate realisations of the targets. Dodd et al. (2002) note that children with phonological delays and even those with *consistent* phonological disorder are *more* inconsistent than the normal population, however it is still possible to identify consistent error patterns. This is the case in Joshua's speech. Joshua's oro-motor skills and articulation of individual phonemes are normal. His phonological errors are all developmental ones expected from a younger child, with no unusual error patterns (Dodd et al., 2002) noted. This cluster of characteristics suggests that he is a child with consistent, delayed speech.

2.4 Child interview and parent / teacher report

This part of the assessment aimed to obtain impressions of Joshua's speech from Joshua himself, his class teacher, LSA and parent. As with the other assessments, this information was used to assist with intervention planning and to evaluate the outcome of the intervention.

2.4.1 Child interview

Joshua was interviewed in a semi-structured way in order to investigate the following areas: (1) his experience of speech and language therapy, (2) his perception of his speech, (3) his

attitudes about communication more generally, and (4) his attitudes to literacy. This interview procedure was carried out at two points in the study, midway through the intervention programme, when a rapport had been established, and at the completion of the intervention study at long-term follow-up. The results of the first interview are presented in Table 6.5 with the results of the second interview presented in the evaluation section for comparison.

Table 6.5
Summary of findings from Joshua's first semi-structured interview following Phase I of intervention

Area of questioning	Main findings	Examples of Joshua's responses
Joshua's experience of speech and language therapy		
• Present (comments on phase I)	Enjoys therapy, and likes therapist	"you're the best"
	Particularly enjoys games and drawing	"I like to draw with those fat pens and that other game you got"
	Doesn't enjoy pictures (i.e. assessment pictures) and some of the social stories	
	Therapy helps children to improve their speech through hard work	"(I'll get better) cos I will learn"
• Past	Can't remember	
Joshua's perception of his speech	He enjoys talking, although he had never thought about it before	"Yes! I do actually... cos its fun."
	He likes listening even more	
	He never has problems understanding people and thinks they can always understand him.	
Joshua's attitude to communication	Not everybody in the world speaks English. He knows some other languages like German, Chinese and Japanese.	
Joshua's attitude to literacy	Reading and writing are difficult. He doesn't think they are important	

2.4.2 Teacher report

Joshua's class teacher and LSA jointly completed Bishop's (1998) CCC. Information from the checklist (Table 6.6) shows that Joshua has difficulties both with speech and the pragmatic use of language. Bishop suggests for clinical purposes that children scoring less than 27 on the speech scale should be followed up with further investigations. Joshua scored 26, and thus fell into this range. His pragmatic composite score (items C-G) is 132, the cut-off point at and below which Bishop considers a pragmatic language impairment to exist.

In order to provide further information about Joshua's academic progress over the course of the intervention, his SATs results were obtained for the assessments carried out prior to intervention (CA 7;3). Joshua obtained scores of 1B for numeracy and writing, and

1A for his reading. These scores are discussed in further detail in the evaluation of the intervention.

2.4.3 Parent report

Joshua's mother was concerned about his speech, language and literacy at the start of the project. These concerns are secondary to concerns about his behaviour. She acknowledged that his speech has improved over time and that most people can understand him now. She would like intervention to improve the clarity of his speech and for him to talk like other children his age.

Table 6.6
Children's Communication Checklist (Bishop, 1998): Joshua's performance on subscales

CCC subscale	Example of behaviours in subscales	Score	Comments*
A. Speech output: intelligibility and fluency	Intelligibility; use of immature speech sounds; rate and fluency	26	Scores of 27 or below require further investigation; Joshua's speech is an area of difficulty
B. Syntax	Grammatical errors, phrase length	30	Acceptable: Scores below 29 require further investigation
C. Inappropriate initiation	Ability to talk appropriately to different people; whether amount and nature of communication is appropriate for the situation	26	Joshua's composite score for the Pragmatic subscales C-G = 132. Scores below 132 are considered indicative of pragmatic impairment.
D. Coherence	Ability to talk logically; make explicit information when needed	24	
E. Stereotyped conversation	Use of favoured phrases and topics; over-precise manner	28	
F. Use of conversational context	Understanding conversational rules; social appropriacy	25	
G. Conversational Rapport	Appropriacy of initiation and response to initiation of conversation; understanding and use of facial expression, gesture and eye-contact	29	
H. Social relationships	Friendships; interactions with children and adults	26	Acceptable: Scores of 24 or less require further investigation
I. Interests	Having very focused interests; prefers to do things alone or with others; interests in factual information	30	Acceptable: Scores of 28 or less require further investigation

* based on clinical guidelines from http://epwww.psych.ox.ac.uk/oscci/dbhtml/CCC/cccinstruct.htm

2.5 Further investigations, themes and questions

(a) *Can Joshua's age-appropriate auditory input skills be reconciled with the problems of listening and auditory attention outlined in his case history, and the fact that he reports enjoying listening*? The speech processing profile showed that Joshua had no peripheral auditory processing problems, was able to discriminate between closely related words

and could recognise familiar words. Yet, he had difficulty attending to auditory stimuli, focusing on speech and following instructions. One explanation for this is that the profile is concerned primarily with *speech* at a single word level, rather than with *language* or connected speech. Joshua may have age-appropriate abilities to process speech signals and perform tasks which do not require explicit understanding of meaning or grammar. His poor performance on the receptive language tasks suggests that this may indeed be the case. An alternative possibility is that Joshua has more general cognitive difficulties with concentration and attention. Tests often use single words so that demands on memory and attention are reduced.

In assessment, Joshua was given tasks that could be carried out without *necessarily* accessing semantic knowledge. If tasks could be found that differed only in terms of the necessity to access semantic (or syntactic) information, and Joshua performed better on the non-language tasks then this might suggest that he has language processing rather than speech processing difficulties, and that there is a dissociation between speech and language.

Task 1: Joshua was given simple CVC non-words (e.g. <dup>) to write from dictation. He obtained a score of 90% for this task. In this activity, he was required to carry out phoneme-grapheme conversion, and did not have semantic or other language information to draw on. Joshua was then given pictures of high frequency CVC targets (from which the non-words had been derived, e.g. <dog>) and asked to write the word next to the picture. The researcher did not name the picture. Joshua found this task more challenging, scoring 60% in contrast to the first task. In this case, he was required to analyse the picture visually and then access his semantic lexicon to find the correct label for the picture.

Task 2: Joshua's performance on two subtests of the PhAB (Frederikson et al., 1997) was compared: The alliteration sub-test, and the supplementary test of alliteration with pictures. When Joshua listened to the researcher listing three words (e.g. SHIP, FAT, FOX) he was able to identify the word that differed from the others because of a different initial consonant. This was an auditory activity that did not require access of semantic representations. Joshua was then shown pictures of similar items (e.g. SUN, LID, SOCK) without the pictures being named by the researcher. He was asked to indicate the odd one out that started with a different sound. Joshua found this hard and scored below the expected level for his age, again suggesting that having to access and integrate semantic information is problematic for him.

(b) *Is there a link between Joshua's output difficulties and his input phonological representations?* The multisyllabic words that Joshua found hard to recognise in the auditory lexical decision task (Constable et al., 1997) were also challenging for him to produce (e.g. CATERPILLAR, ESCALATOR). Lower frequency words had unclear phonological representations and motor programmes, but are likely to develop over time. However, there was a general asymmetry between his input and output representations with the phonological lexicon showing few inaccuracies while output difficulties were more widespread. Joshua's output store of motor programmes seemed 'clogged up' while his input store (i.e. phonological representations) was more free-flowing. He was able to discriminate between closely related onset clusters, but not produce these. The mismatch between input and output was further illustrated by the fact that Joshua was not aware of his own speech difficulties and not able to monitor or correct himself, e.g. sometimes he called his brother Jacob, [dʒeɪpɪb] but when asked to confirm that his brother is [dʒeɪpɪb] he said, 'no.' He could accurately copy the name JACOB and also produced this name correctly on occasions. It seemed as if this immature way of saying his brother's name had stuck in his output lexicon where it competed with a more mature version of the word. It is accurate in his input lexicon. This was the pattern for many of Joshua's stored representations. Interestingly, Joshua was quick to 'correct' the researcher because he could perceive the differences in vowels between the researcher's accent and his own, showing that inter-auditory discrimination was easier than intra-auditory discrimination for him.

(c) *Is there a link between Joshua's spelling and speech? Is he able to spell words with consonant clusters that he finds hard to produce?* Yes, there is a link. Joshua finds it hard to write words with consonant clusters. He was reluctant to write words such as SPOON and SPOT at the initial assessment, and said that he could not do it. When asked to say how he thought he might write them he said he would omit the [s], e.g. he said you should write [bə] [u:] [nə] for SPOON[14]. These findings suggest that his online motor programming may not yet have the 'template' for words with initial consonant clusters. The fact that the clusters do not appear in either speech or spelling suggests an under-specified phonological representation common to both these modalities.

[14] The fact that Joshua used the initial voiced, de-aspirated phoneme [bə] and not [pə] or [sə] indicated that he *has* processed the cluster as a whole and must have some awareness of his speech output and the influence of the neighbouring cluster components.

(d) *How does Joshua perform on non-word spelling tasks that draw heavily on his phoneme-grapheme conversion skills?* Joshua was able to accurately write simple CVC non-words (e.g. [dʊp] written as <dup>). His grapheme-phoneme conversion skills were similarly appropriate: he was able to sound out simple CVC non-words with skill. However, when given non-words with word initial clusters (CCVC) (e.g. [blɒm]) to spell from dictation, he found this challenging and would not attempt the task. Thus, there were no attempts to analyse.

(e) *Is Joshua hyperlexic?* Hyperlexia is an unusually well-developed ability to read, in children with cognitive deficits and behavioural abnormalities. According to Grigorenko, Klin, Pauls, Senft, Hooper and Volkmar (2002) the decoding ability of these children extends beyond what is expected given the children's comprehension and cognitive skills. Joshua met most of the criteria characteristic of the condition: He is a compulsive and indiscriminate reader who shows limited understanding of what he reads, and reads in a fluent but flat monotone. The speech errors described in previous sections were also evident when he read out loud. Joshua did not notice mistakes in texts he was reading or if a page was missing from a book. The clinical implications of his hyperlexia would be to strengthen his verbal and written comprehension by carefully structuring comprehension activities.

(f) *Is Joshua's phonemic awareness commensurate with his word reading skills?* Phonemic awareness is considered to be one of the best predictors of, and a causal factor in, reading acquisition (e.g. Bradley and Bryant, 1983; Stanovich, 1986). Sparks (2001) found that the phonemic awareness skills of hyperlexic readers were not commensurate with their word reading skills, and that wide inter- and intra-individual variations existed on all the phonemic awareness measures. Joshua has age appropriate rhyming skills and was able to identify and generate rhymes with ease. At the phonemic level he also evidenced skills: he was able to identify the 'odd man out' when listening to a string of words with one differing in its initial consonant, and was able to identify initial and final consonants in spoken words. The 'odd man out' alliteration task using pictures only, proved challenging for Joshua but this may have been due to difficulties accessing the correct semantic label rather than for metaphonological reasons. This is another example of a dissociation between auditory skills and picture presentation of stimuli. Joshua was able to create simple spoonerisms in a way that was appropriate for his age. In general it seems that his phonemic awareness skills are appropriate for his age level. This may be contributing to his hyperlexia since his phonological awareness skills have

developed normally resulting in age appropriate decoding, thus creating a mismatch with his comprehension skills.

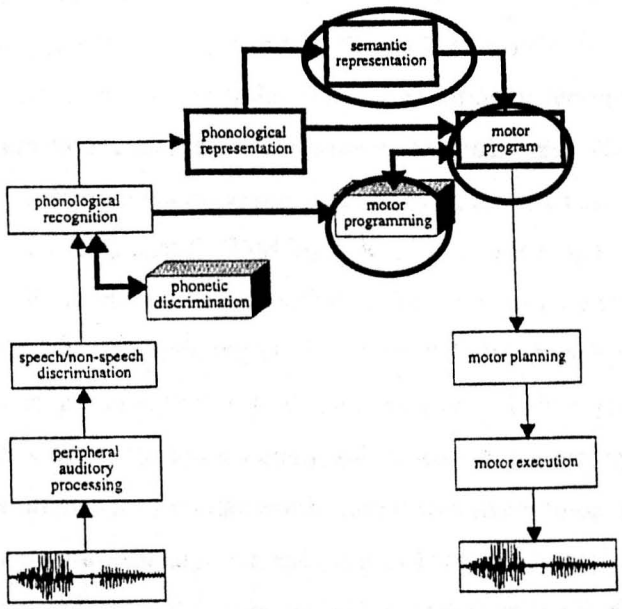
3. MACRO INTERVENTION PLANNING

Intervention planning focused on three main areas with each one serving as a rationale for the work carried out. These included (1) a psycholinguistic rationale which aimed to answer the question: "What aspects of the speech processing system should be worked on?", (2) a phonological rationale which aimed to answer the question: "Which aspects of the sound system should be targeted and (3) a more general child-centred rationale which aimed to answer the question: "What other aspects important to the child should be taken into account? Each of these is discussed in the sections that follow.

3.1 Psycholinguistic rationale – What aspects of the speech processing profile should be worked on?

Joshua's main deficits were mapped from the speech processing profile onto the Stackhouse and Wells (1997) speech processing model. Joshua's main areas of deficit are presented in Figure 6.2.

Figure 6.2
Speech processing model (from Stackhouse and Wells, 1997) showing Joshua's main areas of difficulty at CA 7;2



Joshua's difficulties centred on the mapping of his phonological representations onto motor programs: creating and accessing motor programmes is difficult for Joshua. Whilst his input

phonological representations are generally accurate, motor programs are often inaccurate. Both motor-programming (the online process) and stored motor-programs are affected. Since his semantic skills are weak he has limited top-down support in retrieving motor programmes. In spontaneous speech he used some familiar words in an immature way *and* he repeated unfamiliar / new words in the same, predictable way. Bryan and Howard (1992) describe a child whose non-word repetition was more accurate than spontaneous naming. The child in their study had 'frozen phonology' and had failed to update stored motor programmes while his online motor programming skill *had* improved. Joshua is more similar to the child described by Waters (2001) whose stored motor programmes were inadequate because of current limitations of online motor programming. Joshua's motor programming problems might be conceptualised as resulting from an immature template that acts to simplify words produced. Joshua was highly consistent in his use of cluster reduction and seemed to not yet have the appropriate template for phonotactic structures which incorporate clusters (e.g. see Ingram and Ingram, 2001). Intervention needed to (a) update *stored* motor programs into more adult-like forms, and (b) get the *on-line* motor-programming device to consistently compile accurate programmes for storage by using an accurate template that incorporates the CCVC shape. Where Joshua had extra motor programmes, the aim was to get him to abandon the immature motor programme and retain the mature one.

Input skills are a relative strength for Joshua and were used in intervention to help build up the weaker areas on the output side. Joshua was encouraged to perceive fine phonological differences between words. Joshua had another strength in his ability to utilise phoneme-grapheme conversion for spelling from dictation, and to use grapheme-phoneme conversion in reading tasks. The intervention programme drew on these skills to focus on the development of more accurate motor templates. Therapists working with children with speech difficulties often select stimuli words which are familiar to the child, i.e. they aim to update frozen forms. Working on on-line processing using new words as stimuli might lead not only to more efficient online motor programming and accurate storage of these new words, but also updating of 'frozen forms' already stored. Novel words help to break up habitual patterns as the child can use current skills to produce them (e.g. see MacWhinney, 1985; Gierut, 1999). It was hypothesised that Joshua had established inaccurate motor programmes for familiar words, and it was likely to be difficult to modify these habitual patterns immediately. He had (at least) two forms of many words in his output lexicon – an immature form and a more adult-like representation that he uses inconsistently. It was considered that introducing Joshua to *new* words might help him avoid this competition between new and old forms. Joshua could be introduced to new words in both the spoken and written form. He should be able to tackle the unfamiliar word using his good grapheme-

phoneme conversion skills, and this might help establish the item in his input representations and his motor programmes.

Joshua had difficulties with language processing: his receptive vocabulary is delayed and he finds sentence processing a challenge (see Table 6.2). It may be challenging for him to learn the meanings of new words, but it could help to expand his vocabulary as well as helping to 'shake-up' existing inaccurate motor programmes. It might also provide him with an opportunity to reflect on his own speech production and to improve his self-monitoring skills (see Fig 6.1, level L). Teaching unfamiliar words with emphasis on phonological input, meaning and speech output may result in long lasting and more widespread change in online motor programming and in the way in which motor programmes are stored.

3.2. Phonological rationale - Which aspects of the sound system should be targeted?

PACS (Grunwell, 1985, see Table 6.3) carried out at the start of the study, revealed that Joshua had a good phonetic repertoire, and was able to make most contrasts at a phoneme level. However, at a syllable structure level, he consistently reduced clusters. All clusters were affected word initially as well as some in WF position.

The results of intervention studies addressing clusters are not clear-cut. Barlow (2001) notes that accounting for the acquisition of consonant clusters is problematic, with the difficulties due to "issues of markedness, sonority sequencing and order of acquisition facts." (p.292). In general it is agreed that there is a developmental pattern of consonant cluster acquisition, but that this varies from child to child (see McLeod, van Doorn and Reed, 2001). Two part consonant clusters (e.g. [sp], [pr]) are usually acquired between the ages of 3;6 and 7;0, before 3 part ones (e.g. [spl] or [spr] typically acquired between 6;0 – 8;0 years of age (McLeod et al., 2001)). Word initial consonant clusters are sometimes acquired before and sometimes after word final consonant clusters (McLeod et al., 2001). Treating 3 part consonant clusters can result in widespread generalization to two part consonant clusters according to the complexity account of efficacy (Gierut and Dinnsen, 1987). Stop clusters are not necessarily easier than fricative ones (McLeod et al., 2001). Barlow (2001) notes that [s] clusters may be considered special 'cases' which according to some authors are acquired later than others, and according to others earlier than others. Exactly how they are 'exceptional' has not been agreed on. Consonant glide (e.g. [tɹ]) sequences emerge before consonant liquid (e.g. [flˌ]) sequences (Smit, 1993) and this liquid/glide difference is thought by some to be key to understanding cluster development (Powell and Elbert, 1984). Working on consonant clusters (e.g., [plˌ]) improves singleton production (e.g., [p]), but the reverse has not been found (Gierut, 1999). Working on [s]+stop clusters did not result in generalization beyond those clusters but working on other clusters did (Gierut, 1999).

Joshua had difficulties with all clusters although to slightly varying degrees. Because of the unclear picture of cluster development and intervention, all clusters were targeted since this would allow for observation of the entire set of clusters in English, and their relationship with each other. Exemplar words were selected for each of the 27 clusters occurring word-initially in English. The study aimed to investigate the pattern of change that occurs when all clusters are treated in the same therapy programme, and addressed the questions: (a) Which clusters will improve first, and will this fit in with those that he already has some knowledge of? (b) Will the developmental progression as identified in the literature, be followed?

3.3. Child-centred rationale - What other aspects important to the child should be taken into account?

There was concern regarding Joshua's behaviour and social relationships. An educational psychologist noted that Joshua might benefit from Social Stories. These are short stories written according to a formula, and used to describe social situations that the child with autism finds difficult (see Gray, 1994; Rowe, 1999). They are tailormade for an individual child based on specific scenarios with which the child has difficulty. In order for Joshua's speech and language programme to have maximum relevance to his behaviour, cluster words targeted in intervention were addressed within a social stories context. Intervention focused on Joshua's speech using the Social Stories as a tool for bringing about more general behavioural change. Improvement in speech was monitored through pre- and post intervention measures, while behavioural improvement was not specifically measured in this way.

4. MICRO INTERVENTION PLANNING

Joshua received a total of 24 hours of intervention, which was subdivided into three phases. The intervention used a multiple baseline design with clusters assigned to one of the three phases to be treated at different times. Each phase addressed 9 clusters and was followed by a reassessment of all items. Three lists of stimuli were devised with one treatment list (list A) and two control lists (lists B and C). Each list consisted of 27 monosyllabic CCVC English words and met the following criteria:

(a) All 27 word initial consonant clusters in English were included in each list

(b) The treatment list (list A) consisted of real words, which were unfamiliar to Joshua as determined by picture naming and discussion. Words that could be used readily

in social stories were preferred. Novel words were selected so that Joshua was explicitly given the opportunity to devise and store new motor-programmes.

(c) List B consisted of untreated real words familiar to Joshua as determined by picture naming and spontaneous speech. These words would allow one to see if existing motor programmes had been updated.

(d) List C consisted of untreated non-word items made by randomly joining the initial consonant clusters with a range of medial vowels and coda segments. These words would allow one to determine whether Joshua was generalising the online motor programming skills addressed in therapy to words not directly targeted.

The three stimuli lists are presented in Table 6.7, together with the average age of acquisition (from McLeod et al., 2001) and the PPK rating (from Gierut et al., 1987) for each cluster.

Table 6.7
Joshua's stimuli lists

Consonant cluster	Age of acquisition*	Productive phonological knowledge** 1=maximum 6=no PPK	List A: treated words (novel)	List B: untreated control words (familiar)	List C: untreated control words (non-words)
[tw]	3;6	3	TWIT	TWELVE	[twɛm]
[kw]	3;6	3	QUIT	QUEEN	[kwɛp]
[sp]	5;0-6;0	6	SPITE	SPOON	[spɪb]
[st]	5;0-6;0	4	STATE	START	[stæd]
[sk]	5;0-6;0	4	SCOFF	SCARF	[skɑn]
[sm]	5;0-7;0	6	SMIRK	SMOKE	[smɒf]
[sn]	5;0-7;0	6	SNEER	SNAKE	[snuθ]
[sw]	6;0	6	SWIPE	SWING	[swɔk]
[sl]	7;0	6	SLY	SLEEP	[slɜv]
[pl]	4;0-5;6	6	PLAN	PLATE	[plus]
[bl]	4;0-5;6	6	BLAME	BLACK	[bləuʃ]
[kl]	4;0-5;6	3	CLASH	CLASS	[klɑt]
[gl]	4;0-5;6	3	GLUM	GLOVE	[gleɪθ]
[fl]	4;0-5;6	6	FLED	FLAG	[flaɪm]
[pr]	5;0-6;0	6	PRAISE	PRAM	[præd]
[br]	5;0-6;0	3	BRAVE	BRIDGE	[braup]
[tr]	5;0-6;0	6	TRAIT	TRAIN	[træz]
[dr]	5;0-6;0	6	DREAD	DRESS	[drɛn]
[kr]	5;0-6;0	3	CRUEL	CRASH	[krutʃ]
[gr]	5;0-6;0	6	GREET	GRASS	[grɒdʒ]
[fr]	5;0-6;0	6	FROWN	FROG	[frʌb]
[θr]	7;0	6	THRIVE	THREE	[θraɪŋ]
[skw]	7;0	6	SQUIRM	SQUARE	[skwif]
[spl]	7;0	6	SPLIT	SPLASH	[splaut]
[spr]	8;0	6	SPRINT	SPRING	[sprɛk]
[str]	8;0	6	STRESS	STRING	[strug]
[skr]	8;0	6	SCREECH	SCREAM	[skreɪt]

* From McLeod et al. (2001) ** From Gierut et al. (1987); see Table 6.4

The new words in list A were addressed in therapy, using a task hierarchy which allowed Joshua to move from easier tasks tapping his strengths, to more challenging tasks. The ultimate aim of the programme was for Joshua to devise new and accurate motor programmes for a range of new words containing word initial consonant clusters, and to then 'lodge' these as stored motor programmes. In giving Joshua many listening opportunities and the chance to contrast his phonological input representations with his motor programmes on the output side, it was hypothesised that he would be able to update motor programmes for all clusters, realising the mismatch that exists. The task hierarchy is outlined below:

(1) *Introduce*: Joshua was introduced to the new words with emphasis on the meaning of the word in the context of a story. The social story was presented to him as a short booklet with illustrations (see Appendix 5). No production was required at this stage. This task tapped Joshua's auditory input skills, his visual input skills and orthographic knowledge, and his semantic knowledge.

(2) *Listen and judge*: A more specific listening task was carried out that moved beyond the normal developmental process of new word acquisition. Joshua was confronted with each new word as well as closely related foils for each one. Using a yes / no question format, he was asked to consider the exact phonological representation, e.g. is the new word SPITE (yes / no) or SPRITE? (yes / no). Again, he was not required to produce the new word himself. This task more specifically tapped Joshua's phonological representations.

(3) *Build up links*: Joshua was explicitly helped to build-up the motor programmes by focussing on the written forms of words in the stories and talking about 'how we should say them' and how not to say them. The aim here was to use the newly-acquired semantic, phonological and orthographic knowledge from the first two sessions, to map out new motor programs. Joshua was encouraged to say the words and to experiment with different ways of saying them. This task tapped phonological representations, semantic knowledge and orthographic knowledge and linked these representations with motor programming.

(4) *Produce*: In the final phase, Joshua read the story using the new words in context in connected speech. He was encouraged to think carefully about how to say the new words. This most challenging task tapped motor programming and motor programmes, as well as Joshua's self-monitoring skills.

The 27 words from list A (Table 6.7) were incorporated into social stories. These were written based on guidelines from Gray (1994) and Rowe (1999) (see Appendix 5). Each story begins with a description of a particular scenario. Stories include desired responses to

the situation and are used to prepare children to cope with that scenario, as well as other new situations. The following procedure was adopted in preparing the stories and ensuring that all stimuli words from list A were included:

(1) Six social stories were written

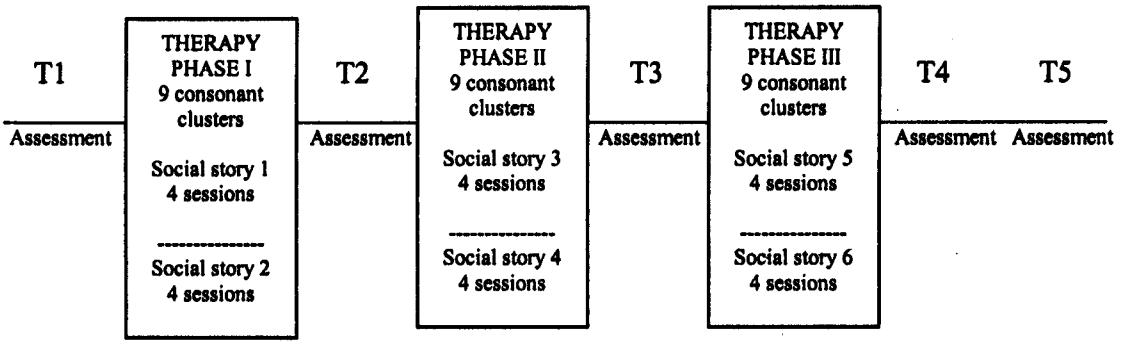
(2) Four or five of the stimuli words from list A were selected for inclusion in each story so that all 27 words were included at some point in the programme

(3) Each word appeared at least three times, and not more than five times, in a story

(4) Each story was worked through over 4 consecutive sessions using the task hierarchy outlined above. Thus, each session comprised one of the tasks from the task hierarchy.

Figure 6.3 shows the design of the intervention.

Figure 6.3
The design of Joshua's intervention programme



Baseline evaluation took place prior to the intervention at T1, and then following each of the three phases of intervention, in accordance with a multiple baseline design. Each phase comprised 8 sessions, i.e. working through the 4 tasks of the task hierarchy twice, for two social stories and the associated nine clusters. On completion of the programme (T4), re-assessment took place, and at T5 long-term follow-up evaluation took place. The assessment involved obtaining single word productions for each of the items in each of the lists as well as obtaining Joshua's written attempts for all words.

The following questions were asked about Joshua's intervention:

(a) Is the intervention effective? If so, improvements in Joshua's speech production of treated items (list A) beyond chance level will be noted.

(b) Does generalisation occur? If so, improvements in Joshua's production of matched untreated control words (lists B and C) will be noted. Improvement in Joshua's production of familiar words with word-initial clusters (list B words) would suggest that the stored motor programmes have been effectively updated. Improvement in Joshua's

production of non-words with word initial clusters (list C words) would suggest that the online motor programming mechanism has been altered.

(c) Is there a relationship between pre-intervention PPK and intervention success? For each of the consonant clusters, Joshua had varying degrees of productive phonological knowledge (PPK). Gierut and Elbert suggest that clusters about which the *least* is known are the most efficient ones to address.

(d) Does the pattern of change observed over intervention follow the developmental trend as outlined in the literature (e.g. by McLeod et al., 2001)? Pre-intervention baselines will show whether Joshua is following normal patterns of development. Does the intervention expedite normal phonological development, or bring about a different pattern of change?

(e) Will targeting a small set of consonant clusters (as in the first phase of intervention) have an effect on the remainder of the consonant clusters?

(f) How does the intervention affect Joshua's written representations of words? The intervention relies heavily on exposure to written forms with both reading and writing of treated items. Does the spelling of the treated words improve through this exposure. If so, will this generalise to the untreated words? This would suggest that orthographic representations have been updated in the case of the familiar words, and that accurate phoneme to grapheme conversion is taking place for the non-words.

5. INTERVENTION

5.1 Overview of intervention

Intervention consisted of three consecutive phases with each phase consisting of two social stories covering 9 target words. Each social story was worked on for 4 sessions each of approximately one-hour duration, i.e. one session for each task in the task hierarchy. There was a total of 24 intervention sessions. The sessions were carried out on a twice-weekly basis in Joshua's school in a quiet room with only him and the therapist present. Joshua was 7;6 at the start of the intervention itself and was 7;11 on completion of the final phase of intervention.

5.2 Intervention report

Each phase centred round a social story and its novel stimuli words with consonant clusters. These are shown in Table 6.8 together with notes from each session.

Table 6.8
Summary of Joshua's intervention sessions

Phase I		
Consonant clusters: [st], [sk], [pr], [sl] [gl], [fr], [str], [skr], [tr]		
Story 1: A story about lining up **Stimuli words: state, scoff, sly, praise**		**Comments**
Session 1	Task 1: Introduce	Joshua listened attentively and said that he liked the story.
Session 2	Task 2: Listen and judge	Joshua missed two sessions due to illness. We went over the story again and I reminded him about the new words: he had forgotten them all. We played the phonological representations 'game' in which he had to judge if similar-sounding words were correct or not (80% correct).
Session 3	Task 3: Build up links	We wrote and practised saying the words today. PRAISE is hardest for him – he typically says "plays" or "lays".
Session 4	Task 4: Produce	Joshua read the story very well and made good attempts at all the target words. He was producing [s] clusters although still needs to leave a little break between [s] and stop. Joshua was very excited to take the story home.
Story 2: A story about talking and reading **Stimuli words: glum, frown, stress, screech, trait**		**Comments**
Session 5	Task 1: Introduce	Introduced new story today. Joshua read it together with me and started colouring in some of the pictures.
Session 6	Task 2: Listen and judge	Went over new words today – Joshua had remembered some of them (50%). Enjoyed phonological representations games - scored 100% correct. He has appropriate phonological representations of the target words, which is quite surprising because it seems like he is not listening when I say or talk about them.
Session 7	Task 3: Build up links	Joshua told me how to spell the words and we talked about how to say them (70% accuracy). I had to remind him to put the [s] in front of the [s] cluster words but otherwise he did well.
Session 8	Task 4: Produce	Joshua did well today: TRAIT and GLUM were correctly produced on all attempts. Others were harder for him but some attempts. Noticed that he said GREEN correctly in spontaneous speech during game.
Phase II		
Consonant clusters: [spr] [tr] [br] [fl] [kl] [pl] [sm] [kw] [tw]		
Story 3: A story about working on my own **Stimuli words: thrive, plan, brave, quit**		**Comments**
Session 9	Task 1: Introduce	Joshua grabbed the story and started reading aloud before I could! Noted some accurate clusters in the story, but not using spontaneously.
Session 10	Task 2: Listen and judge	Re-read the story and spoke about new words. Joshua had remembered some parts of the story. He enjoyed the phonological representations game, scoring 80% correct.
Session 11	Task 3: Build up links	He did well despite the fact that some are confusing to write (e.g. <quit>). He is trying to say all parts of the cluster now and knows when he forgets!
Session 12	Task 4: Produce	We returned to the story today and Joshua read it very well. All his clusters were fine. I gave him a lot of praise and he seemed very proud.
Story 4: A story about walking away from fights **Stimuli words: fled, smirk, sprint, twit, clash**		**Comments**
Session 13	Task 1: Introduce	Joshua liked the new story about fighting. He was concerned about some of the details in the story and the pictures so we spent some time talking about who was represented in the pictures.
Session 14	Task 2: Listen and judge	Joshua was still concerned about the pictures today, and whether he was the boy depicted in them. He read the story well and showed some understanding of the words. When I tried to explain what some of the words meant, he interrupted or started to hum. He scored 90% correct on the representations game. It was interesting to hear him say that "print" is wrong for SPRINT but then carry on reading and say "print" still indicating a mismatch between input and output.

Table 6.8 *Cont.* Summary of Joshua's intervention continued

Session 15	Task 3: Build up links	Joshua was able to help me write the new words and say them. He could say them all when he spoke slowly (100%).
Session 16	Task 4: Produce	Completed this story today. Joshua said some accurate cluster words although at times he forget but could correct himself. He seemed very inconsistent today and unmotivated.
Phase III Consonant clusters: [sp] [sn] [sw] [bl] [dr] [kr] [gr] [skw] [spl]		
Story 5: A story about doing something different Stimuli words: blame, dread, cruel, greet		Comments
Session 17	Task 1: Introduce	Joshua insisted on reading the story to me first, rather than letting me read it to him. There was a mistake in the story and Joshua did not notice.
Session 18	Task 2: Listen and judge	Re-read the story and went over new words and phonological representations. He did well with this (80% correct).
Session 19	Task 3: Build up links	Very good spelling today (70% clusters correct). Noticed that Joshua was inserting schwa between two initial clusters in his speech, e.g. [bəleɪm]. This might be because of how they've been emphasised, or maybe a phase required before getting them correct. He reflects this in his spelling too, on occasion, e.g. <belame>.
Session 20	Task 4: Produce	Good reading and good cluster production (70% correct).
Story 6: A story about being kind and helpful Stimuli words: spite, sneer, swipe, squirm, split		Comments
Session 21	Task 1: Introduce	Joshua was introduced to the new story today. We both had a chance to read it.
Session 22	Task 2: Listen and judge	Joshua scored 100% on the phonological representations task
Session 23	Task 3: Build up links	Joshua did well with the spelling and was able to say most of the words correctly when pointing to the letters. SPLIT is hard for him though: he could either say "spit" or "plit" but not all three consonants together. He was getting frustrated about this.
Session 24	Task 4: Produce	Re-read the story today. Joshua did well but needed some reminding about initial [s] sounds. SPLIT remains challenging for him.

Intervention summary

Joshua received 24 hours of intervention in total. He was seen for sessions of one hour twice a week. He was introduced to 27 new words each with a different initial consonant cluster. Many of these words have complex meanings that Joshua had not encountered before. It was challenging for him to learn these words. He managed to remember most of them in the context of the stories, if not more generally. Some generalisation was noticed in Joshua's spontaneous speech, but this was thought not to be widespread. Joshua enjoyed reading the stories, and demonstrated hyperlexia when doing so. He could decode the new words with ease but was frequently disinterested to know what the words meant. He seemed to enjoy the process of reading more than the content of the stories.

6. EVALUATION

This section focuses on the outcome of Joshua's intervention programme. Section 6.1. is a micro evaluation of the intervention study and aims to look at the specific changes in treated

stimuli and untreated control items outlined in Section 4. Section 6.1.1 provides an overview of results from the micro-evaluation. Sections 6.1.2 – 6.1.4 focus on results for each of the three intervention phases in further detail. Finally, section 6.1.5 summarises the micro evaluation findings. Section 6.2. provides a macro analysis of the intervention, aiming to investigate any broader changes in the following areas: standardised language assessment (6.2.1), speech profiling in a psycholinguistic framework (6.2.2), speech analysis (6.2.3), and subjective measures (6.2.4). This section concludes with a summary of changes at the macro level.

6.1 Micro evaluation

Joshua was reassessed at periodic intervals during the intervention study. Figure 6.3 shows the five points at which he was reassessed. Joshua was assessed on the following tasks:

(1) Repetition of list A words (novel words, targeted in intervention)
(2) Repetition of list B words (familiar words, not targeted in intervention)
(3) Repetition of list C words (non-words, not targeted in intervention)
(4) Spelling of all words in lists A, B and C from dictation

6.1.1 Overview

Table 6.9 gives an overview of Joshua's progress on the three lists by comparing the percentage of consonant clusters correct in his speech and spelling at pre-intervention assessment (T1) with scores obtained on completion of the programme at T4 (short-term follow-up), and at T5 (long-term follow-up). The scoring procedure focussed specifically on initial consonant clusters, not on the remainder of the word. Two points were awarded for each correct consonant cluster production; one point was awarded for close approximations of the target consonant cluster (e.g. phonetic distortions in one of the cluster elements in speech, or one grapheme inserted between correct cluster components in spelling), and no points were given for other responses. Raw scores were converted into percentages.

Table 6.9
Joshua's spoken and written production of stimuli words pre- and post-intervention

	Pre-intervention % of consonant clusters correct* T1	Post-intervention Short-term follow-up % of consonant clusters correct* T4	Post-intervention Long-term follow-up % of consonant clusters correct* T5
Speech: mean for all lists	***6.2***	***40.7***	***57.4***
List A: Treated words	7.4	46.3	53.7
List B: Untreated control words (familiar words)	7.4	48.1	57.4
List C: Untreated control words (non-words)	3.7	27.7	61.1
Spelling: mean for all lists	***25.9***	***50.56***	***38.8***
List A: Treated words	24.1	55.5	40.7
List B: Untreated control words (familiar words)	29.6	62.9	42.5
List C: Untreated control words (non-words)	24.1	33.3	24

* Each consonant cluster correctly spoken or written was awarded 2 points. The rest of the word was not considered. Consonant clusters were given 1 point if considered 'almost correct' e.g. in speech: phonetic distortion of one of the cluster elements, schwa insertion between cluster components; in spelling: one grapheme inserted between cluster components or distorted but recognisable grapheme.

A two-way mixed between-within subjects ANOVA was conducted. There was a statistically significant main effect for time for both speech [$F(4, 75) = 38.39$, $p < .05$] and spelling [$F(4, 75) = 5.839$, $p < .05$]. Both Joshua's written and spoken production of consonant clusters had improved over the course of the intervention programme. The effect size for speech (eta squared = .672) was greater than that for spelling (eta squared = .237), but according to Cohen (1988) both are large effects.

Long-term follow-up took place six months after the intervention when Joshua was CA 8;7-8;8. Paired-samples t-tests showed statistically significant increases when comparing Joshua's speech scores pre-intervention (T1) with post-intervention at short- term follow-up ($t(80)=-6.325$, $p < .05$) and long-term follow-up (T5) ($t(80)=-11.11$, $p < .05$). Furthermore, the difference between speech scores at short and long-term follow-up is statistically significant ($t(80)=-3.3$, $p < .05$) suggesting that Joshua continued to make progress with his speech after the intervention had finished. Looking at the three wordlists for speech, the most significant increase was noted in Joshua's production of non-words

when comparing performance at short and long-term follow up. Joshua's production of wordlist C improved greatly, suggesting a change in his online motor programming. This improvement in non-word repetition is not reflected in improved spelling of those words. The eta-squared statistic indicated a smaller effect size for comparisons of short-term follow-up (T4) with long-term follow-up (T5) (.12) than when comparing pre-intervention (T1) and short-term follow-up (T4) (eta squared = .33) suggesting a greater difference due to intervention.

For spelling, paired-samples t-tests showed a statistically significant increase from pre-intervention baseline scores (T1) to short-term follow-up measures (T4) ($t(80) = -4.548$, $p < .05$). There was however no significant difference noted when comparing the pre-intervention baseline scores (T1) and the results from long-term follow-up (T5) ($t(80) = -1.747$, $p < .05$). Joshua's scores had decreased significantly from the first follow-up at T4 to the second at T5 ($t(80) = 2.403$, $p < .05$) suggesting that while the intervention had brought about changes in his spelling, he was not able to maintain the gains over time once intervention ceased.

The intervention programme followed a multiple baseline design with clusters being assigned to one of three phases of intervention to be treated at different times. The following sections focus on each of these phases in turn, providing an overview of the changes that took place for particular clusters, and how this change related to the point at which intervention for that set of clusters took place. Section 6.1.2 focuses on changes occurring in the phase I clusters; section 6.1.3 details the changes noted in the phase II clusters and section 6.1.4 provides the same information for the clusters treated in phase III. The purpose of a multiple baseline design is to show that items in a particular sub-set are affected only subsequent to treatment. This was not always the case for Joshua since he made improvements with certain clusters irrespective of whether they were being addressed in a given phase.

6.1.2 Phase I

Phase I focused on nine clusters: [st], [sk], [pr], [sl], [gl], [fr], [str], [skr] and [tr]. Table 6.10 gives an overview of how the treated and non-treated speech and spelling stimuli changed over the course of the intervention programme. Paired samples t-tests were carried out to compare Joshua's performance on each wordlist with his performance at subsequent assessments. In Table 6.10, ** indicates scores showing a significant change from the performance on the previous assessment. In terms of the mean for speech, significant increases were noted at the T2 ($t\ 26) = -2.078$, $p < .05$) and T3 ($t(26) = -3.031$, $p < .05$) assessments. The T2 assessment followed intervention. Further change was noted at the T3 assessment suggesting that the effect of intervention was not immediate.

Table 6.10
Phase I consonant clusters [st], [sk], [pr], [sl], [gl], [fr], [str], [skr], [tr]: Changes occurring in Joshua's speech and spelling.

		Assessment T1 % consonant clusters correct*		Assessment T2 % consonant clusters correct*	Assessment T3 % consonant clusters correct*	Assessment T4 % consonant clusters correct*	Assessment T5 % consonant clusters correct*
SPEECH	List A: Treated Words	11.1	I	22.2	61.1**	36.8	38.8
	List B: Untreated Controls	0	N T E R V E N T I O N	38.8**	61.1	61.1	44.4
	List C: Untreated non-words	11.1		16.6	50**	33.3	77.7**
	Mean for speech	***7.4***		***25.9****	***57.4****	***43.73***	***53.6***
SPELLING	List A: Treated Words	11.1		66.6**	66.6	50	50
	List B: Untreated Controls	22.2		50	66.6	72.2	55.5
	List C: Untreated non-words	11.1		27.7	27.7	38.8	22.2
	Mean for spelling	***15.1***		***48.1****	***53.6***	***53.6***	***42.5***

* Each consonant cluster correctly spoken or written was awarded 2 points. The rest of the word was not considered. Consonant clusters were given 1 point if considered 'almost correct' e.g. in speech: phonetic distortion of one of the cluster elements, schwa insertion between cluster components; in spelling: one grapheme inserted between cluster components or distorted but recognisable grapheme.
** Scores which are significantly different ($p<.05$) from the previous assessment score

Comparing the three wordlists in Table 6.10, it is noted that Joshua made significant speech improvements on each of the different lists at different times. For speech, his score for the treated items showed a significant increase at T3 assessment ($t(8)=-2.401$, $p<.05$) indicating a delayed effect of intervention. The untreated, real word controls (list B), improved significantly at the T2 assessment immediately post-intervention ($t(8)=-2.401$, $p<.05$). The non-word items (list C) showed significant improvements at the T3 ($t(8)=-2.309$, $p<.05$) and T5 ($t(8)=-2.683$, $p<.05$) assessments. In learning the meanings of the new words, Joshua may have been using up all his available cognitive resources and thus had few resources left to focus on the correct production of the words. Working on non-words may have been

preferable since the semantic load would have been removed. This important issue of stimuli selection is returned to at a later point. For spelling, fewer significant changes were noted across the programme. Spelling was not the main focus of the intervention although literacy was involved. Joshua showed only a significant increase for the targeted list A words immediately following intervention ($t(8)=-3.592$, $p<.05$).

Results for the long-term follow-up show that overall Joshua was able to maintain the gains made in both speech and spelling. The mean speech score remains significantly increased from the initial assessment ($t(80)=-11.111$, $p<.05$), with the change from T4 and T5 not being significant overall ($t(80)=-3.3$, $p<.05$). There is a significant difference between Joshua's non-word (list C) repetition at T4 and T5 ($t(8)=-2.683$, $p<.05$): he made significant gains in his repetition of untreated non-words, which may suggest that his online motor programming is maturing. A similar improvement was not noted for non-word spelling.

Tables 6.11 and 6.12 show item-by-item change across the intervention programme: Table 6.11 focuses on speech where it can be seen that each word followed one of seven possible patterns of change:

- ***stable and incorrect throughout,*** e.g. non-word /stæd/ consistently realised as [dæd].
- ***stable and correct throughout,*** e.g. treated new word GLUM always produced as [glʊm].
- ***delayed response to intervention, with regression to original form,*** e.g. the untreated familiar word START is produced with a correct cluster not immediately post intervention but at the following re-assessment (T3). By T4 (and at long term follow-up, T5) it has reverted to [dɑt]. The effect of intervention seems weak and transient for these items.
- ***delayed response to intervention, with stabilisation of form,*** e.g. the untreated, familiar word SCARF is initially produced as [kɑf]. Following intervention it is produced as [gɑf]. However, by the next assessment (T3) it is correctly realised and this improvement is maintained at the final re-assessment.
- ***immediate response to intervention with stabilisation of form,*** e.g. the untreated, familiar word GLOVE is initially produced as [gʊv]. Following intervention it has been modified to [glʊv] and this new production is then maintained at all further assessments. Items in this category are limited to 3 items from list B, i.e. familiar, real word controls, and this is relevant given that this response is what one would be wanting for all items.
- ***immediate response to intervention with regression to original form,*** e.g. a cluster becomes evident immediately after intervention but at successive assessments has returned to the original incorrect form. There were no examples of this type of pattern,

suggesting that whenever an immediate change was brought about as a result of intervention, the effect was long lasting.

- ***unstable (correct / incorrect) throughout,*** e.g. PRAM and FROG were words familiar to Joshua that seemed to follow no pattern and are sometimes realised with a cluster [præm] and sometimes with a reduced cluster [pæm].

Table 6.11
Qualitative changes in the Phase I consonant clusters: Speech

		Pre-intervention baseline T1		Assessment T2	Assessment T3	Assessment T4
[st]	new word (treated): STATE	[teɪt]	I	[teɪt]	[deɪt]	[deɪt]
	familiar word (untreated): START	[dɑt]		[tɑt]	[stɑt]	[dɑt]
	non-word (untreated): [stæd]	[dæd]	N	[dæd]	[dæd]	[dæd]
[sk]	new word (treated): SCOFF	[gɒf]		[kɒf]	[gɒf]	[gɒf]
	familiar word (untreated): SCARF	[kɑf]		[gɑf]	[skɑf]	[skɑf]
	non-word (untreated): [skɑn]	[kɑn]	T	[gæn]	[gɑn]	[kɑn]
[pr]	new word (treated): PRAISE	[peɪ]		[peɪz]	[preɪz]	[pweɪz]
	familiar word (untreated): PRAM	[pæm]		[præm]	[pæm]	[pwæm]
	non-word (untreated): [præd]	[pæd]	E	[pæd]	[præd]	[pwæd]
[sl]	new word (treated): SLY	[saɪ]		[ʃaɪ]	[ʃlaɪ]	[ʃaɪ]
	familiar word (untreated): SLEEP	[sip]	R	[ʃip]	[ʃlip]	[ʃip]
	non-word (untreated): [slɜv]	[ʃɜv]		[ʃlɜv]	[səlɜv]	[sɜv]
[gl]	new word (treated): GLUM	[glʊm]		[glʊm]	[glʊm]	[glʊm]
	familiar word (untreated): GLOVE	[gʊv]	V	[glʊv]	[glʊv]	[glʊv]
	non-word: [gleɪθ]	[gleɪp]		[gɛθ]	[gleɪ]	[gleɪ]
[fr]	new word (treated): FROWN	[faʊn]	E	[faʊn]	[fraʊn]	[fraʊn]
	familiar word (untreated): FROG	[fɒg]		[fwɒg]	[fɒg]	[fwɒg]
	non-word: [frʊb]	[fəʊp]		[fʌb]	[frʊb]	[fʊb]
[str]	new word (treated): STRESS	[kɛs]	N	[trɛs]	[strɛs]	[trɛs]
	familiar word (untreated): STRING	[tʃɪŋg]		[sɪŋg]	[strɪŋg]	[strɪŋg]
	non-word: [trʌg]	[tʃʌg]	T	[gʌg]	[trʌg]	[tʃʌg]
[skr]	new word (treated): SCREECH	[kitʃ]		[kitʃ]	[kritʃ]	[gwitʃ]
	familiar word (untreated): SCREAM	[kɪm]		[kim]	[krim]	[grim]
	non-word: [skreɪt]	[keɪt]	I	[keɪt]	[greɪt]	[keɪt]
[tr]	new word (treated): TRAIT	[tweɪt]		[treɪt]	[treɪt]	[treɪt]
	familiar word (untreated): TRAIN	[tʃeɪn]	O	[treɪn]	[treɪn]	[treɪn]
	non-word: [træz]	[tæz]		[træz]	[træz]	[traɪ]
			N			

light grey = correct (2 points) dark grey = almost correct (1 point)

Patterns of change for spelling items are presented in Table 6.12.

Table 6.12
Qualitative changes in the Phase I consonant clusters: Spelling

		Pre-intervention baseline T1		Assessment T2	Assessment T3	Assessment T4
[st]	new word (treated): STATE	s	I	sitat	scik	steb
	familiar word (untreated): START	stra		star	star	star
	non-word (untreated): [stæd]	s		scad	bof	stid
[sk]	new word (treated): SCOFF	S	N	scoof	scoff	scof
	familiar word (untreated): SCARF	star		stor	sfotc	scof
	non-word (untreated): [skɑn]	k	T	scon	scorn	s
[pr]	new word (treated): PRAISE	biss		prisr	pime	plasie
	familiar word (untreated): PRAM	pame	E	pa	pram	pram
	non-word (untreated): [præd]	plag		pad	pard	prat
[sl]	new word (treated): SLY	S		sly	sine	siwe
	familiar word (untreated): SLEEP	sp	R	slep	sleep	sleep
	non-word (untreated): [slɜv]	(n.a)		sileec	sofl	sfir
[gl]	new word (treated): GLUM	glam	V	glum	gulm	guln
	familiar word (untreated): GLOVE	g		glov	glov	golf
	non-word: [gleɪθ]	glef		gilr	dlif	ls
[fr]	new word (treated): FROWN	F	E	farm	forn	far
	familiar word (untreated): FROG	forg		forg	frog	forg
	non-word: [frʊb]	fob	N	forb	farb	frag
[str]	new word (treated): STRESS	S		st	sche	shes
	familiar word (untreated): STRING	st		st	snig	sipb
	non-word: [strʌg]	ga	T	staeg	srag	she
[skr]	new word (treated): SCREECH	(n.a.)		stur	snew	scree
	familiar word (untreated): SCREAM	s	I	srce	srim	scern
	non-word: [skreɪt]	s		scag	skirt	skirt
[tr]	new word (treated): TRAIT	tit		trat	trim	trav
	familiar word (untreated): TRAIN	tera	O	frain	trin	trin
	non-word: [træz]	t		ches	chors	tl
			N			

= correct (2 points) = almost correct (1 point); (n.a) not attempted

These changes are less clear than for speech. Some trends from Table 6.12 include the following:

- Joshua made limited attempts at spelling in the pre-intervention baseline phase: he was afraid of making mistakes and reluctant to try. As he became more familiar with the

researcher, he was more willing to guess at unknown items, and this can clearly be seen in the successive columns.

- There is a general trend towards increasing accuracy across the table with Joshua gradually refining his representations of consonant clusters. Many examples of this trend are those of the list B (familiar) items (e.g. SCARF being initially spelt <star>, then <stor>, then <sfotc> and finally, most accurately <scof>. Joshua was exposed to such words in the classroom.

There is less regression noted in the spelling items than for the speech items. Once Joshua mastered his cluster spelling of a word, this new form was frequently maintained as he was aided by visual feedback. Nevertheless, some of the targeted new words were most accurately spelt following intervention, and then less accurately at successive assessments (e.g. PRAISE was realised as <prisr> post intervention but successive attempts did not have the correct consonant cluster). This is not surprising if one considers that these are challenging, new words for Joshua and ones that he will have a clear memory of immediately post-intervention. This also accounts for the decline in Joshua's non-word spelling score at the long-term follow-up.

6.1.3 Phase II

The second phase of intervention focused on a further nine clusters: [tw], [kw], [sm], [pl], [kl], [fl], [br], [θr] and [spr]. An overview of the results is presented in Table 6.13.

Table 6.13

Phase II consonant clusters [spr] [θr] [br] [fl] [kl] [pl] [sm] [kw] [tw]: Changes occurring in Joshua's speech and spelling.

		Assessment T1 % consonant clusters correct*	Assessment T2 % consonant clusters correct*		Assessment T3 % consonant clusters correct*	Assessment T4 % consonant clusters correct*	Assessment T5 % consonant clusters correct*
SPEECH	List A: Treated Words	11.1	22.2	I	77.7**	55.5	77.7
	List B: Untreated Controls	11.1	33.3	N T	66.6	44.4	66.6
	List C: Untreated non-words	0	5.5	E R	50**	38.8	44.4
	Mean for speech	***7.4***	***20.3***	V	***64.7****	***46.2***	***62.9***
SPELLING	List A: Treated Words	38.8	44.4	E N	38.8	61.1	44.4
	List B: Untreated Controls	38.8	27.7	T	72.2**	55.5	55.5
	List C: Untreated non-words	38.8	33.3	I	27.7	33.3	22.2
	Mean for spelling	***38.8***	***35.1***	O N	***46.2***	***49.9***	***40.7***

* Each consonant cluster correctly spoken or written was awarded 2 points. The rest of the word was not considered. Consonant clusters were given 1 point if considered 'almost correct' e.g. in speech: phonetic distortion of one of the cluster elements, schwa insertion between cluster components; in spelling: one grapheme inserted between cluster components or distorted but recognisable grapheme.

** Scores which are significantly different ($p<.05$) from the previous assessment score

This phase of intervention followed two baseline assessments (T1, T2). The difference between the mean speech scores at T1 and T2 is not statistically significant ($t(26)=-1.0$, n.s.). In Table 6.13 ** indicates assessment scores showing a significant change from the performance on the previous assessment. For speech, the mean scores show a significant difference from T2 to T3 ($t(26)=-4.478$, $p< .05$). The T3 assessment followed intervention, and significant changes in Joshua's cluster production at this point are consistent with effective intervention. Looking at the different wordlists for speech, it can be seen that the changes from T2 to T3 reach significance for the treated words (list A, $t(8)=-3.0$, $p<.05$) and the non-words (list C, $t(8)=-2.8$, $p<.05$), but do not reach significance in the case of the familiar, untreated words (list B, $t(8)=-1.7$, n.s.).

For spelling, no significant change was noted between the two baselines (T1, T2) suggesting that Joshua's written attempts were stable prior to intervention. However, there were also few significant changes post-intervention with a statistically significant increase only being noted for list B items from T2 to T3 following intervention ($t(8)=-2.286$, $p<.05$). Tables 6.14 and 6.15 show changes for the treated and untreated speech and spelling stimuli over the course of the programme. Table 6.14 presents the individual item analysis for speech.

Table 6.14
Qualitative changes in the Phase II consonant clusters: speech

		Pre-intervention baseline T1	Assessment T2		Assessment T3	Assessment T4
[tw]	new word (treated):TWIT	[tɪt]	[tɪt]	I	[twɪt]	[twɪt]
	familiar word (untreated): TWELVE	[tɛlv]	[twælv]		[təlɛlv]	[təwælv]
	non-word (untreated): [twɛm]	[tɛm]	[tɛm]	N	[twɛm]	[twɛm]
[kw]	new word (treated): QUIT	[kwɪk]	[kɪt]		[kwɪt]	[kwɪt]
	familiar word (untreated): QUEEN	[kɪn]	[kwɪn]		[kwin]	[kwin]
	non-word (untreated): [kwɛp]	[kɪp]	[kɛp]	T	[kəwɛp]	[kwɪp]
[sm]	new word (treated): SMIRK	[mɛk]	[mɛk]		[smɜk]	[mɜk]
	familiar word (untreated): SMOKE	[məʊk]	[məʊk]	E	[sməʊk]	[məʊk]
	non-word (untreated): [smɒf]	[mɒf]	[mɒf]		[smɒf]	[mɒf]
[pl]	new word (treated): PLAN	[pæn]	[plæn]		[plæn]	[plæn]
	familiar word (untreated): PLATE	[peɪt]	[peɪt]	R	[pəleɪt]	[pəleɪt]
	non-word (untreated): [plʊs]	[pʊs]	[pʊs]		[plus]	[plus]
[kl]	new word (treated): CLASH	[kwæʃ]	[kræʃ]	V	[klæʃ]	[kæʃ]
	familiar word (untreated): CLASS	[klæs]	[klæs]		[klæs]	[kæ]
	non-word: [klɑt]	[kæt]	[kɑt]		[gɑt]	[kɑt]
[fl]	new word (treated): FLED	[fɛd]	[fɛd]	E	[flɛd]	[flɛd]
	familiar word (untreated): FLAG	[fæg]	[fæg]		[fæg]	[fəlæg]
	non-word: [flaɪm]	[faɪm]	[faɪm]	N	[faɪm]	[feɪm]
[br]	new word (treated): BRAVE	[beɪv]	[breɪv]		[breɪv]	[breɪv]
	familiar word (untreated): BRIDGE	[bɪdʒ]	[bɪtʃ]	T	[bwɪdʒ]	[brɪdʒ]
	non-word: [braʊp]	[bʌp]	[baʊp]		[braʊp]	[baʊp]
[θr]	new word (treated): THRIVE	[faɪv]	[faɪv]		[θəraɪv]	[faɪv]
	familiar word (untreated): THREE	[fwi]	[fi]	I	[θri]	[fwi]
	non-word: [θraɪŋ]	[fæŋg]	[fraɪn]		[θaɪn]	[fweɪŋg]
[spr]	new word (treated): SPRINT	[pɪnt]	[pɪnt]	O	[spɪnt]	[pɪnt]
	familiar word (untreated): SPRING	[pɪŋg]	[pɪŋ]		[spɪŋg]	[pɪŋg]
	non-word: [sprɛk]	[pɛk]	[pɛt]	N	[prɛk]	[pɛk]

= *correct (2 points)* = *almost correct (1 point)*

Individual item analysis for the speech targets (Table 6.14) revealed a range of patterns as outlined in section 6.1.2 for the phase I clusters. There are several examples of the pattern 'immediate response to intervention, with stabilisation of form' (e.g. consider TWIT and FLED in Table 6.14). This pattern of change is not confined to list B items (the familiar control words) as was the case for the items in the first phase. The pattern of change is noted in items from all three lists. There are also many items shown in Table 6.14 which show an inaccurate production at pre-intervention baseline, followed by an accurate realisation *before* intervention has begun for that particular cluster. In the majority of such cases the accurate realisation is then maintained at the subsequent assessments.

Table 6.15 presents the individual item analysis for spelling. Patterns of change for the spelling items (Table 6.15) are similar to those outlined for the phase I clusters. Again, it can be seen that Joshua made limited attempts at spelling in the pre-intervention baseline phase (e.g. <t> for TWELVE, and <q> for QUEEN). There is a general trend towards increasing accuracy across the stimuli with Joshua gradually refining his written production of consonant clusters, e.g. BRIDGE changes from <b> to <bit> to <brig> and <brish>, and FLAG changes from <fack> to <kolon> to <flag>. Spelling of the non-word items was hard for Joshua and he made limited progress with these items, e.g. consider [sprek] which is variously spelt as <peang>, <rsb>, <pirc> and <nim>. Progress is noted more readily for the items from list A and B, although the items in list B are frequently seen reverting to their earlier forms at the T4 assessment, e.g. CLASS has its cluster accurately represented post-intervention but not at the final assessment where it appears as <gass>.

Table 6.15
Qualitative changes in the Phase II consonant clusters: spelling

		Pre-intervention baseline: T1	Assessment T2		Assessment T3	Assessment T4
[tw]	new word (treated):TWIT	ti	stia	I	sirt	tiwe
	familiar word (untreated): TWELVE	t	tle		211	12
	non-word (untreated): [twɛm]	t	time	N	time	tem
[kw]	new word (treated): QUIT	s t	seriah		sire	rine
	familiar word (untreated): QUEEN	q	qen		qane	quane
	non-word (untreated): [kwɛp]	k	cipe	T	kicp	sipm
[sm]	new word (treated): SMIRK	smik	smik		smirk	smirk
	familiar word (untreated): SMOKE	smok	saln		smork	smork
	non-word (untreated): [smɒf]	smot	smof	E	smof	smof
[pl]	new word (treated): PLAN	plan	plan		plan	plan
	familiar word (untreated): PLATE	plit	palt	R	plat	palet
	non-word (untreated): [plʊs]	plose	pal		puls	plo
[kl]	new word (treated): CLASH	clat	clas		chahe	clas
	familiar word (untreated): CLASS	cl	class	V	class	gass
	non-word: [klɑt]	colt	colt		kopw	h
[fl]	new word (treated): FLED	fild	fala	E	fled	flet
	familiar word (untreated): FLAG	fack	kolon		flag	flag
	non-word: [flaɪm]	flem	falm	N	falm	flam
[br]	new word (treated): BRAVE	but	birf		blau	brave
	familiar word (untreated): BRIDGE	b	bit		brig	brish
	non-word: [braʊp]	bla	bord	T	bard	pire
[θr]	new word (treated): THRIVE	f	fient		frin	faive
	familiar word (untreated): THREE	(n.a.)	there	I	theer	ther
	non-word: [θraɪŋ]	feng	fige		frag	bh
[spr]	new word (treated): SPRINT	p	sp		spirt	spin
	familiar word (untreated): SPRING	b	srs	O	sprin	spind
	non-word: [sprɛk]	peang	rsb		pirc	nim
				N		

= correct (2 points) = almost correct (1 point); (n.a) not attempted

6.1.4 Phase III

The final phase of intervention focused on the remaining 9 consonant clusters: [sp], [sn], [sw], [bl], [dr], [kr], [gr], [skw] and [spl]. Table 6.16 shows how the treated and non-treated speech and spelling stimuli changed over the course of intervention.

Table 6.16
Phase III consonant clusters [sp], [sn], [sw], [bl], [dr], [kr], [gr], [skw] and [spl]: Changes occurring in Joshua's speech and spelling.

		Assessment T1 % consonant clusters correct*	Assessment T2 % consonant clusters correct*	Assessment T3 % consonant clusters correct*		Assessment T4 % consonant clusters correct*	Assessment T5 % consonant clusters correct*
SPEECH	List A: Treated Words	11.1	22.2	77.7**	I	44.4	44.4
	List B: Untreated Controls	11.1	33.3	66.6	N T E R V E N T I O N	38.8	61.1
	List C: Untreated non-words	0	5.5	50**		16.6**	61.1**
	Mean for speech	***7.4***	***20.3***	***64.7****		***33.2***	***55.5****
SPELLING	List A: Treated Words	22.2	33.3	27.7		55.5	27.7
	List B: Untreated Controls	27.7	61.1**	83.3		61.1	16.6**
	List C: Untreated non-words	22.2	16.6	16.6		27.7	27.7
	Mean for spelling	***24.03***	***37***	***42.5***		***48.1***	***24****

* Each consonant cluster correctly spoken or written was awarded 2 points. The rest of the word was not considered. Consonant clusters were given 1 point if considered 'almost correct' e.g. in speech: phonetic distortion of one of the cluster elements, schwa insertion between cluster components; in spelling: one grapheme inserted between cluster components or distorted but recognisable grapheme.
** Scores which are significantly different ($p<.05$) from the previous assessment score

Paired samples t-tests were carried out to compare Joshua's performance on each wordlist, and overall, with his performance at subsequent assessments. In Table 6.16 ** indicates assessment scores showing a significant change from the performance on the previous assessment. The intervention for these clusters took place following three baseline assessments (T1, T2, T3). The difference between the mean speech scores at T1 and T2 is not statistically significant ($t(26)=-2.05$, n.s). Joshua's production of these clusters showed a normal amount of chance variation between these assessments. However, there is a statistically significant difference ($t(26)=-2.595, p<.05$) between T2 and T3 speech scores, indicating that he was already making gains in this phase of the programme prior to receiving specific intervention targeting these clusters. A statistically significant difference

in scores was not noted immediately post-intervention when comparing the results from T3 with those from T4 ($t(26)=.848$, n.s) and infact it can be seen from Table 6.16 that Joshua's scores declined somewhat after the intervention. A significant gain was found when comparing the scores at T5 with those from T4 ($t(26)=-2.657$, $p<.05$).

Looking more closely at the different wordlists for speech, it can be seen that Joshua's scores at T4 were uniformly low: he may have been tired and unmotivated by this point in the intervention programme. The treated words (list A) peaked in their improvement prior to intervention at T3. Words from list B (familiar words) steadily increased across the intervention, but did not reach statistical significance at any point. The non-words (list C) made significant gains prior to intervention at T3, decreased significantly after intervention at T4 and then made a further significant improvement at T5.

In terms of spelling, Joshua's mean scores did not vary more than one might expect prior to the intervention. Similarly, there is no statistically significant change post-intervention at short-term follow-up. There is a significant decline at the long-term follow-up ($t(26)=2.164$, $p<.05$) suggesting that Joshua was not able to maintain the small gains he had made in his spelling of these clusters over the longer term. If one looks at the different wordlists, it can be seen that most of the scores change gradually across the table. However, Joshua did make significant gains with his spelling of the untreated, familiar control words (list B), prior to intervention. He was able to maintain this level at the following two assessments at T3 and T4, but assessment T5 shows a significant decline in his spelling performance ($t(8)=2.874$, $p<.05$).

Tables 6.17 and 6.18 show the qualitative changes in speech and spelling which occurred during the programme item by item. Table 6.17 presents the individual item analysis for speech.

Table 6.17
Qualitative changes in the Phase III consonant clusters: Speech

		Pre-intervention baseline T1	Assessment T2	Assessment T3		Assessment T4
[sp]	new word (treated): SPITE	[paɪt]	[paɪt]	[paɪt]		[paɪt]
	familiar word (untreated): SPOON	[bʊn]	[pʊn]	[pʊn]	I	[pʊn]
	non-word (untreated): [spɪb]	[pɪp]	[pɪb]	[pɪb]		[pəbɪb]
[sn]	new word (treated): SNEER	[nɪə]	[nɪə]	[nɪə]	N	[nɪə]
	familiar word (untreated): SNAKE	[neɪk]	[nɛk]	[neɪk]		[neɪk]
	non-word (untreated): [snʊθ]	[nʌθ]	[nʊf]	[nʌf]		[nʌf]
[sw]	new word (treated): SWIPE	[waɪk]	[ʃaɪp]	[ʃaɪp]	T	[swaɪp]]
	familiar word (untreated): SWING	[ʃɪŋ]	[ʃɪŋ]	[ʃwɪŋg]		[swɪŋg]
	non-word (untreated): [swɔk]	[ʃɔk]	[sɔ]	[səwɔk]	E	[ʃɔk]
[bl]	new word (treated): BLAME	[peɪm]	[bleɪm]	[bleɪm]		[bleɪm]
	familiar word (untreated): BLACK	[bæk]	[bæk]	[blæk]	R	[bæk]
	non-word (untreated): [blɔʊʃ]	[bə]	[bʊʃ]	[bəlaʊʃ]		[blaʊʃ]
[dr]	new word (treated): DREAD	[dʒɛd]	[dɾɛd]	[dəɾɛd]	V	[dɾɛd]
	familiar word (untreated): DRESS	[dwɛs]	[dɾɛs]	[dɾɛs]		[dɾɛʃ]
	non-word: [drɛn]	[dʒɛn]	[dʒɾɛn]	[dɾɛn]	E	[dʒɛn]
[kr]	new word (treated): CRUEL	[kʊl]	[kʊl]	[kul]		[kul]
	familiar word (untreated): CRASH	[kræʃ]	[kwæʃ]	[kræʃ]	N	[kɾæʔ]
	non-word: [krutʃ]	[kutʃ]	[kuʃ]	[krutʃ]		[kutʃ]
[gr]	new word (treated): GREET	[gɪt]	[git]	[grit]	T	[grit]
	familiar word (untreated): GRASS	[gɑs]	[gɾæs]	[gɾɑs]		[gwæs]
	non-word: [grɒdʒ]	[gɒʃ]	[gɒʃ]	[gɒtʃ]		[gəʊwɒtʃ]
[skw]	new word (treated): SQUIRM	[gɜm]	[gɜm]	[gɜm]	I	[kɜm]
	familiar word (untreated): SQUARE	[kɛə]	[gɛə]	[gɛə]		[pɛə]
	non-word: [skwif]	[kɪf]	[kif]	[gif]	O	[gif]
[spl]	new word (treated): SPLIT	[pɪt]	[pɪt]	[pəlɪt]		[səpɪt]
	familiar word (untreated): SPLASH	[pætʃ]	[pæʃ]	[plæʃ]	N	[pæʃ]
	non-word: [splaʊt]	[paʊt]	[paʊt]	[praʊt]		[paʊt]

= *correct (2 points)* = *almost correct (1 point)*

Again, there is a range of different patterns as outlined for the consonant clusters in the earlier phases. Four of the clusters in this set, [sp], [sn], [spl] and [skw] were never produced correctly over the evaluations. These clusters changed minimally or not at all from assessment to assessment (e.g. [paɪt] for SPITE; [gɜm] and [kɜm] for SQUIRM). As many of these challenging [s] clusters happened to fall together in this third phase of intervention, it may have skewed results for this set. There were also many clusters that improved prior to

intervention, seemingly affected by the intervention that was taking place for other clusters (e.g. BLAME, DREAD and GRASS in Table 6.17). Some of these words remained accurate while others reverted to immature forms at T3. Again, there is a mixed picture here although it seems as if items from list C, the non-word controls, are more vulnerable to a 'weak' effect of intervention, i.e. they revert back after the priming effect of intervention.

Individual item analysis for spelling data appears in Table 6.18.

Table 6.18
Qualitative changes in the Phase III consonant clusters: Spelling

		Pre-intervention baseline T1	Assessment T2	Assessment T3		Assessment T4
[sp]	new word (treated): SPITE	spi	spit	spirt	I	spir
	familiar word (untreated): SPOON	spoon	spoon	spon		spoon
	non-word (untreated): [spɪb]	b	pub	pub	N	spim
[sn]	new word (treated): SNEER	s	snir	scire		sneer
	familiar word (untreated): SNAKE	snik	snack	snake	T	snak
	non-word (untreated): [snʊθ]	snack	snor	snuf		neht
[sw]	new word (treated): SWIPE	s	step	smepw		swip
	familiar word (untreated): SWING	sick	slen	swig	E	swin
	non-word (untreated): [swɔk]	walk	snork	sun		swalt
[bl]	new word (treated): BLAME	blam	blan	bimt	R	blam
	familiar word (untreated): BLACK	balk	balk	black		palet
	non-word (untreated): [bləuʃ]	blose	buls	bulss		b
[dr]	new word (treated): DREAD	geed	tred	dran	V	trat
	familiar word (untreated): DRESS	t s	ders	derrs		dries
	non-word: [drɛn]	deng	cime	dine		tr
[kr]	new word (treated): CRUEL	clol	cule	nme	E	cule
	familiar word (untreated): CRASH	ca	crar	cras		dres
	non-word: [krutʃ]	ksoe	cunse	chohe	N	rewr
[gr]	new word (treated): GREET	g	gee	gu		gelt
	familiar word (untreated): GRASS	ga	gorrss	grass	T	grras
	non-word: [grɒdʒ]	goej	golse	gsorg		in
[skw]	new word (treated): SQUIRM	s	stoo	scirm		shwe
	familiar word (untreated): SQUARE	s	hee	cray	I	spar
	non-word: [skwif]	gseg	sgtif	sife		sh
[spl]	new word (treated): SPLIT	p	sp	spin		sple
	familiar word (untreated): SPLASH	s	spla	splas	O	spals
	non-word: [splaʊt]	playt	spat	spot		sh
					N	

= correct (2 points) = almost correct (1 point); (n.a) not attempted

Qualitative examination of the spelling data for this set shows that initially Joshua was hesitant to guess, but at later assessments he was willing to attempt all targets. He had difficulties with some of the challenging clusters such as [skw], never approximating the target. Other spellings improved steadily across the programme, e.g. the target SWIPE changes from <s> to <step> to <smepw> to <swip>. Many of these changes do not seem contingent on intervention suggesting that Joshua was becoming more aware of clusters generally as the programme progressed.

6.1.5 Summary of micro evaluation

(a) This evaluation focussed on the specific results of Joshua's intervention by looking at changes in his spoken and written production of word initial consonant clusters in single words. Intervention focused on real words, unfamiliar to Joshua with each of the 27 word initial clusters represented by one word (list A). Control stimuli included familiar words (list B) and non-words (list C) with word-initial consonant clusters. Joshua received a total of 24 hours of intervention which was subdivided into three phases of eight hours each. Each phase addressed 9 clusters and was followed by a reassessment of all items.

(b) There was a statistically significant main effect for time for both speech [$F(4, 75) = 38.39$, $p < 0.05$] and spelling [$F(4, 75) = 5.839$, $p < 0.05$] for T1 to T4 assessments. Joshua's written and spoken production of consonant clusters improved over the course of the intervention. The effect size for speech (eta squared = .672) was greater than that for spelling (eta squared = .237).

(c) Long-term follow-up took place six months (T5) after the intervention was completed when Joshua was CA 8;7-8;8. Overall Joshua continued to make gains in his speech, but less maintenance was noted in Joshua's spelling with his spelling performance reverting to pre-intervention levels. Spelling was not the main focus of intervention. For speech, the most significant change was noted in Joshua's non-word production between T4 and T5 suggesting that online motor programming was improving.

(d) Individual words (both treatment stimuli and controls) were categorised in terms of the patterns of change exhibited. These ranged from 'no change throughout intervention' to 'immediate response to intervention, with stabilisation of form.' In general it was noted that the pattern of response did not seem to depend on the cluster in question but rather on Joshua's lexical knowledge, i.e. the three [sk] or three [br] words did not all respond in the same way, but [sk] and [br] non-words (or familiar words) were more likely to behave in the same way in terms of speech. Joshua frequently made good progress in his cluster production, but this then declined in subsequent assessment. There was less

decline noted in the spelling items than for the speech items. Once Joshua had improved his spelling of a word, this improvement was normally maintained. This fact may reflect Joshua's good visual memory, although the changes in spelling were less dramatic overall.

(e) Four of the clusters, [sp], [sn], [spl] and [skw] were never produced correctly over the course of the observations. Production of these clusters changed minimally or not at all from assessment to assessment (e.g. [paɪt] for SPITE; [gɜm] and [kɜm] for SQUIRM) suggesting that these were overall the most challenging clusters for Joshua to acquire.

(f) The purpose of a multiple baseline design is to show that items in a particular sub-set are affected only by subsequent treatment. Clusters targeted in phase I and II both showed evidence of significant improvement for speech production post-intervention which is consistent with an effective intervention. However, this was not always the case as Joshua made many improvements for specific clusters that were not contingent on a particular cluster's treated phase. Similar improvements may have been made without the treatment, but it is more likely that Joshua's awareness of the *concept* of a cluster may have been increased in the earlier phases of intervention.

6.1.6.Questions and themes revisited

(a) Was the intervention effective? Yes, the intervention strategy brought about significant change in Joshua's speech and spelling for the treated words (list A) from pre- (T1) to post- (T4 and T5) intervention assessment.

(b) Did generalisation occur? Yes, targeting list A words brought about improvements beyond chance level in Joshua's spoken production of familiar (list B) and non-words (list C). For spelling the list C words responded minimally to intervention, making gains during intervention, but reverting to baseline levels post-intervention. The design of the study does not allow one to comment on whether therapy using more familiar words would have been equally effective. Joshua found it difficult to remember many of the new words from session to session, and for his motivation it may have been better to use familiar words. Nevertheless, from a psycholinguistic point of view the strategy of using non-familiar words to tap online motor programming and then 'shake-up' stored motor programmes was effective.

Non-words were included as control stimuli since it was thought that if Joshua fully acquired consonant clusters then his online motor programming would be able to deal with repetition of these words. Joshua did show improvement in terms of his spoken

production of these items, with the greatest long-term improvement being shown on list C for speech, showing that online motor programming had been altered in a lasting way.

(c) *Is there a relationship between pre-intervention PPK and intervention success?* For each of the consonant clusters, Joshua had varying degrees of productive phonological knowledge (PPK) (Gierut et al., 1987). These authors suggest that clusters about which the least is known will be the most efficient ones to address. In Joshua's case, the majority of consonant clusters were in the Type 6 category, phonemes about which Joshua had no phonological knowledge and never used correctly. Two of the clusters, [sk] and [st] were considered to be Type 4 'positional constraint' clusters since Joshua was able to use these correctly in the word final position but not word initially. The remaining 6 clusters, [kl], [kw], [kr], [br], [gl] and [tw] were clusters from Type 3, about which Joshua had the most phonological knowledge. He was able to produce these correctly on occasion but seemed to have frozen forms for some specific words. The Type 6 clusters varied widely in the pattern of changes observed: some were efficiently modified (e.g. [tr]) while others showed no change (e.g. [sp]). Each of the 3-part clusters (e.g., [spl] and [spr]) made very limited change. The two clusters classed as Type 4 also made very limited change, suggesting that although Joshua initially had more phonological knowledge of these sounds, this did not aid the remediation process. Many of the [s] clusters were problematic for Joshua to acquire and this is something that has been noted in the literature (e.g. Barlow, 1991). Six clusters were classed as Type 3 clusters – sounds about which Joshua knew the most. No [s] clusters were included in this set. Joshua made progress with each of these clusters (e.g. see [tw], [kw] and [br] in Table 6.13) suggesting that having some knowledge is a good prognostic factor for intervention. Table 6.19 shows the PPK classification of clusters together with a summary of outcomes for each cluster.

It should be noted that Gierut et al. suggested that working on Type 6 targets maximally promotes *generalisation* to other categories (i.e. it is most efficient) rather than stating that work on Type 6 phonemes is *more effective*. The pleasing results in this study for the Type 3 items are interesting, but patterns of generalisation that might have occurred if only Type 3 or Type 6 items had been addressed, cannot be commented on.

Table 6.19
Joshua's stimuli lists showing clusters for which intervention was deemed a success*

Consonant cluster Shaded clusters – clusters successfully addressed	Age of acquisition from McLeod et al. (2001)	Productive phonological knowledge (PPK)** 1=maximum PPK; 6=no PPK	List A: Treated words	List B: Untreated control words (familiar words)	List C: Untreated control words (non-words)
[tw]	3;6	3	TWIT	TWELVE	[twɛm]
[kw]	3;6	3	QUIT	QUEEN	[kwɛp]
[sp]	5;0-6;0	6	SPITE	SPOON	[spɪb]
[st]	5;0-6;0	4	STATE	START	[stæd]
[sk]	5;0-6;0	4	SCOFF	SCARF	[skɑn]
[sm]	5;0-7;0	6	SMIRK	SMOKE	[smɒf]
[sn]	5;0-7;0	6	SNEER	SNAKE	[snuθ]
[sw]	6;0	6	SWIPE	SWING	[swɔk]
[sl]	7;0	6	SLY	SLEEP	[slɜv]
[pl]	4;0-5;6	6	PLAN	PLATE	[plus]
[bl]	4;0-5;6	6	BLAME	BLACK	[bləuʃ]
[kl]	4;0-5;6	3	CLASH	CLASS	[klɑt]
[gl]	4;0-5;6	3	GLUM	GLOVE	[gleɪθ]
[fl]	4;0-5;6	6	FLED	FLAG	[flaɪm]
[pr]	5;0-6;0	6	PRAISE	PRAM	[præd]
[br]	5;0-6;0	3	BRAVE	BRIDGE	[braup]
[tr]	5;0-6;0	6	TRAIT	TRAIN	[træz]
[dr]	5;0-6;0	6	DREAD	DRESS	[drɛn]
[kr]	5;0-6;0	3	CRUEL	CRASH	[krutʃ]
[gr]	5;0-6;0	6	GREET	GRASS	[grɒdʒ]
[fr]	5;0-6;0	6	FROWN	FROG	[frʌb]
[θr]	7;0	6	THRIVE	THREE	[θrɑɪŋ]
[skw]	7;0	6	SQUIRM	SQUARE	[skwif]
[spl]	7;0	6	SPLIT	SPLASH	[splaut]
[spr]	8;0	6	SPRINT	SPRING	[sprɛk]
[str]	8;0	6	STRESS	STRING	[strug]
[skr]	8;0	6	SCREECH	SCREAM	[skreɪt]

* Points were awarded for each accurate representation of a target word in the post-baseline assessments. Clusters obtaining scores of 4 or more points were considered to have been effectively addressed.
** from Gierut et al. (1987)

(d) Did the pattern of change follow the developmental trend? Pre-intervention baselines showed that Joshua was following a normal developmental sequence in his consonant cluster development. Table 6.19 shows the range of word initial consonant clusters together with norms for age of acquisition (from McLeod et al., 2001). It can be seen that Joshua's clusters classified as having a PPK of 3 are the ones expected to develop earliest. The qualitative information provided in Tables 6.11, 6.14 and 6.17 was considered in terms of each of the 27 clusters, with the three words representing the

cluster from lists A, B and C being grouped together. Points were awarded for each accurate representation of a target word, in the post-intervention measures. Clusters obtaining scores of 4 or more points were considered a success. These 'successful' clusters are highlighted in Table 6.19 which shows that all the Type 3 clusters were considered a success, with the exception of [kl] which fell short of the criterion for success. Secondly, it is striking that the /s/ clusters were not successfully treated – with the exception of [sw]. In general, Joshua is following developmental trends as, by the end of intervention, he had acquired all of the earliest acquired clusters, e.g. those usually mastered by 3;6 ([tw] and [kw]) and those that children typically begin to acquire at 4;0 (e.g. [pl], [bl]) and 5;0 (e.g. [tr], [dr]). The s-clusters, including the three-element clusters, remain challenging for Joshua. Three-element clusters are typically some of the last elements of phonemic acquisition. In general, it seems that intervention was able to expedite normal phonological development, although the s-clusters seemed not to fit in with this pattern, functioning as a separate group and somewhat resistant to change.

Some authors (e.g. Powell and Elbert, 1984) have emphasised that clusters with liquids (e.g. [tr]) are acquired before those with glides (e.g. [sw]). Table 6.19 shows that Joshua does have success with all the glide clusters and with many of the liquid clusters although not with [fl], [sl] and [tr]. There may be some evidence to support the clear distinction between glide and liquid clusters (e.g. see Smit et al., 1993), but in Joshua's case the difference between these types of clusters is not a marked one.

(e) Did treating a small set of consonant clusters have an effect on the other consonant clusters? Yes, Joshua made some improvements on untreated clusters prior to their intervention. The phase II clusters improved slightly between T1 and T2 (prior to intervention) for speech, but these gains did not reach significance. The phase III clusters showed some significant gains prior to their intervention for two of the lists for speech (between T2 and T3), and one of the lists for spelling (between T1 and T2). Joshua's awareness of the *concept* of a cluster at a general level may have increased in the first phase of intervention, thus bringing about spontaneous change in clusters not yet targeted. This may provide evidence for the fact that clusters can be taught as a concept, and that a limited number of exemplars are sufficient to bring about change to all clusters.

(f) How did the intervention affect Joshua's written representations of words? Joshua's written output of clusters were initially stronger than his spoken output. There was a significant main effect of time for spelling scores from T1 through to T4. More

specifically, Joshua made significant spelling improvement over the course of intervention for both the treated wordlist (A) and the familiar controls (list B). For these two lists, Joshua's written representations improved hand-in-hand with his spoken representations. No significant change was ultimately noted for the non-words (list C), showing a mismatch with his greatly improved spoken production of list C words.

The following section returns to the themes highlighted by Joshua's case.

(a) *Can Joshua's age-appropriate auditory input skills be reconciled with the problems of listening and auditory attention outlined in his case history*? This paradox might be explained by making a distinction between speech and language: the profile used in assessment was concerned primarily with *speech* rather than *language*. Joshua may have good abilities to process speech signals and perform tasks not requiring understanding of meaning or grammar. This hypothesis was born out in the course of the intervention: Joshua greatly enjoyed decoding the social stories but was not always able to understand the story. Joshua's auditory input skills as assessed by the profile and over the course of intervention are age appropriate. He has the foundation for good speech production and language learning but finds it hard to integrate the information and use it appropriately.

(b) *Is there a link between Joshua's output difficulties and his input phonological representations?* The second task in the task hierarchy (Table 6.8) focused on Joshua's phonological representations. Joshua was confronted with phonologically similar words and asked if these were the correct target. He enjoyed this task and performed consistently well. As noted in Table 6.8, it was surprising how well he performed given the fact that he frequently could not remember the word or its meaning. Again, there seems to be a dissociation between Joshua's phonological representations and his motor programmes, providing evidence of a two lexicon model of speech processing.

(c) *Is there a link between Joshua's spelling and his speech? Is he able to spell words with consonant clusters that he finds hard to produce?* Pre-intervention, a link was noted between Joshua's speech and spelling production, i.e. he reduced clusters in similar way in speech and writing, although his written attempts were slightly more advanced than those of his speech. Table 6.20 compares the success achieved for speech and spelling, using the same criteria for success as outlined in section 6.1.6 (c).

Table 6.20
Joshua's stimuli lists: Success in speech and spelling

Consonant cluster	Age of acquisition from McLeod et al. (2001)	Productive phonological knowledge (PPK)* 1=most PPK; 6=no PPK	List A: Treated words	List B: Untreated control words (familiar words)	List C: Untreated control words (non-words)	Success in speech √ = success	Success in spelling √ = success
[tw]	3;6	3	TWIT	TWELVE	[twɛm]	√	
[kw]	3;6	3	QUIT	QUEEN	[kwɛp]	√	
[sp]	5;0-6;0	6	SPITE	SPOON	[spɪb]		√
[st]	5;0-6;0	4	STATE	START	[stæd]		
[sk]	5;0-6;0	4	SCOFF	SCARF	[skɑn]		
[sm]	5;0-7;0	6	SMIRK	SMOKE	[smɒf]		√
[sn]	5;0-7;0	6	SNEER	SNAKE	[snuθ]		√
[sw]	6;0	6	SWIPE	SWING	[swɔk]	√	√
[sl]	7;0	6	SLY	SLEEP	[slɜv]		√
[pl]	4;0-5;6	6	PLAN	PLATE	[plus]	√	
[bl]	4;0-5;6	6	BLAME	BLACK	[bləʊʃ]	√	√
[kl]	4;0-5;6	3	CLASH	CLASS	[klɑt]	√	
[gl]	4;0-5;6	3	GLUM	GLOVE	[gleɪθ]		
[fl]	4;0-5;6	6	FLED	FLAG	[flaɪm]	√	√
[pr]	5;0-6;0	6	PRAISE	PRAM	[præd]	√	√
[br]	5;0-6;0	3	BRAVE	BRIDGE	[braʊp]	√	
[tr]	5;0-6;0	6	TRAIT	TRAIN	[træz]	√	√
[dr]	5;0-6;0	6	DREAD	DRESS	[dren]	√	
[kr]	5;0-6;0	3	CRUEL	CRASH	[krutʃ]	√	
[gr]	5;0-6;0	6	GREET	GRASS	[grɒdʒ]	√	
[fr]	5;0-6;0	6	FROWN	FROG	[frʌb]		
[θr]	7;0	6	THRIVE	THREE	[θraɪŋ]		
[skw]	7;0	6	SQUIRM	SQUARE	[skwif]		
[spl]	7;0	6	SPLIT	SPLASH	[splaʊt]		
[spr]	8;0	6	SPRINT	SPRING	[sprɛk]		
[str]	8;0	6	STRESS	STRING	[strug]		
[skr]	8;0	6	SCREECH	SCREAM	[skreɪt]		

* from Gierut et al. (1987)

There is no clear pattern that emerges here, although it can be seen that success in the one modality does not necessarily mean success in the other, e.g., [kw] and [tw] are successful for Joshua in terms of his speech, but in spelling they prove more problematic. Joshua has to visually learn how clusters are represented, because the orthography does not map onto the speech stream directly. It has also been noted that Joshua made no significant gains in his non-word (list C) spelling when comparing T1 and T5 results. This is in contrast to significant long-term gains made for speech production of these same items. It may be that intervention altered his online motor-programming for speech by introducing the CCVC shape. The fact that his non-word

spelling did not change in any significant way may suggest that this task is distinct from the speech production task, tapping into a different set of skills that have not been addressed in intervention. Alternatively, it may be that Joshua considered the non-word spelling to be a challenging task with little relevance to his daily life. He knew the words were nonsense ones and therefore did not adhere to established phoneme-grapheme conversion rules in writing them.

(d) *Is Joshua hyperlexic?* Over the course of intervention, it became clear that Joshua has hyperlexic tendencies. He enjoyed reading the stories, but read in a monotonous voice and did not notice if words were missing. While the intervention was effective in terms of the primary aim of Joshua's phonology, social gains arising from the introduction of the social stories was limited. Joshua was too busy with the mechanics of decoding to focus on the meaning. His social behaviour was not systematically measured but reports from his mother and class teacher suggested that little improvement in his behaviour was noted. This was not a primary aim of the intervention and carryover work was not done.

(e) *Is Joshua's phonemic awareness commensurate with his word reading skills?* Joshua has age-appropriate phonological awareness. Gillon (2000, 2002) has suggested that this might be a good prognostic indicator for intervention success for both speech and literacy. This may have been the case for Joshua: it was easy for him to reflect on words and their structure whilst not considering their meaning. His phonological awareness skills were judged to be commensurate with his word reading skills, although he still had difficulties with comprehension. Again, this contributes to the picture of Joshua as a child who has all the 'mechanical' skills fundamental to speech and language, but who finds it hard to integrate these at a higher level.

6.2 Macro evaluation

Short-term follow-up took place in March 2003, approximately one month after the completion of Joshua's intervention programme at CA 8;0. Long-term follow-up took place 7 months later when Joshua was in Year 4 (CA 8;7). The complete assessment as carried out initially in Section 2 was repeated in order to assess his progress in terms of speech, language and literacy. Assessment is grouped into four main areas: (6.2.1) standardised language assessments, (6.2.2) speech profiling carried out within a psycholinguistic framework, (6.2.3) speech analysis, and (6.2.4) child interview and parent / teacher report.

6.2.1 Standardised assessment

Standardised tests administered at the start of the intervention were re-administered and results are presented in Table 6.21.

Table 6.21
Comparison of Joshua's standardised assessments at CA 7;2 (pre-intervention), and CA 8;2 and 8,8 (post-intervention)

Assessment	Area tapped	PRE-INTERVENTION CA 7;1 Score	PRE-INTERVENTION CA 7;1 Age-Equivalent	POST-INTERVENTION CA 8;2 Score	POST-INTERVENTION CA 8;2 Age-Equivalent	POST-INTERVENTION CA 8;8 Score	POST-INTERVENTION CA 8;8 Age-Equivalent
Receptive language							
Test of reception of grammar (TROG, Bishop, 1989)	Receptive Grammar	Std Score: 72 Centile: 2	4;6	Std Score: 75 Centile: 2.5	5.3	Std Score: 83 Centile: 20	6.0
British Picture Vocabulary Scale (BPVS, Dunn et al., 1997)	Receptive Vocabulary	Std Score: 84	5;1	Std Score: 82	5,04	Std Score: 70	4,11
Expressive language							
Renfrew Word Finding Vocabulary Test (Renfrew, 1995)	Expressive Vocabulary	Centile: 1	3;8	Centile: 2	4;0	Centile: 2*	4;0*
Clinical Evaluation of Language Fundamentals (CELF- 3), Expressive Subtests (Semel et al.,1995)	Expressive Grammar	Std Score: 9 Centile: 40	6;5	Std Score: 8 Centile: 35	6;4	Std Score: 8 Centile: 35	6;4
Edinburgh Articulation Test (EAT, Anthony et al., 1971)**	Articulation	Std Score: 74	~5;0	Std Score: 83	~5;6	Std Score: 83	~5;6
Literacy measures							
Schonell Reading Test (Newton and Thompson, 1982)	Reading single words	Reading age = 6;11 years		Reading age = 8;0 years		Reading age = 8;2 years	
Schonell Spelling Test (Newton and Thompson, 1982)	Writing single words from dictation	Spelling age=6;4		Spelling age=7;0		Spelling age=8,1	

* Renfrew Word Finding Vocabulary Test has norms up to age 8;6 which were used for Joshua at 8;8
** EAT is designed for use with children up to the age of 6;0. Joshua's scores were calculated using this upper age limit although he was 8;2 at the time of the assessment.

Joshua's results showed little change from the first assessment. Given the amount of time that had elapsed between assessments, Joshua's results suggested that the language delays

were increasing relative to his peers. Joshua's reading age was close to his chronological age at the initial assessment and at the first follow-up assessment. However, the result from the long-term follow-up suggests that he may be starting to fall behind in this area too: his score was 6 months behind his chronological age at this follow-up. Bishop and Adams' (1990) critical age hypothesis suggests that children with speech difficulties that have not resolved by 5;6 are at risk of literacy difficulties in later development, and thus it may be worth monitoring Joshua's literacy with this in mind. His hyperlexia may be less pronounced in the future, a finding from Spark's (2001) longitudinal study of children with hyperlexia.

6.2.2 Speech profiling in a psycholinguistic framework

Tests used to build up Joshua's initial speech processing profile (Fig 6.1) were administered again in order to determine if any changes in his profile had occurred. Few changes were noted in the profile. Again, it became clear how disparate Joshua's performance on input tasks is when compared with output tasks. Joshua's profile from the short-term follow-up at CA 8;2 is presented in Figure 6.4 with the differences from the original profile highlighted. Joshua seemed to have made only two specific improvements: He now obtained an age-appropriate score for the auditory lexical decision task (Constable et al., 1997, level E, Appendix 2). This type of task formed an important part of the intervention programme, and Joshua may have been unfamiliar with the requirements of the task when it was initially carried out. On the other hand, Joshua's input skills are good and his strong skills at the lower level of the input side may have now resulted in improvements in some of the more challenging tasks at the top of this level. Joshua still found the PhAB picture alliteration task (Frederikson et al., 1997, level F) challenging. In terms of output, only one change was noted: Joshua performed in an age-appropriate way on the blending subtest from the Aston Index (Newton and Thompson, 1982). Again, this may be because Joshua had become more familiar with non-words through the course of intervention or alternatively that changes had been brought about in his online motor programming. The words used in the Aston non-word blending subtest are shorter, less phonetically complex words than those used in the non-word repetition test (Constable et al., 1997). This suggests that Joshua's motor programming has improved, but might not yet have generalised to longer words. No further differences were noted at the long-term follow-up, but Joshua was able to maintain the progress that had been noted at the short-term follow-up.

Figure 6.4
Joshua's speech processing profile at age 8;1, with changes from his profile at age 7;1 highlighted (from Stackhouse and Wells, 1997)
√ = age appropriate performance
X = 1 s.d below the expected mean for his age
XX = 2 s.d below the expected mean for his age

INPUT

F Is the child aware of the internal structure of phonological representations?
√ - Rhyming test (Vance et al. 1994)
X- PhAB picture alliteration subtest (Frederikson et al. 1997)
√ - Sorting task

E Are the child's phonological representations accurate?
√ - Auditory lexical decision task (Constable et al., 1997)
√ - Sorting task

D Can the child discriminate between real words?
√ – Real word discrimination test (Bridgeman and Snowling 1988)
√ - Aston index discrimination subtest (Newton and Thompson 1982)
√- PhAB alliteration subtest (Frederikson et al. 1997)
√ - Auditory discrimination test (Wepman and Reynolds, 1987)

C Does the child have language specific representations of word structures?

Not tested

B Can the child discriminate speech sounds without reference to lexical representations?
√ – Non-word discrimination test (Bridgeman and Snowling 1988)

A Does the child have adequate auditory perception?
√ - audiometry

OUTPUT

G Can the child access accurate motor programmes?
X – Single word naming test (Constable et al., 1997)
X – Word-finding vocabulary test (Renfrew 1995)
X – Edinburgh articulation test (Anthony et al. 1971)
XX – The Bus Story (Renfrew 1969)

H Can the child manipulate phonological units?
√ - PhAB spoonerism subtest (Frederikson et al. 1997)
√ - PAT rhyme fluency subtest (Muter et al. 1997)

I Can the child articulate real words accurately?
X – Real word repetition subtest (Constable et al., 1997)
√ - Aston index blending subtest – real Words (Newton and Thompson 1982)
√ - Real word test (Snowling)

J Can the child articulate speech without reference to lexical representations?
√ – Aston index blending subtest – nonwords (Newton and Thompson 1982)
X – Non-word repetition subtest Constable et al. (1997)
√ - Non-words test (Snowling)

K Does the child have adequate sound production skills?
√ - Stimulable for all sounds
√ - Oro-motor assessment (Nuffield Dyspraxia Programme, Connery et al. 1994)

L Does the child reject his own erroneous forms?
No

6.2.3 Speech analysis

A post-intervention PACS (Grunwell, 1985) was carried out at CA 8;8 to provide information on Joshua's phonological system (Table 6.22). This was compared with the summary of findings at the initial assessment (section 2.3.1). Many of the findings were the same as for the initial assessment: Joshua's severity indices had not changed (see Chapter 9 on intelligibility). However, it was noted that Joshua's word-initial cluster reduction had decreased significantly from 88% to 66% ($t(48)=-2.335$, $p<.05$). There was no evidence of cluster reversal (e.g. [wɒps] for WASP) at this second assessment. In addition to using more clusters in the word initial position, Joshua was also using more clusters word finally, although this is not yet consistent and did not constitute a significant difference from T1. Joshua still finds it hard to produce longer, multisyllabic words (e.g. [hɒsbɪkɪl] for HOSPITAL; [mə'tɑtəʊ] for TOMATO). He also still has many immature 'frozen' forms of words which he produces like a younger child, e.g. [lɛləʊ] for YELLOW. Joshua's cluster reduction remains a dominant aspect of his speech and one which requires further intervention. Joshua was no longer lateralising [s]: his front teeth had now appeared and it was easier for him to produce a correct [s].

6.2.4 Child interview and parental / teacher report

The child interview, and evaluation from significant others was carried out again at CA 8;8 to provide further impressions of changes in Joshua's speech.

6.2.4.1 Child interview

The same interview procedure as described in section 2.4.1 and Table 6.5 was carried out at the long-term follow-up assessment. Joshua re-iterated much of what he had said initially. He was reluctant to participate in the interview a second time. An important difference noted was that he now considered reading and writing to be important skills for children to learn. He reported that he enjoyed school now. His favourite part of school was P.E. and he also enjoyed assembly since he had recently been awarded a prize for good behaviour here.

6.2.4.2 Teacher report

Joshua's class teacher and LSA were again asked to complete Bishop's (1998) CCC. The same LSA was involved in both of these evaluations, but different teachers (Year 2 and Year 3) took part at the different times. The results of the checklist are presented in Table 6.23.

Table 6.22

Comparison of Joshua's speech data at CA 7;2 (pre-intervention) with CA 8;8 (post-intervention)

Assessment	Pre-intervention CA 7;2		Post-intervention CA 8;8	
Severity indices	PCC 78% PVC 100% PPC 86.7 %		PCC 76% PVC 100% PPC 85.5 %	
Phonetic inventory	Word initial: [m, n, p, b, t, d, k, g, f, v, s, z, ʃ, tʃ, dʒ, j, l, w] Word medial: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w] Word final: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w]		Word initial: [m, n, p, b, t, d, k, g, f, v, s, z, ʃ, tʃ, dʒ, j, l, w] Word medial: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w] Word final: [m, n, ŋ, p, b, t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, j, l, w]	
Stimulability	All phonemes		All phonemes	
Phonological processes analysis (% use)	Developmental processes: Cluster reduction (87.7%); consonant harmony (9%)		Developmental processes: Cluster reduction (66.6%); consonant harmony (7%)	
Single word speech sample	[dʒeɪpɪb] for JACOB [lɛləʊ] for YELLOW [tætikɪlə] for CATERPILLAR [hɒsbɪkɪl] for HOSPITAL [ɒ.ə.bɪl] for HOSPITAL [bʊvə] for BROTHER [kɑf] for SCARF [kʊtə] for SCOOTER	[bun] for SPOON [kul] for SCHOOL [gændæd] for GRANDDAD [wɒps] for WASP [dɛsk] for DESK [vɛst] for VEST [klæs] for CLASS [kɒk] for CLOCK	[dʒeɪpɪb] for JACOB [lɛləʊ] for YELLOW [tætikɪlə] for CATERPILLAR [hɒsbɪkɪl] for HOSPITAL [brʊvə] for BROTHER [skɑf] for SCARF [skʊtə] for SCOOTER	[sbun] for SPOON [skul] for SCHOOL [gændæd] for GRANDDAD [wɒsp] for WASP [dɛsk] for DESK [vɛst] for VEST [klæs] for CLASS [kɒk] for CLOCK
Connected speech sample	[ʃi.gɒ. ə. bækwʊn] for SHE GOT A BLACK ONE [də. fwi. lɪtə. pɪg] for THE THREE LITTLE PIGS [ɑɪm. və. bɪgbæd wʊf] for I'M THE BIG BAD WOLF [nɑʊ.də.tʊlɛf] for NOW THE TWO (ARE) LEFT [fɪŋgə.pʊpɛ] for FINGER PUPPET		[æn.ɑɪgɒtə. twæksut] for AND I GOT A TRACKSUIT [ɑɪm. nɒtəlɑʊd. tu. əʊpɪnɪtɒn. frɑɪdeɪ] for I'M NOT ALLOWED TO OPEN IT ON FRIDAY [ɑɪ.wɛntu.də.tʃɪpʃɒp] for I WENT TO THE CHIP SHOP [idʒumpt.əʊvə.ə.fɛns] for HE JUMPED OVER A FENCE	

PAGE NUMBERING AS ORIGINAL

Table 6.23
Comparison of Joshua's ratings on the Children's Communication Checklist (CCC, Bishop, 1998) pre- and post intervention

CCC subscale	Example of behaviours in each subscale	Joshua's score (pre-intervention	Joshua's score (post-intervention	Comments*
A. Speech output: intelligibility and fluency	Intelligibility; use of immature speech sounds; rate and fluency	26	27	Scores of 27 or below require further investigation
B. Syntax	Grammatical errors, phrase length	30	28	Scores below 29 require further investigation
C. Inappropriate initiation	Ability to talk appropriately to different people; whether amount and nature of communication is appropriate for the situation	26		Joshua's composite score for the Pragmatic subscales C-G was 132 initially and 96 post-intervention. Scores below 132 are considered indicative of pragmatic impairment.
D. Coherence	Ability to talk logically; make explicit information when needed	24	25	
E. Stereotyped conversation	Use of favoured phrases and topics; over-precise manner	28	26	
F. Use of conversational context	Understanding conversational rules; social appropriacy	25	21	
G. Conversational Rapport	Appropriacy of initiation and response to initiation of conversation; understanding and use of facial expression, gesture and eye-contact	29	20	
H. Social relationships	Friendships; interactions with children and adults	26	26	Scores of 24 or less require further investigation
I. Interests	Having very focused interests; prefers to do things alone or with others; interests in factual information	30	28	Acceptable: Scores of 28 or less require further investigation

* based on clinical guidelines from http://epwww.psych.ox.ac.uk/oscci/dbhtml/CCC/cccinstruct.htm

Once again, it is clear from the information obtained from the checklist that Joshua has many difficulties with speech and language. His speech score had improved by 1 point, but still within Bishop's 'danger zone'. Joshua's score for syntax was now, however, in the 'danger zone.' This decrease could be due to the different raters or reflective of the fact that his language difficulties are showing up more as classroom demands increase. Certainly, his CELF score (Table 6.21) seemed to be decreasing in relation to his peers'. His pragmatic composite score (items C-G) was found to be lower than at the initial assessment, confirming that Joshua has a considerable pragmatic language impairment. Bishop suggests that scores less than 132 require further investigation. Initially Joshua obtained a score of 132, but at

follow-up his score had substantially decreased to 96, suggesting again that his social skills and pragmatic abilities are becoming more noticeable as the demands of school increase.

In order to provide further information about Joshua's academic progress over the course of the intervention, SATs results were obtained from the assessments carried out at the end of Year 2 (prior to starting intervention) and at the end of Year 3 (at the completion of intervention). These results are shown in Table 6.24 and indicate that Joshua has made some progress in his general academic work, but it is not greater than might be expected over the course of this time period.

Table 6.24
Joshua's SATs results from pre-intervention (Year 2, CA 7;3) to post-intervention (Year 3, CA 8,2)

Area	Year 2: CA 7,3	Year 3: CA 8,3	Comment*
Reading	1A	2B	Improved 2 grades
Writing (includes spelling and handwriting)	1B	1A	Improved 1 grade
Numeracy	1B	1A	Improved 1 grade

* the numbers indicate the child's level of ability which moves from 1 upwards through to a target of 4 by the end of key stage 2. An A symbol indicates the child is almost ready to progress to the following level, whereas C or B suggests that they need further consolidation at that level. Here changes are reported in 'grades' which are derived from the number of 'letter' changes occurring, i.e. 1B to 1A constitutes an improvement of 1 grade. One would expect an average child to move 2-3 grades in the course of a year.

6.2.4.3 Parent report

Joshua's mother was pleased with the intervention and that Joshua had co-operated and worked hard. She felt that his speech has improved, but would like him to continue with therapy so that further progress can be made. She still considers him to sound babyish.

6.2.5 Summary of macro evaluation

(a) The macro assessment procedures carried out at the start of the project were re-administered on completion of the entire intervention programme in order to evaluate the intervention from a global perspective. Standardised tests of speech, language and literacy showed little change over the course of intervention with Joshua's performance decreasing in many cases when compared to his age-matched peers. Notably, his reading delay seemed to be increasing relative to his peers.

(b) Joshua's speech processing profile was largely unchanged with just two of the levels showing improvement: level E which poses the question: 'Are the child's phonological

representations accurate?' and level J which asks: 'Can the child articulate speech without reference to lexical representations?'

(c) Phonological analysis revealed that Joshua's word-initial cluster reduction had decreased significantly from 88% to 66% ($t(48)=-2.335$, $p<.05$). There was no evidence of cluster reversal (e.g. [wɒps] for WASP) at this second assessment. He was also using more clusters word finally, although this is not yet consistent and did not constitute a significant difference from T1. Joshua's cluster reduction remains a dominant aspect of his speech and one which requires further intervention.

(d) Joshua's teachers and parent continued to express concern about his speech difficulties on completion of the intervention. Although positive about the intervention outcomes, it is clear that Joshua requires further support for his speech, language and literacy needs.

7. DISCUSSION

One of the key themes of intervention research into clusters is the notion that treatment of more marked clusters will cause generalisation to less marked clusters even if the latter are not targeted in intervention. Intervention with a child reported by Gierut (1999) targeted the cluster [bl] with this generalising to 9 other clusters, including [sw], [sm], [sn], [sp] and [st] (Gierut, 1999). In another study, specific three-element clusters (e.g. [spr], [str]) were treated but did not generalise to other 3-element clusters, although some singletons and two-element clusters improved.

Including all clusters in Joshua's treatment programme allowed for the adoption of a holistic perspective on cluster development. Joshua did seem to follow broad developmental trends (as outlined by McCleod et al., 2001) in his acquisition of clusters, but different patterns of change were noted for different words and different clusters. In general it was found that Joshua's pattern of response depended more on his lexical knowledge than on a particular cluster, i.e. non-words or familiar words changed in a similar way as a group, rather than all [sk] or [bl] words acting as a group. Non-words seemed to respond differently to real words. In terms of phonology it was noted that the s-clusters seemed to respond differently to other clusters. This finding is supported by the literature and [s] clusters are frequently described as adjuncts, consonants adjoined more loosely to a word than a true cluster (Barlow, 2001; Velleman, 2002). The special status of [s] clusters has been supported by treatment studies which have found that treatment of these adjuncts does not

result in generalisation to other clusters (Gierut, 1999). Furthermore, it has been noted that the adjuncts as a group may be acquired before other clusters, or after – but essentially that they can be clearly distinguished as a group from the other clusters. [s] clusters certainly seemed most challenging for Joshua, but this may be because he had some difficulties in *articulating* [s] at the start of the intervention.

A multiple baseline design was used with different clusters being treated at different phases of intervention. In the early phases of intervention there was a clear effect of intervention on the particular clusters targeted in that phase, but by the third phase of intervention this pattern was not clear, with clusters from that set improving prior to the specific treatment targeted at them. This finding is not entirely surprising (Seron, 1997), and suggests that the *concept* of a cluster might have been the most important aspect of intervention. A small set of exemplars might have been sufficient in bringing about change rather than attempting to include all clusters. The questions of 'how many exemplars to use?' and 'which exemplars to use?' are important ones. While some authors have suggested that the answer to the first question is just one feature contrast (Blache, Parsons and Humphreys, 1981) or one phoneme (Gierut et al. 1987), others such as Edwards (1983) and Hodson and Paden (1991) have suggested multiple exemplars are preferable. A phonotactic approach to therapy (e.g. as advocated by Velleman, 2002) accords well with this point of view. Velleman suggests that focusing on the concept of a new word shape (e.g. CCVC) may well result in generalisation beyond the treated sounds.

Unfamiliar words were used as the main stimuli for intervention, and this was based on a specific rationale used with some success in previous studies (e.g. MacWhinney, 1985; Gierut, 1999). In the present study, these words did seem to have the overall effect of bringing about improvement in Joshua's speech processing, but it has been questioned whether other stimuli might have had a similar, or even more desirable effect. On the one hand, real and familiar words might have been more motivating for Joshua who tended to forget the new words. Children have a finite set of cognitive skills brought to the learning process – learning non-familiar words was taxing for Joshua and using familiar words might have freed-up more cognitive resources for learning. Alternatively, using non-words might have been another effective strategy which would have reduced the semantic load placed on Joshua. Joshua made and maintained significant gains in his non-word speech production. Children with hyperlexia *and* developmental delays are thought to have a better prognosis than children with developmental delays alone. This hypothesis of improved outcome is thought to be due to better ability to learn through exposure to written materials (Grigorenko et al., 2002). Sparks (2001) describes a longitudinal study of three hyperlexic children. He found that phonemic awareness remained low throughout the children's school years, that one of the children had lost his voracious appetite for reading while the other two still

enjoyed reading, and that the word recognition of all the children had decreased by one or two standard deviations when compared to their peer group. Sparks (2001) questions whether hyperlexic children have strong phonemic awareness skills that cannot be demonstrated because of difficulties with information processing, attention, memory, and / or abstract and conceptual thinking. He notes that researchers will have to determine whether reading can be used effectively to improve the language comprehension skills of hyperlexic children. Joshua would need to be monitored in the long term for this to be evaluated. His facility for decoding material does seem to be a valuable strength which could be harnessed in therapy and in the classroom. Yet, as noted at the follow-up literacy assessment, there is some evidence that his decoding skills may be decreasing over time when compared to his peers.

Joshua's intervention afforded a window into the consonant cluster development of a child with delayed phonological development. Intervention was shown to be effective in promoting acquisition of clusters following a normal, developmental sequence. It was suggested that working on a small set of clusters brought about widespread change in all clusters. Much of this discussion has emphasised the importance of stimuli selection, a theme introduced in Chapter 4 but of importance to all intervention. Joshua's intervention addressed a specific aspect of his phonological processing, adding to clinical and theoretical knowledge of word-initial consonant clusters, while contextualising this linguistic work within social stories in order to have wide-ranging relevance to the child in question and his behavioural difficulties.