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Chapter 1

INTRODUCTION

INTRODUCTION

One of the most prevalent communication disorders in the field of pediatric speech language pathology is the speech sound production disorder (Gierut, 1998). Figures reported suggest that the incidence is as high as 10% to 14% in the pediatric population (Gierut, 2001). It is estimated that 80% of these children have a disorder that is severe enough to warrant speech pathology intervention (Gierut, 1998).

There is wide acknowledgement of the existence of different speech disorders but no widely accepted framework of differential diagnosis. There is a growing need to examine treatment practices to ensure there is consistency between theory and practice (Powell, Elbert, Miccio, Strike-Roussos, & Brasseur, 1998; Rvachew, Rafaat, & Martin, 1999). The need to link theory and practice is confounded by the difficulty labeling the population of children with speech disorders undertaking a particular therapy regime (Dodd, 1996; Strand & McCauley, 1999). Further investigation of the efficacy of treatment approaches is warranted with particular focus on the nature of the disorder in the population being examined (Ballard, 2001; McCauley & Strand, 1999; Rvachew & Norwak, 2001; Wambaugh, 2002).

One population of children with speech disorders for whom efficacy has been less demonstrated comprises a small number of individuals who do not respond readily to treatment (Powell, 1996; Strand & Debertine, 2000). These children have been labeled by some authors with the descriptive term "persistent sound system disorder" (Powell, 1996; Shelton, 1993).

This study aims to evaluate one treatment approach, Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT) (Chumpelik (Hayden), 1984), with a particular subgroup of children with a speech disorder. A group of children with a severe persistent sound system disorder was selected to exclude those children with residual articulation errors that might be seen as persistent but whose disorder was not severe. In the past, the children with severe persistent sound system disorder were resistant to therapy.

Usually children with severe persistent sound system disorders have been exposed to a variety of traditional therapy approaches focusing on awareness and production of the phoneme, mostly with minimal success. Some authors express the view that there may be some children with persistent speech disorders who may be described as having a speech motor programming disorder (Forrest & Morrisette, 1999; Powell, 1996).

Therefore alternative treatment approaches need to be considered for children with severe persistent sound system disorders including those that are said to be useful for speech motor programming disorders. A variety of treatments report targeting speech motor problems however, no one management procedure or program is recognized as being significantly more effective (Marquardt & Sussman, 1991; Pannbacker, 1988; Strand & Skinder, 1999). Amongst the various treatment approaches described some take a motor

system perspective. For such treatment approaches authors have stressed the need to focus on the training of movement sequences and utilization of heightened sensory input in therapy (Marquardt & Sussman, 1991; Square, 1999; Yoss & Darley, 1974). PROMPT, Prompts for Restructuring Oral Muscular Phonetic Targets (Chumpelik (Hayden), 1984) provides both heightened sensory input and the ability to train lengthy movement sequences.

PROMPT is a motor speech approach, reported to be used with both adults and children (Chumpelik (Hayden), 1984; Dodd & Bradford, 2000**;** Pannbacker, 1988; Square, Chumpelik, Morningstar, & Adams, 1986; Square, 1994; Square, Goshulak, Bose, and Hayden, 2000), that is unique in that it utilizes tactile input to facilitate speech production in addition to the auditory and visual cues frequently relied upon in other treatment approaches. It requires the speech pathologist trained in the PROMPT approach to examine the speech motor system and then utilize this information to target specific speech motor goals using appropriate prompts. Prompts are tactile-kinesthetic cues applied to the musculature of the face, jaw and mylohyoid with the speech pathologists fingers. They provide support to the skeletal and neuromuscular system to assist in creating motor schemas or maps of sounds, words and/or phrases and sentences.

Broadly speaking the type of prompt used, that is parameter, complex, syllable, or surface, is distinguished by the type of support and the amount of support the prompt gives to the skeletal and neuromuscular system. Parameter prompts provide base support, they are large, organizing postures or cues. Complex prompts provide tactile-kinesthetic-proprioceptive information about as many components as possible for the production of a sound. They are often used to elicit a sound in isolation which is then re-embedded in a word. Syllable prompts are used to shape beginning CV (consonant vowel) or VC (vowel consonant) syllables. They provide a shaping posture that reflects the vowel shape and in doing this reduce the motor load for the person being prompted. Surface prompts provide signals for components of place, timing and transition of sounds in words. They provide critical information throughout coarticulated movement, and hence can be used to train lengthy movement sequences. In tactile-kinesthetic terms surface prompts provide the least information of any of the types of prompts for the neuromotor system to recognise and produce phonemes. As the movements are sequenced the speech pathologists' use of timing, stress and pressure are crucial. This study examines the efficacy of the PROMPT approach, by replicating a study by Square et al 1986, using surface prompts only, with a group of children who are described as having a severe persistent sound system disorder.

1.1 Speech Disorders

There are a number of disorders that impact on speech production. While some speech disorders are of known origin (e.g., cerebral palsy, intellectual disability, cleft palate, etc.), the focus of this study is on those of unknown origin (Ansel, Windsor, & Stark, 1992; Gibbon, 1999; Gierut, 1998; Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986; Shriberg, 1994; Thoonen, Maassen, Gabreels, & Schreuder, 1999). Several issues arise in relation to speech disorders of unknown origin.

Firstly, many terms have been used to describe breakdown in childrens' sound production. Terms include articulatory disorder, delayed articulation development, speech disorder, developmental phonological disorder, phonological delay, dyslalia, phono-motor disorder, developmental verbal dyspraxia, developmental apraxia of speech

and so on (Davis, Jakielski, & Marquardt, 1998; Gibbon, 1999; Ozanne, 1995; Powell et al., 1998; Shriberg & Kwiatkowski, 1982). This terminology is often used differently by different authors depending on their theoretical perspective and interpretations (Crary, 1993; De Montfort Supple, 1995; Dodd, 1996; Enderby & Emerson, 1995; Lambert & Waters, 1995; McCabe, Rosenthal, & McLeod, 1998; Shriberg & Kwiatkowski, 1982; Shriberg et al., 1986). While speech disorders that have no known underlying cause are referred to by many names, "developmental phonological disorder" is probably the more commonly used term but authors still fail to agree on a consistent, precise, definition of a phonological disorder (Dodd, 1996; Shriberg, 1994).

Another issue is that authors differ on the identification of underlying deficits of speech disorders of unknown origin. Bleile (1997) separates phonological disorders from articulatory disorders stating:-

> Virtually everyone agrees that speech disorders may arise from problems in either speech motor control (articulation disorders) or language knowledge (phonological disorders), even though research has not yet provided the means to make this differential diagnosis in clinical practice. (p. 2).

Shriberg's (1994) definition of a "developmental phonological disorder" incorporates both motor control and phonology. He states that such a disorder

> … is a clinically notable difference in the development of articulate speech that cannot be explained by significant deficits in a child's speech-hearing mechanism, cognitive-linguistic function, or psychosocial processes. (p. 38).

For Shriberg, the diagnosis of a developmental phonological disorder arises due to of the absence of discernable causative factors, rather than as a result of defining characteristics.

It becomes clear on reviewing the literature that the terms used for classifying breakdowns in the speech sound system (including phonological disorder), are too poorly defined to be specifically diagnostic, or fail to incorporate all the different types of speech disorders (Dodd, 1996; Powell et al., 1998; Shriberg, 1994). Some authors have attempted to provide a framework to explain these differences within the broader group of speech disorders (Dodd, 1996; Shriberg, 1994; Shriberg & Kwiatkowski, 1982). To date, however, there is no generally accepted classification system (Thoonen et al., 1999). This lack of agreement on classification of speech disorders, and in particular subgroups of speech disorders, means applying a diagnostic label to any subgroup of speech disordered children is likely to lead to controversy (Thoonen et al., 1999). Therefore, some authors have used descriptive, rather than diagnostic, terms to describe speech disorders. One such term is "persistent sound system disorder" adopted by Shelton (1993) to allow various authors to analyze a particular child, Matthew, and his therapy from several different theoretical perspectives. This term will be used in this thesis to describe a small group of children with speech disorders who do not respond readily to treatment.

1.1.1 Persistence of the Disorder.

While there are no definitions given for clinically determining 'persistent', it is apparent that there are children who are given this label due to their lack of progress or extremely slow progress. Some authors have pointed out the excruciatingly slow progress some clients make, often being in therapy for a number of years (Hodson & Scudder, 1990; Johnson et al., 1999; Rvachew & Norwak, 2001). Johnson et al. (1999) reported in their longitudinal study, carried out over a period of 14 years, that some 40 to 80% of

preschool children diagnosed with speech and language impairment continued to experience persistent problems.

Powell (1996) and others (such as Gierut, 1995 and Shelton, 1993) have noted a subset of individuals for whom there has been less demonstrable treatment efficacy when examining therapy outcomes for young children with speech disorders. Powell has supported Shelton's (1993) use of the term persistent sound system disorder and has stated: -

> Although the number of children with persistent sound system disorder seems to be relatively small, there is evidence of heterogeneity, in that this group may be composed of smaller, distinct subgroups of children (Shriberg, 1994). Despite the fact that the research findings are largely inconclusive and neurological bases have not consistently been identified (e.g., Horwitz, 1984; Williams, Ingham & Rosenthal, 1981; Yoss & Darley, 1974), some of these children have been given diagnoses that are at least suggestive of an underlying organic etiology (i.e., developmental apraxia of speech or DAS). (p. 316)

Similarly Milloy (1991) referred to a group of children, who continue to display a residual core of errors of articulation which neither maturation nor therapy seem to resolve. These children, with persistent sound system disorders, may attract the diagnostic label of dyspraxia or any of the variants of this label, that is, Developmental Articulatory Dyspraxia (DAD); Developmental Verbal Dyspraxia (DVD); Developmental Apraxia of Speech (DAS or DAOS); Childhood Apraxia of Speech (CAS) (Davis et al., 1998; Powell, 1996; Strand, 1995; Velleman, 2003)

This subgroup of children with severe persistent sound system disorders who fail to make adequate progress in therapy demonstrate a number of characteristics. Paucity of babbling, which may be an early indicator of delay in the onset of speech (Maassen, 2002; Oller, Eilers, Neal, & Schwartz, 1999; Paul, 1999) is observed. At some stage of the child's development oral apraxia, groping movements, difficulties with voluntary production of phonemes, poor diadochokinetic (DDK) rates and irregular sound production are also evident. All of these characteristics have been described in the literature as diagnostic of DVD (Adams, 1990; Caruso & Strand, 1999; Maassen, 2002; Murdoch, Porter, Younger, & Ozanne, 1984; Ozanne, 1995; Paul, 1999; Pollock & Hall, 1991; Rosenbek & Wertz, 1972; Williams, Packman, Ingham, & Rosenthal, 1980). Some researchers propose that DVD is a speech motor programming disorder (Ballard, 2001; Caruso & Strand, 1999; Chumpelik (Hayden), 1984; Crary, 1995; Square, 1994; Strauss (Hough) & Klich, 1999; Velleman, 1994; Yoss & Darley, 1974b).

Powell (1996) cites Jaffe (1986) who found that children with persistent disorders of speech sound production (which includes some children diagnosed with DVD) usually have 'impoverished phonetic inventories' suggesting the disorder may well be seen as severe. Any group of children who attract the description of a severe persistent sound system disorder is therefore likely to include individuals who also attract the diagnosis of Developmental Verbal Dyspraxia (DVD) or one of the variants of this label.

1.1.2 Aspects of Severity

Severity is another descriptive term that is often used to classify the speech-disordered population (Ansel et al., 1992; Dodd, 1996; Garrett & Moran, 1992; Shriberg et al., 1986). It is also a key identifier of the subgroup of children examined in this study as there are children in the speech disordered population who present with only minor residual articulation errors, who may be described as having a persistent sound system disorder, but it is not of a severe nature. In order to exclude this population with residual errors of articulation the notion of severity was included. There are measures of severity that can be used with the aim of assessing the severity of involvement (e.g. mild, moderate, severe) among the target population (Garrett & Moran, 1992; Shriberg & Kwiatkowski, 1982b).

The most common way that severity is described is by determining Percentage Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1982b). This provides a severity rating based on the total number of intended consonants that were correctly articulated divided by all the consonants in the sample. Scores of 85% or higher represent normal speech or mild difficulties; when scores fall between 65% and 85% mild-to-moderate problems are postulated; moderate-to-severe involvement is placed between 50% and 65%; and finally those with 50% or less consonants correct are classed as severe.

Another descriptive term used with children with severe speech disorders is level of intelligibility. While the measures above may reflect on the severity of the individuals' speech production, severity scores may not be closely related to overall intelligibility (Stoel-Gammon, 1994). Some authors have defined intelligibility as the percentage of words in a speech sample that can be identified by a listener regardless of accuracy of production (Hodge & Hancock, 1994). For example a child discussed by Shelton (1993), was described at one point as having 28 errors on the Goldman-Fristoe Test of Articulation (1986), which placed him at the fourth percentile for his age. Some two months later intelligibility percentages were calculated from two listeners and 93% of words were found to be intelligible (Tessier, 1993).

Rate and prosody are other aspects of speech, which may impact on its overall intelligibility (Hodge, 1994). Factors that also need to be considered include the degree of concern of interested parties and the consequences or impact of the disorder (Dodd, 1996). The time it takes to respond to therapy might also be seen as an indicator of the impact a disorder has on an individual.

With the lack of clarity about measures that constitute severity in sound system disorders, it is hardly surprising to find that many practicing clinicians use subjective judgments, which allow them to take many factors into account, rather than relying on one or a number of measurement techniques (Shriberg & Kwiatkowski, 1982b; Stimley & Hambrecht, 1999). It may be because of the complexity of determining severity that many studies give little, if any information on severity or overall intelligibility making it difficult to determine the composition of the target population (Hodson & Scudder, 1990).

Studies that do report severity often rely on clinicians to select participants who fit particular parameters, some of which are measured and some of which rely on subjective judgment (Gruber, 1999; Hodson & Paden, 1981). Garret & Moran (1992) compared the perceptual ratings of 10 undergraduate students majoring in elementary education and 10 graduate students in speech pathology with scores obtained from the PCC and PDS (phonological deviancy score) (Hodson, 1980, 1986) for 20 phonologically impaired children. PCC and PDS scores were compiled on both single words and connected speech. To collect data on perceptual ratings the students were initially exposed to samples of speech to demonstrate the range of phonological impairment to which they would subsequently be exposed. The students then rated the severity of each child's phonological disorder on a scale of 1 to 7 where 1 indicated mild involvement and 7 a severe phonological disorder. The resultant severity scores from all five measures revealed a high degree of intercorrelation, suggesting that both clinician ratings of severity and PCC/PDS are valid measures of severity of sound system disorders (Garrett & Moran, 1992).

Thus, a group of children who are considered by their speech pathologist to have a severe sound system disorder, which is subsequently supported by scores of PCC, and who fail to progress in therapy, might be reliably classified as having a severe persistent sound system disorder.

1.1.2.1 Impact on Language Development.

Many children with speech disorders, including those with severe persistent sound system disorders, are also found to have receptive and/or expressive language disorders (Dodd, 1996; Gierut, 1998; Mitchell, 1995; Smith, Goffman, & Stark, 1995; Square, 1994; Tyler, Lewis, Haskill, & Tolbert, 2002). The impact of speech disorders on the development of language is well documented in the literature (Barlow, 2002; Crary, 1984; Grunwell, 1990; Tyler et al., 2002; Tyler & McOmber, 1999) and some studies of infants have shown that early vocalization patterns can be predictive of expressive language delay (McCathren, Yoder, & Warren, 1999; Oller et al., 1999).

The estimate of speech disorders and grammatical difficulties co-occurring has been reported to be between 60% and 80% (Tyler & McOmber, 1999). It is difficult to determine the extent to which these findings reflect the presence of a true language deficit as opposed to one that is a consequence of the severity of the speech disorder (Hoffman, Norris, & Monjure, 1990; Tyler & McOmber, 1999). Therefore, it is expected that most subjects with severe persistent sound system disorders will experience some negative impact on language development and consequently will present with associated expressive language difficulties.

1.2 Treatment Approaches.

There are a variety of treatment approaches proposed for children who are experiencing some difficulty with speech sound production. As this group is so often broadly described, or there is disagreement over the makeup of subgroups, then the treatment strategies often do not delineate which subgroup may best benefit from the proposed intervention (Powell, 1996; Strand & Skinder, 1999).

In clinical practice, therapists may trial a variety of approaches to establish suitability for a particular client. For that subgroup with a severe persistent sound system disorder a number of approaches may have been utilized in less than successful attempts to provide remediation (Powell, 1996; Tessier, 1993). Therapy regimes available for treating speech disorders have generally utilized either a sensory motor approach or a cognitive-linguistic approach (Gierut, 1998). In the absence of efficacy studies pertaining to therapy approaches with this target population it was pertinent to attempt to select a therapy that might be expected to assist this sub group of children with severe persistent sound system disorders. A variety of possible therapy approaches were examined prior to selecting the approach to be studied to ensure this. In order to find a more effective and efficient therapy regime for these children with severe persistent sound system disorders who had received therapy in the past, it was also necessary to eliminate those therapy approaches that participants had been previously exposed to, or that might be similar to those previously used. Some such approaches and why they were considered or discarded are outlined below.

1.2.1 Cognitive-linguistic Approaches.

In general, cognitive-linguistic approaches focus on providing a level of knowledge of the structure and organization of language in order to effect cognitive reorganization rather than focus on production and practice of phonetic segments (Howell & Dean, 1994). Some of the most common cognitive-linguistic approaches are discussed below.

Distinctive feature approaches evolved to remediate features across phonemes rather than sounds themselves (McReynolds & Bennett, 1972). Phonemes are either grouped to represent a target feature, or there is focus on a particular phoneme that emphasizes the missing feature of the phoneme class (McReynolds & Bennett, 1972). Hence training is designed to teach production of features lacking in the child's repertoire.

Minimal Pair treatment involves associating the target sound, in a minimal pair contrast, with its corresponding error substitute. For instance, if the child produces /p/ for the target sound /f/ then these would be produced together and contrasted during treatment sessions (e.g. fit-pit; fat-pat etc.). The aim is to ensure the child learns that it is necessary to use two different sounds to signal different meanings in words (Gierut, 1998).

Metaphon is a cognitive-linguistic treatment that aims to increase metalinguistic awareness as a way of boosting phonological change and improved sound production. It explores the conceptualization of opposites (e.g. long versus short sound) and contrasts the sounds that differ. Minimal pairs are used to make these contrasts. The aim is for the child to develop the knowledge that change is required, that it can be made and information about how change might be achieved (Howell & Dean, 1994).

Cyclic therapy involves auditory bombardment along with sound production (Hodson & Paden, 1991). Once the child's errors and error patterns are identified the sounds are introduced in turn in successive treatment sessions which form a cycle. Mastery of a target sound is not required before a new target sound is introduced, hence this approach does not fit into the sensory-motor category. The child samples target sounds both auditorily and productively across the treatment sessions. If the sound continues to be produced in error it can be 'recycled' until more accurate discrimination and production occur. Thus the child is exposed to a wide range of sounds in an attempt to approximate the process by which children normally develop sound (Hodson & Paden, 1991).

All of these cognitive-linguistic approaches focus on the phonological aspects of the speech sound system but do not consider the motor aspects of speech production. Children with a severe persistent sound system disorder might be given a diagnosis that suggests speech motor involvement (Forrest & Morrisette, 1999; Powell, 1996; Shelton, 1993). This in turn, suggests the need to select an approach that reports to target the motor aspects of speech.

1.2.2 Sensory-motor

The most common sensory-motor therapy, known as the traditional approach, focuses on the perception and production of speech sounds (Hodson & Scudder, 1990; Powell et al., 1998). The child is usually asked to judge the accuracy of a sound in order to improve speech sound awareness. They are also expected to produce the target sound in isolation and then incorporate it into units of increasing linguistic complexity. At each stage, production is usually supported by imitating the clinician's model which is phased out until the child is producing the target sound spontaneously. The approach is considered to be sensory-motor and is often used in treatment with a broad range of speech disorders (Van Riper & Emerick, 1984).

Gestural cueing systems have also been used in the treatment of a range of speech disorders. Systems using visual-gestural cues aim to provide a visual cue for the target phoneme/phonemes and to aid sequencing of phonemes. Included in this approach are systems such as Cued Articulation (Passey, 1990); Adapted Cueing Technique (Klick, 1985) and Cued Speech (Cornett, 1985; Henegar & Cornett, 1971).

Sensory motor approaches do not address difficulties with actual speech motor movements. They rely on using, and improving, auditory and/or visual perception of the sound to provide a correct model and imitation of that model followed by practice, to correct incorrect sound production. The underlying assumption is that given auditory and visual input the person with the speech disorder will be able to change their speech motor pattern to produce the correct sound. This may be difficult for some people in the speech disordered population including those for whom therapy has been less efficacious such as those with severe persistent sound system disorders whose motor system may not be intact (Gierut, 1995; Powell, 1996; Shelton, 1993).

1.2.2.1 Tactile Input

Most children with speech disorders will receive either cognitive-linguistic and/or sensori-motor approaches. Some children, however, especially those with severe persistent sound system disorders will also be given a form of therapy that involves the clinician providing the child with tactile cues aimed at providing input to the motor system.

The Touch Cue system (Bashir, Grahamjones, & Bostwick, 1984) utilizes many components of traditional articulation therapy but also provides tactile cues for the "place" of articulation for eight consonants along with a voicing cue. The cues are given simultaneously with auditory and visual cues. Three stages of therapy are outlined. Stage one involves production of the target phoneme in isolation and in specific drills in nonsense syllables. There is a focus on self-monitoring with the touch cues being used as

a reminder for the accurate articulatory placement required for the target phoneme. Stage two focuses on incorporating the learned articulatory movements in both nonsense and real words. The aim is to “facilitate sequential movements between differing points of articulation” (Bashir et al., 1984, p. 133). The final stage emphasizes carry over into spontaneous speech.

The touch cues can be used in isolation or in sequence. This approach stresses the endpoints of movement sequences and can be used to train short movement sequences. It does not lend itself to training longer movement sequences incorporating rate and melody (Bashir et al., 1984; Square, 1994).

The moto-kinesthetic approach developed by Hill Young in 1938, (Young & Stinchfield Hawk, 1955) had its roots in phonetic placement. The system devised, used tactile cues and signals to assist the client to find the correct placement position or muscles to be used to achieve the target placement. The speech pathologist, however, while required to set the pattern for the location of the movement, “also stimulates the direction and form of the movement needed” (Young & Stinchfield Hawk, 1955, p. 12). Thus the movement involved in speech sequences was incorporated, but the use of this two handed method only enabled short movement sequences to be trained (Chumpelik (Hayden), 1984; Square, 1994, 1999; Young & Stinchfield Hawk, 1955).

The PROMPT system of therapy (Prompts for Restructuring Oral Muscular Phonetic Targets) was developed by Hayden (Chumpelik) in 1984. It utilizes "a dynamic tactile-kinesthetic, oral-facial cueing system designed for the treatment of motor speech disorders" (Square, Chumpelik, & Adams, 1985, p. 319). While PROMPT has maintained the tactile basis developed by Hill Young (Young & Stinchfield Hawk, 1955) it has gone far beyond simple touch for phonetic placement. Instead PROMPT uses the actual neurological correlates of movement, e.g. length, depth and amount of muscular contraction(s) to develop multi-dimensional actions that signal various phonemic components of speech. As a result PROMPT aims to "translate the phonemic system directly to the neuro-muscular movements required for articulatory sequences." (Chumpelik (Hayden), 1984, p. 141)

Prompts may signal the place of the target position, closure or relative amount of aperture opening, the amount and duration of contractions needed and amount or interaction of the number of muscles needed to produce the target movement. These movements in phonological terms translate to place of contact; closure, (reflects degree of jaw openness) and; manner (i.e. duration, continuance, movement, fusion, lateralization, and labialization). Through PROMPT the subject receives direct sensory, kinesthetic feedback to the motor system.

PROMPT is a system that allows for the training of longer movement sequences as it can be used for reshaping individual phonemes at syllable, word, phrase, or sentence level. It does not focus on a static end product but incorporates coarticulation processes and allows for both speech rate and melody to also be targeted (Chumpelik, 1984; Square, 1994).

In the population of children exhibiting a severe persistent sound system disorder, efficacy of therapy intervention has been less demonstrable than in other populations with speech disorders (Powell, 1996; Shelton, 1993). The need for efficacy of therapeutic

intervention for children with a severe persistent sound system disorder warrants evaluation of approaches such as PROMPT where systematic shaping of all the underlying neuromuscular processes is attempted. It was therefore set as a selection criterion for the participants in this study that none of the participants had been exposed to approaches that used tactile input.

1.3 Treatment Selection and Efficacy.

1.3.1 Treatment Efficacy.

The notion of efficacy implies that the desired results of clinically significant change are being obtained with maximum efficiency (Bain & Dollaghan, 1991; Gierut, 2001; Hodson & Scudder, 1990). Bain and Dollaghan (1991) identify three criteria signifying clinically significant change. They say there must be: -

> … a change in client performance that (a) can be shown to result from treatment rather than from maturation or other uncontrolled factors, (b) can be shown to be real rather than random, and (c) can be shown to be important rather than trivial. (p. 264).

Therefore, if all three criteria are met then it might be considered that a clinically significant change has taken place.

In terms of speech production, efficacy in therapy intervention implies measurable changes in a child's sound system (Gierut, 1998; Powell, 1996). It is recognized that these changes might occur with the sound that is being directly targeted in therapy generalizing in production to words and situations not targeted in therapy (Gierut, 1998). Change might also be evident when other sound errors that are not directly targeted during treatment are accurately produced. Sounds that display changes without direct therapeutic intervention are "… largely traceable to certain relationships that exist among sounds in a language" (Gierut, 1998, p.590). This means the untreated sounds can usually be described as similar to the treated sounds in terms of place of articulation or manner of articulation. This is referred to as 'within class generalization' (Gierut, 1998; Powell, 1996; Wambaugh, Kalinyak-Fliszar, West, & Doyle, 1998).

Studies have suggested that mastery of a sound is a gradual process from a sound emerging to consistent accuracy of production, and that this ongoing mastery will continue to occur once treatment is withdrawn (Diedrich & Bangert, 1980; McKercher, McFarlane, & Schneider, 1995; Olswang & Bain, 1985). Evidence of continuing mastery in phoneme production has led to the conclusion "…that it is appropriate to withdraw treatment or reduce the frequency of treatment when children achieve a response rate between 40% and 70% correct" (Rvachew et al., 1999, p. 37). Thus, attaining 40% or greater accuracy in production of a single phoneme might be considered as signifying clinically significant change as ongoing mastery of the phoneme is likely to occur even without further direct intervention.

While there is a growing number of efficacy studies in the field of speech pathology intervention being reported (Gierut, 1998) using a variety of measures there is still a dearth of information relating to treatment efficacy with speech disorders (Kent, 2000; Enderby & Emerson, 1995). Literature reviews by some authors have shown relatively few articles on treatment efficacy for children with speech

disorders published in major research journals (Doehring, 1988; Sommers, Logsdon, & Wright, 1992; Strand & Skinder, 1999). This is somewhat surprising considering the prevalence of such disorders in many speech pathologists' case loads (Enderby & Emerson, 1995; Gierut, 1998; Sommers et al., 1992). There are a number of treatment approaches for which there is relatively little, if any, data that describes the changes that a diverse number of phonological systems undergo following the introduction of treatment (Enderby & Emerson, 1995; Powell, Miccio, Elbert, Brasseur, & Stike-Roussos, 1999).

Few studies are available which provide us with specific information on the efficacy of particular treatment approaches with specific populations of speech-disordered children (Bain & Dollaghan, 1991; Hodson & Scudder, 1990; Powell et al., 1999). Problems occur, in part, because there is no universally accepted framework for diagnosing the different types of speech disorders (Enderby & Emerson, 1995; Thoonen et al., 1999). This makes it difficult for studies to define the population being targeted. It is also apparent that there is little description in most studies regarding the severity of the sound system disorder (Hodson & Scudder, 1990).

Hodson and Scudder (1990) concluded that "Data regarding efficiency are lacking, however, especially for highly unintelligible children" (p. 192). This report suggested that while most 'unintelligible' clients eventually become intelligible, that progress is very slow with some intervention programs lasting five or six years or more.

Similarly, efficacy studies for approaches which are reported to be useful for speech motor disorders are lacking (Kent, 2000; McNeil, 1997; Strand & Skinder, 1999; Wambaugh, 2002). Little has changed since Pannbacker (1988) outlined therapy approaches used with children reported to have DVD, a persistent sound system disorder, and found that most approaches were generally untested. Often studies are based on single case studies which leave the clinician with little guidance in determining what procedure to apply with whom (Crary, 1993; Enderby & Emerson, 1995; Love, 1992; Strand, 1995; Strand & Skinder, 1999; Wambaugh, 2002). Additionally single case studies or studies involving small numbers of participants make it difficult to draw meaningful conclusions (Doehring, 1988; Enderby & Emerson, 1995; Strand & Skinder, 1999). For some populations, for example children with severe persistent sound system disorders, finding a sufficient number of participants may always be problematic however, this might not be so for more commonly occurring populations.

1.3.2 Treatment Selection.

Clinicians will often draw on a combination of approaches because of the complexity of severe persistent sound system disorders (Powell, 1996; Shelton, 1993). Powell (1996) proposed a treatment regime for a child with this disorder to encourage the broadening of the phonetic inventory stimulating production of sounds unknown in the child's repertoire and then incorporating other communicative tasks. Gains were observed in phonetic inventory and in complexity of syllable structures. The therapy used, however, was not dissimilar to other approaches despite a different perspective in selecting target sounds. In "Matthew's" case (Shelton, 1993) five authors postulated different approaches to the problem, but as these were not implemented no conclusions can be drawn. For both the case studied by Powell (1996) and the case studied by Shelton et al (1993), the possibility of an underlying speech motor programming disorder was suggested.

As a result of limited information on efficacy of different approaches with this population and the persistence of the disorder despite the variety of therapy approaches undertaken, alternative treatment approaches need to be considered including those proposed for speech motor programming disorders. There are a variety of treatments that claim to target speech motor problems. These are well summarized by Pannbacker (1988), Love (1992), Crary (1993) and Strand (1995). There is, however, no one management procedure or program that is recognized as being the most appropriate for a child with a speech motor involvement (Love, 1992; Pannbacker, 1988; Strand, 1995; Strand & Skinder, 1999).

Some authors have recognized the need for treatment regimes for children with speech motor programming disorders to include the use of sensory input to achieve training of movement sequences (Marquardt & Sussman, 1991; Square, 1999; Yoss & Darley, 1974). This supports Kent's (1981) notion that while all sensory information (that is, auditory, tactile-kinesthetic and visual) is used in acquiring speech, and the auditory channel is vital in developing speech, that as the skill develops "the child may lessen dependence on the slow-loop auditory channel and rely to a greater degree on tactile kinesthetic feedback." (p. 177).

Square (1994) suggested that tactile treatment would be a useful method for providing another level of sensory input to facilitate phonetic placement. Evidence came from studies which demonstrated that light tactile stimulation activated facial and tongue neurons of the primary motor cortex (Square, 1994). It has also been suggested that tactile information may influence the development of neuromotor pathways. Certainly work by Kass (1991) has reported that therapy which increases sensory input "can increase the sizes of the representations of those parts in central maps" (p. 161).

Schema theory (Schmidt, 1975, 1988) proposed that four types of information are used in motor learning and these are required to develop motor schema (Square, 1999). Included are the organisation or postural pretuning, which in the case of speech means the articulators need to be in a state of readiness to move; secondly, the parameters of movement must be defined in terms of force, velocity and trajectory; thirdly, there must be processing of sensory consequences and this includes tactile-kinaesthetic feedback and the slower auditory feedback and finally, knowledge of results, that is, the outcome in environmental terms (Schmidt, 1975, 1988; Square, 1999).

As motor learning requires all four conditions for schema to be laid down then the use of touch becomes a primary consideration in treatment selection. Hence, an approach that readies the speech motor system for movement, allows for parameters of movement to be mapped in and supplies sensory feedback is deserving of consideration for children with severe persistent sound system disorders.

Phonetic placement techniques which provide tactile input would include moto-kinesthetic methods (Young & Stinchfield Hawk, 1955), Touch Cue (Bashir et al., 1984) and PROMPT (Chumpelik (Hayden), 1984).

While the other systems may provide tactile information to aid phonetic placement, the PROMPT system is unique in that each target or target series can be prompted at a syllable, word, phrase or sentence level. This ability to provide for transitive movement is important where speech motor planning might be a problem as sequencing of

phonemes is often seen to be the greatest difficulty (Ozanne, 1995). That is, the child can produce a phoneme in isolation but finds it difficult to maintain when coarticulation influences are present (Ozanne, 1995).

The advantage of PROMPT over the other two tactile methods described above is its ability to train larger movement sequences thus enabling cues to be used in spontaneous production. In addition, it allows for melody and rate to be targeted if necessary. The tactile, kinesthetic and proprioceptive cues act as a connecting modality to link the motor act with the auditory and visual modalities so that all sensory information is being processed at the same time in a coordinated way or in "parallel" as you would find in an intact system (Kent, 2000; Square, 1999). These factors suggest that PROMPT may be an appropriate therapy approach for children with severe persistent sound system disorders.

1.4 Description of PROMPT

PROMPT is more than a technique. It is also a philosophy, an approach and a system (Hayden, 2002b) and involves far more than simply knowing the actual physical Prompts for each phoneme and applying them. It is a holistic approach that requires the therapist to consider all aspects of the child's development and most importantly what speech motor skills are available to the child. A Systems Analysis enables the trained clinician to examine the acquisition and quality of skills at each level of motor development and then apply that information to the Motor Speech Hierarchy.

The Motor Speech Hierarchy (Figure 1) provides a framework that presents speech motor skills from a developmental perspective as well as demonstrating that development up the hierarchy is dependent on the acquisition of skills at the level/s below and that each level is interdependent on all other levels.

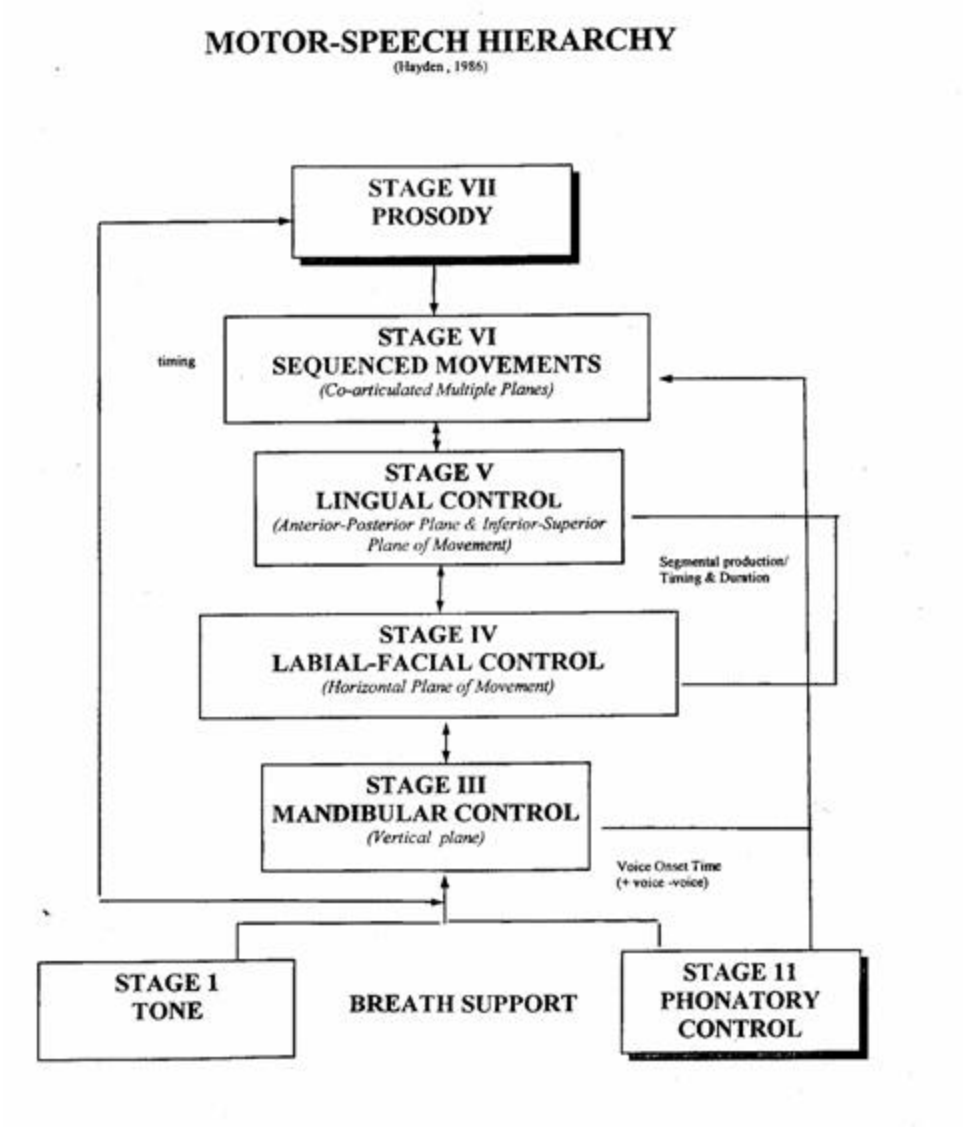


Figure 1.
Note. From Hayden & Square, (1994). Motor speech treatment hierarchy: A system approach. Clinics in Communication Disorders, 4(3), p. 163. Copyright 1986 by D. Hayden. Reprinted with permission.

Applying PROMPT in the intended holistic manner means the child is observed during speech or speech attempts and questions are answered on the Systems Analysis pertaining to the child's speech motor system. The trained clinician can then determine where the child's skills lie and where difficulties exist. Difficulties can then be highlighted on the Motor Speech Hierarchy allowing the clinician to accurately target the motor area or areas that require input. As speech motor skills are dependent on appropriate development at lower levels and interdependent on skills at all levels, then examination of the Motor Speech Hierarchy also enables the trained clinician to identify treatment priorities.

Once the target area for intervention is established then words and phrases/sentences are chosen that target the movement pattern that first needs to be established or refined. This allows the child to receive practice with appropriate tactile kinesthetic input in a functional situation where control can be established at single word, phrase and sentence level. The words/phrases/sentences chosen reflect the movement pattern being targeted which may be in one plane of movement (vertical, horizontal or anterior/posterior) and usually only incorporates a second or third plane, or direction, of movement once some stability has been achieved. Thus, the vertical plane incorporates changes in jaw height (i.e. the amount of opening of the jaw which is essential for clear vowel and diphthong production), the horizontal plane requires rounding and retraction of the facial musculature including the lips, while the third plane refers to intrinsic movement from anterior to posterior (and inferior-superior) in the tongue.

1.4.1 Types of Prompts

Using one hand behind the head or on the mandible, PROMPT provides support for the symmetry and stability of the trunk, head and facial skeletal structures, e.g. jaw. The therapist also uses his/her hand and fingers to give input to either surface or deep musculature as may be needed to construct a phoneme, syllable or coarticulated phrase. This prompting is applied on the jaw (for mandibular excursion), under the chin (anterior to posterior) to engage the tongue, on the face to engage labial-facial musculature or on the structures associated with voicing and nasality.

The tactile kinesthetic input provided by PROMPT can be varied depending on the degree of support required by the system at any one time. PROMPT uses surface, parameter, complex and syllable prompts. These prompts are outlined in the training manual (Hayden, 2002b) and demonstrated to clinicians who undertake training in this approach. Each type of prompt aims to support different components of the motor speech subsystem (e.g. base posture for the movement and stability of muscle groups, the muscles used, the amount of muscle contraction required, manner, duration, target position and transition).

Parameter prompts are large organizing postures where tactile-kinesthetic-proprioceptive input focuses on the skeletal, muscular, or neurological system. These prompts are used to provide stabilization for the mandible or facial structure so that finer control of smaller structures (such as lips and tongue) can be achieved. Parameter prompts can be used to set the degree of opening of the mandible or provide broad rounding or retraction of the facial musculature.

Syllable prompts are used to holistically shape muscle groups for CV or VC productions and they always reflect the vowel shape. Complex prompts are two-dimensional and provide cues for as many components as possible for a motor-phoneme. Complex prompts are used to construct a holistic single motor phoneme.

Surface prompts are one-dimensional surface cues that focus tactile-kinesthetic input to the articulators. They are used for place, timing and transition information when used in syllables, words or phrases (Hayden, 2002a). Although some finger placements may look the same they are not, as variations in timing and pressure are applied depending on the context of the motor-phoneme within the word. These cannot be seen and need to be felt, a necessary focus in the training workshops offered by the Prompt Institute.

Hayden (2002b) describes Prompts using the following terms.

1. **Phonation**. This refers to the presence or absence of voicing by simply stating voiced or unvoiced.
2. **Mandible.** This refers to the degree of opening of the jaw. In speech there are 4 degrees of opening of the jaw. In this instance jaw height 1 refers to neutral or the jaw up as for the production of /i/ or /m/; 2 refers to partially open as in the production of the Australian vowel /ʔ/; Jaw height 3 refers to half open as in the production of the Australian vowel /ʔ/; while Jaw height 4 refers to full open, in the context of speech, not as in a fully open mouth, as used in the production of the Australian vowel /a/. The actual degree of opening will vary from person to person depending upon bone structure, dentition etc.
3. **Labial-facial** . Here there are 11 positions. Prompts need to be applied to these positions symmetrically and equidistant from the midline. They are given at right angles to the face and only the fingers used for the prompt can touch the face. Position 1 and 2 refers to the labial corners, that is the intersection between zygomatic major and obicularis oris; Position 3 and 4 above refers to the juncture of the labial-nasal fold, whilst 3, 4 below, is inside and below the labial corners on the mandible; 5 is on the lower, medial, labial surface; 6 and 7 are beyond the labial corners, that is at the intersection of the buccinator muscle and zygomatic major; the number 8 refers to the point of contact for a nasal prompt (nares are not depressed); the point of contact for 9 is the signal for voicing (if required) and is gentle pressure at the side of the larynx; 10 is vertical placement at the middle of the chin and is the contact point for mandibular position movement in surface prompting; and finally 11 refers to the point of contact used in parameter prompting for breath support or exhalation.
4. **Mylohyoid.** There are 4 positions A, B, C, and D for applying prompts to the mylohyoid area. These stimulate various muscle groups of the tongue and provide timing and tension cues as well as assisting in activating specific portions of the tongue. The position A stimulates the anterior portion of the tongue as for /t/, /d/, /s/ etc and the trajectory of pressure is vital in achieving anterior tongue separation; Position B activates the mid portion of the tongue as for the Australian vowel /e/; position C the mid-back as for /ɞ/; and finally position D activates the back portion of the tongue as for /g/ and /k/. In all mylohyoid prompts the direction of movement or trajectory in which the pressure is applied is vital. Pressure is also applied in narrow or broad bands depending on the contraction required by using a different number of fingers. For instance one finger is used in the production of /t/ which requires a narrow point of contraction while 3 fingers are used for the production of /r/ which requires a broad contraction. Again the position of A, B, C, and D will vary on individuals.
5. **Timing**. This describes the relative duration of time each prompt is applied. Timing is crucial in differentiating differences between different productions. Hold is used for continuants such as /m/, while moderate and quick would be used to differentiate the production of like sounds such as /b/ and /p/.
6. **Pressure**. This refers to the amount of pressure applied with each prompt and the terms light, firm and moderate are used for descriptive purposes. On the

face pressure will only ever be light or moderate, while in the mylohyoid area it will be moderate or firm.

As an example the surface Prompt for the phoneme /m/ is described below: -
Phonation: voiced.
Mandible: 1
Labial-Facial: back of first and second fingers directly but lightly on labial surfaces, while lightly applying nasal prompt 8.
Mylohyoid: None.
Timing: hold
Pressure: neutral.

Photograph 1. The prompt for the phoneme /m/.

The need for demonstration and practice at the individual prompts in workshops is very important as changes in timing and pressure by the speech pathologist applying the prompt are likely to result in production of a different sound. For example when eliciting the production of /m/ if the prompt is released too quickly then /b/ or /p/ is likely to be produced especially in co-articulation. If too much pressure is applied then it is likely that /b/ will be produced instead of the required /m/. This is because, despite there being a difference in finger placement for production of /m/ versus production of /p/ and /b/, timing and pressure are crucial elements of PROMPT which is after all a tactile-kinesthetic approach.

Individual surface prompts are described in detail in the Introduction to Technique manual (Hayden, 2002b). The tactile-kinesthetic input used in PROMPT is crucial in terms of placement, pressure and timing and this is difficult to represent in the written form with any real accuracy as experiential training sessions are required to master the technique.

The PROMPT approach recognizes the necessity for flexible multi movement coordination which varies depending on context, (e.g. changes in rate of production of speech, loudness etc.) Thus: -

> PROMPT does not train static spatial end-products, nor does it train "phoneme" production alone. It highlights the most appropriate spatial and temporal aspects of each utterance given the state of the patient's system and the demands of the task. (Hayden, 2002b, p. 7).

1.4.2 Efficacy of PROMPT.

The efficacy of the PROMPT approach with adults with acquired apraxia has been demonstrated (Bose, Square, Schlosser, & van Lieshout, 2001; Square et al., 1985; Square, Chumpelik, Morningstar, & Adams, 1986). It should be noted that the study by Bose et al. (2001) was published after this current study was commenced in 1998 and data from that study was not available in establishing this research. The 1986 study by Square et al proved efficacious for minimal pairs, polysyllabic words and phrases. Results indicated that some change occurred in some untrained phonemes in some instances. The researchers suggested this may have been because of place or voicing contrasts between trained and untrained phonemes. Thus there is some suggestion that within class generalization might occur when prompting is used.

There are recent, unpublished, findings by Square, Goshulak, Bose, and Hayden, (2000) which indicate efficacy of the approach using parameter prompting (as opposed to surface prompts, complex prompts or syllable prompts) with a group of six children. It was demonstrated that the more normalized speech movements that emerged from the parameter Prompting resulted in perceptually better speech. Generalization to untrained words was evident and overall speech intelligibility and language expression, as measured by SALT (Systematic Analysis of Language Transcripts, University of Wisconsin-Madison), improved markedly. Again this paper was presented after this current study was commenced.

Another study by Dodd & Bradford (2000) with three phonologically disordered participants found PROMPT to be less efficacious than other approaches used in the study, however, it should be noted that the authors did not report any prior training in this approach. This is problematic not only in terms of accurately using the technique (that is the tactile-kinesthetic cues which require not only accurate finger placement but also accurate pressure, timing and movement transition) but also in the way in which the approach was applied with no description of the participants motor speech system or acknowledgement that this was a crucial element in using the PROMPT approach. Since the children in this study had a phonological impairment as the underlying deficit to their speech disorder, it is expected that a therapy approach aimed at addressing motor issues, such as PROMPT would prove less efficacious. Therefore the need remains for ongoing research on the efficacy of this approach with children with severe persistent speech disorders.

1.5 Summary/Conclusion.

It can be seen that much of the terminology pertaining to speech disorders is controversial and inconsistent. While attempts have been made to provide frameworks for more accurate diagnostic categories none of these has met with general acceptance (Thoonen et

al., 1999). The descriptive term "persistent sound system disorder" best describes the subgroup of children who make limited or slow progress in therapy (Powell, 1996; Shelton, 1993).

While the notion of severity is complicated by lack of agreement on measures it has been shown that perceptual judgments correlate highly with some measurement tools such as PCC (Garrett & Moran, 1992). It is important to use the term "severe" to exclude from the subgroup those children who may have 'residual articulation errors' which could be considered persistent (Shriberg, 1994) but whose speech disorder is not considered severe. We have thus defined a group of children which may include children with a speech motor programming disorder. A subgroup of children with severe persistent sound system disorders make minimal progress and it is therefore necessary to search for a more efficacious approach to remediation for these children.

Considering the characteristics displayed by these children and that they do not respond to therapy targeting articulatory or phonological skills, it is proposed that this study will provide some information of the effectiveness of one treatment approach with individual children with severe persistent sound system disorders. Since this group of children could include those with a speech motor programming disorder, the treatment approach chosen was one that takes a motor system perspective, that is, PROMPT.

1.6 Aims of the Study.

The general aim of this study is to examine the effect of the PROMPT system of therapy on a group of children with severe persistent sound system disorders. The study is a replication of the one carried out to test the efficacy of PROMPT with adult clients by Square et al (1986).

It is hypothesized:
1. that children exhibiting severe persistent sound system disorders will display a significant increase in the percentage of accurate productions of the phonemes targeted, in words and functional phrases trained using the PROMPT system of therapy.
2. that the accurate production of phonemes trained will increase in spontaneous utterances.

Chapter 2
METHOD

2.1 Participants

Five children presenting with a severe persistent sound system disorder, aged between 3 years 9 months and 8 years (mean age 6.0 years), acted as participants in order to assess the efficacy of the PROMPT approach. All the participants were male and were recruited from a private practice, a Community Health Center and an Education Department facility in the Gold Coast Region. A description of participants can be found in Table 2.1 and in Appendix A. All participants met the following selection criteria: -

1. History of paucity of babbling. This was recorded in case histories and where necessary verified by directly questioning the participant's primary caregiver.

2. History of delayed speech development. These participants had initially presented at speech pathology clinics due to parental concern over delayed speech development which was apparent on initial assessment.

3. Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.

4. The presence of groping movements or trial and error behavior on production of sounds noted by a speech pathologist.

5. The participant was unable to voluntarily produce isolated phonemes or sequences of phonemes that have been produced on other occasions. This was observed and noted by the referring speech pathologist and subsequently by the examiner on repeated presentation of the Fisher-Logemann Test of Articulation Competence (Fisher & Logemann, 1971).

6. Irregularity of sound productions that cannot be explained in terms of phonological processes reported by the participant's speech pathologist and later supported by irregular production of phonemes during the three separate presentations of the Fisher – Logemann Test of Articulation Competence (Fisher & Logemann, 1971).

7. Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks reported by referring speech pathologist and later determined by set tasks and recorded on video.

8. Significantly better receptive language development than expressive language development as a result of restricted speech development. Significant meaning receptive language index was at least one standard deviation above expressive language index.

9. The disorder was perceived as severe. On initial referral, speech was described as severely affected by the referring speech pathologist and later confirmed by PCC. Participants' speech attempts on Fisher – Logemann Test of Articulation Competence (Fisher & Logemann, 1971) were recorded and consonant production was manually scored as correct or incorrect to obtain a PCC.

10. The participant had undergone a minimum of 12 months of therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches. This was determined by the referring speech pathologist and supported by parental reporting.

Subjects were excluded if they had: -

- A known hearing loss.
- Dysarthria as a primary diagnosis.
- Oral-facial abnormality.
- Visual abnormality.

- Received PROMPT therapy previously

Table 2.1 Characteristics of the Participants.

Participants	Age	DDK	Receptive Language	Expressive Language	PCC	Years in Therapy
			Standard Scores			
1	7;7	Unable.	110	86	45.85 %	3;3
2	4,2	Unable.	112	96	38.41%	1;1
3	8;0	Unable.	74	42	48.37%	4;0
4	3;9	Unable.	75	0	11.03%	1;3
5	6;6	Unable.	79	0	10.89%	3+

Note. Standard Scores reported are from different assessment tools (see Appendix A). For DDK the use of "Unable" indicates the participant was unable to perform the task/s required to measure DDK.

As can be seen in Table 2.1, two participants were unable to complete the expressive portions of the assessment protocols due to the severity of their speech disorder. This is represented by scores of zero. Assessment protocols used varied depending upon the age and capability of each participant and details can be found in Appendix A. None of the participants were able to sustain phoneme repetition sufficiently for DDK measures nor sequence phonemes as required for completing DDK measures so DDK rates could not be calculated. This is recorded on Table 2.1 as "Unable". Again further details on individuals' performance can be found in Appendix A.

All participants had been in therapy for a minimum of one year. Both their speech pathologist and their parents reported that the participant had made minimal gains during intervention and the severity of the speech disorder, as revealed by their PCC scores, would seem to support this. All participants had been exposed to a variety of therapy approaches and schedules with no one approach being observed as being particularly helpful. In all cases the parent and the speech pathologist involved were willing to explore alternatives that might result in a faster rate of progress. Further details of collection procedures can be found in Appendix A.

2.2 Method

The aim of this study was to replicate the study by Square et al. (1986) in carrying out a series of single subject case studies. This study by Square et al (1986) as published and available, contained limited detail, however those details available are discussed in pertinent sections of the methodology. Square's study involved three adult subjects with severe apraxia of speech and aphasia. Performances of each of the three subjects in the study by Square et al. (1986) was baselined over three consecutive days with each subject required to produce 24 minimally contrastive phonemes three times each, 10 bisyllabic words and 9 functional phrases both given ten times each on each of the three days. Following this data collection a speech pathologist, not involved in the data collection, selected phonemes to be targeted by the three subjects in the study.

Square et al.'s (1986) subjects were assigned four pairs of randomly selected minimally contrasting phonemes, based on voicing, which had never been produced correctly; two pairs of phonemes for training with PROMPT, two as controls for probing imitation. Two of the subjects were also given four polysyllabic words, two for training and two for probing. For the third subject, six polysyllabic words were selected, three for training, the remaining three for probing. Functional phrases were chosen for two subjects only. In one instance four phrases were chosen, two for training and two for probing. For the other subject, two phrases were chosen, one for training and one for probing. The much younger participants in the current study required modifications, as outlined below, to the sound production tasks used in the study by Square et al. (1986).

Following Square et al. (1986) the current study employed an experimental design with multiple baseline measures on two behaviours.

2.2.1 Selection of Target Phonemes

During initial data collection to determine target phonemes, consonants produced or attempted were simply scored as correct or incorrect on all measures so a PCC for all speech attempts could be obtained. As each participant produced a limited range of consonants and vowels the percentage consonants correct were collated manually. Each production was transcribed using broad transcription. None of the participants displayed errors of metathesis. This data on the correct/incorrect consonant production was collected over three consecutive sessions as it was in the study by Square et al (1986).

The participants' previous speech pathologists had reported irregular sound production. As the production of sounds was seen as irregular two target phonemes needed to be selected for training that were never produced accurately. It was also necessary to select at least one target phoneme whose minimal pair had not ever been produced accurately to examine within class generalization as some within class generalization had been observed in the study by Square et al (1986). Furthermore it was necessary to select a fourth phoneme, with different features from the trained phonemes, that had never been produced accurately to act as a control probe although the study being replicated utilized 2 phoneme pairs as probes. Thus the study by Square et al (1986) trained a greater number of phonemes, and used a greater number of control probes, however the participants in this study were much younger and hence the number of phonemes trained and probed was reduced.

In the study by Square et al. (1986), three sessions were taken to obtain the initial data however the method used to elicit speech and the type of utterances required differed. Instead of requesting production of 24 minimally contrasted phonemes, 10 bisyllabic words and 9 functional phrases as used by Square et al. (1986), the current study obtained data by requesting: -

- Spontaneous or auditorily cued naming of pictures on the Fisher-Logemann Test of Articulation Competence (Fisher & Logemann, 1971). Participants were shown the picture and if the target word was spontaneously produced then the consonants in the utterance were scored as correct or incorrect. If the participant did not spontaneously name the picture or produced the wrong target word then the speech pathologist named the picture requesting the participant repeat the target word. Consonants in the utterance were then scored as correct or incorrect. Since the phonemes to be targeted

were never produced correctly, that is spontaneously or following an auditory model, then whether the word attempt was elicited was not relevant to the selection procedure.

- Consonants were scored as correct or incorrect in samples of spontaneous speech, where possible, to confirm the accuracy or inaccuracy of phoneme production to ensure target phonemes and control probes were never produced accurately prior to the treatment phase.

The data was collected using the Fisher-Logemann Test of Articulation Competence because it contains picture cues which proved helpful in eliciting the desired utterances in the young participants. For some of the participants whose sound system disorder was severe, the use of bisyllabic words and phrases proved to be too challenging. The data collected on the Fisher-Logemann Test of Articulation Competence and in the spontaneous samples, was transcribed using broad transcription from which a PCC was calculated. A second speech pathologist, not involved in either the data collection or the subsequent implementation of therapy, then rescored 46.6% of randomly selected samples. An inter rater agreement of 96.8% was established.

For each of the subjects, two consistently misarticulated phonemes that were not minimal pairs, (these will be referred to as the 'trained' phonemes) were selected from data obtained on articulation errors to be trained using PROMPT. The author along with the speech pathologist who was re-scoring the data chose these. A minimal pair for one of these phonemes, based on voiced/voiceless contrast (that is place and manner of articulation remained the same, but voice differed), was selected to provide within class generalization scores. This minimal pair phoneme had never been produced correctly either. A fourth unrelated phoneme, that was never produced accurately, was selected as a control probe. This was used to determine if only treated phonemes or their minimal pairs (within class generalization) were subject to change during the treatment phase. It is expected that there would be no treatment effect on these motorically different phonemes. Both the minimal pair and the control probe will be referred to as the 'untrained' phonemes. The author carried out the training, using PROMPT. The second speech pathologist was involved only in scoring data and assisting with phoneme selection.

2.2.2. Baseline Data

Baseline measures of productions to be trained were established once phonemes were selected. For each phoneme the following combinations were targeted: -

- Two CV (Consonant Vowel) words;
- Two CVC (Consonant Vowel Consonant) or CVCC (Consonant Vowel Consonant Consonant) words;
- One functional phrase containing the target phoneme in one word

.

In each instance the target phoneme to be trained was in the initial position in the word and only the target phoneme was scored as correct or incorrect during both baseline measures and in the therapy phase. Thus the accuracy or otherwise of the rest of the word or phrase was not measured. The number and type of utterance selected differed from the study by Square et al. (1986) due to the very young age of some of the children involved and the desire to ensure all words and phrases selected were functional for the individual. Parents were consulted regarding word/phrase choices and their applicability to family

lifestyle and language usage. As a result some CVCC words (using nasal /n/ plus an affricative or stop) were included to ensure a functional vocabulary for the individual.

Table 2.2. Phonemes selected for each participant.

Participant	Phoneme	CV	CV	CVC	CVC-CVCC	Phrase	Min. Pair	Control
Partic. 1	/t?/	chair	chew	cheese	chip	Change the channel.	/d?/	Not completed.
Partic. 2.	/f/	four	fur	food	fish	Me first.	/v/	/l/
	/t?/	chair	chew	chip	cheese	Change it please		
Partic. 3	/f/	four	far	five	fork	I want food	/v/	/?/
	/l/	lie	low	like	lunch	Leave me alone		
Partic. 4	/?/	shoe	she	shirt	sheep	Show me	/?/	Not completed.
Partic. 5	/b/	bye	bee	boat	band	A little bit.	/p/	/f/
	/w/	Why	where	wait	want	What is it?		

A baseline measure was taken on 10 productions of each word/phrase on three consecutive sessions. Words/phrases were presented both auditorily and visually in the form of pictures. Visual presentation was considered vital due to the age of the participants. Target words and phrases were often presented in the form of games to ensure interest level was maintained. As a result repetition of the words/phrases often, though not always, occurred in random order. Target phonemes were scored as correct or incorrect in all baseline productions. Non-target phonemes were not scored. A second speech pathologist scored a randomly selected 33% of baseline measures. Inter rater reliability emerged at 100% agreement on baseline data collected. Training of the target sounds commenced in session 4.

2.2.3. Treatment Phase

The PROMPT training procedure used was very similar to that used by Square et al. (1986). First the participant was given the target word/phrase with an auditory model and accompanying visual stimulus (i.e. picture). No prompts were given. If the attempt was correct, that is the target phoneme was produced correctly in the target word/phrase, praise was given and the response scored as correct. If, however, the response was

incorrect, that is the target phoneme was incorrectly produced in the word/phrase or the target phoneme was separated from the rest of the word (e.g. /b-i/ rather than /bi/), the speech pathologist applied prompts as follows: -

- The participant was instructed not to respond as the speech pathologist "mapped in" the correct motor pattern to be used using surface prompts. The surface prompts used were as instructed in the introductory course and as outlined in the PROMPT Manual (Hayden, 1997). The current initial PROMPT training program, with accompanying manual (Hayden, 2002), is entitled “Introduction to PROMPT Technique” (http://www.promptinstitute.com/). Thus, there was one prompt (or tactile – kinesthetic cue) for each sound in the target utterance. This meant target phonemes were trained within the context of a word or phrase, not as isolated sounds.

- The participant was then asked to attempt the word/phrase as the speech pathologist simultaneously prompted the motor pattern, again using one surface prompt for each phoneme.

The response was then labeled with a "P" to denote the use of a "PROMPT" and scored as correct or incorrect (Square et al., 1986, p. 223). An example of a score sheet is located in Appendix B. The next trial was then presented until a total of 10 trials for each word/phrase were completed.

Training sessions included 10 trials for each selected word/phrase and these sessions continued until at least 80% accuracy was obtained on two consecutive sessions or eight sessions were completed, whichever came first. It should be noted that in the study by Square et al. (1986) all subjects had achieved 80% accuracy in target phoneme production over two consecutive sessions by the seventh session with one subject being an exception on a single measure.

Training for the words and phrases for the second phoneme selected for the study was commenced following three baseline data sessions at the completion of training for the first phoneme. Training continued as for the first phoneme, ending when the 80% criteria was reached or at the eighth session of training. Training sessions, for both the first and second phonemes generally took place twice a week and usually lasted 20 to 40 minutes. Sessions were videotaped and/or audiotaped to allow for data to be collated and rater reliability to be tested.

Six percent of all training sessions were scored by a second speech pathologist and all those scored showed 100% agreement. Recording errors were unlikely to occur given the nature and pace of the training sessions.

In order to test the second hypothesis, that accurate production of phonemes trained would increase in spontaneous utterances, a session was taped at the completion of the study with the participant playing with the speech pathologist. Various toys and games were used depending on the participant’s age and willingness to interact. While the toys were selected at random, for each participant a memory and/or board game that contained examples of the trained phonemes was provided to ensure there was opportunity for each participant to produce words or phrases that included target phonemes. The two target (trained) phonemes were then scored for accuracy. At this time the phoneme chosen as a control (untrained phoneme) was also scored as correct or incorrect in the speech sample

along with the voiced/voiceless minimal pair for the first of the target phonemes (untrained phoneme). Inter rater reliability was established with a second speech pathologist scoring all spontaneous speech samples and percentage agreement emerged at 99.3%.

Chapter 3.
RESULTS

The data from five participants with severe persistent sound system disorders were analyzed to determine the efficacy of the PROMPT approach. Two phonemes that had never been accurately produced, were selected for each participant for training using the PROMPT approach. A minimal pair for one of the selected phonemes to be trained, that had also never been accurately produced, was chosen to determine if any generalization occurred across motorically similar productions. That is, the phonemes differed only with respect to voice (voice/voiceless contrast). A fourth phoneme, also never produced accurately, was selected as a control probe to ensure only those phonemes trained, or their minimal pairs, showed positive change following treatment.

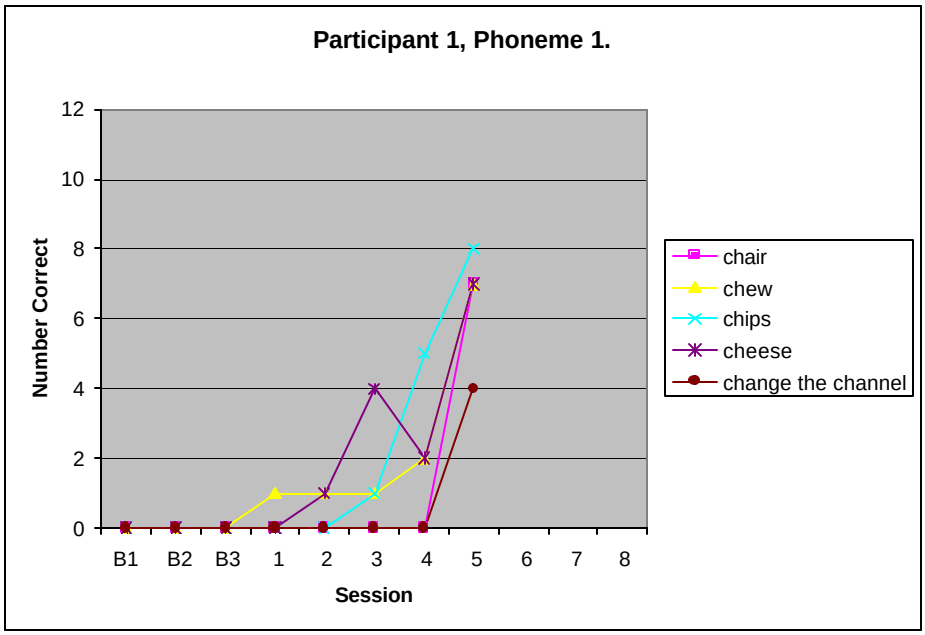
Results for each individual participant for each baseline and treatment session for each of the phonemes targeted are presented in the form of line graphs to illustrate changes in phoneme production (see Figures 2 to 9). Results for the production of the two trained phonemes, the untrained minimal pair and the untrained control in spontaneous speech are presented in a column graph (see Figure 10). The column graph displays the percentage of phonemes correct in spontaneous speech at the conclusion of the study.

3.1 Target Phoneme Measures for Each Participant

For each participant the number of correctly produced, that is, unprompted target phonemes for each utterance elicited were plotted on a line graph. The graphs (Figures 2 to 9) show how many of the 10 initial attempts for each word/phrase in each session contained correctly articulated target phoneme/s. All incorrect productions were prompted as described in the methods.

3.1.1. Results for Participant 1

3.1.1.1. Phoneme / t?



/

Figure 2. Number of correct productions of target phoneme 1, for Participant 1, for three baseline line sessions (B1-B3) and for each treatment session (1-5).

As can be seen, Participant 1 was only able to attend five sessions. In this final session the words “chair”, “chew” and “cheese” had the phoneme /t?/ produced correctly on 7 out of 10 occasions, while it was produced correctly on 8 out of 10 occasions in the word “chips”. For the phrase “change the channel” production of /t?/ was correct on 4 out of 10 attempts. This participant was unable to continue with the study for family reasons.

3.1.2. Results for Participant 2

3.1.2.1.Phoneme /f/

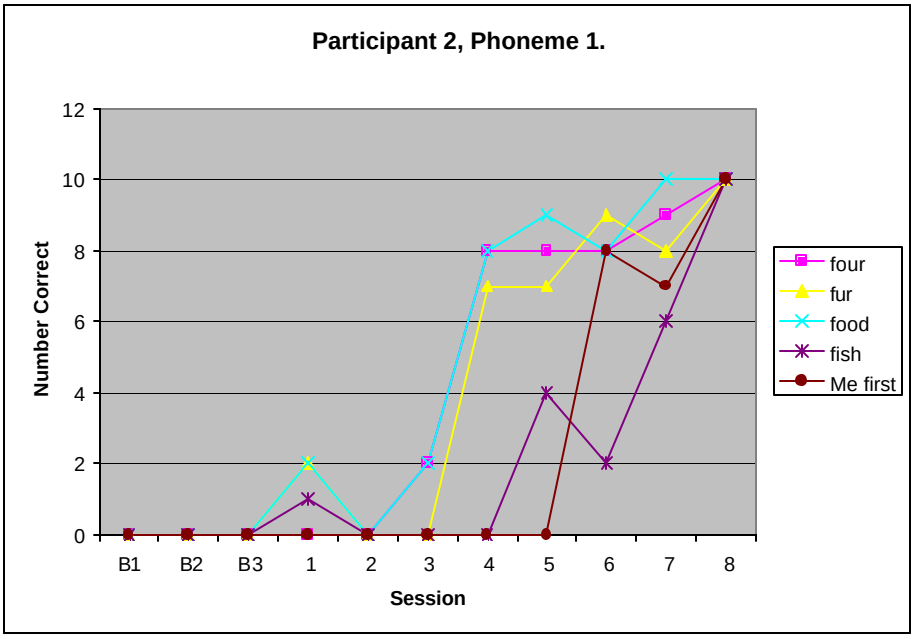


Figure 3. Number of correct productions of target phoneme 1, for Participant 2, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

For Participant 2 by session 7, three of the four target words were correct on 8 or more occasions. By session 8 all productions of the target phoneme /f/ were produced correctly. The word “fish” and the phrase “Me first” took until the final session to reach the criteria. The most significant gains in correct production of the target phoneme were noted after session 3.

3.1.2.2. Phoneme /t?/

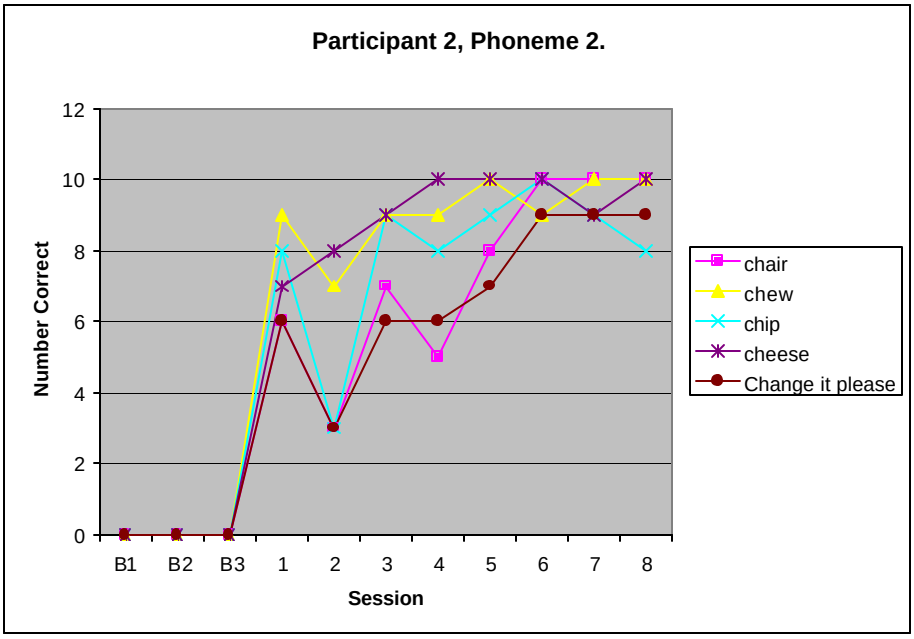


Figure 4. Number of correct productions of target phoneme 2, for Participant 2, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

The criteria for the correct production of the phoneme /t͡ʃ/ had been reached by session 7 for all utterances and remained fairly stable through session 8. Immediate gain was noted on phoneme 2 as soon as prompting was introduced (session 1), although there had been no change in production over the three baseline sessions.

3.1.3 Results for Participant 3

3.1.3.1.Phoneme /f/

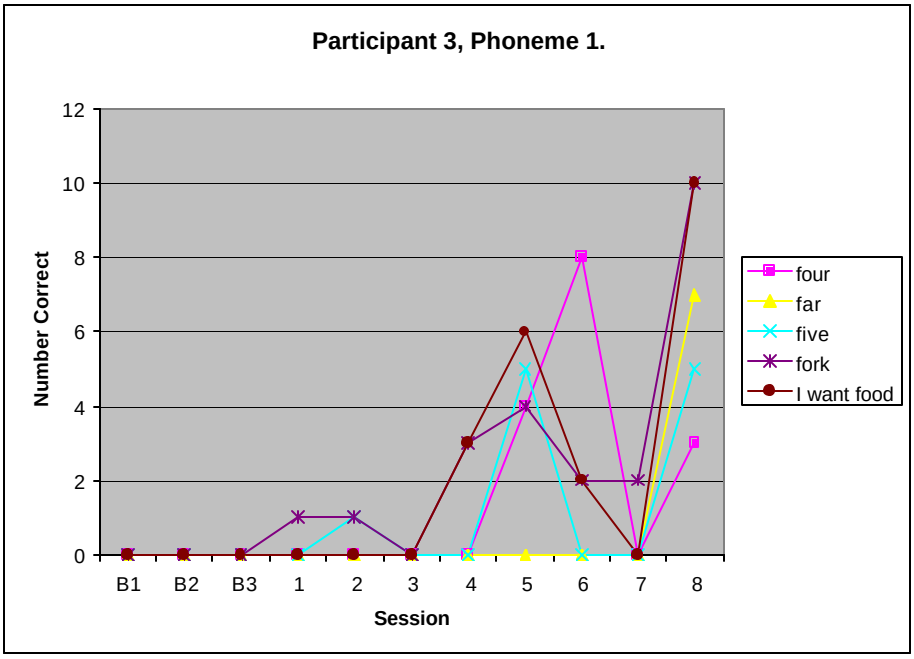


Figure 5. Number of correct productions of target phoneme 1, for Participant 3, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

While two of the utterances with the target phoneme / f / scored 10 out of 10 in the final session, it can be seen that this participant's responses were highly unstable. It should be noted that following successful production Participant 3 would often insist he could produce the word correctly without help and so would not allow further prompting resulting in subsequent incorrect productions. While prompting would sometimes be resumed it was often dispensed with again following a correct production. Thus protocol could not always be adhered too.

3.1.3.2. Phoneme /l/

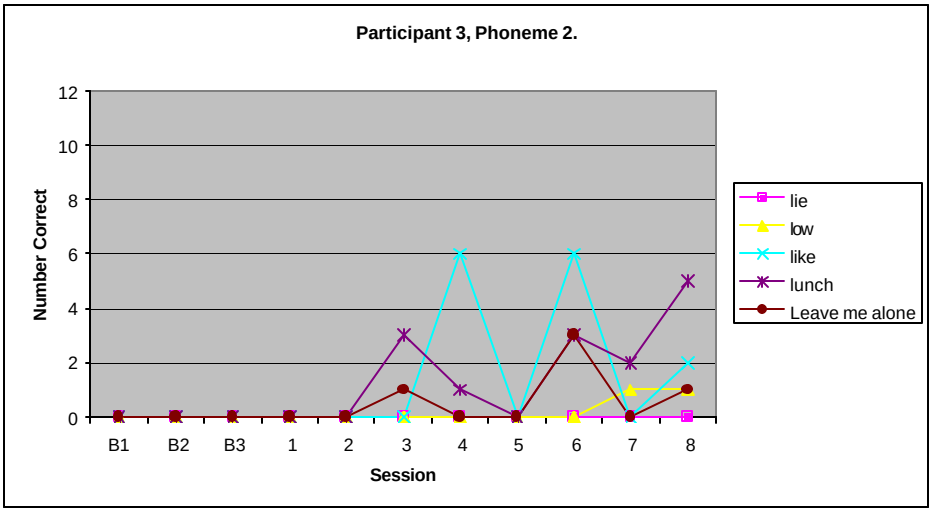


Figure 6. Number of correct productions of target phoneme 2, for Participant 3, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

With phoneme 2, /l/, a highly irregular pattern can again be observed with frequent refusal to allow prompting on incorrect productions following earlier success. With the words “lie” and “low” protocol was rarely observed as Participant 3 said these words were “too easy” and he could do them without help.

3.1.4 Results for Participant 4

3.1.4.1 Phoneme /ʃ/

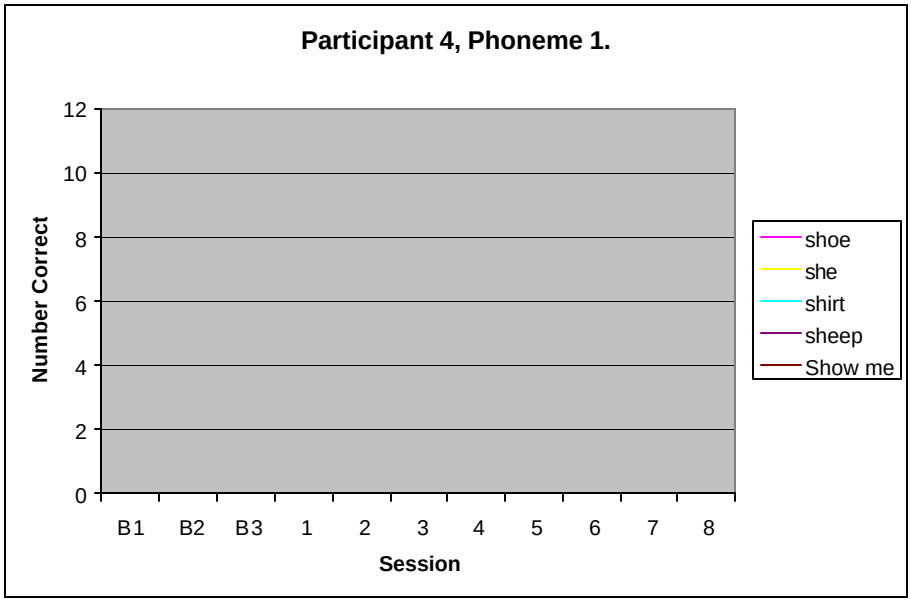


Figure 7. Number of correct productions of target phoneme 1, for Participant 4, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

The above graph shows that no correct responses were made at any time during the eight sessions for Participant 4. This participant would take the therapists' hand and place it on his face for help with speech during the session. However, because he was extremely tactile defensive, when prompting was attempted he would grimace, which resulted in muscular contraction of his face, jaw and neck. Despite persisting over the eight sessions for each of the phonemes targeted, /ʔ/ and /k/, desensitization did not occur and hence there was a lack of adherence to protocol for the duration of the study. The phoneme /ʔ/ could be produced in isolation by the end of the sessions but Participant 4 was unable to extend this into a word, as can be seen in the graph above, which required the target sound to be correctly produced in the target words, not in isolation. The same pattern was seen for the phoneme /k/ with none of the target words (car, cow, cat, cup) nor the target phrase "Come here" ever being correctly produced.

3.1.5 Results for Participant 5

3.1.5.1. Phoneme /b/

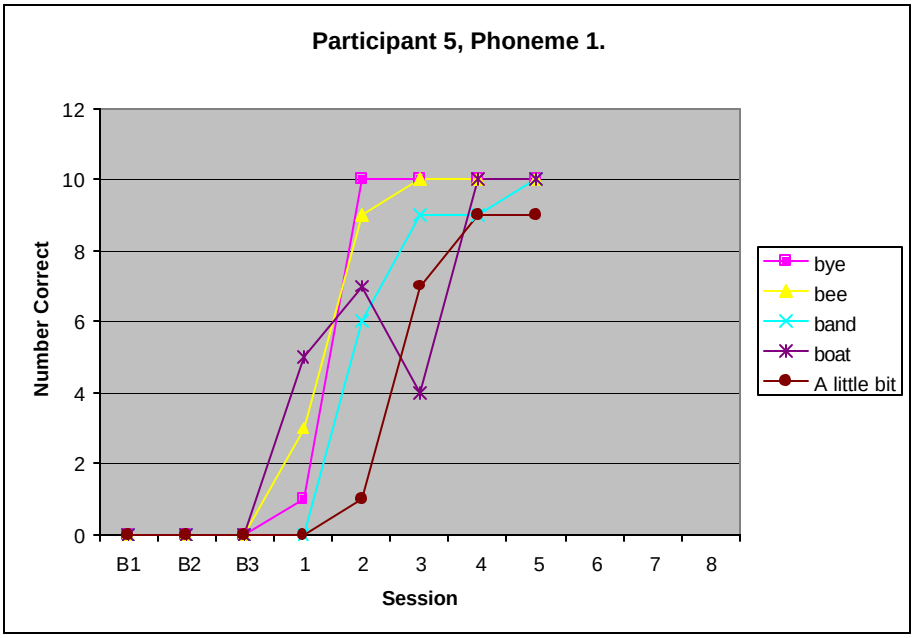


Figure 8. Number of correct productions of target phoneme 1, for Participant 5, for three baseline line sessions (B1-B3) and for each treatment session (1-5).

The scores in Figure 8 indicate Participant 5 responded rapidly to the introduction of PROMPT in session 1 and was achieving 8 out of 10 accurate productions of the phoneme /b/ in all target words and the target phrase by session 4. This degree of accuracy was sustained in session 5 when, as per the protocol (i.e. 80% accuracy obtained

on two consecutive sessions or eight sessions were completed, whichever comes first), treatment was discontinued.

3.1.5.2. Phoneme /w/

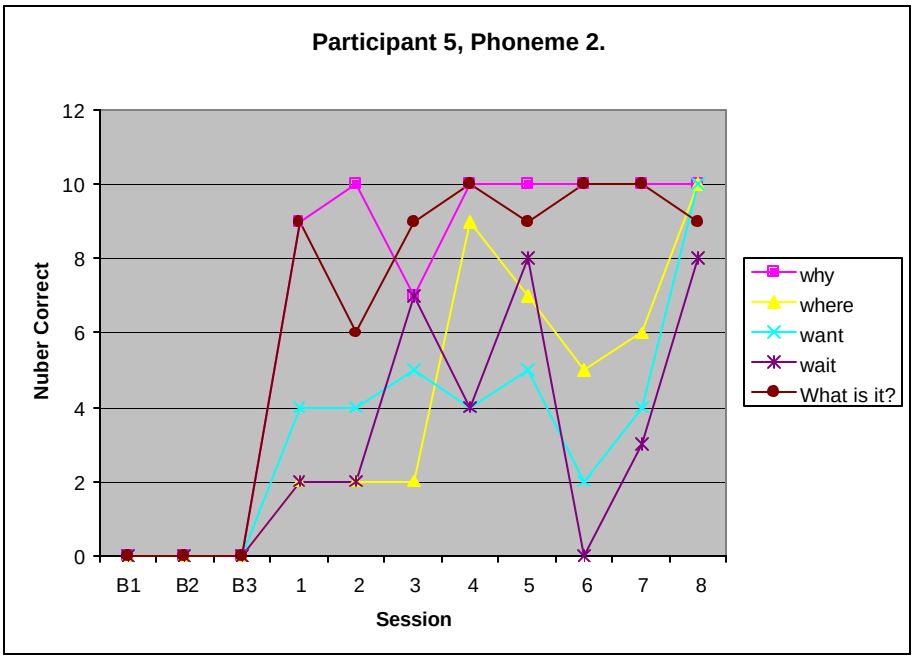


Figure 9. Number of correct productions of target phoneme 2, for Participant 5, for three baseline line sessions (B1-B3) and for each treatment session (1-8).

Scores in Figure 9 indicated responses for the phoneme /w/ were varied for Participant 5. Two utterances, “why” and “What is it?” were easily achieved and production sustained above 80% accuracy. The target words “want” and “wait” scored low in session 6 as Participant 5 began isolating the /w/ from the rest of the production. An isolated production of /w/ was scored as incorrect because although the phoneme /w/ was itself correct it was produced in isolation and not as a part of a word (e.g. /u ʔ - eʔt/ rather than /ueʔt) as was required in the study.

3.2. Production of Trained Phonemes in Spontaneous Speech

For three of the five participants spontaneous speech samples were analyzed to assess the accuracy of production of trained phonemes in both trained and untrained words. For Participant 1 this was not possible as training was incomplete. For Participant 4 no scoring of spontaneous speech was undertaken as there was no spontaneous speech evident at any time prior to, or after the study. Participant 4 was also unable to respond to prompting due to marked tactile defensiveness so protocol could not be adhered to. Results for the remaining three participants are presented in Figure 10.

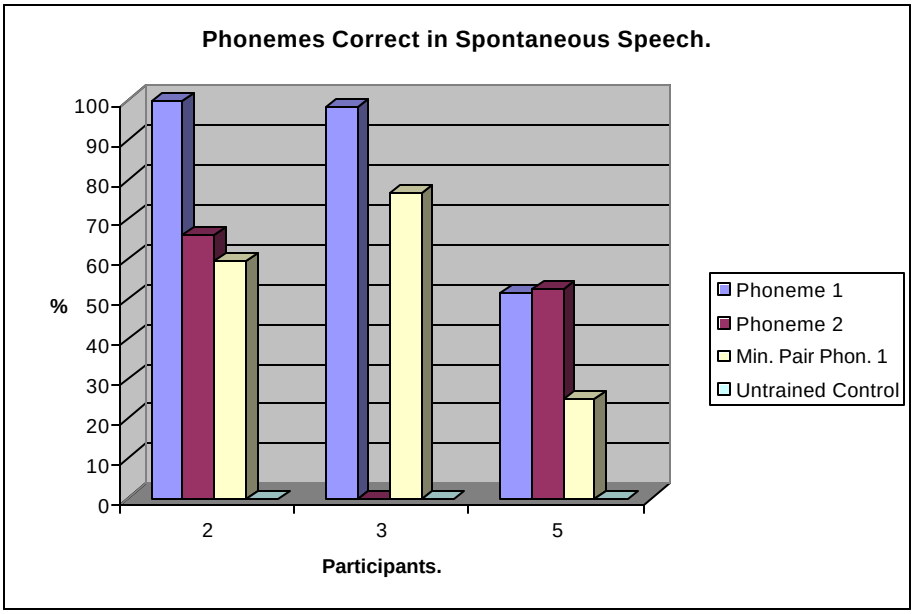


Figure 10. Phonemes Correct in Spontaneous Speech for Participants 2, 3 and 5.

Legend: - Phoneme 1 = First phoneme trained. Phoneme 2 = Second phoneme trained. Min. Pair Phon. = Minimally paired phoneme for Phoneme 1 – untrained. Untrained control = control phoneme selected.

Participant 2 Phoneme 1 = /f/. Phoneme. 2 = /tʃ/. Minimal pair Phoneme = /v/. Untrained control = /l/.

Participant 3 Phoneme 1 = /f/. Phoneme 2 = /l/. Minimal Pair. Phoneme = /v/. Untrained control = /ʃ/.

Participant 5. Phoneme 1 = /b/. Phoneme 2 = /w/. Minimal Pair Phoneme = /p/. Untrained control = /f/.

3.2.1. Results for Participant 2.

Figure 10 indicates that for Participant 2, phoneme 1 increased in spontaneous speech to 100% accuracy for both trained and untrained words. Participant 2 was able to use the phoneme /f/ in all words in all positions, that is, initial, medial and final position, with complete accuracy.

The integration of phoneme 2, /tʃ/, into speech was not as consistent. As can be seen in Figure 10, 66% of utterances containing phoneme 2 were accurately produced in trained and untrained words in spontaneous speech. In the sample elicited, errors in production of this phoneme appeared to be random and unrelated to the position of the target sound in the word (i.e., initial, medial, or final).

The untrained minimal pair for phoneme 1 was /v/. Accuracy of production in spontaneous speech for the untrained minimal pair of phoneme 1 increased from 0% in baseline measures to 60% at the completion of therapy. The untrained control phoneme selected was /l/. The control phoneme was assessed for accuracy in spontaneous speech at the completion of therapy and remained at 0% correct production as it had throughout the project.

3.2.2. Results for Participant 3

Figure 10 indicates that for Participant 3, 98.25% of utterances containing phoneme 1, /f/, were correctly produced in spontaneous speech when this was recorded at the completion of training. For trained words/phrases, accuracy was 100 %, while for untrained words accuracy was recorded at 97.7 %.

In contrast to the results for phoneme 1, the second phoneme trained (i.e. /l/) was not produced accurately in the spontaneous speech sample for either trained or untrained words/phrases. That is, Participant 3 attained 0% accuracy for production of the phoneme /l/ in spontaneous speech.

The minimal pair for phoneme 1, /v/, was found to be correct 76.6% of the time in the spontaneous speech recorded. The untrained phoneme selected was /ʔ/. Analyses revealed that this phoneme remained at 0% accuracy throughout the study and was found to be 0% accurate in spontaneous speech at the completion of therapy.

3.2.3. Results for Participant 5.

For Participant 5 the first phoneme trained was /b/ which was found to be 51.5% accurately produced in spontaneous speech at the completion of the treatment phase (Figure 10). Speech production was predominantly at the single word level and production of the phoneme /b/ was irregular. For target words, 100 % accuracy in spontaneous speech was recorded while for nontarget words 44.8 % accuracy was evident.

Figure 10 shows that for the second phoneme /w/, accurate production in spontaneous speech emerged at 52.63%. All trained target words were produced 100% accurately in spontaneous speech, however, accuracy of production on untrained words was highly unreliable emerging at 10 %.

The minimal pair for phoneme 1 was /p/. At the completion of the treatment phase the accuracy of production of this phoneme in spontaneous speech had risen from 0% to 25%. The untrained phoneme selected as a control probe was /f/. The accuracy of this phoneme was 0% throughout the study and remained at 0% at the completion of the study.

Chapter 4
DISCUSSION

DISCUSSION

4.1 General Findings

The aim of this study was to examine the effect of the PROMPT system of therapy (Prompts for Restructuring Oral Muscular Phonetic Targets) on a group of children with severe persistent sound system disorders (Shelton, 1993) by replicating the study carried out to test the efficacy of PROMPT with adult clients by Square et al., (1986). It was hypothesized that children exhibiting severe persistent sound system disorders would demonstrate a significant increase in the percentage of accurate productions of the phonemes targeted, in words and functional phrases trained using the PROMPT system of therapy and additionally, that the accurate production of phonemes trained would increase in spontaneous utterances. This notion of efficacy required evidence that change was demonstrated to be a result of treatment and that the degree of change was sufficient to be accepted as clinically significant.

The first hypothesis was accepted for two of the four participants who completed the treatment phase, these two participants being the only participants who adhered to protocol. The two successful participants (Participants 2 and 5) achieved the criterion of 80% or greater accuracy for each phoneme in trained words and phrases signifying significant gains. Two of the four phonemes trained reached the criteria of 80% or more correct over two consecutive sessions during the treatment phase, with the remaining two phonemes achieving 80% or more by the final session. As both participants achieved more than 40% to 70% accuracy in production of the target phonemes (Rvachew et al., 1999) by the end of the treatment phase it was assumed that ongoing mastery would occur even though treatment had been withdrawn. This would support the notion that sufficient change in correct production of the target phonemes had occurred in the treatment phase. In the study by Square et al., (1986) all three participants achieved 80% or greater accuracy on trained phonemes and trained polysyllabic words. All three adult participants in the study by Square et al (1986), however, adhered to protocol and this may be one reason for the differences in results between the two studies.

The two participants in the current study, who adhered to protocol and completed the treatment phase, can also be described as having met the criteria for clinically significant change as outlined by Bain & Dollaghan (1991). That is change for Participants 2 and 5 can be shown to be a result of treatment, real rather than random and, important rather than trivial.

It is clear that untrained control phonemes showed no change for Participants 2 and 5 while target phonemes did change, indicating that change resulted from treatment rather than maturation, or other uncontrolled factors. While treatment on the first phoneme targeted produced change, the measures for the second phoneme to be targeted, collected at the end of the treatment phase for phoneme 1, showed no change until prompts were introduced further supporting the conclusion that the change in phoneme production was due to treatment rather than any other event. This adds further support to the notion of the efficacy of the treatment.

The consistency in correct production of target phonemes towards the end of the treatment phase and at completion of treatment indicated real rather than random progress. The presence of the target phonemes were validated by a second speech pathologist scoring as correct/incorrect phoneme production during randomly selected sessions. Secondly at the completion of the treatment phase changes were found for the minimal pairs probed, demonstrating within class generalization (Gierut, 2001), while correct production of control phonemes remained at 0%.

The importance of the change in the participants' correct production of phonemes can be demonstrated in terms of the magnitude and rate of change. Target phonemes for both clients started at 0% correct, as seen during both the assessment and collection of baseline data, and reached the target of 80%+ correct production, the criterion for success, by the end of the treatment phase. This 80%+ correct production is too large to be seen as random or trivial (Bain & Dollaghan, 1991). These changes in phoneme production took place over a maximum of 16 twenty to forty minute treatment sessions, a maximum of 8 sessions for each phoneme, over a period of eight weeks. These children, with severe persistent sound system disorders, had previously shown very slow or minimal progress in therapy. The timeframe for treatment would suggest that the changes seen for this population in this study were relatively rapid (Powell, 1996; Shelton, 1993).

It is evident that phonemes targeted during the treatment phase where acquired by the two participants in a manner that was neither 'random' nor 'trivial' according to Bain & Dollaghan's (1991) criteria for efficacy. The rate at which each phoneme was acquired could be seen as relatively rapid. The fact that the control probes showed no change suggests that treatment was responsible and hence for these two participants (Participants 2 and 5) PROMPT was both an effective and efficient treatment.

Line graphs displaying data for the treatment phase for both phonemes targeted for Participant 2 and 5 show generally accelerating learning curves, however, some irregularity in performance is evident. Results from the study by Square et al. (1986) display a similar irregularity in performance particularly in the early training sessions. The nature of the speech production deficits in both populations and the history of irregular performance would indicate that some irregularity in learning would be expected (Ballard, 2001; Guyette & Diedrich, 1981; Maassen, 2002; Shelton, 1993).

Participant 1 made good progress in the five sessions completed but did not reach the criterion of 80% or more correct required in this shortened time frame. The results collected do, however, form a profile similar to that of the two participants who completed the study and adhered to protocol. That is, there was a general trend observed that showed a gradual increase in correct phoneme production over the five sessions. This profile is also similar to those seen in the three adult participants over the first five sessions in the study by Square et al. (1986). If Participant 1 had continued with the study it would be reasonable to predict ongoing improvement in percentage correct production of the target phoneme. The positive response in the short time frame suggested that PROMPT might have been an efficient and effective approach for this participant had treatment continued.

Results for Participant 3, who conformed to the protocol intermittently, are highly irregular on both target phonemes. For instance for the word "five" Sessions 1 to 4 were at 0% accuracy, session 5 at 50% accuracy, session 6 and 7 were again at 0% accuracy

and session 8 at 50% accuracy. None of the participants in the study by Square et al. (1986) displayed this degree of variance in their scores. Thus, while gains were noted for Participant 3, it is not possible to say he displayed a significant increase in the percentage of accurate productions of the target phoneme. No definite conclusion regarding efficacy can be drawn because of the intermittent and irregular application of surface prompts. The participant did, however, display good outcomes for the first phoneme targeted as displayed in spontaneous speech measures and as described below, so it is unclear whether or not such difficult participants should be excluded from future studies. The gains exhibited do suggest that from a clinical perspective, where adherence to protocol is not required, that PROMPT is at the very least and approach worthy of consideration.

No gains were evident for Participant 4 who was unable to conform to protocol at any time due to tactile defensiveness. Once again no definite conclusion on the efficacy of PROMPT with this participant can be reached as the participant's actions meant the ability to perceive the tactile-kinesthetic cues from the use of surface prompts was compromised.

Three of the five participants in this study were able to produce a spontaneous speech sample at the end of the training phase as required to test the second hypothesis " that the accurate production of phonemes trained will increase in spontaneous utterances". The second hypothesis was accepted for five of the six phonemes trained for Participants 2, 3 and 5 indicating generalization to untreated words and context (Gierut, 2001). That is, trained phonemes were correctly articulated in spontaneous speech in both target and nontarget words. Both of the phonemes trained for Participants 2 and 5, and one of the phonemes trained for Participant 3, were produced with accuracy in the speech samples collected, while phoneme 2 trained for Participant 3 displayed no change.

Neither Participant 1 nor Participant 4 were included in the sample for testing the second hypothesis. No results could be obtained for Participant 1 as he did not complete the study. Participant 4 was unable to provide a spontaneous speech sample due to ongoing paucity of speech production.

Generalization of sound production skills was explored in a single case study using PROMPT with a patient with "severe chronic apraxia of speech and moderate Broca's aphasia" (Square et al., 1985, p. 319). Square et al.'s (1985) study reported "… improved intelligibility scores as derived from the Assessment of Intelligibility of Dysarthric Speech (Yorkston & Beukelman, 1981) … improved from 13% to 27%." (p.319). Over a five-month period with monthly therapy this improvement had dropped to 18%. Thus the study by Square et al. in 1985 indicated some generalization of skills in the adult population when PROMPT was used, however, no measures of generalization of skills were reported in the second PROMPT study (Square et al., 1986).

In the current study, with child participants, none of the control phonemes probed showed any change with 0% accuracy for all control phonemes for all participants on each occasion of measurement. In contrast to the Square et al., (1986) study with the adult population, where there were some correct productions on some untrained phonemes, polysyllabic words and phrases although correct production of these was extremely irregular.

Changes (in excess of 40%) were noted in the Square et al. study with two of the three untrained pairs probed, and some success (25%) with the third untrained pair probed. A closer examination of the data provided by Square et al. (1986) reveals some untrained probes that demonstrated change were in fact also minimal pairs of trained phonemes this showing within class generalization. Results with polysyllabic words and phrases are less easily explained, however, it would be reasonable to predict this might occur with acquired apraxia of speech as adults have "… already acquired stable top-down processes" (Maassen, 2002, p.257) which allow for production of a variety of untrained utterances that previously existed in the adult participants' repertoire. This means that pre-morbidly, the adults in the Square et al.'s (1986) study had been producing the untrained phonemes, polysyllabic words and phrases with accuracy.

The participants in the current study have never had the experience of accurately producing the untrained control phonemes so it would not be expected that accurate production of untrained exemplars would occur as it did with the adults in the study by Square et al (1986). That no change occurred in untrained control phonemes, however, strongly suggested that the use of PROMPT was responsible for the changes in the correct production of target phonemes and this indicated that PROMPT was indeed efficacious.

4.2 Response in Target Words and Phrases.

As previously stated, the two participants (Participant 2 & 5) who adhered to the protocol in the current study provided support for the first hypothesis that children exhibiting severe persistent sound system disorders would display a significant increase in the percentage of accurate productions of the phonemes targeted in words and functional phrases trained using the PROMPT approach.

For Participant 2, the first phoneme introduced was /f/ with Participant 2 taking until the final session (session 8) to reach the 80% criteria. This was not significantly different from the efficacy study on adult apraxics by Square et al., (1986) where all subjects had reached the 80% criteria for minimal pairs by session 7. The phrase "Me first" took the longest time to respond but as phrases are more motorically complex than CV or CVC words and error rates tend to increase with length and complexity of the utterance, this might be expected (Maassen, 2002).

For phoneme 2 for Participant 2, /t?/, the response was immediate once PROMPT was introduced. Familiarity with the procedure may have contributed to the speed of response. The target phrase for /t?/, also responded more quickly on this occasion, showing some accuracy during session 1 of the treatment phase. This may in part be due to the target phoneme, /t?/, being articulated first in the phrase "Change it please" as initial position in words has been recognized as the most vulnerable position for treatment (Odell, 2002). Treatment was successful for this participant who had a PCC of 38.41 following approximately one year of therapy using approaches that did not utilize tactile kinesthetic input. Success with PROMPT for this participant supports the notion that the training of movement sequences and utilization of heightened sensory input to achieve this may well impact positively on speech motor programming (Marquardt & Sussman, 1991; Square, 1994; Yoss & Darley, 1974). The use of touch might be seen as efficacious with this participant.

For Participant 5 for the first phoneme introduced, response was noted to prompting in session 1 and continued through to criterion in session 5. With phoneme 2 the response was again immediate, however 3 of the 5 target words phrases took longer to reach the criteria and for the target word "wait" progress was irregular. This irregularity of performance was not seen in any of the three subjects in the study by Square et al. (1986).

Participant 5 had an extremely severe speech disorder with only 10.89 PCC following more than three years of intervention using therapies that did not involve tactile kinesthetic input. In contrast, Participant 5 reached the criteria on both trained phonemes within eight weeks indicating that the PROMPT approach was indeed efficacious for this participant. As other therapies had been unsuccessful, again these results suggest that touch (tactile-kinesthetic input) might be the unifying factor in allowing Participant 5 to acquire the speech motor skills necessary for production of the two target phonemes (Bose et al., 2001; Chumpelik (Hayden), 1984; Square, 1999). Participant 5's success, coupled with previous failures, might support the notion that while all sensory information (that is auditory, tactile-kinesthetic and visual) is used in acquiring speech, the faster tactile-kinesthetic loop becomes the most significant feedback loop once speech development starts (Kent, 1981).

Participant 3 displayed a highly irregular response pattern. Once Participant 3 had met with some success he would often refuse to be prompted although he would repeat the target word/phrase as requested. Despite failing to meet the criteria, Participant 3's irregular performance supported the notion that tactile-kinesthetic input assists with changing sensory motor maps (Kass, 1991; Square, 1994, 1999) as noted by correct responses following prompting and incorrect responses when prompting was refused.

For Participant 1, who did not complete training, the response to PROMPT in target words was clear despite only attending for five sessions during the treatment phase for the first phoneme. By the fifth session 70 to 80% accuracy can be seen on all target words with 40% correct phoneme production at phrase level. As a phrase is considerably more motorically complex than single words (Maassen, 2002), it would be expected that acquiring control at phrase level would take longer. While the data on this participant is incomplete it must be remembered that after 3 years 10 months in therapy Participant 1 had only a PCC of 45.85. Some authors (Hall, 2000; Hodson & Scudder, 1990; Johnson et al., 1999) have commented that some clients make extremely slow progress often being in therapy for a number of years so any approach that may decrease this time frame should be considered. Given the severity and persistence of Participant 1's disorder, the speed of response to the introduction of PROMPT would suggest that this approach may well be worth pursuing for Participant 1 even though the criterion of 80% accuracy was not reached.

Participant 4 could not benefit from tactile-kinesthetic input as he would grimace when touched which resulted in muscular contraction of his face, jaw and neck. While the 'mapping' in of movement patterns, as provided by PROMPT, is thought to reorganize the sensory and motor maps (Kass, 1995), musculature needs to be in a state of readiness to receive the tactile kinesthetic input postulated to be the critical element in facilitating change to the motor schema (Schmidt, 1975, 1988). It was not possible to direct movement through the application of pressure as the musculature involved was already in a state of tension. Despite these difficulties, Participant 4 would take the therapists hand

and place it on his face for help during speech suggesting at least a desire for physical assistance.

That PROMPT was highly successful with two participants and partly successful with two others, one who did not complete the study and one who did not adhere to protocol, suggests that PROMPT was an efficacious treatment for phoneme production with this particular population. PROMPT has been shown to be both effective and efficient in treating children with severe persistent sound system disorders. The use of "touch" is considered crucial in differentiating PROMPT, and other tactile approaches, from therapies with cognitive-linguistic or sensory-motor basis which had previously been used with participants in this study (Bose et al., 2001; Chumpelik (Hayden), 1984; Square, 1999).

4.3 Response in Spontaneous Speech

The second hypothesis, that the accurate production of phonemes trained would increase in spontaneous utterances, was supported with positive outcomes for 5 of the 6 phonemes measured. Three of the five subjects were able to provide spontaneous speech samples.

Mastery of a sound is seen as a gradual process from when a sound first emerges to the time it is produced in spontaneous speech with consistent accuracy and this mastery continues to occur once treatment is withdrawn (Diedrich & Bangert, 1980; McKercher et al., 1995; Olswang & Bain, 1985). Rvachew et al., (1999) suggested that when 40% to 70% accurate production with an individual phoneme was achieved then it was appropriate to withdraw treatment for that sound. The greater time delay between completing training on the initial phoneme and data collection for spontaneous speech analysis could explain why the initial phonemes trained for two participants displayed the greatest carryover into spontaneous speech. There was less chance to develop ongoing mastery with the second trained phoneme as collection of the spontaneous speech sample occurred soon after completion of the treatment phase for this phoneme.

For the speech pathologist, increasing the child's intelligibility is a primary goal in improving communication (Gierut, 1998) and while intelligibility measures were not used in this current study, due to the severity of the disorders and the limited speech samples, there was an attempt to ensure the treatment approach used impacted positively on spontaneous communication. By examining trained and untrained phonemes in spontaneous speech it was demonstrated that generalization of trained phonemes and untrained minimal pairs (voiced/voiceless contrast) had occurred. This is an important element in determining efficacy as it is not possible to teach every target sound in every word and yet there is a need to change the child's sound system so it becomes more like that of the target language (Gierut, 1998; Bain & Dollaghan, 1991). The patterns of generalization to spontaneous speech varied for each participant for each phoneme.

For Participant 2, both trained phonemes carried over into spontaneous speech in more that 40% of utterances (100% and 66% respectively). Participant 2 displayed the greatest generalization into spontaneous speech on the first phoneme trained. Similarly for Participant 3, the initial phoneme trained displayed significant carryover into spontaneous speech with 98.2% correct production of the phoneme /f/ found in the spontaneous speech sample. The carryover for Phoneme 1 was far greater than for the second phoneme trained, /l/, which did not carryover (0% correct) into spontaneous speech at all.

This pattern of greater increase in carry over for phoneme 1 was not evident for Participant 5 where production of the first trained phoneme /b/ in spontaneous speech had an accuracy of 51.5% while the second phoneme trained, /w/, achieved 50% accurate production.

Despite the individual differences discussed above there was significant carryover into spontaneous speech for 5 of the 6 phonemes trained supporting the belief that, "… if a sound is taught in a limited number of words, change extends broadly to other words that also contain that target sound" and that "… treatment at the word level promotes improvement in sound accuracy in spontaneous connected speech" (Gierut, 1998, p.S90). In other words, it is commonly found that generalization occurs with untrained exemplars of trained behaviors also becoming accurately produced (Ballard, 2001; Gierut, 1998; Wambaugh et al., 1998).

Generalization to untreated sounds was supported by the data provided by the three participants in this current study whose untrained minimal pairs (in this case voiced/voiceless contrasts) showed changes in rate of accurate production. Participant 2 showed significant carryover with 60% accurate production of the minimal pair /v/. Similarly Participant 3 who achieved 76.6% accurate production of the minimal pair /v/ in spontaneous speech demonstrated excellent within class generalization. Considering the irregular performance with the phoneme /f/ during the training phase for Participant 3, and the failure to adhere to protocol, this was an exceptional result. Within class generalization was less evident for Participant 5. The untrained minimal pair /p/ achieved 25% correct production in spontaneous speech which, while not as significant as the generalization for Participants 2 and 3, was interpreted as good progress for this child with an extremely severe speech disorder (10.89 PCC). It is postulated that these changes can be traced to the relationship between the target sound and the minimal pair, in this case the voiced/voiceless contrast (Ballard, 2001; Gierut, 1998).

The results in this current study demonstrated a clinically significant change for 5 of the 6 phonemes trained for the three participants who completed the study and who were able to provide a spontaneous speech sample with further clinically significant changes for 2 of the 3 untrained minimal pairs. The use of PROMPT can therefore be seen as effective and, given the time frame, efficient in producing positive change. That none of the control phonemes probed displayed any change, staying at 0% accurate production, indicated that the PROMPT approach was responsible for the changes recorded

4.4 Possible Impact of Phoneme Choices From a Motor Speech Hierarchy View

While it has been concluded that PROMPT made a clinically significant change in the children who adhered to the protocol it is possible more consistent results may have been achieved. One reason for the limited progress shown in parts of this present study may be that phonemes were chosen simply because they were absent from the participant's repertoire as per the original study by Square et al. (1986). Neither the Systems Analysis nor the Motor Speech Treatment Hierarchy proposed by Hayden and Square (1994) were considered during the phoneme selection procedure. The motoric complexity of the target phonemes was not determined nor the motoric complexity of any of the words or phrases that were subsequently chosen. However analysis of the motor speech system and its application in choosing appropriate words and phrases/sentences is integral to the

PROMPT approach and while the choice of phonemes was by necessity based on lack of accurate production, it would have been entirely possible to make these choices within the boundaries of the study while still working largely within the Motor Speech Hierarchy framework proposed by PROMPT. Prompt is based on motor movements not on sound-by-sound production and so consideration of speech motor skills at each level of the Motor Speech Hierarchy is crucial to the PROMPT approach.

The PROMPT approach demonstrates that in order to acquire mature, age appropriate speech motor skills, adequate development and control is required at each level of the Motor Speech Hierarchy and each level is interdependent on the other (Hayden, 2002b). An example might be that mandibular control is required to develop good facial rounding and retraction and later allow the tongue to separate from the jaw to enable it to develop the fine control that is required for mature speech patterns. When excessive jaw movements are used then lip rounding and lip retraction become difficult as the jaw needs to be up (not down) to enable the lips to round to produce clear concise sound such as /u/, /ʔ/ etc. during speech.

Similarly, to produce sounds that require some retraction such as /i/, /s/ etc. the jaw needs to be up. Lip retraction is very difficult with a wide aperture. If this pattern is revealed in a Systems Analysis then there will be a need to focus on jaw gradation and stability if the child is to acquire good control of the labial-facial area, thus jaw gradation will be the priority followed by lip rounding.

It is also clear that producing sounds which require the tongue to move independently of the jaw, such as in the mature production of /t/ and /d/ where the anterior portion of the tongue is used, then reduced jaw opening will be required to enable the tongue to articulate with the alveolar region. Tongue separation will become a later priority to be targeted once there is jaw gradation and labial-facial control.

The motoric difficulty of the lexicon chosen needs to reflect the movement pattern being targeted with due consideration being given to the number of planes of movement present in any chosen target utterance (Hayden, 2002a, 2002b). Moving across multiple planes within an utterance greatly increases the complexity of speech motor control required and increases the opportunity for failure. If consideration had been given to the implications for motor complexity in targeting a particular level of the Motor Speech Hierarchy, it is likely that in some cases different phonemes and different words/phrases would have been chosen as more appropriate for a particular participant. This could have been incorporated without compromising the original focus of replicating the study by Square et al (1986) and may have produced a truer measure of the efficacy of PROMPT itself.

If priorities of speech motor control had been considered in the fullest sense, then it is likely that this study would have then included the use of parameter and complex prompts as well as surface prompts, which were the only type of prompts used. A recent study by Square et al. (2000) demonstrated the efficacy of using parameter prompting with a group of six children so the use of a variety of prompts, other than surface prompts, might have been more appropriate. This current study was however, conducted in 1998 and so relied on research that was available at that time. In using surface prompts only, as per the study in 1986 by Square et al, then it is clear that the PROMPT approach was not used to its full extent and this needs to be considered in the discussion so there is awareness of the shortcoming of the design.

Clinicians newly trained in the PROMPT approach are likely, however, to implement treatment in a fashion similar to that used in this current study. That is focus on the use of surface prompts to achieve individual phonemes missing from the child's repertoire rather than to implement PROMPT in the holistic manner intended. It takes time and experience to use the holistic approach of PROMPT to its full extent.

Thus, while this study's process of selecting target phonemes may have been problematic in terms of the Motor Speech Hierarchy and the selection of words and phrases failed to appreciate the planes of movement involved, such difficulties reflect the approach recently trained clinicians might choose in practice. The efficacy study by Square et al. (1986), which was being replicated in the current study, used minimally contrasting phonemes which had never been produced correctly. There are a number of studies which report that treatment of nonstimulable sounds leads to a greater change in both untreated stimulable sounds and in nonstimulable sounds (Gierut, 1998; Ballard, 2001). Thus simply selecting nonstimulable phonemes may have some merit but further discussion is warranted regarding the motoric complexity of each word or phrase used and the implications this might have had as PROMPT is no longer designed to be used in the narrow way it has been in this study.

Participant 1 only completed 5 sessions but results suggested that tactile kinesthetic input might have been helpful. From a motor perspective, however, some words chosen were far more difficult than others and the target phrase used all three planes of movement. If consideration had been given to choosing words, including words within the phrase, that minimized the number of changes required in terms of planes of movement (Hayden & Square, 1994; Hayden, 2002a, 2002b), then acquisition of correct production of the phoneme may have been faster.

The first phoneme introduced to Participant 2 was /f/. The criteria was reached for all words and the phrase however, the choice of the phoneme /f/ was dictated only by its absence. Fortunately in terms of the Motor Speech Hierarchy, where individual lip control (Stage IV) is dependent on adequate mandibular control (Stage III) being established, Participant 2 displayed the appropriate level of motor control. The four words chosen happened to require individual lip movement, followed by some lip rounding with little if any change required in jaw height. Thus the words chosen were in the horizontal plane of movement. The phrase also stayed at jaw height 1 to 1½ but required both rounding and retraction and finer tongue control. If the Motor Speech Hierarchy is considered then the phrase "Me first" involves more complex motor control than the single words and it would therefore be reasonable to predict that Participant 2 would take longer to acquire accuracy with the phrase (Hayden, 2002a, 2002b).

Response to the introduction of PROMPT for phoneme 2 trained for Participant 2, /t?/, was almost immediate. While /t?/ involves lingual control (Stage V) again all words chosen kept the jaw height relatively stable at a 1 to 2 which probably assisted in the rapid acquisition of control of the target phoneme.

With Participant 3, a highly irregular response pattern was seen. While the failure to adhere to protocol, discussed previously, may be the major factor accounting for the irregularity of performance, failure to acknowledge the breakdown of skills at Stage III

(mandibular control) meant the phoneme /f/ may not have been the most appropriate choice. Even given the poor choice of the target phoneme better word choices might have assisted Participant 3 to acquire better control especially when excellent carryover into spontaneous speech was observed despite this difficulty. While the words "far" and "five" are produced in the vertical plane the words "four" and "fork" are largely produced in the horizontal plane with the phrase "I want food" crossing two planes. Given the severity of Participant 3's disorder, this frequent changing of planes of movement, as the words and the phrase were presented randomly, would have made it more difficult to achieve stable production of the target sound.

The choice of /l/ for the second target phoneme was problematic given Participant 3's lack of madibular control. The accurate production of /l/ requires good tongue control (Stage V) and to achieve tongue control the jaw (Stage III) must be relatively stable. Furthermore, the word choices included diphthongs in all but one word. Given the severity of motor system involvement for Participant 3 and his poor jaw control, the changes in jaw height required during the articulation of diphthongs were an added difficulty. That is with the words chosen in this study, Participant 3 needed to exhibit both jaw control (Stage 111, vertical plane) and tongue control (anterior posterior plane) within a single word before he had developed stability at the level of the mandible (stage 111). The production of /l/ in the CVCC word (lunch) included in this study was produced with 50% accuracy in the final (eighth) session. While this particular response was better than for any other words/phrases targeted (20% for "like", 10% for "low" and "Leave me alone"; 0% for "lie") the irregularity of production made it difficult to draw any real conclusions. It could be said, however, that the use of a final blend did not impact negatively on the production of the target sound.

Participant 4 had the diagnosis of Autism Spectrum Disorder (ASD) and proved to be extremely tactile defensive around the head and neck. Prompting was persisted with for the entire 16 sessions however the muscle tension remained and protocol could not be maintained. Following completion of the study, however, prompts were used successfully with Participant 4. In view of this success the use of the PROMPT approach with those few children who are truly tactile defensive should not be disregarded. Consideration might be given to the use of parameter prompts as these prompts are large organizing postures where tactile-kinesthetic-proprioceptive input focuses on the skeletal, muscular, or neurological system. Parameter prompts can be maintained for the duration of the utterance and therefore involve less movement across the facial and mylohyoid areas and so expose the child to less changes in tactile-kinesthetic input.

For Participant 5 for phoneme 1, response was noted to prompting in session 1 and continued through to session 5 where the stated criteria were met (80% or more correct over two consecutive sessions). These results were promising but may have been more substantial if the words had been chosen with greater care to use jaw grading along with lip movement. The production of the target sound /b/ in the CVCC word (band) reached criteria by session 9 indicating that the use of a final blend did not affect outcome. The sounds /n/ and /d/ are produced in the same place and hence the motor load for producing this blend is not great. The more motorically difficult "boat" (which involves both the vertical and horizontal planes due to the diphthong used in Australian production of this word) took a little longer to reach criteria, as did the phrase "A little bit". Although the target phoneme was in a relatively easy word, that is "bit", the preceding word "little" involved a motoric complexity far exceeding Participant 5's skills. Evaluation after this

study identified Participant 5 required assistance as a priority at Stage III on the Motor Speech Hierarchy. Production of the word "little" would require mastery at Stage V and its use in the phrase added to the overall complexity of the motor production required.

The response to the introduction of PROMPT was again immediate for phoneme 2 for Participant 5, however, for the target words "wait" and "want" progress was irregular. The phoneme /w/ is articulated as /u/ plus the following vowel and in session 6 Participant 5 began isolating the /w/ from the rest of the word. The isolation of /w/ was scored as incorrect as while /w/ was itself correct the /u/ was produced with the schwa /ʔ/ in isolation from the rest of the word (e.g. /uʔ-ʔnt/ rather than /uʔnt/). While the word "want" involved a final blend it is likely, given there were 2 words that proved difficult, that Participant 5's error producing /w/ may have arisen because all other target words involved minimal jaw height changes with the primary movement involving lips whereas "wait" and "want" required a greater range of jaw movement simultaneously with lip movement. Thus, two planes of movement were required instead of one. Interestingly the error producing /w/ did not occur with the word "what" in the phrase "What is it?" even though "what" involved a jaw height change (1 – 3 – 1). In this phrase it is likely the jaw remained stable in a more closed position due to the coarticulation involved by the inclusion of "is" and "it", both of these being produced with the jaw up (Jaw height 1).

4.5 Limitations of Current Study

Apart from the major limitation discussed above, the number of subjects chosen for this current study was small and as such rendered it difficult to provide definitive evidence of efficacy for this population particularly as one participant (Participant 1) did not complete the study and a second (Participant 4) proved unsuitable. For Participant 4, who was very tactile defensive, his inclusion in the study should have occurred after adequate exposure to the PROMPT system and adequate desensitization had taken place so protocol could be adhered to and results evaluated accordingly.

In studies assessing efficacy in the field of Speech Pathology, the use of limited numbers of participants is common. Sommers et al. (1992), in reporting on research design, examined data from 63 published studies and found 33 of the studies based on single subjects with a further 5 being small group studies which they defined as under 10 participants. Gierut (1998) reported that "… single-subject experimentation is predominant in the published literature on functional phonological disorders." (p. S85) While single case studies and small group studies can be valuable, Gierut pointed to the need to replicate such studies to demonstrate treatment effectiveness. It is difficult to generalize findings in efficacy research without large group studies or without sufficient replication of small group/single subject studies

This study attempted to replicate one small group study (Square et al., 1986) however, using an entirely different population limited direct comparisons between the two studies. Changes to the Square et al. (1986) study, that used minimal pairs, polysyllabic words and phrases, were required because the present study's sample was drawn from a different population. The number and type of utterances used in the study by Square et al (1986) proved to be too challenging for the participants in this current study and so the number of target words and phrases was reduced. Despite the reduced requirement two participants were unable to adhere to protocol, a difficulty not experienced in the 1986

study. By investigating a different population and making necessary methodological changes, no direct comparison of findings can be made nor is there any literature published to date where direct comparison might be possible.

While "speech-language pathologists face increasing pressure to implement maximally efficient treatment programs." (Rvachew et al., 1999, p.33) it may prove continually difficult to carry out studies with a sufficient number of participants to provide clear outcomes on efficacy with some populations due to the low prevalence of the disorder. Those children with a severe persistent sound system disorder may fall into this category. Nevertheless, this study might have been more conclusive had the number of participants been larger.

Many studies in the literature have described difficulties in replicating studies when no widely accepted framework of differential diagnosis exists (Thoonen et al., 1999). Rather than a diagnostic label the descriptive term, persistent sound system disorder, (Powell, 1996; Shelton, 1993) was used in this study. A PCC of 85 is said to signify "normal" speech or mild difficulties but "Many children with speech delay achieve the 85% PCC criterion but retain residual distortion errors" (Gruber, 1999, p 449). Providing a description of the severity of the disorder would more clearly define the population being studied by excluding those with persistent speech difficulties that were not severe (Hodson & Scudder, 1990). This study attempted to provide some detail of severity by using PCC (Shriberg & Kwiatkowski, 1982b). It may prove useful in future, however, to look more closely at severity as determined by some measure of speech intelligibility, although intelligibility is again poorly defined (Dodd, 1996; Hodge, 1994; Shelton, 1993). To facilitate future replication the current study attempted to define a specific population. Identifying homogeneous populations is a problem faced by many researchers in speech pathology and difficulties in examining outcomes for specific populations will remain unless greater consensus is reached within the profession on differential diagnosis (Sommers et al., 1992).

While all the participants in the current study had been exposed to a minimum of one year of therapy using other, non tactile kinesthetic approaches with minimal response, there was no attempt to directly compare outcomes with PROMPT with those treatment approaches previously used or other treatment approaches not yet trialed. This is again a difficulty encountered in much of the literature with respect to comparisons of both therapy approaches and the time taken in therapy (Gierut, 1998). As Odell (2002) says, "The goal of treatment is to effect the greatest change in communicative behavior with the least amount of treatment" (p.309). To determine which approach is the most successful in terms of measurable outcomes and economy of therapy time with any one group of speech disordered children therapy regimes need to be compared.
One further limitation may have been that the results reflected the speech pathologists level of clinical expertise with PROMPT rather than a true efficacy study of the approach. As previously discussed, the level of PROMPT training (Wambaugh, 2002) and clinical practice at using PROMPT is likely to have influenced the results. This study was commenced within weeks of the therapist undertaking Level 1 Certification in PROMPT, currently called "Introduction to Technique". There are currently four levels of PROMPT Training.

1. Introduction to Technique – PROMPT.
2. Bridging PROMPT Technique to Intervention

3. PROMPT Certification Evaluation
4. PROMPT Instructor.

Clearly the application of PROMPT requires both training and experience. Introductory training was commenced in November 1997 and this study was commenced in early 1998 so the researcher had little experience in applying the PROMPT approach. This lack of experience resulted in a number of difficulties some of which have already been discussed.

There was limited practice of the "technique" of PROMPT, that is the application of surface prompts used to stimulate the oral musculature, due to the short time frame between training and implementing the study. This lack of experience resulted in difficulties moving from one prompt to another particularly at phrase/sentence level. There was difficulty at times with matching the timing of the prompts with the participant's utterance as required in the final treatment phase where the participant was asked to attempt the word/phrase as the speech pathologist simultaneously prompted the motor pattern. The fact that some participants made significant gains in the accurate production of phonemes demonstrates that the novice PROMPT practitioner can achieve substantial results, however, a more practiced speech pathologist may see more consistent results in a faster time frame.

To attain a minimal level of skill to apply PROMPT in therapy, introductory training at least is required (Wambaugh, 2002) and while PROMPT can be used successfully following Introductory training it takes time, practice and training to become fully cognizant with the approach (Hayden, 2002b).

4.6 Future Research.

There is an overall lack of efficacy studies in sound system disorders for distinct subgroups of children (Bain & Dollaghan, 1991; Gierut, 1998; Kent, 2000; Pannbacker, 1988). This present study aimed to examine the efficacy of the PROMPT approach with a population of children with severe persistent sound system disorders (Powell, 1996; Shelton, 1993). It did not attempt to examine the efficacy of the PROMPT approach with other populations. It would be useful to consider further research into the effectiveness of PROMPT with different subgroups of children with speech disorders. A research difficulty may be defining populations for research, especially considering the lack of a framework for differential diagnosis of sound system disorders (Dodd, 1996; Powell et al., 1998; Shriberg, 1994). It is also very difficult to find children in the population who do not have a mixed disorder (Dodd, 1996; Powell et al., 1998; Shriberg, 1994).

The literature reveals there are few studies that explore the changes that occur in a child's sound system as a result of the effect of one type of treatment approach versus another (Gierut, 1998). An obvious goal of further research would be to compare the PROMPT approach with other therapy approaches that report to be appropriate for this difficult target population of children with severe persistent sound system disorders.

To be deemed efficacious an approach needs to be efficient as well as effective (Bain & Dollaghan, 1991; Gierut, 1998; Hodson & Scudder, 1990; Rvachew, 1994; Rvachew & Norwak, 2001). Future research might involve examination of the time taken in therapy in terms of both duration of the sessions and the number of sessions required especially

when comparing PROMPT to other approaches (Gierut, 2001; Hodson & Scudder, 1990). Frequently research papers do not report on the number of therapy sessions with 25 out of 63 papers reviewed by Sommers et al. (1992) failing to do so. It was found that 20 of the 63 articles did not report on session duration. It seems reasonable to suggest that if these details were included in future studies it might enable speech pathologists to make clearer judgments about the efficacy of individual approaches.

4.7 Conclusions.

This study examined the efficacy of a particular therapy approach, PROMPT with a particular subgroup of five children who were considered to have a severe persistent sound system disorder. The data obtained for the two participants who completed the study and adhered to protocol meant the first hypothesis that children exhibiting severe persistent sound system disorders would display a significant increase in the percentage of accurate productions of the phonemes targeted, in words and functional phrases trained using the PROMPT system of therapy was accepted. The support for the hypothesis for two of the three remaining participants is less clear although the failure to adhere to protocol appears to have impacted negatively on phoneme acquisition. One participant did not complete the study although initial gains looked promising.

Within class generalization was clearly evident with two of the three participants who could be assessed at the completion of the treatment phase, and evident to a lesser degree with the remaining participant. Within class generalization provided further support for the efficacy of the PROMPT approach.

The second hypothesis, that the accurate production of phonemes trained will increase in spontaneous utterances, was accepted as it was supported in five of the six phonemes trained for the three participants who completed the study and who were able to provide a spontaneous speech sample, including one who did not adhere to protocol. The hypothesis could not be tested on the remaining two participants as one did not complete the study and the other had almost no spontaneous speech.

There is sufficient data to suggest that further investigation of the PROMPT approach for use with children with severe persistent sound system disorders is worthwhile. The study met all three criteria for clinically significant change as outlined by Bain and Dollaghan (1991). From a clinical perspective there is evidence that the use of "touch" may provide the missing sensory cue for some children who do not progress, or make minimal progress with other approaches. While there are other methods that utilize tactile-kinaesthetic input the PROMPT approach is unique in that each target or target series can be prompted at a syllable, word, phrase or sentence level. The ability of PROMPT to provide for transitive movement is important particularly as speech motor planning might be a significant problem with this population.

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APPENDIX A

Details of data collection procedures for Participants

Materials and Selection Procedures.

The following procedures were undertaken to ensure all participants met the stated selection criteria.

History.

Much of the historical data was obtained from clinical records especially those pertaining to developmental history and previous response to therapy. Where clinical notes were unclear on a particular detail pertaining to the history of the disorder then clarification was sought via interview with the parent and/or previous speech pathologist (SP). Criteria (1) through to (6) were noted by speech pathologists previously involved in the participant's treatment and where possible were confirmed by the researcher either through interview or clinical observation / assessment.

For each participant, a videotape was made of the participant attempting oral motor movements and DDK tasks. The video used was a Panasonic 8mm format video mounted on a tripod and placed directly in front of the participant at some 1.5 meters distant. In assessing DDK for each participant, videotapes were observed by a second speech pathologist although none of the participants could complete the tasks sufficiently for measures to be taken. Observations regarding DDK (criterion 7) are noted in Table 2.1.

The results from the following assessment tools were used to establish selection criterion 8 and are outlined in Table 2.1. All participants participating in the study had been assessed by a speech pathologist (not necessarily the principal investigator) on either the Clinical Evaluation of Language Fundamentals – Preschool (CELF-P) (Wiig, Secord, & Semel, 1993) or the Clinical Evaluation of Language Fundamentals – Revised (CELF-R) (Wiig, Secord, & Semel, 1987) or the Clinical Evaluation of Language Fundamentals – 3 (CELF-3) (Wiig, Secord, & Semel, 1995). All assessments were chosen as having well established reliability and validity and because they were readily available in the clinical setting. The CELF-3 was used if assessment was required at the time of admittance to the study, however, if the results of previous assessments using the CELF-R were available then these were used. Where there were difficulties with completion of these, the Peabody Picture Vocabulary Test III (PPVT-III) (Dunn & Dunn, 1997) and Expressive Vocabulary Test (EVT) (Williams, 1997) were also utilized. Again these assessments were chosen for their well established reliability and validity and because the PPVT-III and EVT are co-normed to provide evidence of significant differences between Receptive and Expressive scores.

Speech Assessments were based on the Fisher-Logemann Test of Articulation Competence (Fisher & Logemann, 1971) as the level of intelligibility of the five participants rendered many spontaneous speech samples unintelligible and/or the participant used very limited speech. Initial samples of spontaneous speech were therefore used only to confirm the absence or presence of a particular phoneme during selection of target phonemes. Samples of spontaneous speech were obtained largely through picture description activities as there was a need for context cueing to interpret speech. A spontaneous speech sample, elicited as described above, and the Fisher-Logemann Test of Articulation Competence were recorded for each participant on three separate occasions to allow for inconsistencies in speech production and to ensure that phonemes chosen as target phonemes were never produced correctly in speech. Samples of spontaneous speech and all Fisher-Logemann assessments were recorded on either 8mm Panasonic video format or on tape with the microphone placed less than 1 meter from the participant. All tapes were transcribed by the examiner and 46.6% of samples were randomly selected to be retranscribed by a second registered Speech Pathologist as a measure of inter rater reliability. The inter rater reliability for this initial data collection showed 96.8% agreement.

Percentage Consonants Correct (PCC) was used to determine the severity of the speech disorder (Shriberg & Kwiatkowski, 1982b). Severity ratings were arrived at based on the total number of intended consonants that were correctly articulated divided by all the consonants in the sample. The score was calculated from the Fisher-Logemann Test of Articulation Competence. Scores of 85% or higher represent normal speech or mild involvement; when scores fall between 65-85% mild-to-moderate involvement is postulated; moderate-to-severe involvement is placed between 50-65%; and finally those 50% or less are classed as severe (Shriberg & Kwiatkowski, 1982b). Results of this analysis are incorporated in Table 2.1.

Details in note form for each participant are tabled below: -
Participant 1.

Criterion	**Description.**	**Selection Criteria**
1	History of paucity of babbling.	Mother described the participant as loud but said the variety of sounds produced were limited. Babbling had rarely been observed.
2	History of delayed speech development.	Mother reported delayed speech onset & this was noted in the clinical case notes.
3	Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.	An interview with the participants previous SP (11/1997) revealed that while oral apraxia was not greatly considered in the past parental observation of the poor quality of oral movements was noted and confirmed. Observation by the researcher revealed that the participant was usually able to perform the requested oral motor tasks but movements, especially left to right, were often uneven and irregular.
4	The presence of groping movements or trial and error behaviour on production of sounds noted by a speech pathologist	Reported by the participants' previous speech pathologist (SP) in a letter dated 09/12/97.

5	Unable to voluntarily produce isolated phonemes or sequences of phonemes that have been produced on other occasions.	Reported by the participants' previous SP in a letter dated 09/12/97.
6	Irregularity of sound productions that cannot be explained in terms of phonological processes.	Completion of the Fisher-Logemann 3 times and spontaneous speech samples confirmed irregular sound p roduction.
7	Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks.	A video recording made on the 19/3/98 showed the participant was unable to sequence any phonemes. DDK rates were unable to be scored.
8	Significantly better receptive language development than expressive language development as a result of restricted speech development (significant = 1 Standard Deviation or more between the 2 scores).	On the 28/03/95 the CELF-P Receptive score was 116 and expressive score was 90. In December 1998, the CELF -3 Receptive score was 110 and the expressive score was 86 (SD = 15).
9	Disorder was perceived as severe.	The participant's previous SP (11/1997) said the participant had a "severe" speech disorder. This was verified by PCC found to be 30.76% on the Fisher-Logemann.
10	Participant had undergone a minimum of 12 months of therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches.	Information contained in letter from referring SP (09/12/97), & a report dated 14/4/94 plus phone contact and discussions with the previous SP confirmed that the participant had received therapy from 2/94 to 4/97, a period of 3 years 3 months.

Participant 2.

Criterion	**Description.**	**Selection Criteria**
1	History of paucity of babbling.	Father reported a lack of variety in sounds during babbling which mainly consisted of vowel sounds.
2	History of delayed speech development.	Father noted that the participant was slower starting to speak than his twin brother and subsequently the length of utterances was reduced in comparison to his twin. Intelligibility was always problematic.
3	Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.	Observed by the researcher in clinic when the participant first commenced therapy with the researcher. The information is contained in the case notes.
4	The presence of groping movements or trial and error behaviour on production of sounds noted by a speech pathologist	Observed by researcher in clinic when the participant first commenced therapy with the researcher. This is documented in the case notes.

5	Unable to voluntarily produce isolated phonemes or sequences of phonemes that have been produced on other occasions.	. Observed by researcher in clinic when the participant first commenced therapy with the researcher. This is documented in the case notes.
6	Irregularity of sound productions that cannot be explained in terms of phonological processes.	Confirmed by completion of the Fisher-Logemann 3 times along with a spontaneous speech sample.
7	Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks.	A video recording on the 23/01/98 showed the participant was able to achieve a maximum 6 repetitions of a single phoneme (e.g. /pa/) and was unable to sequence 2 sounds (eg. /pa -ta/). Data was insufficient to score DDK.
8	Significantly better receptive language development than expressive language development as a result of restricted speech development (significant = 1 Standard Deviation or more between the 2 scores).	On the CELF -P the Receptive score attained was 122 while the Expressive score was 96. (SD = 15).
9	Disorder was perceived as severe.	PCC = 38.41%
10	Participant had undergone a minimum of 12 months of therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches.	The participant had received therapy for 1 year 3 months. The father reported there had been little change in speech production and so the family were seeking alternative therapy approaches.

Participant 3

Criterion	**Description.**	**Selection Criteria**
1	History of paucity of babbling.	A parent interview revealed that single sound production was evident in infancy rather than sound repetition (babbling).
2	History of delayed speech development.	Interviews with mother and with the previous SP revealed a family history of delayed speech development (09/12/97).
3	Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.	Oral movements had been targeted in therapy by the previous SP (20/9/96) who stated that poor oral motor control continued to be evident throughout therapy.
4	The presence of groping movements or trial and error behaviour on production of sounds noted by a speech pathologist	This was confirmed by observation in the clinic by the researcher.
5	Unable to voluntarily produce isolated phonemes or sequences of phonemes that have been produced on other occasions.	Inconsistent production was noted in a report from the previous SP dated 20/9/96.
6	Irregularity of sound productions that cannot be explained in terms of phonological processes.	Confirmed when the participant completed the Fisher-Logemann 3 times and a spontaneous speech sample was analysed.

7	Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks.	Confirmed and taped on 20.02.98. The participant was unable to sustain repetition of /pa/, /ta/ but was able to repeat /ka/. No phonemes could be sequenced. Rates for DDK could not be scored.
8	Significantly better receptive language development than expressive language development as a result of restricted speech development (significant = 1 Standard Deviation or more between the 2 scores).	A letter from the participants previous SP (9/12/97) stated that the CELF-P was completed but scores were not available. The CELF-R was incomplete. An expressive score of 71 was obtained but no score was possible receptively as the participant refused to complete 1 subtest. PPVT-111 = Standard Score (SS) 74, EVT = SS 42 (SD=15)
9	Disorder was perceived as severe.	Supported in a report from the previous SP dated 20/09/96. PCC measures varied from 51.98% & 44.76% with a mean of 48.37%.
10	Participant had undergone a minimum of 12 months of therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches.	A letter from the previous SP (09/12/97) stated that the participant had received therapy since 12/93, a period of 4 years.

Participant 4

Criterion	**Description.**	**Selection Criteria**
1	History of paucity of babbling.	Very little of any sort of sound reported in infancy or noted at the commencement of the study.
2	History of delayed speech development.	The participant had no speech development at CA 3 years 9 months.
3	Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.	Observed by the researcher in clinic when the participant first commenced therapy and recorded in the case notes.
4	The presence of groping movements or trial and error behaviour on production of sounds noted by a speech pathologist	Observed by researcher in clinic prior to and during research and recorded in the case notes.
5	Unable to voluntarily produce isolated phonemes or sequences of phonemes that have been produced on other occasions.	The participant produced very little sound and the variation of sound produced was very limited.
6	Irregularity of sound productions that cannot be explained in terms of phonological processes.	Confirmed when the participant attempted the Fisher-Logemann 3 times and attempts to imitate single phonemes were irregular.

7	Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks.	A video was recorded on 19/01/98 and the participant was unable to repeat any phonemes and was unable to perform any oral movements on command. DDK rate could not be calculated.
8	Significantly better receptive language development than expressive language development as a result of restricted speech development (significant = 1 Standard Deviation or more between the 2 scores).	On the CELF-P the participant achieved a Receptive score of 75 but was unable to complete any of expressive portion of the assessment protocol.
9	Disorder was perceived as severe.	PCC = 11.3%
10	Participant had undergone a minimum of 12 months o f therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches.	The participant had received therapy for 1 year 3 months and mainly used AAC to communicate. Very little oral or verbal control had been established despite constant input at one time daily on ABA programme.

Participant 5

Criterion	**Description.**	**Selection Criteria**
1	History of paucity of babbling.	The participant's mother reported little speech sound was produced in infancy.
2	History of delayed speech development.	When the study commenced the participant was 6 years 6 months old. Speech largely consisted of single words and was mostly unintelligible.
3	Oral apraxia diagnosed by a speech pathologist either as currently being present or as being evident when the participant was younger.	This was reported by previous SP and confirmed by the researcher who observed difficulties sequencing motor movements (eg. Bite then blow).
4	The presence of groping movements or t rial and error behaviour on production of sounds noted by a speech pathologist	This was observed by previous SP and the researcher and noted in clinic notes. It was also observed and noted on a video recording on 5/8/98.
5	Unable to voluntarily produce is olated phonemes or sequences of phonemes that have been produced on other occasions.	This was observed by previous SP and by the researcher. This was further noted in communication attempts when context cues rendered these intelligible.
6	Irregularity ofsound productions that cannot be explained in terms of phonological processes.	Confirmed by the participant completing the Fisher-Logemann 3 times and by a spontaneous speech sample.
7	Slow diadochokinetic (DDK) rates and / or difficulty sequencing phonemes on DDK tasks.	The participant was unable to sustain phoneme repetition and unable to sequence any phonemes so no DDK rate could be recorded. This was taped on 5/8/99.

8	Significantly better receptive language development than expressive language development as a result of restricted speech development (significant = 1 Standard Deviation or more between the 2 scores).	On the CELF -P. the participant attained a Receptive score of 79 but was unable to complete the expressive portion. The Formulated Labels subtest was attempted but largely unintelligible.
9	Disorder was perceived as severe.	PCC 10.89%
10	Participant had undergone a minimum of 12 months of therapy and had demonstrated minimal gains with traditional articulation therapy approaches and/or phonological approaches.	Following 3 years plus of therapy speech was mostly unintelligible. The participant was able to use AAC but did not use it once he commenced primary school.

APPENDIX B
Example of record keeping for treatment phase.

Example of record keeping for treatment phase.

Presentations 1 **Participant 2 Session 4, phoneme 1.**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
four XPv	v	v	v	XPv	v	v	v	v	v
fur v	v	v	v	v	v	XPv	v	XPv	XPv
food v	v	v	XPv	v	XPv	v	v	v	v
fish XPv	XPv	XPv	XPv	XPv	XPv	XPv	XPv	XPX	XPv
Me first. XPX	XPv	XPv	XPv	XPv	XPv	XPv	XPv	XPv	XPv

Explanation.

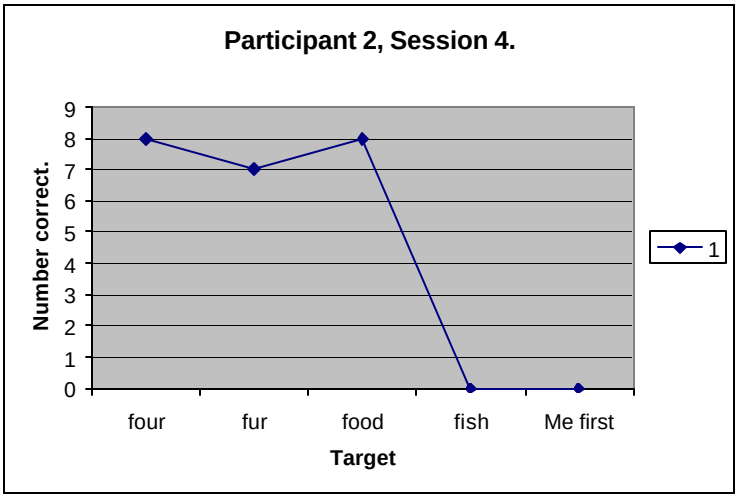
X = incorrect. P = Prompted (mapped in) v = correct.

If the target phoneme was produced correctly with the initial presentation of the stimulus word/picture then it was simply recorded as v and scored as correct.

If the initial presentation resulted in an incorrect production of the target phoneme this was recorded as “X” followed by “P” to indicate target was then mapped in using surface prompts. Following this, the target word/phrase was prompted while the participant simultaneously produced the word/phrase and then “X” or “v” used to indicate whether the phoneme was correct or incorrect. The phoneme was scored as correct overall only when it was accurately produced on the initial presentation of the target word/phrase.

As can be seen Participant 2 achieved 8 correct /f/ sounds in the word “four” without prompting and these were recorded, as can be seen in the graph below, as correct. On two occasions initial articulation of /f/ was incorrect and following prompting was correct, however these were recorded as incorrect on the graph below as the initial attempt at the word “four” was incorrect.

For the phrase “Me first” it can be seen on the first presentation that Participant 2 produced the phoneme /f/ incorrectly. He was then prompted but production remained incorrect on the next attempt where he said “Me first” while simultaneously being prompted. This was scored as incorrect. All subsequent attempts were also scored as incorrect because all initial attempts at producing the correct phoneme were incorrect and required Prompting



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The data from the table was translated to a graph, shown above, for session 4. Clearly it can clearly be seen that three of the target words were correct on 7 or 8 occasions (of the 10 times presented) while the remaining target word and the phrase were incorrect on all occasions