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A comparison of three therapy methods for children with different types of developmental phonological disorder

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Abstract

Treatment case studies of three children whose speech was characterized by non-developmental errors are described. Three therapy methods were trialed with each child: phonological contrast; core vocabulary and PROMPT. The accuracy and intelligibility of the children's connected speech improved throughout the course of the programme. Intervention that focused on teaching a rule about the contrastive use of phonemes was most successful for a child who consistently made non-developmental errors. Children making inconsistent errors received most benefit from the core vocabulary approach that markedly enhanced consistency of production. However, once consistency was established, one child benefited from phonological contrast therapy. While the results of the study should be interpreted with caution due to the small sample size and the cumulative effects of intervention, the findings suggest that different parts of a child's phonological and phonetic system may respond to various types of treatment approaches that target different aspects of speech production. The implication drawn is that just as no single treatment approach is appropriate for all children with disordered phonology, management of some children may involve selecting and sequencing a range of different approaches.

Keywords: phonology, disorder, therapy, efficacy.

Introduction

The effective remediation of developmental speech disorders is a challenging goal for paediatric speech therapists. A range of intervention techniques has been

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developed that reflect theories of speech disorder. Consequently, there are treatment programmes that focus on phonetic skills (e.g. Chumpelik 1984); distinctive features (e.g. Costello and Onstine 1976); phonological contrasts (e.g. Dean et al. 1995); motor impairment (e.g. Hayden and Square 1994) and language development (e.g. Hoffman 1993). Choosing an appropriate method for individual clients is difficult because little attention has been paid to the evaluation of specific treatment methods, and the need to tailor therapy for different subgroups of developmental speech-disorder has been largely ignored.

The results of investigations of auditory processing, cognitive–linguistic, motor-speech, imitation, and fine motor planning skills of children with speech disorders support the hypothesis that they do not form a homogeneous group. Research suggests that different deficits underlie subtypes of developmental speech disorder (Dodd and McCormack 1995, Bradford and Dodd 1996). One clinically relevant way of classifying developmental speech disorders is in terms of the surface error patterns. These error patterns and their hypothesized deficits are:

- *Delayed development.* Children who make errors characteristic of younger normally developing children have no specific deficit in the speech processing chain. Rather, phonological delay has been attributed to delayed neurological maturation or lack of appropriate environmental support for language development (Dodd 1993).
- *Consistently used non-developmental error patterns.* Non-developmental error patterns are those not typical of normal development (e.g. deletion of all syllable initial fricatives). Based on their poor performance on phonological awareness, meta-linguistic and literacy tasks and normal performance on oro-motor and speech motor planning tasks, these children have been hypothesized to have a cognitive–linguistic impairment in abstracting the phonological rules governing language (Dodd and McCormack 1995, Bradford and Dodd 1996).
- *Inconsistent errors.* Children whose speech is characterized by inconsistent production of the same lexical item in a single-word production task (in the absence of oro-motor difficulties) are hypothesized to have a deficit at the level of constructing, storing and/or retrieving a phonological output plan.

Consistency of word production

Some inconsistency, for example between the correct target phoneme and a consistently used error form, is positive: it indicates that the phonological system is developing. However, inconsistency characterized by multiple error types (e.g. umbrella produced as [ʌnvɛ, ʌbɛdʌ, and ʌmbɛjʌ]) is negative and poses the theoretical problem of how to account for such a surface error pattern and the clinical problem of choosing what to target, and what to contrast, in therapy.

Repeated realizations for particular lexical items are not usually elicited as part of the assessment battery used with phonologically disordered children. The identification of children whose speech is characterized by high levels of negative inconsistency (Dodd *et al.* 1989) led to experiments that sought to identify associated underlying deficits in the speech processing chain. In comparison with children whose speech was characterized by the consistent use of developmental and non-developmental error patterns, the 'inconsistents' performed better on measures of

phonological awareness (Dodd *et al.* 1989) and literacy (Dodd *et al.* 1995). However, they perform less well on: standard expressive vocabulary measures (Dodd and McCormack 1995); imitation of non-words; and learning to pronounce new words (Bradford and Dodd 1996). These children also performed within normal limits on oro-motor assessments unlike children suspected as being dyspraxic. This profile of deficit suggests an impairment at the level of phonological assembly: neither cognitive–linguistic nor dyspraxic/articulatory deficits can account for their severely unintelligible speech.

If different deficits *do* underlie different types of surface error patterns, then intervention targeting the primary area of deficit for children is likely to be more effective than other treatment techniques. Few research studies, however, have compared intervention methods for children with disordered speech (Elbert 1992). Specific intervention techniques, previously trialed on heterogeneous groups of children with mixed success, might be appropriate for particular subgroups of children with phonological disorder.

Intervention approaches

Although intelligible speech is the long-term goal for most intervention approaches for children with speech-disorders, different programmes use different techniques to target various aspects of the speech production process and development of the different speech units. The study described here trialed three therapy approaches that differed not only in the type of speech production unit targeted, but also in terms of theories of deficit underlying speech disorder.

Targeting phonological processes

The aim of phonologically based therapy is to suppress error patterns that reduce intelligibility (e.g. clusters are marked by bilabial fricatives). These techniques use meaning to encourage reorganization of the sound system (e.g. Blanche et al. 1981). Dean *et al.* (1995) presented a phonological programme based on a combination of theories of phonological disorder and children's learning styles. The programme is designed to facilitate change in phonological skills by targeting the child's awareness and use of the meta-linguistic attributes and contrastive nature of phonemes. Children are required actively to participate in the learning process to encourage acquisition and reorganization of phonological information. Data on 13 phonologically disordered children who received *Metaphon* therapy indicated that this phonologically based treatment method was effective in eliminating consistently used developmental and non-developmental error patterns (Dean *et al.* 1995). Dodd and Iacono (1989) presented data on six children who received intervention targeting the use of non-developmental phonological rules. The phonological rule approach was particularly successful in eliminating consistent non-developmental errors. However, this method was less successful for a child who made multiple errors inconsistently.

Targeting consistency of production using a core vocabulary

Inconsistency across words, and within repeated productions of the same word, often results in the listener failing to understand the intended message. Therefore,

a major goal of therapy should be to increase consistency of production of words (Dodd *et al.* 1994). Gierut (1989) suggested that therapy focussing on maximal, rather than minimal, oppositions may be an appropriate form of therapy for children whose speech is inconsistent. Although this hypothesis has not been tested in the literature, results of other studies (e.g. Dodd and Iacono 1989) indicate that therapy targeting only phonological contrasts may not be effective for children who produce words variably. Similarly, results of an intensive group programme using whole language treatment indicated that this method was not effective in increasing consistency of word production in those children in the group who made inconsistent speech errors (Alcorn et al. 1995).

One procedure that directly targets increasing consistency of word production is the core vocabulary approach that advocates teaching a small vocabulary of functional words that are to be produced in a developmentally appropriate way (Dodd *et al.* 1994). Consistency of production is stressed rather than correct production and this is reinforced in the clinic and in all other contexts. Dodd and Iacono (1989) reported data on a child who produced lexical items variably, and showed no response to phonological therapy after 8 months. The subject was then taught a core vocabulary of lexical items for which consistent developmental productions were required. After 2 months of therapy, consistency in production had generalized and the phonological process approach was re-adopted with success. Similarly, Dodd *et al.*'s (1994) use of core vocabulary therapy for children with Down's syndrome led to increased consistency of lexical production and a decreased proportion of non-developmental phonological errors.

Targeting volitional speech/motor control and articulation using PROMPT

The PROMPT system is based on the principles of moto-kinesthetic therapy (Stinchfield and Young 1938). The emphasis of PROMPT therapy is on teaching the child motor programming skills by imposing target positions and sequences of movements. The child is not required to use imitation or perceptual comparisons to organize movements (Chumpelik 1984). The clinician provides physical input in terms of spatial targeting of place, manner of production, degree and direction of mandibular and tongue movement, and segment or syllable durations (Square-Storer and Chumpelik Hayden 1989). Tactile and kinaesthetic awareness of movement patterns is encouraged as the appropriate movement of articulators is guided by the clinician. The efficacy of the PROMPT system for developmental speech-disorder has not been evaluated. However, Square et al. (1986) reported that PROMPT therapy was effective for three patients with acquired apraxia of speech in that they acquired phoneme contrasts that were previously unmarked.

Aims of the investigation

There have been no investigations of how children with different subtypes of speech disorder respond to a variety of intervention methods hypothesized to address different underlying deficits. This investigation aims to provide quantitative and descriptive data on the speech production skills of three children who were enrolled in therapy, and to document changes occurring during the intervention programme. A further aim was to compare the effects of three intervention programmes

(PROMPT, Phonological Process, Core Vocabulary) that targeted different units of production (sound production, phoneme contrasts, words).

It was hypothesized that the child who used non-developmental rules consistently would respond best to the phonological–metaphonological therapy that focuses on phonological contrasts. It was predicted that the children with inconsistent speech disorder would respond best to the core vocabulary therapy because it focuses on the word in phonological processing. It was predicted that PROMPT therapy, which focuses on speech sound production, would not be effective for phonologically disordered children.

Methods

Participants

Three boys with phonological impairment participated in the investigation. They were referred to the study by the Regional Health Authority speech–language therapist who was requested to select children between 3 and 5 years who had a moderate-to-severe phonological disorder. No other criteria were given since the study's aim was to investigate efficacy of therapy for children who were typical of a clinician's caseload. At assessment their ages ranged between 3;5 and 4;3 years. Two of the children had previously received intervention for their speech disorder, and one child had been assessed and was on a waiting list for treatment. Although the children varied in age, schooling history and severity of speech disorder, they all displayed moderately to severely impaired intelligibility on referral to the intervention study. All children had normal hearing, as tested within 6 months of participation in the intervention programme and mothers reported no current concerns. The subjects came from single income, two parent families of middle socio-economic status. The mother was the primary care giver in all cases.

No control subjects were included in the study for two reasons. Health Authority ethical guidelines prohibit the use of experimental designs involving withholding of needed treatment. Further, the complex nature of the speech disorders and individualized treatment programmes involved precluded specific comparisons between subjects since it is not possible to match speech-impaired children on all the relevant variables (Dodd and Iacono 1989).

Pre-treatment assessment

To allow for differential diagnosis of their speech disorder, the participants' speech, language and oro-motor skills were assessed by an experienced speech–language therapist (A.B.) in a quiet clinic room. All mothers were present for the assessment.

Procedure

A speech sample was elicited in a free play situation with a variety of toys and books. The same stimulus materials were used again to collect subsequent speech samples to maintain continuity and to allow for direct comparison over time. The Goldman–Fristoe Test of Articulation (Goldman and Fristoe 1986) and the 25 Word Test for Inconsistency (Dodd 1995) were also administered to ensure that a wide variety of phonemes and phonetic contexts had been attempted, to measure consistency of production, and to enable measurement of phonological change throughout the

intervention programme. When a word could not be elicited on the 25 Word Test for Inconsistency, imitation was prompted and the response was recorded. However, the reported consonant accuracy scores do not include imitated responses. All speech data were tape-recorded for later phonetic transcription. Point-to-point interrater reliability on 10% of speech samples, which were randomly selected, was 84% for spontaneous speech samples and 81% for the one-word elicitation samples.

The Oral and Speech Motor Control Protocol (Robbins and Klee 1987) and the Movements in Context and Sequenced Oral Movements tasks (Ozanne 1992) were administered to provide descriptive and quantitative information about the integrity of the subject's speech motor system. Receptive language skills were screened using the Test for Auditory Comprehension of Language-Revised (TACL-R) (Carrow-Woolfolk 1985), and connected speech samples were inspected for appropriate use of semantic, syntactic and morphological structures.

Three measures were taken from the speech data: percentage consonants correct (PCC) from the 50 utterance spontaneous speech sample, the articulation and inconsistency tests was calculated as a measure of severity; a phonetic inventory was derived (two spontaneous productions in any word position); and the complete corpus of spontaneous speech was inspected for the use of developmental and non-developmental phonological rules. (For children whose speech errors are consistent, this approach to error analysis provides useful information. The validity of this type of analysis for children with unpredictable realizations is questionable [Ball 1994]). A rule was considered to be present if there were five or more exemplars involving different words in the total speech data. Counter examples of rules were noted.

Baseline data

All participants had had a break from therapy for at least 4 weeks before the commencement of the study. Single word naming responses on the Goldman–Fristoe Test of Articulation were collected by their referring speech–language therapist and were compared with single word naming data collected at the start of the intervention programme. To establish further the stability of the phonological system, comparison of the consonant accuracy of the three attempts at the 25 Word Test for Inconsistency at the pretreatment assessment was made.

Experimental design

Following a 4-week break from therapy, a pretreatment assessment evaluated language, speech and oro-motor skills. A multiple baseline design with alternating treatments was used. Treatment 1 was implemented after the initial assessment, followed by a 3-week withdrawal period, Treatment 2, withdrawal, then Treatment 3. The order of treatments was random. There were 12 (30-min) individual therapy sessions in each 6-week treatment block. For home follow-up, parents repeated the activities observed in the most recent therapy sessions using the same target words or contrasts focused on in therapy. There was no revision during the breaks. A final assessment occurred three weeks after the final treatment session. The 25 Word Test for Inconsistency was elicited at the beginning and end of each treatment phase. Data on production of treated and untreated targets were collected every second session during treatment phases. Production of the target core vocabulary words and matched probe words was elicited three times at the beginning and end

of the core vocabulary treatment phase as a measure of consistency. The three productions of the treated and untreated words (pre- and post-treatment) were compared, and the proportion of words produced consistently calculated (table 7 for summary of design).

Three intervention programmes were trialed:

- *Phonological contrast therapy (targeting phonological processes).* A single phonological rule was chosen based on phonological analysis of the connected and elicited speech samples. Criteria for phonological process target selection included: stimulability of speech sounds required; the relative effect on intelligibility of successful remediation of different processes; normal developmental sequence maintained; targeting deviant before developmental processes and consistency of use of the rule (Dodd and Iacono 1989). Rules that were not frequently used were considered poor candidates for this approach because remediation would be likely to have a limited effect on overall accuracy. Target minimal pairs/triplets were used in a standard Metaphon programme (Dean *et al.* 1995).
- *Core vocabulary therapy (targeting consistency of word production).* Parents selected words that were powerful or useful for the subject to say consistently and in a manner that could be recognized by other people in their environment (Dodd and Iacono 1989, Dodd *et al.* 1994). The investigator decided on an appropriate productive realization of each target based on the child's phonological system and phonetic inventory. A set of real words of similar phonemic and phonotactic structure to the target words was used to probe generalization. Five words were introduced initially, and each was worked on separately every session. Production was drilled sound by sound, using cues such as sound and syllable segmentation, imitation, and cued articulation (Passy 1990). When a word was produced consistently and appropriately to a 90% criterion in a single session, it was then incorporated into phrases and a new word was added to the target list. See Appendix 1 for each child's core vocabulary targets and acceptable realizations.
- *PROMPT system therapy (targeting articulation).* PROMPT treatment (Prompts for Restructuring Oral Muscular Phonetic Targets) focuses on aspects of motor control and motor programming (Square-Storer and Chumpelik Hayden 1989). The clinician reshapes articulation of isolated and connected phones using a specific set of tactile cues described by Chumpelik (1984). Prompts are designed to convey information regarding place of contact of the articulators, jaw closure, manner of production, and segment and syllable durations (Chumpelik 1984). Articulation of the individual target phonemes was trained first in isolation then in words and phrases. To avoid contamination by phonological information, the contrastive nature of the phonemes and their effect on the meaning of words was not discussed during treatment. Criteria for sound selection included: trialing stimulability of speech sounds; effect on intelligibility of successful remediation and normal developmental sequence.

Case study: TS

TS was referred to the intervention study at 3;4 years. He had no previous therapy. His birth and medical history was without incident and developmental milestones were age appropriate.

Pre-treatment assessment

TS's receptive and expressive language skills were within normal limits. Performance on the oro-motor assessments was age appropriate. Speech intelligibility was poor and characterized by the consistent use of developmental and non-developmental rules (table 1).

Baseline data

Comparison between TS's pattern of substitutions on the Goldman–Fristoe Test of Articulation 4 weeks before treatment and his initial pretreatment assessments revealed no notable differences. Comparison of the PCC scores on each of the three pretreatment administrations of the 25 Word Test for Inconsistency showed that consonant accuracy across attempts was relatively stable, varying within a 3.7% range.

Therapy one: phonological therapy

The non-developmental rule of medial consonant substitution/deletion was targeted. Whenever possible the target words were contrasted with real words of similar structure that used TS's preferred medial sounds [h, w, j] (e.g. *tyre* versus *tiger*). A set of 14 words with a range of medial consonants was used to probe generalization. The processes of final consonant deletion and stopping of fricatives were also monitored.

Progress

By the end of the therapy block TS used target words with appropriate voiced medial phonemes in three- and four-word phrases and in connected speech. Progress

Table 1. TS's performance on on the Speech Measures at the Pre-treatment Assessment

Assessment	Comments	
25 Word Test	17.6% Inconsistent	
	15.3% Consonants correct	
Spontaneous Speech	24.1% Consonants correct	
Goldman–Fristoe	14.4% Consonants correct	
Phonetic Inventory	Word initial position: /d, b, n, w, j, m/	
	Word medial position: /d, b, k, w, j, h/	
	Word final position: /p, ŋ/	
Phonological Analysis (% use of process in 25 Word Test)	Developmental processes: final consonant deletion (91.4%); weak syllable deletion (100%); prevocalic voicing (100%); velar fronting (50%); stopping of fricatives and affricates (100%); gliding of liquids (100%); and cluster reduction (100%)	
	Non-developmental error processes: medial consonant deletion and substitution (52%), and nasal assimilation (50%)	
Test for Auditory Comprehension of Language—Revised	Subtest	(Standard score)
	Word classes and relations	(+0.74)
	Grammatical morphemes	(+0.52)
	Elaborated sentences	(− 1.23)
	Total score	(+0.39)

on targets and untreated probes is shown in figure 1. Some increase in the use of final consonants was noted throughout the therapy block while stopping of fricatives remained at a basal level.

Therapy two: core vocabulary therapy

Consistency and accuracy of taught and untaught core words was monitored, as was stopping of fricatives and affricates and the use of medial and final consonants.

Progress

Of the 12 words introduced, only four were produced with consistent developmental productions in phrases. Transfer to spontaneous speech was limited. Comparison of the consistency of production of treated and untreated core vocabulary target words indicated that more of the treated words were produced consistently before the therapy block as compared with after the therapy block (pretreatment 50% versus post-treatment 41.7%). Conversely, more of the untreated words were consistent after the therapy block (72.8%) than before treatment (54.5%). That is, focusing on the word level appeared to destabilize TS's phonological system. There was little change in use of word medial and final phonemes and fricatives.

Therapy three: PROMPT therapy

Production of the fricatives /s/ and /ʃ/ was targeted. The stops /t/ and /d/ were also taught. Untreated /s/ and /ʃ/ words and other words with initial fricatives or affricates, core vocabulary items, and medial and final consonants were monitored.

Progress

Production of the phoneme /s/ proved particularly difficult for TS. Word level activities for all target phonemes were provided. TS produced words with the appropriate initial phoneme at the conclusion of therapy, however [s] and [ʃ] were not blended with the rest of the word. Progress on probed treated and untreated words, core vocabulary items, the use of final consonants and labio-dental fricatives

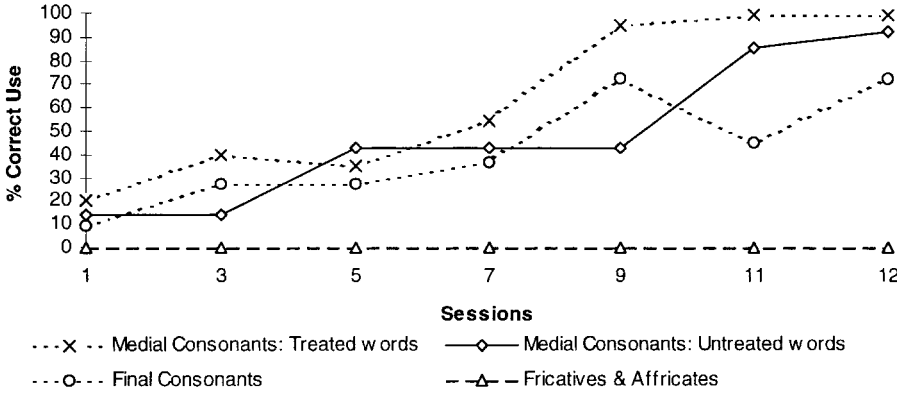

Figure 1. TS's progress on treated and untreated probes during Block 1: Phonological Therapy.

can be seen in figure 2. Stopping of /f/, although not a target in therapy was eliminated by the last session of therapy, however final assessment analyses revealed that this was not maintained (table 2).

Final assessment

At the final assessment, three weeks following therapy, language skills remained stable. Results of the speech assessments (table 2) indicated considerable improvement in the accuracy of sound production (table 1 for comparison).

Summary

TS reached the set criteria and maintained skills taught during the the phonological contrast therapy block, where meta-phonological knowledge was employed to teach

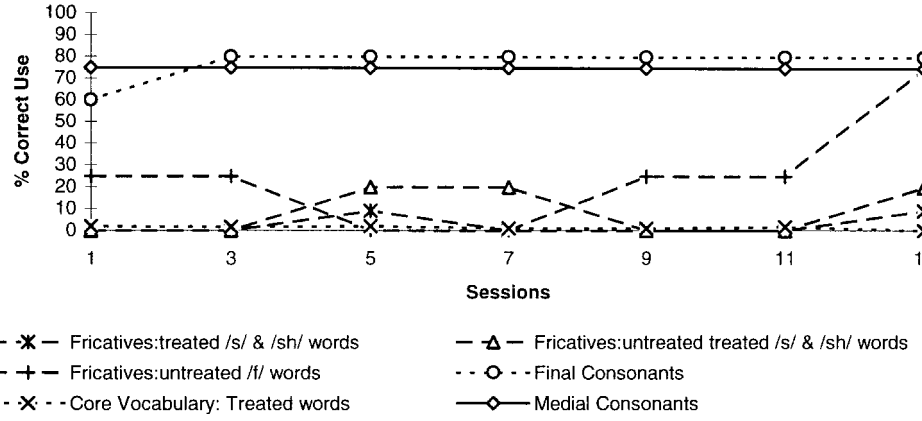

Figure 2. TS's progress on treated and untreated probes during Block 3: PROMPT Therapy.

Table 2. TS's performance on the Speech Measures at the Final Assessment

Assessment	Comments	
25 Word Test	28% Inconsistent	
	35.7% Consonants correct	
Spontaneous Speech	37.5% Consonants correct	
Goldman–Fristoe	38.1% Consonants correct	
Phonetic Inventory	Word initial position: added /h, v, dʒ/	
	Word medial position: added /n, ŋ, m, f, p, g, v, t/	
	Word final position: added /d, k, g, v, n, f, b, m/	
Phonological Analysis (% use of process in 25 Word Test)	Developmental processes: final consonant deletion (35.4%); weak syllable deletion (80.8%); prevocalic voicing (97.6%); velar fronting (75%); stopping of fricatives and affricates (100%); gliding of liquids (100%); and cluster reduction (84.4%)	
	Non-developmental error processes: medial consonant deletion and substitution (16%)	
Test for Auditory Comprehension of Language—Revised	Subtest	(Stardard score)
	Word classes and relations	(+0.58)
	Grammatical morphemes	(+1.34)
	Elaborated sentences	(− 1.34)
	Total wscore	(+0.44)

sound contrasts. Conversely he learned few words during the core vocabulary phase and treated words actually decreased in consistency following this intervention. Treated sibilants showed no improvement during PROMPT therapy where sound production was targeted.

Case report: MC

MC's birth and medical history was without incident. Gross motor developmental milestones were age appropriate. No family history of speech, language or academic problems was reported. MC had received speech therapy intervention for 4 months before his referral at 4;3 years. The speech therapy notes indicated that his rapid speech was characterized by inconsistent errors. Prior intervention had focused on articulation of /f/ in all word positions.

Pre-treatment assessment

Results of the TACL-R indicated mostly age appropriate comprehension skills, except for understanding complex sentences. The connected speech sample showed delays in the use of bound morphemes and auxiliary verbs. Oro-motor assessments suggested no deficits. Intelligibility of single words was fair; however, intelligibility of connected speech was poor. Results of the speech measures are presented in table 3.

Table 3. MC's performance on the Speech Measures at the Pre-treatment Assessment

Assessment	Comments	
25 Word Test:	44% Inconsistent	
Results and examples	65.7% Consonants correct Slippery slide: fɪpwi paɪ, fɪpwi fwaɪ, fwɪpwi fwaɪd Kangaroo: kɪngʌwu, kɛŋgʌwu, kɛŋʌwu Lady bird: jeɪjibɜ, jɪdi bɜd, jeɪdibɜ Umbrella: ʌmbwɛjɜ, ʌmbwɛː ɜ, ʌmbɛlu Zebra: zɛbwu, ɕɛmbu, zɛwu	
Spontaneous Speech	48.6% Consonants correct speech rate was rapid	
Goldman–Fristoe	60% Consonants correct	
Phonetic Inventory	Word initial position: /m, n, p, b, d, t, k, g, f, ʃ, s, ç, j, tʃ, dʒ, h/ Word medial position: /m, n, p, b, d, k, g, f, s, z, l, w, j, ŋ/ Word final position: /m, n, p, t, d, k, ç, j̚, ±ʔ, ŋ, ʃ, v, tʃ, dʒ/	
Phonological Analysis	Inconsistent developmental errors: final consonant deletion; glottal stop replacement; cluster reduction; weak syllable deletion; prevocalic voicing; stopping of fricatives; and gliding of liquids Nondevelopmental errors: initial and medial consonant deletion and substitution, vowel errors, in clusters of the /s/ +nasal form, /s/ was consistently produced as a nasal fricative	
Test for Auditory	Subtest	(Stardard score)
Comprehension of	Word classes and relations	(− 0.47)
Language—Revised	Grammatical morphemes	(− 0.47)
	Elaborated sentences	(− 1.4)
	Total score	(− 0.95)

Baseline data

Comparison of MC's pattern of substitutions on a single word articulation test 4 weeks before therapy and just before the clinical trial indicated no differences between the profiles. MC's pattern of speech production errors remained inconsistent. Comparison of the PCC scores on each of the three pretreatment administrations of the 25 Word Test for Inconsistency revealed that overall PCC was relatively stable. The scores varied within a 2.8% range, even though lexical items were produced inconsistently.

Therapy one: core vocabulary therapy

The accuracy and consistency of taught and untaught core words were monitored in addition to observation of the use of final consonants, glides and clusters.

Progress

Of the 18 words introduced, 16 were produced with consistent developmental productions in phrases. Comparison of consistency of production of treated and untreated vocabulary targets across the pre- and post-treatment productions showed that more of the treated and untreated words were produced consistently following therapy. Treated words were produced consistently: 50% pretreatment versus 69% post-treatment; untreated words were produced more consistently: 31% pretreatment versus 69% post-treatment. There was no change in glide production, but a 21% increase in accuracy of final consonants and a 35% increase in accuracy of cluster realization.

Therapy two: phonological therapy

Ten minimal pairs targeting the liquid and glide contrast were chosen and an additional six minimal pairs served as generalization probes. Selected core vocabulary items and cluster reduction and final consonant deletion were also monitored.

Progress

Considerable improvement in both treated and untreated targets was seen during the therapy block (figure 3). Generalization to connected speech was observed and was maintained. Consistency of core vocabulary items continued to improve. Figure 3 also shows data on the two control processes (consonant clusters and use of final consonants) which were not expected to vary during the therapy block.

Therapy three: PROMPT therapy

Substitution of a nasal fricative for /s/ before nasals in clusters was targeted. Articulation of the target phones /s/, /m/ and /n/ was elicited by prompts in isolation and then articulation of the entire cluster was prompted at word level. Development of untreated /s/+nasal clusters, /s/+oral stop clusters, final consonant deletion, liquid gliding and selected core vocabulary items was monitored.

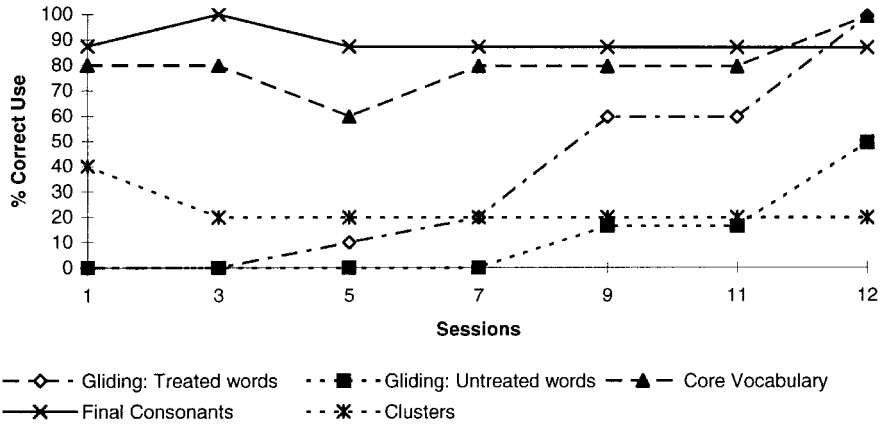

Figure 3. MC's progress on treated and untreated probes during Block 2: Phonological Therapy. Note: clusters were counted correct if two phonemes were used.

Progress

Following therapy, MC produced the targets as initial consonants, but was unable to blend [s] with the nasal phones. Without prompts, he reverted to use of the deviant cluster substitution. There were no correct productions of either treated and untreated /s/+nasal clusters in words. Production of other clusters, liquids and core vocabulary targets showed little change at the end of this treatment phase.

Final assessment

Receptive language skills (TACL-R) were within normal limits, while use of auxiliary verbs remained problematic. Consistency and accuracy of speech had improved since the pretreatment assessment (table 4).

Summary

Consistency of word production was attained during the core vocabulary block of therapy, generalizing to untreated words. This consistency was maintained throughout the other two blocks of therapy. MC also benefited from the block of phonological contrast therapy where gliding was eliminated for treated words, although generalization to untreated words was more limited. MC did not benefit from the PROMPT therapy approach.

Case report: TN

TN was first referred at 2;2 years. Birth and medical history was without incident, except for occasional middle ear infections. Hearing assessment indicated normal pure tone thresholds. Developmental milestones were age appropriate. Initial assessment indicated delayed expressive and receptive language skills and poor attention. Speech was reported to be 'babble-like' but was not formally assessed. Responses to a picture naming task, when TN was 2;9 years, indicated the presence of some developmental error patterns, so intervention focused on syntactic structures.

Table 4. MC's performance on the Speech Measures at the Final Assessment

Assessment	Comments	
25 Word Test	28% Inconsistent	
Results and examples	72.3% Consonants correct Slippery slide: slɪpwi slaɪd, slɪpwi slaɪd, slɪpwi slaɪd Kangaroo: kæŋʌwu, kæŋʌwu, kæŋʌwu Lady bird (beetle): leɪdi bidu, leɪdi bidu, leɪdi bidu Umbrella: ʌmbwɛlɜ, ʌmbɛdɜ, ʌmbɛlʌ Zebra: sɛbwɜ, sɛbwɜ, sɛbwɜ	
Spontaneous Speech	79.7% Consonants correct	
Goldman–Fristoe	69.9% Consonants correct	
Phonetic Inventory	Word initial position: added /l, θ/ Word medial position: added /s, z, t/ Word final position: added /z, l/	
Phonological Analysis	Inconsistent developmental errors: final consonant deletion (in connected speech only); cluster reduction; gliding (in clusters only); simplification of affricates; stopping of /ð/; and fronting (/ʃ→[s]) Nondevelopmental errors: substitution of nasalised [s] in /sn/ or /sm/ clusters, marginal vowel errors	
Test for Auditory Comprehension of Language—Revised	Subtest	(Stardard score)
	Word classes and relations	(− 0.55)
	Grammatical morphemes	(− 0.81)
	Elaborated sentences	(− 0.23)
	Total score	(− 0.47)

Formal assessment at 3;4 years revealed final and medial consonant deletion leading to therapy targeting VC structures.

Pre-treatment assessment

When TN (3;7 years) was assessed just before therapy, he had a mild receptive language delay. Two and three word utterances predominated and the development of syntax and morphology was delayed. Performance on oro-motor assessments was mostly age appropriate. Although single words were moderately intelligible, connected speech was poor (table 5).

Baseline data

Comparison of TN's speech on a picture naming test before referral to this study and three months later, at pretreatment assessment, revealed a similar pattern of errors, despite two months of therapy targeting word final consonants. Comparison of PCC scores for each of the three pretreatment administrations of the 25 Word Test for Inconsistency showed that although TN's lexical productions were inconsistent, overall consonant accuracy was similar, varying within a 9.6% range.

Therapy one: core vocabulary therapy

The consistency and accuracy of taught and untaught core vocabulary words was monitored as were final consonant deletion, cluster reduction, and backing of nasals.

Table 5. TN's performance on the Speech Measures at the Pre-treatment Assessment

Assessment	Comments	
25 Word Test	63.6% Inconsistent	
Results and examples	27.7% Consonants correct Helicopter: akoʊ, koʊ koʊ, bɪgboʊk Vacuum cleaner: bæjum, bwæ: pwinʌ, bægin Jump: jʌmp, dʒʌ, ʃʌm Bridge: bɪ, fi, fwɪd Ladybird: leɪbɜd, leɪdibɜ, leɪbɜd	
Spontaneous Speech	51.6% Consonants correct	
Goldman–Fristoe	42.5% Consonants correct	
Phonetic Inventory	Word initial position: /p, b, m, n, t, d, k, g, f, ʃ, tʃ, j, l, w/ Word medial position: /p, m, n, k, g, ʃ, j, w/ Word final position: /p, b, m, n, d, k, ŋ/	
Phonological Analysis	Inconsistent developmental errors: final consonant deletion; velar assimilation; cluster reduction; weak syllable deletion; reduplication; and stopping of fricatives Nondevelopmental errors: vowel substitutions, cluster substitutions, and backing of nasals. Exceptions to most processes and examples of isolated errors not adequately described by phonological processes were noted	
Test for Auditory Comprehension of Language—Revised	Subtest	(Stardard Score)
	Word classes and relations	(− 0.84)
	Grammatical morphemes	(− 2.05)
	Elaborated sentences	(− 1.64)
	Total score	(− 1.64)

Progress

Of the 15 words taught, 12 were produced with consistent developmental realizations in phrases. Some unusual stress patterns were acquired with multisyllabic words (e.g. *banana* had equal stress on each syllable). TN used more developmentally appropriate realizations of all targets following this therapy. Figure 4 shows changes in the production of nasals, final consonants and clusters.

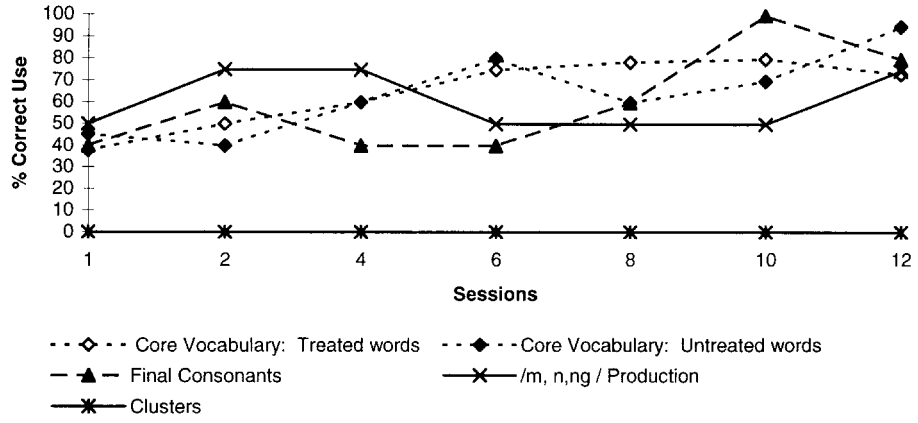

Figure 4. TN's progress on treated and untreated probes during Block 1: Core Vocabulary Therapy. Note: core vocabulary scores for session 1 and 12 are means for the three pretreatment/post-treatment productions.

Therapy two: PROMPT therapy

The articulation of eight examples each of /n/ and /ŋ/ were targeted, in separate activities, because these phonemes were confused in word final position. Eleven words with word final nasals /n, m, ŋ/ were used as untreated generalization probes. Some core vocabulary items, final consonants and clusters were monitored.

Progress

TN had difficulty with production of /n/ and /ŋ/ at word level. Although he could articulate both sounds in words, he appeared unsure of which phoneme was required. Consequently, production of [n] and [ŋ] in both treated and probe words was unstable and no improvement was discernible post-therapy. While production of core vocabulary items continued to improve, there was no change in accuracy of production of final consonants and cluster reduction accuracy decreased.

Therapy three: phonological therapy

Cluster reduction of /s/ + consonant clusters was targeted. Eleven minimal triplets depicting the target contrast, in initial word position, were used in teaching activities and 13 words with /s/ clusters were used as generalization probes. Selected core vocabulary items, final consonants, and production of [n] and [ŋ] was monitored.

Progress

TN was unable to complete auditory activities requiring categorization of targets according to their meta-phonological concept. However, he did complete word to word matching discrimination activities using cluster targets at 90% accuracy. Clusters remained error prone following the auditory phases of the programme. TN did not appear to know whether a cluster or singleton was required and frequently made several attempts at targets. There were few examples of correct production of consonant clusters in probe words throughout the treatment phase, irrespective of whether the words were treated. Production of core vocabulary items and word final [ŋ] and [n] showed no change.

Final assessment

Receptive language skills remained stable. The spontaneous language sample indicated persistent delays in expressive syntax and morphology. Results of the speech assessments (table 6) reflected considerable increases in consistency and consonant accuracy since the pretreatment assessment.

Summary

TN benefited from the core vocabulary block of therapy. Consistency of production of both treated and untreated items was increased and that gain was maintained. In contrast, neither of the other two therapy blocks led to improvement.

Table 6. TN's performance on the Speech Measures at the Final Assessment

Assessment	Comments	
25 Word Test	37.5% Inconsistent	
Results and examples	64.5% Consonants correct	
	Helicopter: koʊpɒtʌ, koʊkɒptʌ, hoʊkɒptʌ	
	Vacuum cleaner: bæklinʌz, bæklinʌ, bwækinʌ	
	Jump: dʌmp, dʌmp, dʌmp	
	Bridge: bwɪdz, bwɪdz, bis	
	Ladybird: beɪdizbɪg, bɪg, big	
Spontaneous Speech	71.1% Consonants correct	
Goldman–Fristoe	68.3% Consonants correct	
Phonetic Inventory	Word initial position: added /s, h, tʃ, dʒ, ð/	
	Word medial position: added /t, d, f, s, z, l/	
	Word final position: added /t, g, f, v, s, z/	
Phonological Analysis	Inconsistent developmental errors: final consonant deletion (connected speech, mostly [t], [l]); cluster reduction; gliding (/l/→[w]); simplification of affricates; stopping /dʒ, v/; fronting /ʃ/	
	Marginal vowel errors, and infrequent initial consonant deletions were observed. Exceptions to most error patterns were noted	
Test for Auditory	Subtest	(Stardard score)
Comprehension of	Word classes and relations	(− 1.13)
Language—Revised	Grammatical morphemes	(− 1.48)
	Elaborated sentences	(− 1.75)
	Total score	(− 1.75)

Discussion

Three children with disordered speech participated in an intervention programme that trialed three therapy methods. All children increased their consonant accuracy in connected speech and their intelligibility improved throughout the course of the programme. As the children displayed relatively stable phonological systems for at least 1 month before the study, improvements in accuracy may cautiously be attributed to the intervention programme. The absence of disproportionate development in language comprehension skills for all the participants suggests that improvement in consonant accuracy was not due to a general increase in language competency during the programme. The results of the study should be interpreted with caution due to the small sample size of a heterogeneous group and the cumulative effects of intervention. Nevertheless, some trends with regard to the children's responses to the three different therapy programmes are worth emphasizing (table 7).

Treatment of a child with deviant consistent phonology

Although only one child with consistent non-developmental phonological disorder, TS, participated in the study, his performance bears comment due to the similarity with other cases reported in the literature. Based on research suggesting that children like TS have difficulty abstracting the appropriate rules of the language (e.g. Dodd *et al.* 1989), it was hypothesized that TS would respond best to phonologically based intervention. This hypothesis was supported. TS had considerable difficulty with targets of both the core vocabulary and PROMPT system approaches. He learned few words during the core vocabulary phase and treated words actually decreased

Table 7. Summary of three subjects' response to sequenced types of therapy

	Phonological contrast	Core vocabulary	PROMPT
TS	1	2	3
	m	×	×
MC	2	1	3
	m	m	×
TN	3	1	2
	×	m	×

m, Improvement in treated items, generalization to untreated probes; ×, no improvement in treated targets.

in consistency following this therapy. Treated sibilants showed no improvement in the PROMPT therapy phase where the phonetic placement and movement aspects of sound production were targeted, rather than the contrastive nature of the phonemes. Neither of these therapy methods allowed TS to break the constraints of his stable phonological system. Conversely, TS reached set criteria and maintained skills taught during the phonological contrast therapy block, where meta-phonological knowledge was employed to teach sound contrasts.

The finding supports the hypothesis that children whose speech errors are characterized by the consistent use of non-developmental phonological rules respond best to therapy that targets reorganization of phonological knowledge rather than therapy that focuses on the articulatory aspects of speech production. The results of this efficacy study are consistent with previous research (Leahy and Dodd 1987, Dean *et al.* 1995) and support the hypothesis that children who make deviant consistent errors have a deficit in the acquisition and use of the phonological constraints governing their native language (Dodd *et al.* 1989), rather than deficits at the level of articulation of individual phones or consistent word production.

Treatment of children with inconsistent speech disorder

MC and TN presented with inconsistent lexical productions at the start of the intervention study. Phonological process analysis was inappropriate because conflicting examples of correct production of a word as well as developmental and/or non-developmental errors were identified in their speech data, illustrating the need to sample individual lexical items more than once. As a deficit in phonological planning was hypothesized to underlie inconsistent deviant speech disorder (Bradford and Dodd 1996), it was predicted that these children would respond best to the core vocabulary intervention method which focused on establishing the consistent production of a limited number of words. It was hypthesized that core vocabulary enhances the acquisition of, or access to, phonological plans for words.

The core vocabulary approach resulted in increased consistency of production despite the children previously maintaining high levels of inconsistency before joining the programme. At the final assessment, both children had learned to produce more words to the accuracy and consistency criterion set in the core vocabulary phase than TS. At final assessment both children's inconsistency score had decreased to less than 40% on the 25 Word Test for Inconsistency (the criterion for diagnosis of inconsistent disorder).

However, there were differences between the children's response to the three

therapy approaches. TN performed as hypothesized, he responded well to core vocabulary therapy (first therapy block) but failed to make any gains during the second (PROMPT) or third (phonological) blocks. In contrast MC benefited from both core vocabulary (first) and phonological (second) therapy blocks, but not PROMPT (third) therapy blocks. There are a number of competing explanations for the children's differing response patterns including: child specific factors (e.g. other abilities, family situation); disorder characteristics (more detailed examination of speech error patterns might reveal differences between children); target of therapy choice; length of block; and sequencing of therapeutic approaches.

While it is likely that at least some of these factors interact, an important consideration is the sequencing of therapies that target different speech units. MC, who received core vocabulary therapy (and achieved consistency) went on to achieve the specific goals of the next scheduled therapy, phonological therapy. The consistent use of a developmental phonological process was quickly and effectively targeted using a phonological process approach. However, phonological contrast therapy was not successful in remediating the consistent developmental process of cluster reduction for TN. There are several possible explanations for this lack of success: he was younger than MC, he may have needed longer than the 12 sessions of therapy to consolidate skills, and he had a poor understanding of the meta-phonological description of the target contrast. Alternatively, the scheduling of PROMPT therapy between the other two approaches may have hindered progress.

Children whose speech is prone to inconsistent productions of the same lexical items may have multiple underlying deficits in the speech processing chain (Woodyatt and Dodd 1995). The sequence in which therapy targets the deficits may be important. For example, it seems plausible to assume that it is important to gain consistency of production at the word level, before focusing on phonological processes. Dodd and Iacono (1989) reported a case where phonological therapy was unsuccessful before, but successful after, consistency had been established. Future research could investigate, more carefully, the importance of sequencing therapies that focus on different speech units for children making inconsistent errors.

The observation that information about the phonetic placement of the target phones (PROMPT) was of minimal use to any of the children was predicted. None of the children participating in the study had an articulation disorder (a difficulty in producing perceptually acceptable versions of individual speech sounds). They were phonologically disordered. It is unlikely, then, that a therapy method that focused on the motoric production of speech sounds would have a major impact on their speech. For example, although TS acquired /f/ during the PROMPT phase of therapy, it was not maintained since the final assessment results showed that he was still stopping *all* fricatives and affricates. It seems that because PROMPT therapy did not provide TS with phonological information about the contrastive nature of /f/ and /p/, he was unable to generalize or maintain correct production.

Summary and clinical implications

The children who participated in this study showed a range of underlying deficits. TS's speech disorder appeared to be related to a single deficit: impaired knowledge of the way sounds are used to convey meaning contrasts. Meta-phonological therapy (Dean *et al.* 1995) appeared to address this deficit and contributed to the development of less deviant phonological skills. The core vocabulary approach was not as

successful for TS. In contrast, inconsistency of production was best addressed by teaching a core vocabulary of words, although one of the inconsistent children also benefited from meta-phonological therapy once consistency had been established, suggesting more than one deficit in the speech processing chain.

Clinically there is a need for thorough assessment of all children who present with developmental speech disorders. The results of this investigation indicate that different parts of the speech processing chain may respond to various types of treatment that target different links in the chain: articulation of phones, contrastive use of phonemes, and consistent production of words. Just as no single treatment approach is appropriate for all children with disordered phonology (Winitz 1989), management of some children with speech disorder may not simply involve choosing one appropriate intervention approach, but selecting and sequencing a range of approaches to address different underlying deficits (Elbert 1992).

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Appendix 1. Targets and acceptable productions for core vocabulary therapy.

TS		MC		TN	
Target	Response	Target	Response	Target	Response
grandma	gwænma	brother	bwʌdʒ	Tom	tɒm
banana	bænana	nothing	nʌfɪn	Dad	dæai
Thomas	dɒmæs	between	bətwin	Cathy	kæfi
Christmas	dɪməs	little	jɪdu	swing	wɪŋ
water	wɔdʌ	spaghetti	bʌgɛdi	honey	hʌni
sandwich	sænwɪs	preschool	pwigu	star	da
Rosey	woʊzi	lemonade	jɛmɒneɪd	twinkle	tɪŋku
drink	dwɪŋk	goggles	gɒguz	horse	hɔshi
grandad	gwændæd	family	fæməwi	sandwich	sæmɪʃ
train	dweɪn	look	jʊk	banana	bænana
pencil	pɛnsʊ	swimming	fwɪmɪn	Kelsey	kɛʃi
		asleep	ʌfwip	Lucy	juʃi
		never	nɛbə	truck	twʌk
		computer	kɒmpudʌ	trailer	tweɪju
		lunchbox	wʌntʃbɒks	scissors	sɪsɪz
		hospital	hɒtdubu		
		Robin Hood	wobɪn hʊd		