

Research Report

Intervention for children with severe speech disorder: A comparison of two approaches

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Abstract

Background: Children with speech disorder are a heterogeneous group (e.g. in terms of severity, types of errors and underlying causal factors). Much research has ignored this heterogeneity, giving rise to contradictory intervention study findings. This situation provides clinical motivation to identify the deficits in the speech-processing chain that underlie different subgroups of developmental speech disorder. Intervention targeting different deficits should result in a differential response to intervention across these subgroups.

Aims: To evaluate the effect of two different types of therapy on speech accuracy and consistency of word production of children with consistent and inconsistent speech disorder.

Methods & Procedures: Eighteen children (aged 4;08–6;05 years) with severe speech disorder participated in an intervention study comparing phonological contrast and core vocabulary therapy. All children received two 8-week blocks of each intervention. Changes in consistency of production and accuracy (per cent consonants correct) were used to measure the effect of each intervention.

Outcomes & Results: All of the children increased their consonant accuracy during intervention. Core vocabulary therapy resulted in greater change in children with inconsistent speech disorder and phonological contrast therapy resulted in greater change in children with consistent speech disorder.

Conclusions: The results provide evidence that treatment targeting the speech-processing deficit underlying a child's speech disorder will result in efficient system-wide change. Differential response to intervention across subgroups provides evidence supporting theoretical perspectives regarding the nature of speech disorders: it reinforces the concept of different underlying deficits resulting in different types of speech disorder.

Keywords: phonological disorder, therapy, inconsistency, phonological contrast, core vocabulary.

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Introduction

Speech–language pathologists (SLPs) have many options when deciding how to treat children with speech disorder. These intervention options include the unit to target (e.g. sound, error patterns, whole word, whole language); target selection (e.g. the specific sounds or pattern to target first); the number of contrasts to target; the approach to delivery of intervention; and service delivery options. The literature contains descriptions of many intervention approaches, reflecting different analysis procedures and theoretical perspectives of speech disorder. SLPs can choose to use or adapt these approaches in their clinical practice.

SLPs aim to implement the most efficient treatment programmes to resolve children's spoken difficulties and prevent later literacy problems. However, it is sometimes difficult to ascertain from the research literature exactly what the programmes involve and how to implement them. It can be difficult to ascertain what the intervention aims to change and which children will receive most benefit from its use. Determining the subtle or not-so-subtle ways in which the intervention differs from other programmes can be problematic. The plethora of conflicting results reported in the literature also makes it difficult for SLPs to determine the 'evidence-base' on which to select their intervention options. Many intervention approaches report mixed success (e.g. Forrest and Elbert 2001) and contradictory findings are common (e.g. Gierut *et al.* 1996, Rvachew and Nowak 2001). These findings reflect the complexity of the population.

Few research studies have compared the efficacy and efficiency of different specific intervention approaches. Most recent research has examined the effect of manipulating one variable within a given parameter rather than attempting to determine the most effective approach. Intervention programmes differ within three broad parameters: the target selected, the approach selected; and the implementation structure selected.

Target selection

One parameter in which interventions differ, target selection, has received significant research attention. Intervention targets are usually selected on 'super-ordinate properties' (e.g. markedness or implicational relationships, productive phonological knowledge, complexity) of a sound system (Gierut *et al.* 1996) or the function of sounds within a child's system (Williams 2000).

Gierut *et al.* (1996) compared the effect of targeting early versus later developing sounds in two groups of children. Their results indicated that both targets resulted in phonological change; however, greater system-wide change occurred when the targets were later-developing sounds. Rvachew and Nowak (2001) provided counter-evidence. Their group study of 48 children with moderate or severe speech delay showed greater local generalization for early developing rather than later developing targets.

Stimulability is another target selection variable examined in the literature. Miccio and colleagues reported that stimuable sounds experience change without direct intervention (Powell and Miccio 1996, Miccio *et al.* 1999). Miccio (2002) suggested if a sound is stimuable it is being acquired naturally and may not require intervention. In addition, stimuable sounds may be added to the phonetic inventory even when not chosen specifically as therapy targets (Powell and Miccio 1996).

In contrast, Rvachew and Nowak (2001) found differences in the rate of treatment progress and generalization when they targeted stimuable and non-stimuable sounds. Children who received therapy for early developing phonemes of which they had productive phonological knowledge made more progress than children who received therapy for late developing phonemes of which they had little productive knowledge. Generalization occurred to untreated stimuable phonemes but not untreated unstimuable phonemes. Rvachew and Nowak questioned the efficacy of treatment response when targeting non-stimuable sounds: 'Unless the treatment of unstimuable phonemes boosts the rate of progress for stimuable phonemes beyond that due to maturation, it is difficult to see how the selective treatment of unstimuable phonemes could be the most efficient procedure' (p. 621).

Error consistency is a third target selection variable evaluated in the literature. The consistency of articulation error substitutes and the effect of this (in)consistency on intervention outcomes have been examined with differing findings. Forrest *et al.* (1997, 2000) and Forrest and Elbert (2001) investigated children with articulation disorders and divided them into children with consistent sound substitutes (same substitute for the omitted sound in all instances) and those with variable substitutes (substitute varied both within and across word positions). Using traditional articulation therapy techniques, they found that children with consistent error substitutes were able to learn and generalize intervention targets effectively. The children with inconsistent substitutes did not benefit from the intervention. These findings have been taken as evidence that it is most effective to target consistent error patterns using traditional techniques.

Tyler *et al.* (2003) examined the predictive value of error consistency to change in accuracy following intervention. In contrast to Forrest *et al.*, they found that a highly inconsistent system (measured by the total number of different sound substitutions/omissions made across word positions) was more likely to change than a consistent system. However, this study involved very different intervention techniques (morphosyntactic) to those used by Forrest and Elbert, which might account for the contradictory findings.

Methods of phonological contrast intervention

The second parameter in which interventions differ involves the decision of *how* to target the selected target. A range of phonological intervention methods have been developed and described. Five currently used methods follow (Baker and McLeod 2004):

- Minimal pairs: the approach contrasts the child's error with the target sound using minimal pairs of words (e.g. Ferrier and Davis 1973, Blache and Parsons 1980, Weiner 1981, Gierut 1991). Two words that differ by one sound only form a minimal pair. A set of minimal pairs focuses on the contrast being targeted (e.g. f — b: fun — bun, fin — bin, fill — bill, fit — bit). The minimal pair method is often implemented when error pattern analysis has been used and clear patterns are evident. It is considered a 'conceptual form of sound teaching and is frequently used in the treatment of phonological disorders stemming from cognitive or linguistic difficulties' (Gierut 1998, p. S89). The minimal pair method has been used across different frameworks including phonological process analysis, distinctive

feature analysis and generative analysis. It assumes that there are patterns (e.g. stopping all fricatives) that are the basis for the child's error and sound organization.

- Maximal oppositions: Gierut (1990) described a variation on the minimal pair method. Instead of contrasting the target sound with the child's error, the intervention uses an independent comparison sound. The contrast to the target needs to be a sound that the child can produce correctly and one that is maximally different to the target sound. Gierut claimed that targeting maximal oppositions is more effective than minimal pairs.
- Empty set: Gierut (1991) developed another method of intervention: a variation on maximal oppositions known as contrasts within an empty set. This method involves single contrastive pairings of two target sounds. The target sounds are unknown, independent, and maximally different from each other.
- Multiple oppositions: the intervention method targets more than a single contrast pair (Williams 2000, 2003). This method involves multiple contrastive pairings of the child's error with several target sounds. It uses the child's functional system as the basis for target selection. It is based on the system as a whole rather than on phonological error patterns that describe components of the systems (e.g. [t] for /k/ is fronting, [t] for /s/ is stopping).
- Metaphon: Dean *et al.* (1995) described Metaphon, another intervention method. It is based on contrasting speech sounds and properties. However, unlike other contrast methods, Metaphon aims to increase metalinguistic awareness. It emphasizes similarities and differences in sounds, recognizing, matching and classifying sounds according to their features.

Intervention structure

The third parameter in which interventions differ is the structure of the intervention. After choosing an approach to reorganize the child's speech system the clinician must consider how to implement the approach (the structure of the treatment). Again, the clinician is faced with choices. Fey (1986) described two treatment structures: vertical versus horizontal presentation. A vertical structure chooses a single target (sound or pattern) and works with this target to a set criterion of mastery. An alternative structure of intervention is a horizontal approach. The horizontal approach teaches several targets (sounds or patterns) simultaneously for a predetermined period of time. A third approach incorporates elements of the vertical and the horizontal structure. This is the cyclical approach (Hodson and Paden 1991). In a cyclical approach, the clinician selects several targets that they change at weekly intervals (e.g. targeting stopping 1 week, cluster reduction the next, gliding the next). The targets are then cycled (e.g. stopping targeted again in the fourth week). The approaches differ in two main ways: the number of targets selected for treatment, and the criterion used for progression (i.e., performance versus time based).

Williams (2000) is one of the few researchers who have examined the effect of models and structures of intervention on outcome. Williams examined word versus

naturalistic speech intelligibility models of intervention and horizontal, vertical and cyclical structures of intervention in ten longitudinal case studies of children with moderate to profound phonological impairments. All children in the study progressed through the models of intervention so, initially, they experienced a high degree of focus on a target (e.g. vertical intervention structure with a word level model). This changed to a low degree of focus to facilitate generalization (e.g. combined structure at a conversational level model). Williams (2000, p.27) suggested that 'one treatment model or structure may not fit all children or may not fit a child throughout the course of intervention. Models and structures may need to change as the child's needs change'.

The question of efficacy and *efficiency* of intervention is under-examined in the literature (e.g. comparison of rate of progress between groups of children using different target selection criteria — measured in clinical sessions and weeks/months involved). For example, it might be possible to show that selecting a later developing, non-stimulable, consistently in error target sound results in acquisition of the target sound with spontaneous generalization to a number of sounds not targeted directly. However, it is also necessary to show that this process is more efficient (i.e. takes less time) than directly targeting each of those sounds in a developmental order.

Few studies directly compare different intervention approaches for children with speech disorder. Hesketh *et al.* (2000) compared the effects of metaphonological and articulation-based therapy on the phonological ability of 61 children with developmental phonological disorders. The children were allocated to a treatment approach and received ten weekly sessions of individual therapy. Children receiving metaphonological therapy completed general phonological awareness (PA) tasks and specific PA tasks involving their target error pattern. Children in the articulation group practised the production of problematic phonemes. They found that both groups significantly improved on phonological awareness and output measures but with no effect of therapy type. They found no evidence that working on metaphonological skills was necessary for children with phonological disorder.

Dodd and Gillon (2001) criticized Hesketh *et al.*'s (2000) study suggesting that their results could reflect the heterogeneity of the participants and the content of the metaphonological therapy. Children with speech disorder are a heterogeneous group in terms of severity (number of errors), type of errors (surface speech pattern), underlying causal factors, and maintenance factors. Many research studies, however, continue to ignore heterogeneity giving rise to contradictory findings.

Subgroups of children with speech disorder

Different deficits in the speech-processing chain underlie the subgroups of developmental speech disorder (Dodd and McCormack 1995). Research that considered the subgroups of children with speech disorder found that children respond differently to therapy approaches that target different aspects of the speech-processing chain (Alcorn *et al.* 1995, Holm *et al.* 1997, Dodd and Bradford 2000).

Previous research indicates four subgroups of children with speech disorder (Brierly 1987, Bradford and Dodd 1994, Dodd and McCormack 1995). A psycholinguistic perspective has allowed the testing of hypotheses regarding the factor/s or deficit/s underlying the different types of disorder. The level of

breakdown in the speech-processing chain for each of four subgroups has been identified:

- **Articulation impairment:** inability to produce a perceptually acceptable version of particular phonemes, either in isolation or in any phonetic context. Children may consistently produce a specific distortion (e.g. lateral lisp) or substitute another phoneme (e.g. [w] for /r/) (Grundy 1989). Articulation errors are due to a peripheral problem where the wrong motor programme for the production of specific speech sounds has been learned (Fey 1992).
- **Delayed phonological skills:** speech characterized by the use of regular error patterns that occur in normal development but at a chronological age when the patterns should not be evident. Little is known about the cause of phonological delay. Children with phonological delay have not been found to have a specific deficit (Dodd and McCormack 1995). However, studies of the natural history of delay suggest that some delayed children remain delayed, others achieve age-appropriate speech, and some typically developing children become delayed (Dodd *et al.* 2000).
- **Consistent deviant disorder:** systematic use of atypical (non-developmental) phonological patterns (e.g. deleting all syllable initial consonants) (Leonard 1985, Ingram 1989). An impaired ability to abstract and/or organize knowledge about the nature of the phonological system causes these errors (Dodd and McCormack 1995). For example, Brierly (1987) found that children with consistent deviant phonology performed more poorly than other speech impaired children on tasks of phonological awareness, such as recognition of alliteration and rhyme. These children have poor understanding of the phonemic rules of the language when assessed on a legality awareness task (Dodd *et al.* 1989). This cognitive deficit arises at the internal organizational level of the speech-processing chain (Grundy 1989).
- **Inconsistent speech disorder:** speech characterized by variable productions of the same lexical items or phonological features not only from context to context, but also within the same context. Inconsistency characterized by multiple error types (unpredictable variation between a relatively large number of phones) suggests the lack of a stable phonological system because of a deficit in phonological planning. Phonological planning refers to the process of phoneme selection and sequencing. Dodd and McCormack (1995) argued that children with speech characterized by inconsistency generate under-specified or degraded phonological plans for word production. This leads to phonetic programmes with articulatory parameters that are too broad, leading to additional phonetic variability even when the correct phoneme is selected. Inconsistent speech disorder is distinct from childhood apraxia of speech (CAS) — although inconsistency characterizes both disorders (Ozanne 1995). Children with CAS are unlike children with inconsistent disorder in a number of important ways: (1) they are worse in imitation than in spontaneous production (whereas children with inconsistent disorder are better in imitation than in spontaneous production); (2) cues to elicit production of words differ; and (3) they have oro-motor difficulties.

Broomfield and Dodd (2004) report the following prevalence rates for the four subgroups: 12.5% articulation impairment, 57.5% delayed phonological skills, 20.6% consistent deviant phonological disorder and 9.4% inconsistent phonological disorder. Researchers broadly agree on the prevalence rates cross-linguistically for Dodd's classification of functional speech disorder sub-groups with the subgroups identified in Cantonese (So and Dodd 1994), Putonghua (Zhu and Dodd 2000), German (Fox and Dodd 2001), Turkish (Topbas and Konrot 1996) and Spanish (Goldstein 1995). The cross-linguistic similarities of the types of speech disorders suggests that the deficits underlying disorder are independent of the phonological system *per se*. The surface speech errors reflect underlying deficit/s in the speech-processing mechanism regardless of the phonological system of the language being acquired.

Most previous research on intervention efficacy has focused on a single heterogeneous group of children with speech disorder rather than comparing the relative effects of differing approaches with different children. Dodd and Bradford (2000) compared three therapy approaches for children with different types of phonological disorder. They presented three detailed case studies: two children with inconsistent speech disorder and a child with consistent speech disorder (speech output characterized by consistent use of developmental and non-developmental error patterns). The study trialled three therapies with each child: phonological contrast, core vocabulary, and PROMPT (Hayden 1999). The results indicated that children who were making inconsistent errors received the most benefit from core vocabulary that focused on consistency of whole-word production. One child with inconsistent speech disorder also benefited from phonological contrast therapy after consistency had been established. The child with consistent speech disorder received the most benefit from phonologically based intervention.

Dodd and Bradford's results provide evidence that aspects of a child's speech system (phonetic, phonological) may respond to different types of therapy approaches that target different aspects of the speech-processing system. The results of their study also suggested that the sequence of therapy might be important. For example, a child with inconsistent speech disorder may benefit from phonological contrast therapy after consistency has been established.

The study described in this paper compares the effect of two therapy approaches with two subgroups of children with speech disorder. The intervention differed in terms of the underlying deficit targeted and the speech unit targeted.

Phonological contrast therapy targeting a cognitive-linguistic deficit

Phonological contrast approaches target speech error patterns. The aim of therapy is to reorganize a child's linguistic system. Most phonological intervention approaches rely on a communicative need for phonological reorganization. For example, words are contrasted to confront the child's system with communicative breakdown ('I don't know whether you mean sun, fun or bun because they all sound like bun to me'). Intervention, therefore, aims to develop these meaningful contrasts of words. The clinician shows the child that phonemes contrast a difference in meaning (key-tea, shoe-two) and that these contrasts need to be made to avoid misunderstanding. This process requires recognition of similarities and differences

of sounds and how these mark differences in meaning. The process allows the child to organize sounds into classes and sequences into structures. Active participation in this process results in new hypotheses and patterns (Grunwell 1997). The resulting reorganization should be evident in the pattern of generalization. The approach predicts that the target contrast will generalize to other sounds affected by the child's error pattern (e.g. f — b will generalize to other fricatives affected by stopping). Alternatively, a range of contrasts within an error pattern can be targeted simultaneously (e.g. a child who stops all fricatives might be given pairs including: sun — bun, shin — pin, shoe — two, thick — tick). Intervention should aim to facilitate within and across class generalization not just local generalization (Gierut 2001).

Core vocabulary therapy targeting phonological planning

Inconsistency across words and within the same linguistic context indicates a pervasive speech-processing difficulty (Grunwell 1981, Forrest *et al.* 1997, 2000, Williams and Stackhouse 2000). Children with inconsistent speech disorder are resistant to phonological contrast or traditional therapy (Forrest *et al.* 1997, 2000). Intervention target selection is difficult as a child with inconsistent speech disorder may use a range of sound substitutions that differ in manner of production, place of production, or voicing. Taking an articulatory approach that targets a single sound is ineffective when a child with adequate oromotor control sometimes produces the target accurately or, is stimulable for the sound.

The core vocabulary approach effectively improves consistency of word production (Holm and Dodd 1999, Dodd and Bradford 2000). Core vocabulary therapy does not target surface error patterns or specific sound features; it targets whole word production. Learning to say a set of high frequency, functional words consistently, targets the underlying deficit in phonological planning. Providing detailed specific information about a limited number of words and drilling the use of that information with continued systematic practise improves the ability to create a phonological plan on-line.

Aims of the investigation

Few studies have examined how children with different speech disorders respond to interventions that target different underlying speech-processing deficits. The primary aim of this study was to investigate the effect of two treatment approaches on the consistency of word production and speech accuracy of children with either an inconsistent speech disorder or a consistent disorder. It was hypothesized that children with inconsistent speech disorder would best respond to core vocabulary therapy that targets the ability to form phonological plans (templates) on-line. Children with consistent non-developmental speech error patterns were hypothesized to respond best to phonological contrast therapy targeting the reorganization of cognitive-linguistic information. A third hypothesis was that children with inconsistent speech disorder who received core vocabulary therapy first would benefit more from the phonological contrast therapy than the inconsistent children receiving the phonological contrast therapy first. A final hypothesis was that intervention targeting the contrastive use of phonemes would

be more effective for children with inconsistent speech disorder once consistency was established.

Methods

Participants

Speech–language pathologists from Education Queensland (Australian state government service provider) were asked to refer children aged between 4;6 and 7 years with moderate to severe phonological disorder. Twenty children were recruited who met the following inclusion criteria:

- Severity: standard score of 3 on the per cent consonants correct (PCC) measure of the Phonology Assessment (DEAP — Diagnostic Evaluation of Articulation and Phonology [standard score mean of 10, normal range of 7–13], Dodd *et al.* 2002).
- Subgroup classification: to be included in this study, children were required to have either an inconsistent speech disorder or a consistent speech disorder. Children were considered to have an inconsistent speech disorder if they had a score of 40% or more on the Inconsistency Assessment. Children were considered to have a consistent speech disorder if they scored below 40% on the Inconsistency Assessment and used at least two atypical error patterns on the Phonology Assessment (*cf.*, Dodd *et al.* 2002).
- Oromotor structure and skills: no structural problems apparent on oral examination. Within the normal range on one or more of the components of the oromotor assessment of the DEAP examining isolated movements of the lips and tongue, sequenced volitional movements and diadochokinetic skill (mean of three standard scores above 6).
- Receptive language: within the normal range on the Clinical Evaluation of Language Fundamentals — Preschool (Wiig *et al.* 1992).
- Non-verbal skills: within the normal range on the Visual-Motor Integration Assessment (Beery and Buktenica 1997).
- Hearing: normal hearing as shown by the child's last hearing test.
- Language background: monolingual speaker of English.

Two children withdrew from the study for reasons unrelated to the research. The results of 18 children are presented here. The group included 11 boys and seven girls, ranging in age from 4;08 to 6;05 years, with a mean age of 6;02 years. Table 1 reports the details of the children included in the study.

Pre-treatment assessment: differential diagnosis of speech disorder

An experienced paediatric speech–language pathologist assessed each child in a quiet room at their school or preschool. Parents were invited to be present at the assessment. Each child's speech, oromotor and receptive language skills were assessed to allow for differential diagnosis of their speech disorder. The Articulation, Inconsistency and Phonology Assessments of the Diagnostic Evaluation of Articulation and Phonology (DEAP; Dodd *et al.* 2002) were used to measure speech skills. The DEAP

Table 1. Participant details and pre-intervention assessment data

Child	CA (months)	Gender	Rec Lang SS	VMI SS	Oromotor mean SS [†]	Initial PCC	Initial inconsistency (%)	Subgroup	Phonetic inventory*
1	77	M	112	111	8	43	56	inconsistent	all sounds
2	57	F	120	112	10	62	60	inconsistent	all sounds
3	60	M	108	79	7.5	51	40	inconsistent	all sounds except /g, z/
4	60	M	120	90	8.7	51	60	inconsistent	all sounds
5	67	F	110	112	9	46	46	inconsistent	all sounds except /k, g/
6	66	M	91	87	6.7	25	44	inconsistent	all sounds except /t, d, s, z/
7	56	F	102	107	10	50	56	inconsistent	all sounds
8	57	M	79	79	7	34	56	inconsistent	all sounds
9	60	M	110	124	10	53	40	inconsistent	all sounds except /tʃ
10	67	M	85	110	10	31	56	inconsistent	all sounds except /s, z/
11	60	M	118	102	6	55	36	consistent	all sounds
12	65	M	110	107	7.7	48	36	consistent	all sounds
13	67	M	110	82	7.5	76	36	consistent	all sounds except /k, g/
14	58	M	96	96	9	45	12	consistent	all sounds
15	60	F	100	102	10	32	32	consistent	all sounds except /tʃ, dʒ/
16	62	F	102	90	9.3	36	28	consistent	all sounds except /tʃ, dʒ/
17	59	F	104	85	10	56	24	consistent	all sounds except /s, t, g/
18	62	F	108	116	10	49	24	consistent	all sounds

[†]Mean of the three oromotor SS from DEAP;

*as appropriate for chronological age (Dodd *et al.*, 2003).

provided standard scores with a mean of 10 and normal range of 7–13 for each assessment. The assessing SLP made on-line transcriptions of the speech data. All productions were recorded using a Marantz CP130. All on-line transcriptions were checked against the audio recording following the assessment to ensure accuracy.

The Articulation Assessment established the child's phonetic inventory by examining the child's ability to produce phonemes in words or in isolation. Thirty tokens (mostly CVC) were elicited in a picture-naming task. All consonant sounds (except J) were sampled in syllable-initial and -final positions. If a child failed to produce a sound in the picture-naming task, the examiner asked the child to imitate the sound in an open syllable or in isolation.

The Phonology Assessment data was used to examine phonological ability by identifying and classifying error patterns in a child's speech. The assessment consisted of two parts: picture naming — eliciting 50 tokens covering all consonants in syllable-initial and final position; and picture description — eliciting 14 tokens from the naming task in a connected speech context. The PCC was calculated from the phonology data in accordance to the assessment manual instructions. Consistent speech error patterns (five examples of error pattern) were identified and classified according to the assessment manual as typical or atypical of normal development. Children identified as having at least two non-developmental patterns were categorized as having consistent speech disorder.

The Inconsistency Assessment was administered to establish consistency of word production. Each child named a set of 25 pictures three times within the assessment session. Each trial was separated by an activity or different speech task. The three realizations of the same lexical item from the same context were compared to calculate an inconsistency score. For example, if the child produced ten items differently across the three trials they would obtain a score of 40%. Four categories of response were differentiated (Grunwell 1992): three productions of the same lexical item correct and consistent; three productions consistent but incorrect (e.g. zebra [dɛbwə], [dɛbwə], [dɛbwə]); variation between correct and incorrect realizations (e.g. zebra [zɛbrə], [dɛbrə], [zɛbrə]); and all three productions incorrect and inconsistent (e.g. zebra: [dɛbwə], [vɛbə], [zɛbə]). Children who produced at least 40% of words variably were considered to have an inconsistent disorder.

Ten of the 18 children in the study had an inconsistent speech disorder (seven boys and three girls). Eight children had a consistent speech disorder (four boys and four girls). The two groups were comparable for age and severity of speech impairment. An analysis of variance confirmed no significant differences between the inconsistent and consistent subgroups in chronological age ($F(1,17)=0.18$, $p=0.68$) or PCC ($F(1,17)=0.73$, $p=0.41$). There was a significant difference between the two groups on the inconsistency score at initial assessment ($F(1,17)=34.84$, $p<0.001$). Table 1 presents the pre-intervention assessment data for the two subgroups of children with speech disorder.

Reliability

Inter-rater reliability measures were taken for the phonemic transcriptions, the inconsistency score and the child's differential diagnosis (i.e. inconsistent speech disorder, consistent speech disorder).

Phonemic transcriptions

Broad transcriptions (phonemic) were made on-line during assessment sessions. The assessors checked their own on-line transcription with reference to the audio-recording following the assessment. To determine inter-judge reliability, an independent experienced SLP re-transcribed ten of the children's assessment transcriptions (phonology and inconsistency assessments) from the audio-recordings (equivalent to 11% of all assessment data). Point-to-point reliability was calculated based on each judge's transcription of each phoneme. Identical segmental transcriptions (excluding diacritics) were coded as agreements. The overall mean for broad transcription agreement was 93.7%, range 87.4–98.2%. The original assessor's transcription was used for all analyses.

Inconsistency score

Each assessor determined an inconsistency score for each child's transcription. The samples re-transcribed to examine transcription reliability were also used to examine the reliability of the Inconsistency Scores. The reliability transcriber calculated an Inconsistency Score for each of the transcribed samples. Point-to-point reliability was calculated based on each judge's score for each of the 25 items (inconsistent versus consistent production). Identical scores were coded as agreements. The overall mean for inconsistency item agreement was 94.7%, range 84–100%.

Diagnosis of speech disorder

Each assessor provided a diagnosis of speech disorder for each child based on all of the data collected at the initial assessment. Identical diagnoses were coded as agreements. The overall agreement on the differential diagnosis was 100%.

Consistency of intervention approach

Three measures were undertaken to ensure an appropriate consistency of approach across the two clinicians: (1) target and goal selections were planned jointly; (2) the same resources, when applicable, were used; and (3) videotapes of sessions conducted by each clinician were shared. To ensure that there were no differences in intervention outcomes for each clinician a two-factor analysis of variance with repeated measures (difference scores \times clinician) was calculated. There was a significant effect of difference scores ($F(1,3)=4.18$, $p=0.01$) but not clinician ($F(1,1)=0.11$, $p=0.75$). Results showed no significant interaction of difference scores and clinician ($F(1,1)=0.03$, $p=0.87$).

Baseline data

To establish the stability of the children's phonological systems baseline data was collected before intervention. The initial speech assessment was repeated with a 3-week interval. A paired samples t -test compared the measures and revealed no significant change ($t=0.11$, d.f. 17, $p=0.92$). The Pearson correlation coefficient,

$r=0.82$ ($p<0.001$), confirms the high inter agreement between the two measures. The children's phonological systems were considered to be stable before intervention.

Project design

A multiple baseline design with alternating treatments was used. Once eligibility was confirmed, children were allocated to one of the two therapies by order of referral. Treatment 1 was implemented after the baseline period followed by a 4-week withdrawal period, followed by treatment 2. The method of allocation to treatment ensured children in both subgroups of speech disorder received the blocks of therapy in both possible orders (core vocabulary followed by phonological contrast; phonological contrast followed by core vocabulary).

Each child participated in 16 (30-minute) individual therapy sessions in each 8–9-week treatment block. Two experienced paediatric speech language pathologists (the first two authors) administered the intervention. All children received both intervention blocks from the same SLP. In most cases one intervention session each week was provided at home and one session at school to allow the SLP to liaise with both parents and teachers. Parents were asked to complete daily practise activities at home during the treatment blocks. There was no revision during the withdrawal periods. The Phonology and Inconsistency assessments from the DEAP were elicited at the end of each treatment block and again 8 weeks after the final assessment.

Two treatment approaches were provided to each participant:

(1) Phonological contrast therapy (targeting error patterns): error patterns were identified from analysis of the phonological assessment data. An error pattern was selected for intervention according to the following criteria: targeting non-developmental patterns before developmental; consistency and frequency of the use of the error pattern; effect on intelligibility of successful remediation; and stimulability of the speech sounds required.

Children with highly inconsistent speech rarely have clearly identifiable error patterns. This makes intervention target selection very difficult. A child with inconsistent speech disorder may use a range of sound substitutions that differ in manner of production, place of production or voicing. For example, one of the children with inconsistent speech in this study marked /s/ with [b, f, v, t, d, s] or deleted the sound. It is difficult to select the appropriate error to contrast given the range of substitutions and lack of identifiable patterns (i.e. there were no identifiable patterns to the substitutions in terms of word position, surrounding phonemes etc. and the inconsistency was occurring in the same lexical item in the same linguistic context so could not be attributable to factors such as differences in stress or prosody). The children with inconsistent speech who received phonological contrast therapy first therefore received therapy generally targeting structural error patterns (e.g. final consonant deletion, cluster reduction) evident in their speech.

Each error pattern was targeted in four stages: auditory discrimination; production in single words; production in phrases (set and then spontaneous); and production in sentences within conversation. A 90% accuracy-training criterion (based on the final 20 productions of target items elicited in the session) was required to move from word to phrase to sentence stage. When an error pattern

moved to phrase stage a new error pattern was introduced. Ten non-treated probe words were elicited at the end of every second session to monitor generalization (three times throughout treatment block).

A minimal pair approach (sometimes with multiple oppositions) was used to reorganize the child's phonological system. The homonymy in the child's system was directly exposed to show the children that they were failing to contrast meaning adequately, that is, the comparison sound to the target was the child's error. The minimal pairs were selected to target specific error patterns. A multiple oppositions approach was used where possible. Pairs of words were included simultaneously targeting a range of sounds affected by the error pattern (e.g. final consonant deletion: bee — beep — beak — bead — beef — bees — beam — beach — bean — beat; backing: tea — key, tar — car, dough — go, die — guy).

The first stage of the treatment was auditory discrimination. This process was also important to ensure that the stimuli words were familiar and recognizable from the pictures being used. The child was required to discriminate accurately (e.g. sort into words with a final sound versus words without a final sound) and recognize each pair of words.

The child was then required to start producing the minimal pairs, initially in imitation, and then spontaneously. Feedback was given regarding the pattern being targeted. For example, the presence of a final sound (bee — no/beep — yes), what the final sound was (e.g. 'beep has a /p/ on the end... bee — p' and whether or not the child had used the sound appropriately (e.g. 'I didn't hear a /p/ on the end when you said beep — it sounded like bee to me'). Similar linguistic and communicative feedback was given throughout each stage of intervention and for each error pattern targeted. The meaning or communicative basis for the contrast was maximized throughout intervention. Activities were planned that resulted in communicative breakdown if the child did not use the correct form.

(2) Core vocabulary therapy (targeting consistency of word production): a modified core vocabulary approach to that described previously in the literature was implemented (Dodd and Iacono 1989, Holm and Dodd 1999, Dodd and Bradford 2000). The complete intervention programme (e.g. therapy activities, information provided to parents/teachers) used in the current study is detailed in Dodd *et al.* (2004).

The child, parents and teacher selected a list of 50 words that were functionally 'powerful' for the child. The types of words commonly included on the children's lists were people's names (e.g. family, teacher, friends), pet names, places (e.g. home street, school, toilet, shops), function words (e.g. please, sorry, thank you), foods (e.g. weetbix, cornflakes, toast, water, chips, drink) and the child's favourite things (e.g. Simpsons, Polly Pocket, teddy, games). The words were not selected according to word shape or segments. They were chosen because the child frequently used the words in their functional communication. The child's increasingly intelligible use of the words selected motivated the use of consistent productions.

Each week, ten words were randomly selected from the set of 50 target words. The clinician established the child's best production of each target word. The child's best production was achieved by teaching the word sound-by-sound, using cues such as syllable segmentation, imitation and cued articulation as outlined in Passy (1990). For example, to teach *Joseph*, the clinician might say: 'Joseph has two syllables — [dʒoʊ] and [səf]. The first syllable [dʒoʊ] has two sounds, /dʒ/ and /oʊ/, and the

second syllable [səf] has three sounds /s/, /ə/ and /f/. You try it — [dʒoʊ]: child's imitation, SLP's feedback, child tries again. Now [səf]: response, feedback, try again. Now put it together: [dʒoʊ-səf]. For some children, a highly effective technique is to link sounds to letters. Usually, children with inconsistent speech disorder are able to imitate all (or most) sounds. If it is not possible to elicit a correct production then the best production may include developmental errors (e.g. [dɔʊsəf] for Joseph, [tæmrə] for camera).

After the best production was established, the child was required to produce those ten words in the same way throughout the week. The parents and teacher practised the words daily with the child, and reinforced productions of those words in everyday communication situations. The SLP emphasized to parents and other people involved with the child (i.e. teacher, child care worker) that the primary target of the intervention was to make sure the child said the ten words exactly the same way each time they attempted to say them, not the achievement of error-free productions. The ten target words were revised in games and activities during the second weekly session with the SLP.

During the core vocabulary therapy, it was considered important to be explicit about the purpose of therapy, the nature of the errors made, and how they could be corrected. If the child produced a target that deviated from the best production, the clinician imitated the production and explicitly explained that the word differed and how it differed. For example, the child's target word was 'sun' and he produced [gʌn]: the clinician would say '[gʌn], that's different to how I say it. That had a [g] sound at the start but you need to make it a [s], [sʌn]'. The SLP avoided asking the child to imitate the target word since imitation provides a phonological plan that inconsistent children can use without having to generate their own plan for the word. Instead, the SLP provided information about the plan.

At the end of the second weekly session, the child was asked to produce the ten words three times. Any words they produced consistently were removed from the list of 50 words. Inconsistently produced words remained on the list from which the next week's ten words were chosen randomly. Once a fortnight a set of ten untreated probe words of two or more syllables (e.g. giraffe, elephant) were elicited three times to monitor generalization.

Results

The effects of core vocabulary and phonological contrast therapy were compared for children with inconsistent and consistent speech disorder on two outcome measures: inconsistency of word production and speech accuracy (PCC calculated from the phonology assessment). Difference scores were calculated for each child on the two outcome measures following each type of therapy. Thus, each child had four scores:

- Difference in PCC following core vocabulary therapy.
- Difference in PCC following phonological contrast therapy.
- Difference in inconsistency score following core vocabulary therapy.
- Difference in inconsistency score following phonological contrast therapy.

Analysis of variance with repeated measures compared the outcome measures (within subjects factor of therapy: core vocabulary versus phonological contrast; between subjects factor of subgroup: inconsistent versus consistent speech disorder). No evidence was found against the claim that the distribution for the difference scores was normal. A Kolmogorov–Smirnov test for goodness-of-fit was insignificant for each of the difference scores ($p > 0.05$): difference in PCC following core vocabulary therapy, $Z = 0.069$, $p = 0.72$; difference in PCC following phonological contrast therapy, $Z = 0.79$, $p = 0.56$; difference in inconsistency score following core vocabulary therapy, $Z = 0.50$, $p = 0.96$; difference in inconsistency score following phonological contrast therapy, $Z = 0.94$, $p = 0.34$.

Effect of therapy on consistency of word production

Table 2 shows the PCC and inconsistency scores for each child across the three main assessments in the study. Table 3 shows the mean (SD) difference in inconsistency scores following each type of therapy by subgroup of speech disorder. An ANOVA with repeated measures compared the amount of change on the inconsistency measure (difference between initial assessment and following treatment) made by the two subgroups of children with speech disorder (inconsistent and consistent) during the two types of therapy.

The results showed a significant effect of therapy ($F(1,17) = 5.62$, $p < 0.05$) and group ($F(1,17) = 5.77$, $p < 0.05$). The interaction between the type of therapy and subgroup of speech disorder was also significant ($F(1,17) = 13.79$, $p < 0.005$). Core vocabulary resulted in greater change to consistency than phonological contrast therapy. As predicted, children with inconsistent speech disorder changed more than children with consistent speech disorder.

The interaction was examined by plotting each subgroup's mean difference on the inconsistency measure following core vocabulary and phonological contrast therapy (figure 1). The consistency of the children with inconsistent speech increased most through core vocabulary therapy. In contrast, the consistency of children with consistent speech disorder changed more when they received phonological contrast therapy.

Effect of therapy on speech accuracy

Table 3 shows the mean (SD) difference in PCC following each type of therapy by subgroup of speech disorder. An ANOVA with repeated measures compared the change in speech accuracy (difference on PCC between initial assessment and following treatment) made by the two subgroups of children with speech disorder (inconsistent and consistent) during the two types of therapy. The results show a significant effect of therapy ($F(1,17) = 4.52$, $p < 0.05$). Overall, phonological contrast therapy was more effective in changing the PCC than core vocabulary therapy. The effect of group was not significant ($F(1,17) = 0.98$, $p = 0.34$).

The results show a significant interaction between the type of therapy and subgroup of speech disorder ($F(1,17) = 18.75$, $p < 0.001$). Figure 2 illustrates the interaction by plotting each subgroup's mean difference on PCC measure following core vocabulary and phonological contrast therapy. Phonological contrast therapy was most effective in changing the PCC of children with a consistent speech

Table 2. Inconsistency and PCC measures at initial assessment and after each block of intervention for each participant

Child	CA (months)	Gender	Subgroup	Order of therapy	PCC				Inconsistency (%)			
					Initial	Block 1	Block 2	Post	Initial	Block 1	Block 2	Post
1	77	M	inconsistent	CV PC	43	75	89	82	56	24	12	20
2	57	F	inconsistent	CV PC	62	89	98	99	60	16	0	0
3	60	M	inconsistent	CV PC	51	54	62	62	40	20	20	16
4	60	M	inconsistent	CV PC	51	66	64	73	60	40	36	20
5	67	F	inconsistent	CV PC	46	53	60	64	46	28	30	36
6	66	M	inconsistent	CV PC	25	37	44	67	44	24	32	20
7	56	F	inconsistent	CV PC	50	60	82	90	56	32	24	0
8	57	M	inconsistent	PC CV	34	41	57	32	56	48	24	28
9	60	M	inconsistent	PC CV	53	61	84	92	40	44	12	8
10	67	M	inconsistent	PC CV	31	48	61	58	56	48	36	28
11	60	M	consistent	PC CV	55	68	70	81	36	36	24	24
12	65	M	consistent	PC CV	48	90	98	100	36	8	4	0
13	67	M	consistent	PC CV	76	83	90	94	36	28	20	12
14	58	M	consistent	PC CV	45	67	73	87	12	8	12	4
15	60	F	consistent	PC CV	32	65	68	87	32	32	24	12
16	62	F	consistent	CV PC	36	47	80	77	28	36	4	8
17	59	F	consistent	CV PC	56	65	75	69	24	20	16	32
18	62	F	consistent	CV PC	49	57	92	88	24	12	12	4

Table 3. Group summary of change in inconsistency score and PCC following each intervention

Group	Change in inconsistency (% mean, SD)		Change in PCC (mean, SD)	
	Core vocabulary	Phonological contrast	Core vocabulary	Phonological contrast
Consistent ($n=8$)	5.00 (7.63)	9.50 (12.99)	6.75 (3.01)	24.62 (12.88)
Inconsistent ($n=10$)	24.6 (9.14)	4.20 (7.57)	15.80 (9.05)	9.70 (6.57)
Overall	15.89 (12.99)	6.56 (10.35)	11.78 (8.28)	16.33 (12.22)

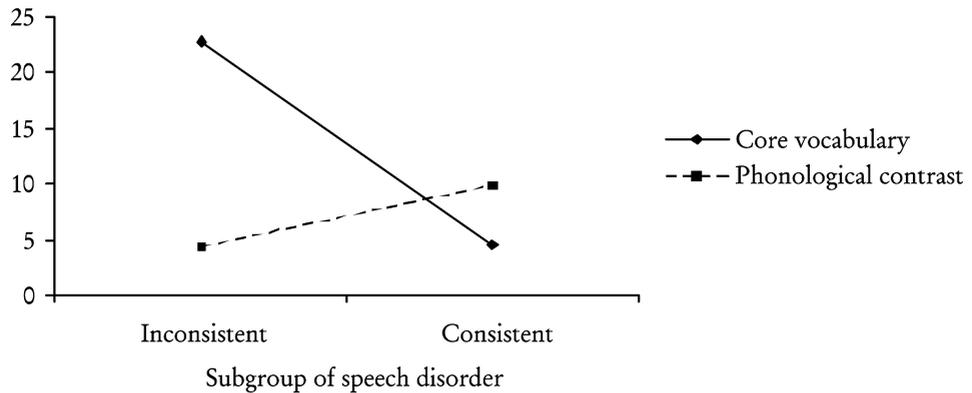


Figure 1. Mean change in inconsistency for each therapy by subgroup of speech disorder.

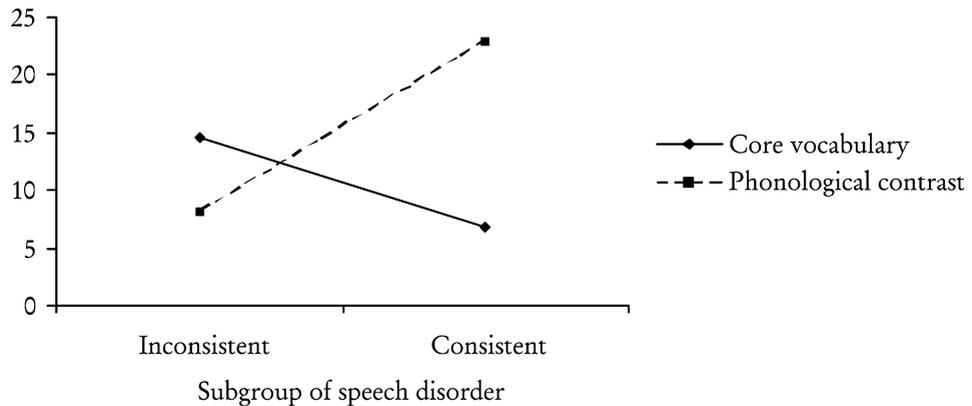


Figure 2. Mean change in PCC for each therapy by subgroup of speech disorder.

disorder. In contrast, the PCC of children with inconsistent speech disorder increased when they received core vocabulary therapy.

Maintenance of progress

All children were assessed 8-weeks post-intervention to examine whether the gains made during therapy were maintained. An analysis of variance with repeated

measures compared the PCC of the two subgroups of children with speech disorder (inconsistent and consistent) at the post-therapy and follow-up assessments. The results show no effect of assessment time (immediately following therapy versus follow-up, $F(1,17)=4.19$, $p=0.06$), group ($F(1,17)=2.82$, $p=0.11$) or interaction between time of assessment and group ($F(1,17)=0.81$, $p=0.38$). All children maintained the accuracy gains made during therapy.

An analysis of variance with repeated measures compared the inconsistency score of the two subgroups of children with speech disorder (inconsistent and consistent) at the post-therapy and follow-up assessments. The results show an effect of assessment time ($F(1,17)=6.36$, $p<0.05$) but not group ($F(1,17)=2.15$, $p=0.16$). The interaction between time of assessment and group was not significant ($F(1,17)=1.19$, $p=0.29$). The mean inconsistency scores continued to decrease following withdrawal of therapy (children with inconsistent speech disorder: mean change 6.3%; children with consistent speech disorder: mean change 2.5%).

An analysis of variance confirmed no significant differences at follow-up between the subgroups of children (between group: inconsistent versus consistent speech disorder) on either the PCC measure ($F(1,17)=3.08$, $p=0.99$) or inconsistency score ($F(1,17)=1.05$, $p=0.32$).

Order effects for children with inconsistent speech disorder

It was hypothesized that children with inconsistent speech disorder would make more progress (accuracy: PCC) if they received phonological contrast therapy after core vocabulary therapy. An analysis of variance (between subjects factor of therapy order: CV-PC versus PC-CV) examined whether there were any order of therapy effects for children with inconsistent speech disorder. There were no significant differences between the groups on difference in PCC following phonological contrast therapy ($F(1,9)=0.08$, $p=0.78$) or the PCC at the follow-up assessment ($F(1,9)=0.001$, $p=0.98$).

Discussion

The purpose of this study was to evaluate the relative effects of two different types of therapy on the consistency of word production and speech accuracy of children with consistent or inconsistent speech disorder. Eighteen children with severe speech disorder participated in an intervention programme that compared phonological contrast and core vocabulary therapy. All the children increased their consonant accuracy during intervention. However, core vocabulary therapy resulted in greater change in children with inconsistent speech disorder and phonological contrast therapy resulted in greater change in children with consistent speech disorder. The results provide evidence that treatment targeting the speech-processing deficit underlying the child's speech disorder will result in generalization. Core vocabulary therapy provided to children diagnosed with an inconsistent disorder resulted in consistent phonological output of both treated and untreated words. Similarly, phonological contrast therapy resulted in suppression of error patterns, not just remediation of targeted lexical items.

The experimental designs in the majority of therapy efficacy studies fail to account for the heterogeneous nature of children with speech disorder.

Consequently, conflicting results emerge. Children present with different speech disorders (i.e. surface characteristics). Grouping children with speech disorder according to severity, causal factors or linguistic symptomatology is unsatisfactory because it fails to explain the mental operations that result in the production of disordered speech. Psycholinguistic profiling approaches (e.g. Stackhouse and Wells 1997) enable specific intervention targets to be selected based on the individual child's needs. Dodd (1995) proposed four subgroups of functional speech disorder that reflect different breakdowns in the speech-processing chain. It seems logical that therapy targeting the specific breakdown will most effectively change the surface speech characteristics.

The introduction outlined three parameters across which interventions differ. This study examined one of these broad parameters: the intervention approach. Before manipulating individual variables such as target selection, more research is needed to determine whether specific intervention approaches are more effective with different types of speech disorder. Once treatment selection has been determined target selection and other more specific variables become an issue. This study examined phonological contrast therapy that targeted a cognitive-linguistic deficit (unit: phonological error patterns) and core vocabulary therapy that targeted a deficit in phonological planning (unit: whole word).

This study recruited children from two subgroups of speech disorder: consistent and inconsistent phonological disorder. Children were classified as having a consistent speech disorder if they used consistent non-developmental speech error patterns. These children also used some developmental rules that were appropriate for their chronological age, or delayed. However, the presence of unusual, non-developmental error patterns signals an impaired ability to derive and organize knowledge about the nature of their native phonological system (Dodd and McCormack 1995).

It was hypothesized that therapy highlighting the phonological contrasts in error would result in an increase in phonological accuracy as measured by PCC. The results confirmed this hypothesis. Core vocabulary therapy was not hypothesized to alter the child's phonology significantly because it targets a different aspect of the speech-processing chain. When children with consistent speech disorder received core vocabulary, therapy analysis showed little change to their inconsistency score or PCC. It is not surprising that a therapy approach targeting consistency of production did not promote change as the children were already consistent. This type of therapy did not highlight homonymy and so the children did not receive the information they required about the contrastive nature of phonemes.

In contrast, phonological contrast therapy resulted in significant system-wide changes. The interaction between accuracy (PCC) and the type of therapy showed that while therapy worked for both groups of children, children with consistent speech disorder made greater accuracy gains than children with inconsistent speech disorder when they received phonological contrast therapy. This finding is consistent with previous research (Dodd and Bradford 2000) and provides evidence for the hypothesis that children whose speech errors are consistent and atypical have a cognitive-linguistic deficit that benefits from therapy that targets reorganization of their phonological knowledge.

Children were identified with inconsistent speech disorder if their phonological output had a high degree of variability (at least 40%) and was characterized by multiple error forms for the same lexical item in the same linguistic context. The

surface speech characteristics reflect a deficit in phonological planning. It was hypothesized that core vocabulary therapy targeting the ability to form, or access, phonological plans (templates) on-line would increase consistency in children with inconsistent speech disorder. The results supported the hypothesis. Core vocabulary therapy resulted in increased consistency of production in children with inconsistent speech disorder.

An unexpected finding was that core vocabulary therapy created system-wide change for children with inconsistent speech disorder. Not only did the specific aspect being targeted change (i.e. consistency), but also a global measure of accuracy (PCC) increased. The results provide support for the hypothesis that the underlying deficit for this subgroup of children was phonological planning and not a cognitive-linguistic deficit. By improving the ability to form or access phonological plans, the phonological system was able to self-correct and operate successfully.

Dodd and Bradford (2000) observed that the sequence of therapies that target different speech deficits might affect phonological outcome. Specifically, children with inconsistent speech disorder may benefit more from phonological contrast therapy once they established consistency of production.

To investigate order of therapy effects, the current study used an alternating treatment design. It was hypothesized that children with inconsistent speech disorder who received phonological contrast therapy after receiving core vocabulary would have a better outcome (PCC) on the phonological therapy than children with inconsistent speech disorder who received the therapy approaches in the alternative order (i.e. phonological contrast therapy first followed by core vocabulary). The results did not support the hypothesis. Core vocabulary resulted in the most change to PCC with no differences noted in the amount of change due to phonological contrast therapy, irrespective of whether it was the first or second block of intervention.

This finding was surprising. It is logical to assume that a consistent system will be more open to change from phonological contrast therapy than an inconsistent system as it is difficult to identify any patterns in the inconsistent system, let alone target them effectively. It is this factor that might be obscuring the results slightly. The children with inconsistent speech who received phonological contrast therapy first had therapy that targeted structural error patterns (e.g. final consonant deletion, cluster reduction). It is possible that the inconsistent children used some of the information provided in the phonological contrast therapy to improve their phonological planning anyway.

Phonological planning involves selection and sequencing phonemes. The phonological contrast therapy given to these children gave them specific feedback regarding one aspect of this planning: the consonant-vowel structure of words. Further research needs to examine whether inconsistent children respond differently to phonological contrasts targeting other error patterns such as fronting or stopping. Regardless of the lack of order effect, the most significant finding remains that core vocabulary therapy was more effective than phonological contrast therapy in terms of changes in both the consistency and accuracy of the children with inconsistent speech.

Successful interventions not only need to create system-wide change, but also need to maintain that change. An intervention that targets the underlying deficit and not just the surface characteristics of a speech disorder should do both. It should promote real phonological change that is maintained. This study showed significant

differences in accuracy and consistency measures between initial assessment and final assessment. Accuracy and consistency improved. All children maintained the gains in the per cent of consonants correct after therapy was withdrawn.

This study revealed a difference in consistency measures between the final assessment and post-therapy (8 weeks of therapy withdrawal). Consistency of word production continued to improve. The greatest change was observed in the children with inconsistent speech disorder. This pattern of maintenance may reflect a phonological system continuing to integrate a new processing skill. Therapy that teaches or refines a child's ability to formulate phonological plans would influence the speech-processing system. The period of monitoring in this study (8 weeks) may not have been long enough to observe the final result of integration.

The results differ from previous efficacy studies of children with inconsistent speech in terms of change in accuracy and maintenance of progress made in therapy. Forrest and Elbert (2001) reported a treatment programme for four boys who had variable substitution patterns and who had made limited progress in therapy. A multiple baseline treatment design was implemented. The target sound was a fricative omitted from the phonetic inventory by each child. The boys received two 45-minute sessions per week. Therapy targeted the chosen sound in word-final position in three words. The stages of therapy were auditory exposure, imitation and spontaneous production elicited by picture stimuli. Generalization probes measured change in untreated contexts. Only one child met the criteria for treatment termination. Two children showed some generalization to untreated word positions. One child did not show any evidence of generalizing the treated sound to untreated word positions. Forrest and Elbert interpreted the results as evidence that children with variable productions of a sound not in their inventory are rigid when they learn to produce the sound and are unable to recognize that the sound can be produced in different contexts (e.g. other word positions).

The differences between the current study and Forrest and Elbert's study may reflect significant methodological differences. Forrest and Elbert implemented a different categorization of inconsistency. The subject details given in their paper do not allow comparison with the subjects in the current study. The second major difference between the studies is the approach implemented. Forrest and Elbert used an articulatory approach that did not directly target inconsistency. Core vocabulary therapy specifically targeted consistency of word production. Treating consistency created system wide change that subjects maintained.

Conclusions

The results indicate that different parts of the speech-processing chain respond differently to therapy targeting different processing skills. A phonological planning deficit can be targeted effectively using a whole word approach. A cognitive-linguistic deficit responds best to a phonological contrast approach. Clinically, it is essential to differentially diagnose consistent from inconsistent phonological disorders. The two are caused by different deficits in the speech-processing chain and respond best to different therapeutic approaches. The results provide an evidence-based choice of phonological treatment for children with moderate-severe speech disorder.

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