Advances in Speech–Language Pathology, September 2006; 8(3): 220 – 230

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A core vocabulary approach for management of inconsistent speech disorder

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Abstract
Developmental speech disorder is accounted for by theories derived from psychology, psycholinguistics, linguistics and medicine, with researchers developing assessment protocols that reflect their theoretical perspective. How theory and data analyses lead to different therapy approaches, however, is sometimes unclear. Here, we present a case management plan for a 7 year old boy with unintelligible speech. Assessment data were analysed to address seven case management questions regarding need for intervention, service delivery, differential diagnosis, intervention goals, generalization of therapeutic gains, discharge criteria and evaluation of efficacy. Jarrod was diagnosed as having inconsistent speech disorder that required intervention. He pronounced 88% of words differently when asked to name each word in the 25 word inconsistency test of the *Diagnostic Evaluation of Articulation and Phonology* three times, each trial separated by another activity. Other standardized assessments supported the diagnosis of inconsistent speech disorder that, according to previous research, is associated with a deficit in phonological assembly. Core vocabulary intervention was chosen as the most appropriate therapy technique. Its nature and a possible protocol for implementation is described.

Keywords: *Inconsistent speech errors, intervention, phonological disorder.*

Introduction

Every child referred with unintelligible speech is unique. Clinicians consider the characteristics of the child's speech errors, other language abilities, the family, educational context, medical and social history. This information is used to deduce causal and maintaining factors of the disorder and determine whether therapy is indicated. If therapy is offered, clinicians make a series of decisions about diagnosis, setting goals for the child and carers, planning how to implement intervention and monitor its effectiveness. Here we present a clinical management plan for Jarrod, a 7 year old boy with unintelligible speech.

Our management approach is based on a clinical problem solving model (Whitworth, Franklin, & Dodd, 2004) developed for speech-language pathology undergraduates that poses seven questions (see Table I). There is no one right answer for any question. Rather, the questions elicit systematic consideration of evidence from the child's data in the context of each clinician's evidence base that includes knowledge of theory and research, clinical experience and the constraints of the governing speech-language pathology service. Experienced clinicians make decisions without reference to a formal schema, but here we use it to make our clinical management explicit.

Background

This paper answers seven clinical management questions about Jarrod, a 7 year old boy who was assessed by Holm & Crosbie (2006). He was identified by an Education Queensland speech-language pathologist working in Brisbane, Australia and consent obtained. Jarrod's speech and language was assessed to provide data for a special issue of *Advances in Speech-Language Pathology* devoted to the topic of intervention for a child with phonological impairment. Individual assessment by unfamiliar, experienced paediatric speech-language pathologists was conducted at school in a quiet environment in three 75-minute sessions, with breaks between tasks. The assessments were video and audio recorded for transcription and scoring. Jarrod was compliant with assessment demands, initiated conversation and responded well to encouragement. Standardized test results were communicated to Jarrod's parent, teacher and speech-language pathologist. Jarrod's data are

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ISSN 1441-7049 print/ISSN 1742-9528 online
Published by Taylor & Francis
DOI: 10.1080/14417040600738177

Table I. A series of clinical management questions and data sources.

Information from Child and Family	Speech-Language Pathology Service Policy
1. Is intervention indicated?	
Child and carer concern	Service policy
Diagnosis, ability profile	Prioritization
Practicality of attending therapy	Intervention evidence base
2. What is the client's diagnosis?	
Assessment of articulation, phonology, oro-motor skills, language, cognition	Service protocols
3. What service delivery model should be chosen?	
Diagnosis	Service constraints
Practicality of attending therapy	
Carer and child preference	
4. What are the goals of intervention?	
- Ultimate (prognosis)	
- Long term (episode of intervention)	
- Short term (session plans)	
Diagnosis, cognition, severity, case history, assessment data, service delivery chosen	Service constraints
5. How will generalization be aided?	
Carer/school capacity for involvement	Multidisciplinary working
Service delivery chosen	
6. What discharge criteria?	
Carer/child opinion; prognosis; progress	Service policy
7. How will efficacy be assessed?	
Clinician knowledge base	Service auditing

described in other papers in this volume and rather than summarize that information we include it to justify our answers to the seven clinical management questions.

Is intervention indicated?

Olswang and Bain (1991, p. 255) recommend that the decision to offer intervention (i.e. ''focused, intensive stimulation designed to alter specific behaviours'') should be based on whether a particular linguistic skill matches other abilities; and, whether there is potential for change. Other factors involve carer, teacher and child concern and the effects of the communication difficulty on social and academic development. Another issue is the practicalities of intervention irrespective of the degree of disability. The advantages of attending therapy must outweigh the difficulties of provision.

Jarrod's speech difficulty warrants intervention for the following reasons:

(i) His profile of ability was uneven when he was assessed by standardized measures. Jarrod's speech was unintelligible, even to his mother when out of context, but his language performance was within the normal range on all subtests except expressive vocabulary. His verbal IQ scores have also been consistently poorer than his performance IQ.

(ii) Jarrod expressed concern about his unintelligibility and playing alone. His mother has sought speech-language pathology intervention and recognized his current need for further intervention. His teacher's concern was demonstrated by her referral of Jarrod to speech-language pathology.

(iii) Jarrod's grandparents noted an inconsistent behaviour profile. There were times when he does not comply with instructions, lacks eye contact, and has a short attention span. The psychologist's report noted; however, that Jarrod could be brought back to task and answered questions readily. He was reported to concentrate for long periods on activities that interest him. His teacher reported poor social skills although his mother expressed no concern. These inconsistencies may indicate that Jarrod's speech difficulties are affecting his social and learning behaviour.

Jarrod's potential for change may be limited, however, since little progress has been noted over the past 3 years despite several episodes of intervention from different speech-language pathologists and a year in special educational placement.

What is the client's diagnosis?

Assessment data allow differential diagnosis of the aspects of the communication system that are disordered, establishing linguistic patterns, severity, and possible causal and maintenance factors. Planning individualized client management is dependent upon identification of the deficit(s) in the speech processing chain that underlie the speech disorder since that knowledge governs the choice of skills (e.g. oro-motor, auditory discrimination) or language units (e.g. sentences, phrases, words, syllables, phonemes, phones) that should be targeted

in therapy. The speech processing chain is often presented as a model of the mental processes involved in the sensation, perception, representation, phonological planning (of word shape), phonetic planning (of speech sound production) and motor execution of speech (e.g. Dodd & McCormack, 1995). Here we considered Jarrod's assessment data under specific headings (mental abilities implicated in the speech processing chain) and then drew conclusions about diagnosis, causal and maintenance factors.

The headings provided a way of summarizing the information about Jarrod and his disorder. Their ordering, while based loosely on models accounting for phonological disorder (e.g. Dodd & McCormack, 1995; Stackhouse & Wells, 1997) reflects Jarrod's profile of impairment rather than the linear ordering of those models. Some aspects were considered more than once under different headings, leading to overlap. For example, in ''articulation'', Jarrod's phoneme repertoire was examined, raising peripheral motor involvement as a possible cause of his difficulties. The ''oro-motor abilities'' section considered formal assessment of those skills. Information under each of the headings contributed data useful in the diagnostic process. Poor performance on one set of skills may be *causative* (i.e. indicate a specific deficit that underlies the speech disorder), or *co-morbid* (i.e. reflect impaired processing that affects more than one set of speech skills). A third possibility is that poor performance on one set of skills may be a *consequent* to another identified deficit in the speech processing chain (Bishop, 1997). Diagnosis therefore involves reconciling all available data.

Hearing

Otitis media led to insertion of grommets when Jarrod was 2 and again at 4 years. Assessment when he was 4;1 indicated ''functionally normal hearing for speech and hearing at least in the better ear'' and no routine screening since then has indicated hearing difficulties. Fluctuating hearing loss during early speech and language acquisition may have exacerbated Jarrod's early grammatical delay and poor auditory attention and may have contributed to his early lack of response to intervention.

Speech

Articulation. Jarrod could produce most consonant phones word initially with three others (/v, ʃ, tʃ/) appearing either medially or finally, and /dʒ/ being produced as an error. Figure 1 indicates that only /z, ʒ/ were not produced at all. All vowels were apparent in the speech samples except for /ɪə/, which was pronounced as [ʔeə] and [ʔeəh] in two production of *ear*. A number of non-Australian-English phones appeared in Jarrod's speech samples (e.g. [ɬ, ɲ, ɦ, y, x]). There was some distortion of consonants and vowels according to the narrow phonetic transcription.

Jarrod's phone repertoire indicates that he has adequate articulation skills for speech production of both consonants and vowels; however, instances of distorted phone production may indicate motor involvement. Further data is needed to support a peripheral motor explanation, however, since previous research (Dodd, Holm, Crosbie, & McCormack, 2005) indicates that children who make inconsistent errors have a deficit in phonological assembly with flow-on effects to phonetic programming. That is, impoverished phonological plans for words may fail to provide sufficient detail for phonetic planning.

Prosody. Jarrod's prosody had a staccato quality when he was picture naming. This characteristic, however, may have been due to his resentment at the administration of a very long assessment process, and/or his online phonological assembly of words as he attempted to mark all phonemes. In spontaneous speech, however, Jarrod imitated voices showing versatile use of pitch and normal affective prosody.

Syllable shape. A variety of syllable shapes were apparent in the speech samples: CV, CVC, V, VC, CCV, CCVC, CVCC. No tri-consonant clusters were observed. Medial and final consonants were often marked by a glottal stop that was used as a default consonant.

Word shape. There was often a mismatch between the target word's consonant-vowel shape and Jarrod's production. For example, in 47 productions of the CVC words in the DEAP's inconsistency subtest, 17% had the accurate CVC shape, 51% had a CV shape, and the remaining 32% had one of the following structures CVʔ, CVʔC. CCV, CCVC or CVCC. Difficulty increased as word shapes became more complex. For example, Jarrod produced the following word shapes for *umbrella* (VCCCVCV): VCVVCV, ʔVCCVCV, VCCCVCV, VCCCCVʔCVV.

There was a mismatch in word shape between the target and Jarrod's productions. His productions for the same word were variable in terms of consonant and vowel sequencing. Word length affected performance, though even simple CVC word shapes were vulnerable to error. These characteristics indicate an impaired ability in phonological assembly (i.e. generating a plan for word production that specifies the sequences of consonants and vowels to be produced). Phonological assembly differs from phonetic planning (i.e. generating a plan for the production of speech that specifies oro-motor movements) and motor execution (i.e. operation of the articulatory mechanism).

Inconsistency. Jarrod's severity score on the DEAP phonology test was 44% phonemes correct. In the inconsistency assessment of the DEAP, Jarrod

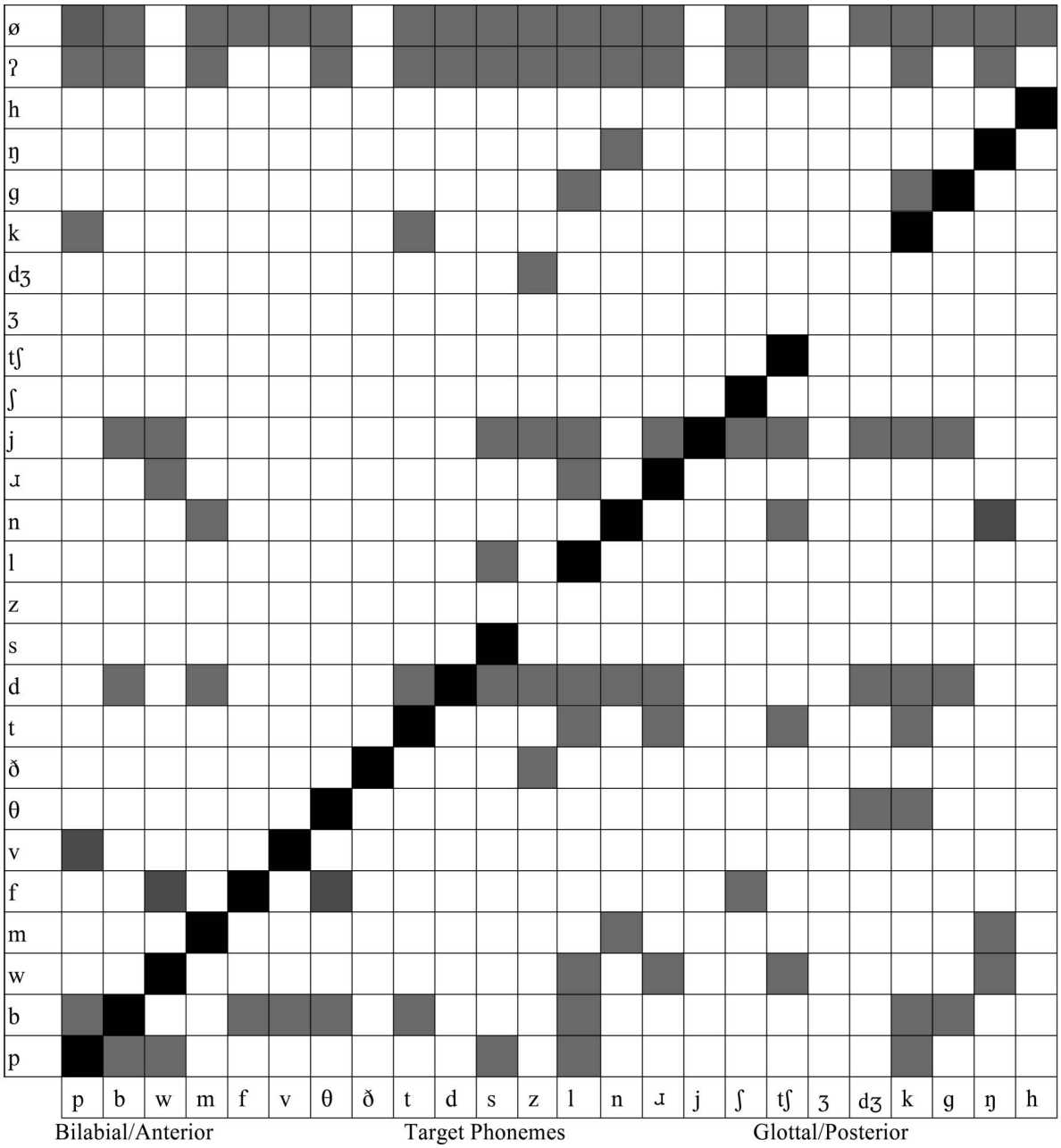

Figure 1. Matrix of phoneme substitutions from DEAP data.

named the same 25 pictures on three occasions, each occasion separated by another activity. He produced 22 of the words (88%) differently on at least two of the three productions (e.g. *tongue* as [bʌns], [dʌn]; and [bʌʔm]; *witch* as [bw::ætʃ], [bwæ] and [bwɛʔt]). For two of the words, the consonants were consistent, but the vowels varied (*teeth* as [di] and [deɪ] and *bridge* as [wɛ:] and [wəi]. The inconsistency of production was marked for most words, particularly those with more than one syllable (*zebra* as [dʒeuwa], [jeiʊa] [jeʔdwʌ]; *birthday cake* as [bɜθdeɪkʰeɪʔk], [bɜfde:pʰeɪʔt], [bɜθdæɪ t̪ʰʌʔt]). The first production of birthday cake was correct, yet subsequent productions were in error in different ways (e.g. /kʰ/ was realized as [tʰ] and [pʰ]). Figure 1 shows a matrix describing the ways in which target sounds were realized. While all phonemes were produced correctly except for /dʒ/, /z/ and /ʒ/ in the inconsistency test, the number of different substitutes for any sound was high (e.g. /l/ was substituted for by nine other sounds). At the same time /b, j, d/ were used as substitutes for many other sounds.

One surprising characteristic of Jarrod's productions of words was the inconsistency with which vowels were realized. For example, [eu], [eɪ] [ʌ] [a] and [æ] were all used as substitutes for /e/, and 18 of the words (72%) in the inconsistency subtest elicited vowel errors. On the DEAP phonology subtest, where there are many more CVC words, his per cent vowels correct score was 70%. Although no specific assessment compared imitated and spontaneous productions of the same words, analyses of

eight words (38 phonemes) that were both spontaneously produced and imitated revealed that spontaneous productions yielded 21% phonemes correct and imitated productions 50%.

Jarrod's high inconsistency score indicates a possible impairment in phonological assembly (Dodd et al., 2005). Previous research suggests that children who make inconsistent errors typically have intact understanding of the system of phonological contrasts (e.g. awareness of phonological legality), but perform more poorly than control and other speech-disordered children on assessments of expressive vocabulary, phonological assembly (new word learning) and sequencing of fine-motor non-verbal acts (tracing shapes).

Oro-motor abilities. The VMPAC (Hayden & Square, 1999) indicated that Jarrod's global motor control was age appropriate but that he performed below the fifth percentile for neuromuscular integrity for his age. Problems highlighted included jaw control, jaw-lip movement, and tongue control, that was more apparent in connected speech than single words. In contrast, informal assessment by Jarrod's speech-language pathologist and his performance on the DEAP oro-motor assessment suggested no anomaly of oral structure or oro-motor function.

Although Jarrod's performance on the VMPAC indicated poor oro-motor skills, this may reflect difficulties with planning sequences of oral movements rather than impaired neuromuscular integrity. Given that there is no history of oro-motor difficulties (e.g. feeding, dribbling, oro-motor games like blowing bubbles), his poor score may be related to performing unfamiliar oro-motor actions. Children with inconsistent speech errors have difficulties learning novel phoneme strings compared to other speech disordered children (Bradford & Dodd, 1996). Production of unfamiliar speech sound sequences can elicit errors even from typical speakers. For example, Australian-English speakers produce the affricate /ts/, but only word finally (e.g. *cats*). Production of /ts/ word initially however proved difficult for newsreaders attempting '*tsunami*'.

Phonological processing abilities

Jarrod had a standard score of 3 on both the rhyme awareness and phoneme isolation (''what's the first sound of...'') subtests of the *PIPA* (Dodd, Crosbie, McIntosh, Teitzel, & Ozanne, 2000) indicating poor performance on tasks usually mastered in the pre-school years. He scored only 18 on the *Sutherland Phonological Awareness Test* (Neilson, 2003), when the average score range for his age is 33–45. Although he performed within normal limits on the letter knowledge task, he would not attempt the non-word reading or spelling tasks. Jarrod's performance on the QUIL (Dodd, Holm, Oerlemans, & McCormick, 1996) indicated that while he did well when segmenting syllables, he performed at the bottom of the normal range on the rhyme recognition task. He was unable to score on the non-word reading and spelling subtests or on the phoneme manipulation tasks, but that is not-unusual for his age, according to the norms, perhaps because these tasks demand phonological assembly of unfamiliar words. A very recent report indicates number and letter reversals but a good understanding of the role of phonics.

Non-word repetition tasks are thought to measure phonological working memory, that is, the ability to hold speech information in a short-term memory loop. Jarrod performed extremely poorly on this task. This is not surprising. All speech disordered children perform poorly on non-word repetition tasks because of their speech disorder. Children who have a phonological assembly deficit have particular difficulty with non-word repetition, perhaps because they are unable to assemble the phonology of unfamiliar words for temporary storage in phonological working memory.

When Jarrod was asked whether two (non-)words were same or different, he made few errors on pairs where words differed by a feature (e.g. [jeɪs]/[jeɪt], *loss/lot*), but had more difficulty when the words differed by a sequence ([vʌts]/[vʌst], *rates/raced*). All items involved word final discrimination of /s/ vs /t/, or /ts/ and /st/. This task involves storing and comparing two words in phonological working memory.

Jarrod performed within normal limits on the lexical decision task, where he heard a word and had to judge whether it was a real word or a non-word (e.g. identifying [fluwi] as a non-word and *flower* as a real word). Jarrod's score correct was 23/24. The results suggest that Jarrod has intact phonological representations of the words used in the assessment. The task does not involve phonological working memory.

Poor performance on phonological processing tasks is usually assumed to reflect deficits underlying speech disorder. When speech errors are characterized by inconsistency, however, the speech disorder may underlie poor performance on phonological processing tasks. Impaired phonological assembly means that words cannot be readily coded for phonological working memory (sequencing phonemes in auditory discrimination tasks), spoken output (non-word repetition) or phonological manipulation. Support for this interpretation is the finding that Jarrod had no difficulty with the lexical decision tasks. This finding is not congruent with his poor performance in the auditory discrimination task, since the lexical decision task should also be affected by poor auditory discrimination.

Language

Jarrod has a reported history of grammatical delay, but when the *Clinical Evaluation of Language Fundamentals-4* (CELF-4) (Semel, Wiig, & Secord, 2004) was administered in mid-2005, all subtest scores (except expressive vocabulary standard score of 6)

were within the normal range of 7–13. His expressive (112) and receptive (103) language scores were in the average range. The assessing clinician concluded that his language skills were consistent with his cognitive abilities and that Jarrod did not meet the criteria for diagnosis of language impairment, despite having a severe speech impairment.

Jarrod's communication difficulty seems specific to speech. Only on the expressive vocabulary task did he perform below the normal range, a result typical of children with inconsistent disorder who perform more poorly than other children with speech disorder on expressive vocabulary measures (Dodd et al., 2005).

Medical and developmental history

Jarrod's recent diagnosis of ADHD (medicated with Ritalin), his history of ear infections and difficulties with fine motor planning (now resolved for writing) are significant factors.

Family context

There is a history of phonological processing difficulties in both maternal and paternal families: mother's father has a history of dyslexia, and father has persisting errors from a developmental speech disorder for which he received therapy. Jarrod's 10 year old sister is reported to have difficulties integrating information from left and right sides of the brain. Jarrod's parents are separated but he sees his father often and regularly. He is well supported and cared for by his mother and extended family.

Diagnosis

Current models of the speech processing chain (e.g. Stackhouse & Wells, 1997) can be used to identify abilities that are related to disordered speech. The deficits identified, however, may reflect causal, comorbid or consequent difficulties. Diagnostic categories of subtypes of speech difficulties need to account for the range of phonological symptoms, profiles of associated abilities, social and academic outcomes, and response to particular types of intervention. One way of categorizing children with speech disorder is in terms of their linguistic symptomatology, that is, the nature of their surface speech error patterns. Experimental evidence (Dodd et al., 2005) suggests that children classified as belonging to one of the proposed subgroups of speech disorder, described below, have different performance profiles on tasks designed to assess aspects of the speech processing chain. The four proposed sub-groups can be diagnosed by the *DEAP* (Dodd, Crosbie, Zhu, Holm, & Ozanne, 2002).

Articulation disorder: an impaired ability to pronounce specific phonemes, usually /s/ or /ɹ/, the child always producing the same substitution or distortion of the target sound in words or in isolation irrespective of whether the sound is spontaneously produced or imitated.

Phonological delay: all the phonological error patterns derived to describe a child's speech occur during normal development but at least some are typical of children of a younger chronological age level.

Consistent phonological disorder: consistent use of some non-developmental error patterns. Most children who use non-developmental error patterns also use some delayed developmental error patterns. They should nevertheless be classified as having a consistent disorder, since the presence of unusual, non-developmental error patterns signals an impaired acquisition of the phonological system's constraints.

Inconsistent phonological disorder: children's phonological systems show at least 40% variability (when asked to name the same 25 pictures on three separate occasions within one session). Multiple error forms for the same lexical item must be observed since correct/incorrect realizations may reflect a maturing system.

The evidence indicates that Jarrod has *inconsistent speech disorder* due to a deficit in phonological assembly. While deficits in phonological assembly are assumed to underlie inconsistent phonology in aphasia (e.g. Berndt & Mitchum, 1994), inconsistency as a type of developmental speech disorder has only recently been accepted (Forrest, Elbert, & Dinnsen, 2000). Velleman and Vihman (2002) argued for a word "template" that contains the phonological specifications for word production—a phonological plan. It is a blueprint that does not involve the motor-speech system. Children whose speech is characterized by inconsistent errors may have difficulty selecting and sequencing phonemes (i.e. in assembling a phonological template for production of an utterance). Alternatively, the plan may not fully specify the segments in the plan. Jarrod's highly inconsistent speech errors, despite his almost intact phone repertoire, fluent speech and poor expressive vocabulary indicate a deficit in phonological assembly (Dodd et al., 2005).

The data suggest that other diagnoses can be explicitly rejected. For example, Jarrod is not dyspraxic, despite his inconsistent errors, because his word production is better in imitation than in spontaneous production. In childhood apraxia of speech, imitation is poorer than spontaneous production (Bradford-Heit & Dodd, 1998; Crary, 1984; Ozanne, 2005). Further, Jarrod's oro-motor assessment showed adequate speech motor control (cf. VMPAC, Hayden & Square, 1999) and there was no evidence of groping. He has an adequate phone repertoire, uses a range of syllable shapes and produces fluent connected speech with appropriate prosody.

Jarrod's diagnosis does have some complicating factors. His family history of spoken and written

communication difficulties identifies him as genetically as well as environmentally at risk. His history of hearing impairment may have contributed to his poor auditory attention and subsequent diagnosis of ADHD. Training auditory attention should be part of the therapy approach. His speech disorder may reflect a more general deficit in planning sequences of fine motor movements (Bradford & Dodd, 1996) that should be targeted in therapy. Therapy should, however, prioritize the main characteristic of Jarrod's unintelligible speech—inconsistent speech production. Inconsistency maximizes his lack of intelligibility (Dodd et al., 2005), is associated with persistent difficulties (Forrest et al., 2000), obscures his phonological knowledge and makes intervention target selection difficult.

Inconsistency characterized by multiple error types (unpredictable variation between a relatively large number of phones) reflects an unstable phonological system. Grunwell (1981) and Williams and Stackhouse (2000) argue that inconsistency indicates pervasive speech processing difficulties. Forrest et al. (2000) argued that inconsistency "will have a negative impact on phonological acquisition and may contribute to a profile that characterizes children with persistent phonological disorders" (p. 530).

Children with inconsistent speech disorder usually inconsistently produce the same words or phonological features not only from context to context, but also within the same context (Dodd & Bradford, 2000; Holm & Dodd, 1999; McCormack & Dodd, 1998). They may pronounce the same word differently each time they say it. Describing and analysing the inconsistent child's surface error pattern in terms of phonological rules is not possible and deciding the focus of therapy is difficult (Dodd & Bradford, 2000). Forrest et al. (2000, p. 529) agree that "it is difficult to [treat] these children, because one may not know the appropriate sound to use in contrast to the error. This may mean that children with a variable substitution will fare worse in treatment than other children because the available protocols for this population are not as effective as other procedures".

The aim of therapy, then, cannot be to contrast phonemes using minimal or maximal pairs in a way that would be appropriate for a child with phonological delay or consistent phonological disorder associated with phonological processing difficulties. Nor would it be worthwhile to teach individual speech sounds in isolation, using motor cues, when Jarrod can already produce most phonemes. Rather, core vocabulary therapy was chosen to focus on teaching Jarrod how to assemble word phonology in single words and then in connected speech. A description of the core vocabulary approach to therapy (Dodd & Iacono, 1989; Crosbie, Holm, & Dodd, 2005) is provided in Section 4 under long and short term goals of therapy.

What service delivery model should be chosen?

There are a range of inter-related factors that need to be considered in choosing appropriate service-delivery. Service-delivery decisions concern the agent(s) of therapy, group or individual therapy, scheduling of intervention (length, frequency of sessions), site of intervention (home, school, clinic) and length of episode of intervention. Jarrod's diagnosis of inconsistent speech disorder directed the planning of service delivery. Research efficacy studies (Crosbie, Holm, & Dodd, 2005; Dodd & Bradford, 2000) have established best practice for core-vocabulary intervention.

Jarrod should receive two, 30-minute, intervention sessions each week. One-to-one therapy is necessary since core vocabulary is individually tailored making group intervention impossible. A speech-language pathologist would be the primary agent of therapy, with carers playing an important role. They would observe sessions and ensure the target words are practised daily at home. Jarrod's teacher would help choose therapy targets and be asked to monitor his speech to ensure that the best production of the target words at school.

While intervention can occur at home, school or in a clinic, there are advantages in using a cross-environmental approach (e.g. generalization from clinic to home/school). Since Jarrod's grandparents are important carers, therapy might occur once each week in his home and once at school. Research indicates that the therapy approach should be implemented for 8 weeks. Most children establish consistency of production in this time. Another episode of intervention may be required if 3-monthly review shows a loss of the consistency gained or consistent speech error patterns that affect intelligibility.

What are the goals of intervention?

Ultimate (prognosis)

The ultimate goal for Jarrod is error-free spoken and/or written communication skills since his cognitive and language skills are within the average range, and he has no physical or current sensory impairment.

Long term (for episode of intervention)

The long term aim would be to establish consistency of best production of a minimum of 50 words using a core vocabulary intervention approach, with generalization of enhanced consistency to non-treated words. Core vocabulary differs from approaches often used for childhood apraxia of speech. For example, Strand and Debertine's (2000) integral stimulation intervention focuses on motor learning, using direct imitation to target increasingly phonetically complex utterances. In contrast, core

vocabulary targets online planning of words, avoids direct imitation and includes multisyllabic words from the first session. The aim of therapy is consistent, rather than accurate, word production. The reason for treating inconsistency is the negative impact it has on intelligibility. Jarrod's speech is often unintelligible, even to members of his family.

Another reason for targeting consistency of production is that until a child's speech errors are consistent, intervention target selection is very difficult. Jarrod uses a range of sound substitutions that differ in manner of production, place of production or voicing. For example, he marked /l/ with a [l, b, w, t, d, r, j, g, ʔ] or deleted the sound. It is impossible to select the appropriate error pair to contrast given the range of substitutions. It is also not effective to take an articulatory approach that targets a single sound when it is already part of Jarrod's speech sound repertoire.

Jarrod's previous lack of progress in intervention for his speech disorder reflects research that children with inconsistent speech disorder are resistant to phonological contrast (Crosbie, Holm, & Dodd, 2005; Forrest, Dinnsen, & Elbert, 1997) or traditional articulation therapy. A retrospective post-hoc analysis of 14 children with speech disorder (Forrest et al., 2000) compared children who made consistent sound substitutions for sounds not present in their inventories (e.g. /k/ always produced as [t]), those who had inconsistent sound substitutions across word positions (e.g. /v/ substituted by [b] word initially, but [f] word finally), and those that used a different sound substitution within (word initial /s/ being substituted by /v, f, d, b/) and across word positions. The three groups were matched for severity of phonological impairment and all received phonological contrast therapy targeting a single error in single words. The children with consistent sound substitutions learned the sound and generalized to other word positions. The children with inconsistent sound substitutions across word positions learned the sound but only in the treated position. The children with variable sound substitutions within and across word positions did not learn the sound in the treated or untreated word position. These results demonstrate the need to focus not on knowledge of phonological contrasts, but rather on the ability to assemble phonology.

Short term (session plans)

Target selection. Before therapy begins a list of 50 target words (minimum) should be selected in collaboration with Jarrod, his family and teacher. The words should be functionally powerful and often include people's names, pet names, places (e.g. home street, school, toilet), function words (e.g. please, sorry, thank you), favourite foods, toys and games. The words are not selected according to word shape or segments. They are chosen because the child frequently uses these words in their functional communication. The child's increasingly intelligible use of the functionally powerful words selected motivates the use of consistent productions. It is important to emphasize to carers and others (e.g. teacher) that the primary target of the intervention is to make sure children says a word exactly the same way each time they attempt to say it, not to achieve error-free production.

Establishing best production. Each week, the first 30 minute session would focus on Jarrod randomly selecting up to 10 words from a bag containing all targets. The clinician would then teach Jarrod the selected words sound-by-sound, using cues such as syllable segmentation, imitation and cued articulation (Passy, 1990). For example, to teach Jarrod to say his own name, the clinician would explain that *Jarrod* has two syllables—[dʒæ] and [ɹəd]. The first syllable [dʒæ] has two sounds, /dʒ/ and /æ/, and the second syllable [ɹɛd] has three sounds /ɹ/, /ə/ and /d/. The child attempts the first syllable—[dʒæ]—receives feedback and makes further attempts after being given models and receiving feedback about each attempt. When the child's best production of the first syllable has been established, the second—[ɹɛd] is targeted, and then the two syllables are combined—[dʒæ-ɹəd]. A highly effective technique, for some children, is to link sounds to letters and this should be used with Jarrod since he is 7;0 and being exposed to formal literacy instruction at school. If it is not possible to elicit a correct production then Jarrod's best production, which would include developmental errors would be accepted. (e.g. [dæwəd] for *Jarrod*, [tæmɹa] for *camera*).

Drill. The second session each week involves practise of the target words. Games are used to elicit a high number of repetitions. Any game that Jarrod is highly motivated to participate in could be used to elicit productions. Elbert, Powell, and Swartzlander (1991) suggest a child should produce approximately 100 responses in 30 minutes. Jarrod's carers should be involved in these sessions since they will need to elicit, give feedback and monitor spontaneous productions of the target words daily at home. It should be emphasized that only the selected words for each week should be targeted.

Treatment on error. Leahy (2004) wrote that children do not always understand why they are attending therapy and what they are required to do in sessions. Consequently it is important to be explicit about the purpose of therapy, the nature of the error made, and how it can be corrected. If Jarrod produces a target that deviates from the best production the clinician/carer/teacher can imitate the production and explicitly explain that the word differed and how it differed. For example if Jarrod's target word was "sun" and he produced [gʌn] the clinician would say

"[gʌn], that's different to how we say it. That had a [g] sound at the start but we need to make it a [s], [ʌn]'. Jarrod's clinicians should avoid simply asking him to imitate the target word since imitation provides a phonological plan that inconsistent children can use without having to assemble/generate their own plan for the word. Instead, clinicians should provide information about the plan.

Monitoring consistent production. Towards the end of the second session each week, Jarrod would be asked to produce, three times, the set of target words that have been the focus of therapy for the past week. Any word that he produces consistently using his best production is removed from the list of words to be learned. It may be placed on a chart showing what he has achieved. Words produced inconsistently remain on the list (go back in the bag of words yet to be learned). Even though there are 50 target words that form a core vocabulary for Jarrod's 8 weeks of intervention, such monitoring allows for words that have not been mastered to be readdressed in another week.

How will generalization be aided?

Learning to produce a target in a clinical situation does not necessarily mean it will be produced correctly in spontaneous speech outside the clinic. Weiss, Gordon and Lillywhite (1987) argued that generalization needs to be explicitly taught. Core vocabulary intervention aims to stabilize the phonological system, resulting in consistent productions. The therapy would not be beneficial if the effect of therapy was limited to the treated target items. To monitor generalization, Jarrod's clinician should use a set of untreated items (ten words) fortnightly, eliciting three productions of the untreated items in a therapy session. The untreated probes will enable system change to be monitored (i.e. identify when Jarrod's speech production becomes consistent). Generalization should be enhanced by provision of intervention at home and at school and by the involvement of his carers and teacher in daily feedback and practice.

What discharge criteria will be set?

There is evidence that different speech and language therapy services discharge clients at different points in their remediation (Enderby & John, 1999). Efficacy studies suggest that core vocabulary intervention should increase Jarrod's consistency and accuracy of production, his errors being characterized by developmental, not atypical, error patterns. Some children, however, require more than one intervention approach to achieve age-appropriate speech. For example, Dodd and Bradford (2000) report a case study of a boy with inconsistent speech production. Once consistency was established he benefited from phonological contrast therapy that targeted his remaining developmental error patterns. Given Jarrod's severity, resistance to previous therapy and the complicating factors of ADHD, motor planning and family history, he may require more than one episode of intervention.

How should efficacy be assessed?

Intervention needs to be monitored to establish effectiveness. To evaluate the efficacy of the core vocabulary approach to intervention for Jarrod, the clinician would:

(i) establish a pre-therapy baseline (analyses of three speech samples over 2 months) for consistency, per cent consonants and vowels correct, and conversational speech;
(ii) implement therapy over 8 weeks (as described);
(iii) reassess Jarrod using the same measures used for the pre-intervention baseline.

This design would meet Bain and Dollaghan's (1991) criteria for clinically significant change (intervention efficacy). Any change could be shown to result from intervention rather than from maturation or other uncontrolled factors because a pre-intervention baseline would be established. Change would be shown to be important rather than trivial because it would measure consistency and accuracy of production of words not targeted in therapy and the change would be real, rather than random because of the short duration of intervention.

Discussion

Developmental speech disorder has been accounted for by theories derived from psychology, psycholinguistics, linguistics and medicine. Consequently, researchers have devised specific assessment protocols for differential diagnosis of speech disorder (e.g. Hayden & Square, 1999; Stackhouse & Wells, 1997). They argue that their assessment data allow the identification of deficits underlying speech disorder and planning of cost-effective intervention. This article presented a case management plan for a 7 year old boy with highly unintelligible speech. Analysis of assessment data was used to address seven case management questions regarding need for intervention, service delivery, differential diagnosis, intervention goals, generalization of therapeutic gains, discharge criteria and evaluation of efficacy.

Intervention was judged necessary for Jarrod because of his uneven pattern of communicative performance, the concern his speech disorder caused Jarrod, his carers and teacher and the probability that it was a contributing factor to academic and social difficulties. He was diagnosed as having inconsistent speech disorder. He pronounced 88% of words

differently when asked to name each word in the 25 word inconsistency test of the *Diagnostic Evaluation of Articulation and Phonology* (Dodd et al., 2002) three times, each trial separated by another activity. Given that the arbitrary criterion for diagnosis of inconsistency is 40%, Jarrod's inconsistency score was very high. The diagnosis was supported by other findings such as intact phoneme repertoire, poor expressive vocabulary and poor performance on judging sequences of phonemes but good lexical decision skill.

Jarrod's performance on Hayden and Square's (1999) oro-motor tasks was interpreted as showing poor ''neuromuscular integration''. It is difficult to rule out a motor contribution to Jarrod's speech disorder, given group studies suggesting that children with inconsistent speech disorder have a general difficulty planning sequences of fine motor movement (Bradford & Dodd, 1996). Nevertheless, given that his SLP did not observe any motor difficulty, Jarrod's ability to produce most phones and syllable shapes, and his better performance in imitation as compared to spontaneous production, it seems unlikely that his speech disorder can be attributed solely to an oro-motor deficit.

It is sometimes difficult to distinguish impaired abilities that are causal from those that are consequent difficulties. Since Jarrod's difficulty seems to be limited to speech production, a deficit in phonological assembly accounts for his inconsistency and non-organic speech-motor signs. His deficit in phonological working memory can also be interpreted as a consequence of his inability to assemble phonology for phonological processing. Core vocabulary intervention was chosen as the most appropriate therapy technique because it directly addresses planning of words that are functionally powerful in the client's social and academic context. While the technique focuses on phonological assembly, it involves focusing and maintaining auditory attention and can include motor prompts to address difficulties in planning oro-motor speech sequences.

The speech processing chain is complex. It not only involves input (sensation and perception) and output (motor) processing, but also mental processes that allow the acquisition of phonological knowledge through attention to, memory for and analyses of, the phonological aspects of language. Current research focuses on identifying deficits that give rise to speech difficulties. As yet, little is known about the interaction between genetic, environmental and damaged neurological strata that underlie those deficits that cause speech difficulties.

In conclusion, we have argued that choice of therapy technique should be linked to diagnosis. Identification of deficit(s) underlying a child's speech disorder allows case management decisions that result in cost-effective intervention using best practise that has been identified by research. All intervention approaches have their merits. Clinical skill is reflected by choice of the appropriate intervention for a child's specific deficit.

Acknowledgments

Our thanks go to Jarrod and his family, teacher and speech-language pathologist for their patience, time and interest in this project.

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