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Evidence-based management of phonological impairment in children

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Abstract

Evidence-based management of phonological impairment in children is a dynamic process. Speech and language therapists need to evaluate published evidence and use their professional judgement to decide on an intervention plan, evaluate the efficacy of their intervention and re-evaluate decisions. Two case studies are presented to illustrate this process of evidence-based management of phonological impairment in children. Both of the children have a phonological impairment of unknown origin with similar case histories; however, their intervention outcomes were completely different. The two case studies highlight the importance of considering individual differences in the management of phonological impairment in children. They also highlight the importance of integrating up-to-date knowledge with clinical expertise.

Evidence-based management of phonological impairment in children

Everyone is an individual. There are individual differences between children with typical phonological development (McLeod, 2003; Vihman and Greenlee, 1987). Heterogeneity in children with speech impairments has been widely acknowledged (Fox and Dodd, 2001; Shriberg, 1997); although there is an accumulating body of evidence documenting the efficacy of various

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phonological interventions (Gierut, 1998b), speech and language therapists face the challenge of using evidence to identify intervention approaches that are best suited to individual clients. Once an approach has been identified, speech and language therapists need to use data to evaluate the efficacy of the selected intervention. There is value in providing efficacious intervention as preschool children with phonological impairment may be at risk of later literacy difficulties (Dodd and Gillon, 2001).

Consideration of the individual is central to the concept of evidence-based practice (EBP). Evidence-based practice has been derived from the field of evidence-based medicine (EBM) (Taylor, 2000; Trinder, 2000) and refers to 'the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients' (Sackett *et al.*, 1996: 71). As this definition indicates, EBP is not just about using evidence to decide a course of intervention. Rather, it combines the use of evidence with clinical expertise to make sound clinical decisions tailored to individual clients. For speech and language therapists working with children with phonological impairments, this means searching for recent, valid and reliable evidence of efficacious (effective and efficient) phonological interventions, then using this evidence in conjunction with their own clinical expertise to select and implement suitable intervention on a case-by-case basis.

Evaluating the evidence: selecting the appropriate intervention approach

There are a number of methodologies that have been discussed and utilized to assess interventions. The National Health and Medical Research Council (NHMRC, 2000) identify four major study designs: 1) systematic review; 2) experimental studies (including randomized controlled trials); 3) comparative studies (including nonrandomized and observational studies); and 4) other observational studies (including pre- and post-test case series). The speech-language therapy literature contains a variety of approaches for working with children with phonological impairment of unknown origin (Baker, 1997). However, to date, none of these approaches has been examined to the highest levels of scientific rigour identified by proponents of EBP (NHMRC, 2000; Taylor, 2000). That is, to date, in the area of phonological intervention, systematic reviews and meta-analyses have not been conducted. Instead, as Gierut (1998b) concluded, literature attesting to the value of phonological intervention currently comprises a body of published evidence based on experimental studies and nonexperimental studies, opinion or expert discussion. Literature on phonological intervention from the past 20 years was gleaned from internationally refereed journals. Few randomized controlled trials on the effectiveness of intervention for phonological impairment were identified (Almost and Rosenbaum, 1998; Glogowska *et al.*, 2000). The majority of studies comprised nonrandomized experimental and nonexperimental studies. Table 1 provides a list of intervention approaches, a selection of studies in support of each approach and a description of the participants suited to each approach.

As illustrated in Table 1, there are a number of intervention approaches that are available for use with most children with phonological impairments of unknown origin. For example, individuals with moderate–severe impairment may benefit from approaches such as minimal oppositions contrast intervention (Weiner, 1981), Metaphon (Howell and Dean, 1994), or cycles (Hodson and Paden, 1991). Many of these approaches share common components (for example, most begin at word level). However, each approach also has a unique focus (Baker, 1997). For example, some focus on the phoneme selected for intervention (Gierut, 1989; 1990; 1991; 1992; 1998a; 1999; Williams, 2000a; 2000b), others focus on the dialogue between the therapist and child (Howell and Dean, 1994; Weiner, 1981), while others focus on inclusion of parents (Bowen, 1996; Bowen and Cupples, 1999). The merits of each programme must be weighed with the individual in mind. However, it is still likely that there will be a range of intervention approaches that theoretically may be suitable for the individual. One final factor that may influence the type of intervention approach used by a therapist is the therapist's own experience, understanding and prior success with a particular intervention approach.

Once an intervention approach has been selected, the next step to ensuring that individuals receive appropriate evidence-based intervention is to monitor the efficacy of the intervention to ensure that it has the desired outcome.

Using data to evaluate the efficacy of intervention

Olswang and Bain (1994) proposed a data-based decision-making model to assist speech and language therapists in the evaluation of children's progress during intervention. They posed four questions that therapists need to address:

1) Is the child responding to the intervention programme?
2) Is clinically significant and important change occurring?
3) Is intervention responsible for the change?
4) How long should a therapy target be treated?

Table 1 Phonological intervention approaches and supporting research

Intervention	Examples of supporting research	Children suitable[a]
Core vocabulary	Bradford and Dodd, 1997; Dodd and Bradford, 2000.	Children with an inconsistent speech disorder (Dodd and Bradford, 2000).
Cycles	Hodson and Paden, 1991; Montgomery and Bonderman, 1989; Rvachew *et al.*, 1999; Tyler *et al.*, 1987; Tyler and Waterson, 1991.	Children with highly unintelligible speech (Hodson and Paden, 1991). Severity: moderate, severe.
Imagery	Klein, 1996a; 1996b.	Children with one or many phonological processes (Klein, 1996a).[b] Severity: mild, moderate, severe.
Maximal opposition contrast (maximal pairs)	Gierut, 1989; 1990; 1991; 1992.	Children with at least six sounds excluded from phonetic and phonemic repertories (Gierut, 1989). Severity: moderate, severe.
Metaphon	Dean *et al.*, 1996; Harbers *et al.*, 1998; Howell and Dean, 1994; Jarvis, 1989.	Preschoolers and older children who have a phonological impairment (Bauman-Waengler, 2000).[b] Severity: mild, moderate, severe.
Minimal opposition contrast (minimal pairs)	Baker, 2000; Blanche *et al.*, 1981; Dodd and Bradford, 2000; Elbert *et al.*, 1991; Hoffman *et al.*, 1990; Powell *et al.*, 1991; Tyler *et al.*, 1987; Weiner, 1981.	Children who have sounds in their phonetic repertoire, but fail to use them contrastively (Weiner, 1981).[b] Severity: mild, moderate, severe.
Mnemonic	Young, 1987; 1995.	Children with specific difficulty with syllable–structure processes (for example, cluster reduction, final consonant deletion, weak syllable deletion) (Young, 1987).

Multiple opposition contrast	Williams 2000a; 2000b.	Children who collapse several adult phonemes to a single phone, resulting in extensive homonymy. Severity: severe phonological impairment.
Nonlinear phonological intervention	Bernhardt, 1990; 1992; Bernhardt and Stemberger, 2000.	Any child with a phonological impairment, although most useful with children who have a moderate or severe impairment. Severity: mild, moderate, severe.
Parents and children together (PACT)	Bowen, 1996; Bowen and Cupples, 1999.	Children with a phonological impairment (Bowen and Cupples, 1999). Severity: mild, moderate, severe.
Psycholinguistic intervention	Stackhouse and Wells, 1997; 2001.	Children with difficulties in perception, processing, storage and/or production of speech.
Whole language	Hoffman *et al.*, 1990; 1996; Tyler and Sandoval, 1994.[c]	Children with concomitant phonological and expressive language impairments (Hoffman *et al.*, 1990).

Adapted from Baker and McLeod, 2001; with permission from Speech Pathology Australia.

[a]Some intervention approaches have specific guidelines regarding the types of speech-sound problems suited to a particular approach (Dodd and Bradford, 2000, for inconsistent speech disorder). Other intervention approaches have been developed for the general population of children with a phonological impairment. Where specific recommendations have been made, comments are provided within the table.

[b]Tyler (1993) suggests that contrast therapy activities are more appropriate for children who have relatively intact cognitive skills.

[c]Evidence in support of the whole-language approach for remediation of phonological impairments is inconclusive. Tyler and Sandoval (1994) found that the whole-language approach combined with direct phonological intervention yielded a better outcome than whole-language intervention alone.

These questions can be answered by collecting clinical data on individual clients; they will be demonstrated in an illustrative case study.

Categories of clinical data

Clinical data can be divided into three broad categories: treatment data, generalization probe data and control data (Olswang and Bain, 1994). Treatment data, collected during intervention, provides a measure of a client's response to the therapist's instructional feedback (Olswang and Bain, 1994). An example of treatment data would be the percentage of correct productions of fricatives in single words following feedback from the therapist when targeting stopping of fricatives.

Data that are gathered outside the intervention conditions are called generalization probe data and provide important insight into the impact of intervention on a child's phonological system. Generalization probe data can be further divided into two groups: response generalization data and stimulus generalization data. Response generalization data capture a client's response to untrained items while stimulus generalization data reflect generalization to new materials, new people or new settings (Hegde, 1985). Table 2 provides a summary of various types of generalization during phonology intervention, based on work by Baker (2000) and Elbert and Gierut (1986).

The third and final category of clinical data is called control data. Olswang and Bain (1994: 57), view control data as reflecting behaviours 'that could change as a result of other "cosmic occurrences" but their change would not be considered directly tied to the treatment effects'. That is, control data provides a measure of a behaviour *not* expected to change as a result of intervention. An example of control data would be measuring the percent occurrence of velar fronting while targeting stopping of fricatives.

Each of these three broad categories of clinical data can be further classified as either quantitative or qualitative. Quantitative data refers to behaviours that are 'operationally defined for observation and measurement' (Olswang and Bain, 1994: 56). For example, quantitative treatment data may be collected by calculating the percentage of accurate responses during a particular intervention task. Qualitative data may reflect the therapist's own observations about a client's response to intervention, the client or caregiver's own thoughts about the impact of intervention, or perhaps comments from a client's teacher about the client's overall intelligibility. For example, qualitative stimulus and response generalization probe data could comprise a rating of child's overall intelligibility during 10 minutes of conversational speech, based on the rating scale proposed by Bleile (1995): 1 = completely intelligible; 2 = mostly intelligible; 3 = somewhat intelligible; 4 = mostly unintelligible; and 5 = completely unintelligible.

Table 2 Types of response and stimulus generalization during phonology intervention[a,b]

Type of generalization	Description and example
(A) Response generalization	
• Generalization of a trained sound in a select number of intervention words to other words containing the trained sound in the same word position and different word positions.	• Generalization of the trained sound/s to words not used during intervention; for example, generalization of a trained cluster /sp/ from the intervention word/spɪn/*spin* to the nonintervention word /spɪl/ *spill*. • Generalization of the trained sound/s to other word positions; for example, generalization of a trained initial /s/ consonant cluster /sp/ from the intervention word /spɪn/ *spin* to an untrained final cluster in the nonintervention word /wɒsp/ *wasp*.
• Generalization across linguistic units	• Generalization of the trained sound/s to more complex linguistic units such as sentences and conversational speech; for example, generalization of the trained cluster /sp/ in intervention words to sentences such as /aɪ laɪk to spɪn ðæt/ *I like to spin that*.
• Generalization within sound classes/ categories	• Generalization of the trained sound/s to sound/s within the same class; for example, generalization of the trained cluster /sp/ to other types of initial /s/ + consonant clusters such as/sm, sk/.
• Generalization across sound classes/ categories	• Generalization of the trained sound/s to sound/s not within the same class; for example, generalization of the trained cluster /sp/ to clusters in other categories such as /gl, kl/ or /gr, kr/.
• Generalization based on implicational relationships	• Generalization of the trained sounds to sound/s thought to exist by implication once the intervention target exists; for example, generalization of the trained cluster /sp/ to /s/ as a singleton consonant (Hodson and Paden, 1991).
(B) Stimulus generalization	
• Generalization across situations	• Generalization of the trained sound/s to settings outside the clinic environment such as home or preschool, and to listeners other than the therapist or researcher such as parent, teacher, sibling or peer; for example, generalization of the trained cluster /sp/ to the home environment while talking with a parent.

[a]Adapted from Elbert and Gierut, 1986
[b]Reprinted from Baker and McLeod, 2001, with permission from Speech Pathology Australia.

Numerous types, frequencies and contexts of data collection are possible. The specific type of data collected may vary, depending on the behaviour or skill being targeted and the resources available. A mix of qualitative and quantitative data is possible. The frequency of data collection may vary depending upon the category of data being collected and the behaviour being measured. For example, treatment data may be collected every session while generalization probe data and control data may be collected once a month. The context of data collection may vary from a naturalistic setting (for example, observation of the child talking during free play at home or preschool) to highly structured (for example, child naming 10 pictures in the clinic with the therapist). The therapist should decide what types of data will be collected, when it will be collected, and who will collect it.

Using clinical data to answer clinical questions

Data provide therapists with an ideal platform for answering the four clinically important questions proposed by Olswang and Bain (1994). Each category of data is suited to a particular question.

1) Is the child responding to the intervention programme? Treatment data are collected to determine whether the child is responding to the cues/prompts/feedback provided by the therapist.
2) Is significant and important change occurring? Generalization probe data are collected to determine whether the child is showing generalized acquisition of the targeted speech skill. The task of judging whether the rate, magnitude and extent of generalization is not only clinically significant, but important for the child's overall well-being can be a formidable one (Olswang and Bain, 1994). Bain and Dollaghan (1991) provide a helpful review of this issue.
3) Is intervention responsible for the change? Control data are collected to determine whether the targeted speech skill is improving in the absence of an improvement in an unrelated but developmentally equivalent skill yet to receive intervention.
4) How long should a therapy target be treated? Generalization probe data are collected to determine at what point therapy on the targeted speech skill can discontinue.

Clinical application: aligning practice with research

This section presents two case studies of children with a phonological impairment of unknown origin. Each case will illustrate the clinical decision-making process from selecting evidence-based intervention through to making informed decisions about the efficacy of intervention based on treatment, generalization and control data.

Participant characteristics

The two children who participated in this investigation were Cody (4;9) and James (4;4). Both children were referred to the Communication Disorders Treatment and Research Clinic (CDTRC), The University of Sydney, for management of unintelligible speech. The two participants in this investigation were from a larger cohort of children involved in a study on the efficacy of intervention for phonological impairment reported by Baker (2000). An in-depth speech and language assessment was conducted by the first author. Hearing assessment and psychometric evaluation were conducted by an audiologist and psychologist, respectively. Both children attended preschool two days per week. They were somewhat intelligible to their parents, but mostly unintelligible to unfamiliar listeners. Cody and James presented with similar pretreatment characteristics (see Table 3). Specifically, they both had:

- a moderate–severe phonological impairment, based on a measure of percent consonants correct (PCC) (Shriberg *et al.*, 1997) during 330 words during conversational speech;
- a family history of speech, language or literacy difficulties;
- normal hearing, oral musculature structure and function (Ozanne, 1992);
- no known history of otitis media with effusion;
- no symptoms consistent with development verbal dyspraxia;
- no apparent neurological or neuromotor abnormalities;
- no behavioural difficulties or known psychiatric disorder;
- no prior intervention for speech or language difficulties.

Table 3 Participants' pretreatment characteristics

Skill	James	Cody
Percent-consonants-correct (PCC) during conversational speech	54.1	59.8
Percent-consonants-correct (PCC) during 200 single word sample	54.5	48.3
Receptive language score, based on CELF-P[a]	98	102
Expressive language score, based on CELF-P	94	104
MLUm[b] based on two $\times$ 50 utterance pretreatment conversational speech samples, as recommended by Paul (1995)	3.5	4.73
Performance IQ, based on WPPSI-R[c]	113	101

[a]Clinical Evaluation of Language Fundamentals – Preschool (Wiig *et al.*, 1992).
[b]Mean length of utterance in morphemes.
[c]Wechsler Preschool and Primary Scale of Intelligence – Revised, Australian edition (Wechsler, 1989).

Intervention approach

Independent and relational phonological analysis of single word and connected speech samples revealed a moderate–severe phonological impairment of unknown origin. Although both children had some knowledge of the phonological system they were learning, they each presented with a set of inventory, positional, and sequence constraints. For instance, although each child had productive knowledge of some clusters in initial and final position, there was no evidence of initial /s/ clusters. Tables 4 and 5 provide an overview of the results of the phonological analysis for each child, based on analysis using the PROPH+ module of Computerized Profiling version 9.0 (Long *et al.*, 1998).

Given this diagnosis, a suitable intervention approach needed to be selected. An evidence-based question was subsequently constructed: *What is the evidence for the effectiveness of phonologically based intervention for improving intelligibility in children with a moderate–severe phonological impairment of unknown origin and no obvious receptive or expressive language problems?*

Using the information in Table 1, a range of phonologically based interventions were suitable: minimal oppositions contrast intervention (Weiner, 1981), Metaphon (Howell and Dean, 1994), cycles (Hodson and Paden, 1991), PACT therapy (Bowen, 1996), maximal oppositions (Gierut, 1992), imagery (Klein, 1996a), and nonlinear phonological intervention (Bernhardt and Stemberger, 2000). As illustrated in Table 1, each of these approaches had evidence (varying in levels of scientific rigour) attesting to the effectiveness of the approach. Of this range, the minimal opposition contrast intervention was selected as it has been used by speech and language therapists for many years, could be used to target the phonological process of initial /s/ consonant cluster reduction evident in the speech of both children, and could possibly enhance the children's speech repair strategies. Given that the children were part of a larger study examining the impact of intervention dialogue during phonological intervention (Baker, 2000), an approach with few variables that could impact the outcome of the study (for example, different and multiple processes being targeted at the one time, varying input from caregivers) needed to be chosen. The minimal opposition contrast approach met this need.

Data collection schedule

Initial /s/ consonant cluster reduction was selected as the first target to be treated. This target was chosen based on evidence supporting the selection of consonant clusters over singleton consonants to facilitate widespread change in children's phonological systems (Gierut, 1998a). Thus, the short-term goal of intervention was that James and Cody would produce initial /s/ consonant clusters (both trained – /sp, st, sn/ and untrained /sm, sl, sk, sw/) during

Table 4 Summary of Cody's phonological skills based on an independent and relational analysis of single words and conversational speech samples

Inventory of consonant phones	Range of phones: Singletons	Range of phones: Consonant clusters	Marginal clusters
(a) *Independent analysis*			
Initial	p b t d m n h w l		bl
Medial	p b t d k g m n s z ʒ w l		
Final	p b t d k g m n ŋ s z	st	nd nt nz ts ŋk

- Inventory constraints: [f v tʃ dʒ j r θ ð].
- Positional constraints: [h] only in initial position, [k g s z] only in medial and final position.
- Sequence constraints: Use of /s/ + consonant sequence [st] in final position. Marginal use of consonant + [l] sequence in initial position. Marginal use of nasal + consonant sequences in final position. No [s, r, w] + consonant sequences in initial position.

Inventory of word shapes	Range of possible word shapes across single words and conversational speech	Canonical word shapes
Monosyllables	$C_{0-(2)}VC_{0\text{-}2}$	CV, CVC
Disyllables	$C_{0-1}VC_{0-1}$, $C_{0-1}VC_{0-1}$	CVCV
Polysyllables	$C_{0-1}VC_{0-1}$, $C_1VC_1VC_{0-1}$ including 2 × 4 syllable words CVCVCV(C)CV(C)	CVCVCV

(*continued*)

Table 4 Continued

Percent correct measures			Main phonological processes		
	Percent correct			Percentage use	
Measure	Single words	Conver speech	**Phonological process**	Single words	Conver speech
(b) *Relational analysis*					
PCC	48	60	Initial /s/ cluster reduction	100	100
PVC	90	93	Initial /l, r, w/ cluster reduction	100	100
Plosives	75	73	Fronting of initial velars	100	100
Nasals	88	96	Stopping of fricatives (initial position)	100	100
Fricatives	24	36	Stopping &/or deaffrication of affricates	100	100
Affricates	0	0	Gliding of /r/ to [w] or [l]	89	90
Glides	68	75	De-gliding of /j/ > [l]	100	[a]
Liquids	37	48			
Initial and final clusters	18	29			

[a]Less than four opportunities for /j/ during conversational speech. All showed evidence of /j/ > [l].

Table 5 Summary of James' phonological skills based on an independent and relational analysis of single words and conversational speech samples

Inventory of consonant phones	Range of phones: Singletons	Range of phones: Consonant clusters	Marginal singletons/clusters	
(a) *Independent analysis*				
Initial	p b t d m n f θ s z ʃ h tʃ dʒ w j l	fw pw	v r	bw
Medial	p b t d m n f v θ s z ʃ dʒ w j l		r tʃ	
Final	p b t d m n f v s z ʃ tʃ dʒ l	nt ntʃ	θ	st mp nd ntθ

- Inventory constraints: [k g ŋ ð].
- Positional constraints: [h] only in initial position.
- Sequence constraints: Use of consonant + [w] sequences in initial position. (Limited to labial + labial sequences.) Use of nasal + consonant sequences in final position. Marginal use of [st] in final position. No [s] + consonant or consonant + [l, r] sequences in initial position.

Inventory of word shapes	Range of possible word shapes across single words and conversational speech	Canonical word shapes
Monosyllables	$C_{0-2}VC_{0-2}$	CV, CVC
Disyllables	$C_{0-2}VC_{0-1}$, $C_{1-2}VC_{0-2}$	CVCV
Polysyllables	$C_{0-1}VC_1VC_1C_{0-1}VC_{0-2}$ including 1 × 4 syllable word CVCVCVCV	CVCVCV

(*continued*)

Table 5 Continued

Percent correct measures			Main phonological processes		
	Percent correct			Percentage use	
Measure	Single words	Conver speech	**Phonological process**	Single words	Conver speech
(b) *Relational analysis*					
PCC	55	54	Initial /s/ cluster reduction[a]	100	100
PVC	94	97	Velar fronting	100	100
Plosives	71	57	Initial /l, r, w/ cluster reduction	53	43
Nasals	67	88	Initial /l, r, w/ cluster simplification	21	40
Fricatives	66	42	Affrication of /l, r, w/ clusters	16	10
Affricates	100	88	Coalescence of /l, r, w/ clusters	8	7
Glides	84	100	Gliding of /r/	86	75
Liquids	38	18	Fricative simplification	73	5
Initial and final clusters	14	17	Stopping of /ð, θ/	5	95

[a]While the majority of consonant clusters were reduced to one of the two constituents, some showed evidence of coalescence or affrication.

Table 6 Data collection schedule for participants (Long-term goal: Cody and James will produce initial /s/ consonant clusters (both trained /sp, st, sn/ and untrained /sm, sl, sk, sw/) during 10 minutes of conversational speech with the therapist in the clinic with 70% accuracy)

What?	Category and type of data	When?	Where?	Who?
Production of trained initial /s/ clusters /st, sn, sp/	Quantitative treatment data: Percent correct trained initial /s/ consonant clusters.	Every session, for each set of 25 trials.	In the clinic.	Therapist
Generalized production of trained and untrained /s/ clusters: /sn, sm, sp, st, sk, sw, sl/	Quantitative response generalization probe data: Production of initial /s/ consonant clusters during a) single word production task containing 20 words, and b) 10 minutes of conversational speech.	At the beginning of every fourth intervention session.	In the clinic.	Therapist
	Qualitative response generalization data: Parent observation of child's use of initial /s/ consonant clusters during conversational speech at home.	Once per fortnight.	At home.	Parent/ caregiver
Production of control behaviour (Cody – initial /k, g/ and James – velars, all positions).	Quantitative control data: Production of control behaviour (Cody – initial velar fronting; James – velar fronting), during 10 minutes of conversational speech. Data on their production of initial /l, r, w/ clusters was also collected.	At the beginning of every fourth intervention session.	In the clinic.	Therapist

10 minutes of conversational speech in the clinic with the therapist with 70% accuracy. Other phonological processes were identified as requiring intervention. For Cody, they included initial /l, r, w/ cluster reduction, initial velar fronting, stopping of fricatives in initial position, stopping and/or deaffrication of affricates, gliding of /r/ to [w] or [l], and de-gliding of /j/ to [l]. For James they included initial /l, r, w/ cluster reduction and simplification, velar fronting, and gliding of /r/. Given these goals and the selected intervention target, a data collection schedule was created, as shown in Table 6.

The children worked with the first author twice weekly. The sessions lasted 45 minutes and within each session there were 100 trials. Intervention was based on the minimal oppositions contrast approach outlined by Weiner (1981). A computer-based activity (Baker, 2000) was used to maintain consistency in the intervention stimulus delivery between Cody and James. In this activity computerized scenes were presented and the children could request that the therapist click on a particular figure within the scene. The figures commencing with a consonant cluster were animated and had an accompanying sound. The figures commencing with a single consonant were not animated, so were less appealing. Intervention dialogue typically consisted of conceptually based feedback (for example, When the child said 'nail' for 'snail', the therapist provided feedback such as 'Do you mean nail or snail, I'm not sure what you mean, tell me again'). Phonetic cues were provided when necessary (for example, 'Remember to use the /s/ sound when you want to say snail'). Intervention began at the word level with feedback and progressed through a series of performance-based criteria to sentence level without feedback. The efficacy of intervention for both Cody and James was then evaluated using the collected data.

Results

The results of the intervention will be described by considering the four questions posed by Olswang and Bain (1994).

Did the participants respond to the intervention programme?

The treatment data indicated that Cody and James responded to the intervention programme. Specifically, Cody achieved 100% correct production of the trained clusters /sp, st, sn/ in words at sentence level without a model or feedback from the therapist by the seventh intervention session, while James achieved the same goal by the 11th session.

Did significant and important change occur?

Generalization probe data from both single word and connected speech samples were used to determine whether significant and important change had occurred. Figure 1 presents a summary of these data. For Cody, significant and important change occurred. He achieved the predetermined goal of 70% correct production of trained and untrained initial /s/ consonant clusters during conversational speech by the third generalization probe (equivalent to 12 intervention sessions, which was seven weeks after starting intervention). (Note: although 12 therapy sessions should have been consistent with six weeks duration, both Cody and James missed the occasional scheduled appointment due to unforseen circumstances such as illness.) Parental observation indicated that Cody was using /s/ clusters during conversational speech at home by the third generalization probe.

James' response to intervention was quite different (see Figure 1). While the treatment data indicated that he was responding to the intervention programme, the generalization probe data indicated that significant and important change was not occurring. Using these data, a decision was made to change James' intervention in three ways.

First, intervention changed from a vertical intervention strategy (targeting one process at a time) to a horizontal intervention strategy (targeting more than one process during an intervention session), in line with a suggestion by Bleile (1995). This decision was made, as it was unclear whether the intervention approach was ineffective or the intervention target was not responding to the

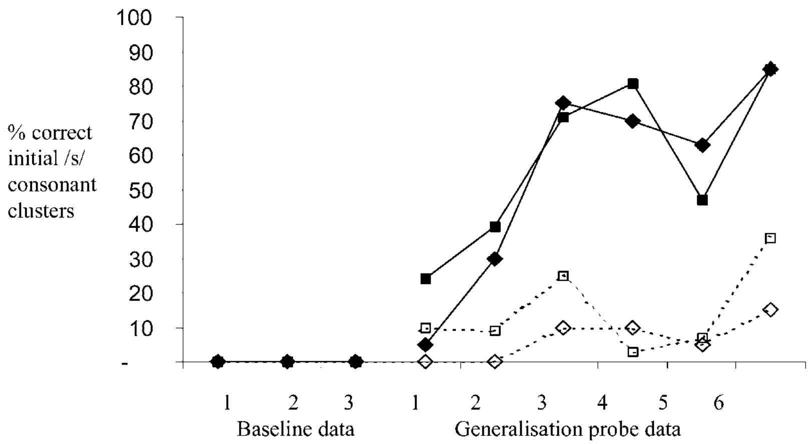

Figure 1 Participants' percent correct initial /s/ consonant clusters during single-word and conversational data. (Baseline data collected weekly, prior to intervention study. Generalization probe data collected every fourth intervention session.) Cody's data = solid line with shaded markers; James' data = dashed line with open markers; □ = conversational speech data; ◇ = single-word data

intervention approach. Thus, after 16 intervention sessions targeting initial /s/ consonant cluster reduction only, intervention targeted initial /s/ consonant cluster reduction and velar fronting. Velar fronting was selected, as James had no knowledge of velars (100% velar fronting across all word positions). A brief nonspeech activity (for example, play with a ball), was used to signal the change from intervention on clusters to intervention on velars during each session. Like intervention for initial /s/ clusters, the minimal opposition contrasts intervention approach was used to target velar fronting.

Secondly, the intervention approach used to target initial /s/ consonant clusters was modified. A number of observations of James' productions of initial /s/ clusters prompted this modification. Specifically, it was noted that the few initial /s/ consonant clusters that James did produce sounded unnatural. The /s/ was either excessively long (for example, [s::ta] for star), or there was a breath between the /s/ and the remainder of the word. For /st/ and /sk/ clusters, James occasionally produced two /s/ phonemes with a breath in between productions, so that /sta/ would be pronounced as [s sa]. During intervention sessions, the naturalness of James' /s/ clusters seemed to improve with production practice. Given these observations, it seemed that James' intervention approach for /s/ clusters needed to change. In an experimental study focused on facilitating generalization to conversational speech, Elbert *et al.* (1990) recommended increasing the number of words used during intervention sessions when children fail to generalize. Therefore, the number of words was increased from 10 to 15. Two of the untrained /s/ clusters /sl, sw/ were also introduced during intervention in an attempt to facilitate response generalization. Drill-type activities were also introduced to increase James' opportunities for production practice, in an attempt to facilitate more natural articulation. The drill activities typically involved James producing five to 10 correct repetitions of the requested figure during the computer-based activity.

The third change that was made to help facilitate response generalization involved the role of James' parents. Specifically, James' parents were encouraged to provide James with feedback at home. They were asked to use specific praise when James used /s/ clusters correctly in words. Conversely, when James failed to use initial /s/ consonant clusters appropriately in words his parents were asked to give specific instructional feedback in the form of a request for clarification including the way James said the target word and how it should have been said. This feedback was considered to be similar to that received in the clinic from the therapist.

After 32 sessions (five months following the start of intervention) the /s/ clusters generalized to conversational speech. James' generalized acquisition of velars showed no change during this five-month period, despite 16 intervention sessions. Parental observation of James' speech at home confirmed that the /s/ clusters had generalized.

Was intervention responsible for the change?
Control data were used to determine whether intervention was responsible for the change. Velar fronting was selected as the 'control' process for each child. For both Cody and James, their use of initial velar fronting remained at 100% over the period of time taken to remediate initial /s/ cluster reduction. Thus, it could be said that intervention was responsible for the improvement in their production of /s/ clusters. Note that for James, it was unclear which modifications made to his intervention regime were responsible for the improvement.

How long should a therapy target be treated?
The generalization probe data guided the therapist's decision as to when to stop or modify intervention targeting /s/ cluster reduction. For Cody, the generalization probe data were used to stop intervention targeting /s/ clusters by the 12th intervention session and start intervention on a new target. For James, the generalization probe data guided the decision to modify the intervention approach, given the clinically insignificant improvement by the 16th intervention session.

Summary and conclusion

This paper provides practical insights for evidence-based management of phonological impairment in children. A summary of research is coupled with methods for clinical decision making based on individual children. The paper highlights the need to consider the evidence in conjunction with the child's response to intervention in order to make informed and individually appropriate decisions not only at the outset of intervention, but over the course of intervention. In the case studies, Cody took seven weeks to achieve the predetermined goal of generalized acquisition of initial /s/ consonant clusters, whereas James took five months. Each child received intervention from the same therapist, using the same service delivery format, on the same intervention target. The decision to modify James' intervention was guided by the data collected by the therapist. The way in which James' intervention was modified was informed by James' response to intervention, in conjunction with evidence from published literature regarding ways to facilitate response generalization.

The question of why the Cody and James showed such different rates of progress is an intriguing one. Over the years, numerous studies have been conducted with the aim of identifying a variable that could explicate the findings from intervention research to address the question of why children show such varied responses to intervention. To date, no single pretreatment variable has emerged as a predictor of individuals' rates of progress (Kwiatkowski and Shriberg, 1993). Rather, it would seem that a child's overall combination of capability (presenting clinical profile) and focus (intrinsic motivation within a child and motivating events in a child's environment) might influence progress rate (Kwiatkowski and Shriberg, 1998). This would seem to be the case for Cody and James. Despite having fewer consonant phones in his independent phonetic inventory compared with James, Cody had the better expressive language skills. Cody also seemed to have better focus during intervention sessions. Given Cody's performance during intervention, perhaps these particular skills contributed to his good progress rate. Conversely, perhaps factors in James' presenting clinical profile in combination with his relatively reduced focus during intervention influenced his slower progress rate. Whether James would have benefited from a different intervention approach from the outset, or intervention on a different treatment target is unknown. Baker and Bernhardt (2004) explore the issue further in a retrospective evaluation of James' case. Unanswered questions aside, what is evident from these two cases is that speech and language therapists need to be mindful of published evidence so that informed, evidence-based decisions can be made that are tailored to individuals' needs.

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