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Intervention for a child with persisting speech and literacy difficulties: A psycholinguistic approach

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Abstract
This paper illustrates a psycholinguistic approach to investigating children's speech and literacy difficulties by describing a ''three-way'' intervention plan for Jarrod, a 7 year old boy with unintelligible speech. First, a speech processing profile, a speech processing model and developmental phase models of speech and literacy were used to determine the relationship between his spoken and written language skills and what strengths could be built on in an intervention programme. Second, an analysis of the speech data was used to examine contributing factors to Jarrod's unintelligibility and what intervention targets might be selected to promote his speech, phonological awareness and literacy skills. Third, who might be involved in his intervention programme is suggested and what training might be needed to ensure appropriate interaction between child and listener in the therapy/teaching situation. A psycholinguistic approach can be helpful for children like Jarrod as it tackles speech and literacy simultaneously and has inbuilt assessments, monitoring and evaluation. The intervention can also be carried out by others and in groups. However, this approach needs to be combined with that derived from other perspectives (e.g. linguistic, educational, medical and psychosocial) to ensure a comprehensive management programme is carried out.

Keywords: *Auditory discrimination, phonological representation, speech difficulties, phonological awareness, letter knowledge.*

Introduction

To plan a comprehensive management programme for a child with persisting speech difficulties, a number of perspectives need to be adopted: educational; linguistic; psycholinguistic; medical; psychosocial. This paper aims to describe a psycholinguistic approach to a child with persisting speech and literacy difficulties, bearing in mind that this is just one piece of the jigsaw needed in understanding the nature of persisting speech difficulties in children and their impact on school and home life.

The basic premise of a psycholinguistic perspective is that children's speech and literacy development is the product of an intact speech processing system comprising:

- speech input processing; for example, auditory discrimination;
- lexical representations; for example, where components of words are stored: semantic, phonological, motor, grammar and orthographic;
- speech output processing; for example, programming and production of speech.

This is illustrated in Figure 1. The corollary of this is that children's speech difficulties arise from a breakdown in one, two or all three of the above speech processing domains (i.e. at one or more points within the model depicted in Figure 1). Further, because these speech processing skills are also necessary for phonological awareness to develop, a breakdown at one or more levels in the speech processing system will not only lead to spoken language difficulties but also impact on written language development.

Thus, the broad aims of a psycholinguistic approach to the management of a child with speech difficulties are to:

1. Discover where speech errors are arising within a psycholinguistic model (taking note of medical information; for example, if the child has a hearing loss, neurological condition or structural abnormality).
2. Examine relationships with other aspects of development; for example, phonological awareness; word finding; reading; spelling.

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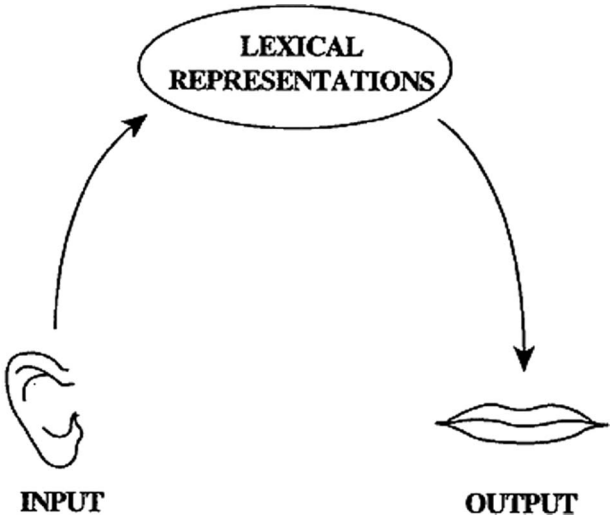

Figure 1. A simple speech processing model (from Stackhouse & Wells, 1997, p. 9) Copyright John Wiley & Sons. Reproduced with permission.

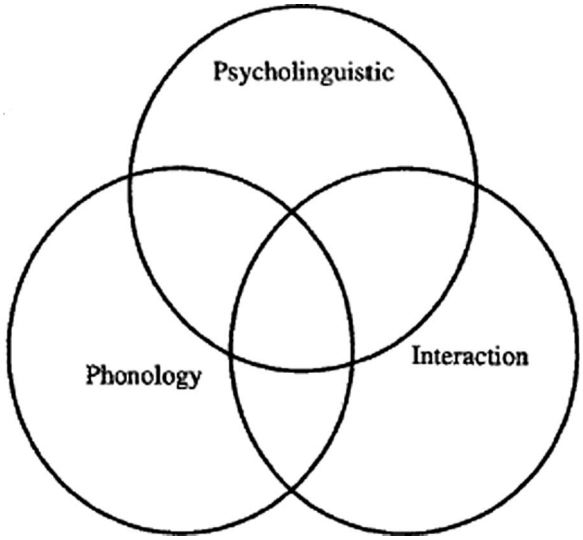

Figure 2. An integrated three-way approach to intervention for children with speech difficulties (from Pascoe, Stackhouse, & Wells, 2006). Copyright John Wiley & Sons. Reproduced with permission.

3. Draw up a profile of speech processing strengths and weaknesses on which an intervention programme can be based.
4. Select targets for intervention from a linguistic analysis of speech output data.
5. Use a child's strengths to work on these targets.
6. Interpret within a psycholinguistic model the child's performance on tasks and when interacting with others.
7. Evaluate intervention outcomes.

In this paper, the psycholinguistic framework developed by Stackhouse and Wells (1997) will be used to illustrate a psycholinguistic approach to the management of Jarrod, a 7 year old boy with speech and literacy difficulties (presented by Holm & Crosbie, 2006). This approach is part of a three-way link between a psycholinguistic profile of speech processing strengths and weaknesses, the speech targets derived from the phonetic/phonological analyses, and the interaction between speaker and listener in intervention tasks (see Figure 2).

After examining the case history and speech data, the assessment results are presented on a speech processing profile to highlight Jarrod's strengths and weaknesses, and interpreted with reference to two theoretical models. We then consider where to start on Jarrod's speech intervention and who might be involved.

Psycholinguistic investigation

An essential aspect of a psycholinguistic investigation is to develop hypotheses about the nature of a child's difficulties and then to test them out through further investigation, either by using/devising specific tests or as an integral part of the intervention process. A first step can be to scrutinize a child's case history information for some hypotheses which might help determine what assessments to choose (see Holm & Crosbie, 2006, for details of Jarrod's case history information).

Hypotheses derived from Jarrod's case history information

Speech history/age of child: CA: 7 years

Jarrod was late developing speech and had not resolved his speech difficulties before starting school which puts him at risk for literacy difficulties. The critical age hypothesis, proposed by Bishop and Adams (1990) states that children who do not resolve their speech and/or language difficulties by the age of 5 years and 6 months are likely to have persisting speech/language difficulties and associated literacy problems. Further, Jarrod's severe and persisting speech difficulties indicate a more pervasive underlying speech processing difficulty involving: speech input, output and word store (Nathan, Stackhouse, Goulandris & Snowling, 2004). Therefore, investigations need to include tests of auditory skills, lexical representations, reading and spelling as well as speech output.

Family history

The family history of speech and literacy difficulties indicates a genetic basis to his speech processing difficulties and the likelihood of phonological problems (Snowling, 2006). Investigations need to include an examination of phonological awareness skills and letter-sound knowledge.

Attention deficit and hyperactivity disorder (ADHD)

Medical information suggests that Jarrod has ADHD. Asking Jarrod's main teacher to complete a questionnaire about his behaviour in class would help to establish the impact of ADHD at school; for example, the *Strengths and Difficulties Questionnaire* (SDQ, Goodman, 1997) or the *AFASIC Check Lists* (included in Speake, 2004).

Asthma

Jarrod has been hospitalized on two occasions because of asthma and uses medication for this condition. Although asthma in itself is not a ''cause'' of speech difficulties in children, an indirect consequence of any chronic condition in childhood is absence from school. It should therefore be established if Jarrod's literacy difficulties are ''specific'' and/or a consequence of missing teaching and learning opportunities, particularly as he is repeating the Year 1 curriculum.

Motor development

An occupational therapy assessment identified fine motor difficulties. An investigation of both specific speech motor skills (see Hayden, 2006) and handwriting skills (Taylor, 2006) would therefore be important. If handwriting in itself is a problem, spelling skills need to be assessed by other means (e.g. by assembling letter shapes), to disambiguate motor versus phonological/alphabetic difficulties as contributors to Jarrod's spelling performance.

Language and cognitive skills

Although his Verbal Intelligence Quotient (81) and his Verbal Comprehension Index (81) both put him at the 10th percentile, his Performance Intelligence Quotient is 93 and his Perceptual Reasoning Index is 111 (76^{th} percentile). Given this discrepancy between verbal and nonverbal skills it is pleasing to see he had done so well on the *Clinical Evaluation of Language Fundamentals* (CELF, Semel, Wiig, & Secord, 2000) obtaining a Core Language Score (a composite of both receptive and expressive language) of 111. This suggests that at this point in time (a) his difficulties may be speech specific and underlying speech processing skills need investigation, (b) cognitive strengths can support spoken skills development and meta-phonological tasks can be incorporated into his intervention programme.

Psychosocial information

Although Jarrod's mother describes him as being happy and able to develop friendships, the teacher reported that Jarrod did not have particularly good social interactions. Both feel he is not inhibited by his speech difficulties but he reported feeling annoyed when he was not understood (*Speech Participation and Activity Assessment of Children*, SPAA-C; see McLeod, 2006). Investigation of how he manages his unintelligibility is key here (Nash, 2006) and we need to establish if it is necessary to follow a psychosocial support programme to help him manage his unintelligibility (e.g. Nash, Stengelhofen, Brown, & Toombs, 2002).

Hypotheses derived from Jarrod's speech data

Jarrod presents as unintelligible but willing to talk. He seems to have difficulties with oral movements for speech suggesting a difficulty at the bottom, right-hand side of the model in Figure 1. Further evidence for this is Jarrod's moist lips and the apparent collection of saliva at the front of his mouth indicating he is not swallowing enough and/or typically. However, Jarrod's speech difficulties are unlikely to be explained fully by an isolated lower level motor difficulty (i.e. in the mouth only), although oral motor skill may be one aspect of his training programme (see Hayden, 2006).

Detailed speech analyses (see Holm & Crosbie, 2006) reveal a number of reasons why Jarrod remains unintelligible. These include:

Segments. Jarrod has restricted segment use in spontaneous speech and naming; for example, in word initial position, his onsets consist mainly of /d/, /b/, /j/ and occasionally /ɡ/; in word final position he either omits segments or uses a glottal stop or /h/. However, he is variable in these substitutions and although one can apply some simplifying process terminology; for example, prevocalic voicing or gliding, there are other examples where his productions are influenced by the phonetic context resulting in consonant harmony across the word. His variable production of segments therefore needs to be examined further to see if these are attempts to get closer to the target or are more random. Another variable influencing his speech is whether his responses are repeated or spontaneous. For example, he correctly produced the word final fricative in *fish* and the word initial affricate in *jam* perfectly well on imitation but not spontaneously. Two further areas need to be checked: (a) stimulability: can he produce the sounds in isolation, even if he does not use them in speech? (b) can he discriminate between sounds he does and does not produce?, and (c) imitated vs. spontaneous productions, is there a difference between the two?

Clusters. Jarrod does not produce two- or three-element clusters accurately. His reduction of /ɡl/ → [d], /sp/ → [b] and /sn/ → [n] might be described as immature cluster reduction. However, his tendency to reduce clusters to the second element; for

example, [r] for /tr, br, sw, θr, pr/; [w] or [wr] for /fr/; [w] for /spl/; and [j] for /skw/ is more unusual. Occasionally he marked friction in an onset cluster e.g. str → /sj/. See Table I.

Multisyllabic words. This is where Jarrod's inconsistent speech output is most apparent and is typical of children who have not been able to (a) store stable motor programmes for known words, and/or (b) cannot assemble a motor programme for a new utterance as well or as quickly as their peers. Further investigation would confirm if Jarrod can detect the correct number of syllables in spoken words and if his motor programmes for known and unfamiliar words keep the appropriate rhythm and stress pattern even if the segments within the word are incorrect.

Connected speech. The staccato rhythm of his connected speech is more likely to be arising from the omission of final consonants—i.e. an open syllable pattern—than from a core prosodic difficulty. This is typical of difficulties with motor planning of utterances and we need to check how he "glues" words together for phrases, i.e. the "between word processes" as well as the simplification processes within words (Newton & Wells, 1999).

Although we can now describe why he is unintelligible, the speech data does not tell us why his speech difficulties are occurring; only a psycholinguistic investigation of his speech input, output and representations will reveal if his difficulties are specific to the output level or more pervasive (Baker, Croot, McLeod, & Paul, 2001).

Jarrod's speech processing profile

The speech processing profile devised by Stackhouse and Wells (1997) was used as a starting point to organize Jarrod's test results. It is based on the simple speech processing model in Figure 1 and comprises a series of questions about a child's input skills, lexical representations and output skills. The profile is not divided into assessment sections (e.g. auditory discrimination, phonological awareness, speech, language) or into lists of tests given. Rather, assessment data is collated by answering the questions posed on the profile which involves knowing "What do tests really test?" (see Stackhouse & Wells, 1997, Chapters 2 and 3 for details of how to do this). Figure 3 shows Jarrod's completed speech processing profile. Questions A–F on the left-hand side of the profile summarize Jarrod's input skills and G–K his output skills. Question L focuses on his monitoring of his own output so links both left and right. Questions near the top of the profile ask about the nature of the stored representation while at the bottom they relate to more peripheral skills; for example, hearing (question A) or oral motor skill (question K). Thus, the profile has two key interacting dimensions: left/right and top/bottom.

Input skills

A. Does Jarrod have adequate auditory perception?
Tests have not revealed any current hearing impairment. However, his history of glue ear may have contributed to his speech processing problems and influenced how he has processed and stored items in the past.

B. Can Jarrod discriminate speech sounds without reference to lexical representations? and *D. Can Jarrod discriminate between real words?*
These two questions are addressed together so that Jarrod's performance on discriminating between pairs of unfamiliar words (B) and pairs of familiar words (D) can be compared. This comparison is important because if only real words are used in our assessments, for which Jarrod already has stored representations, we will not know if he can deal with unfamiliar material, a skill he needs every time he is exposed to new vocabulary. Further, with older children like Jarrod, it is important to make the stimuli challenging enough. Administering simple and familiar CVC minimal pairs to discriminate between (e.g. are these the same or not: *pin*/*bin*?) may

Table I. Examples of Jarrod's production of single words with consonant clusters, and his production of these words in connected speech.

	Single word target	Jarrod's single word production	Jarrod's production in connected speech
1.	spider	/baɪdʌ/	/aɪ dɒ baɪdəmæ wʌn/ *I got Spiderman one*
2.	star	/da/	/æn aɪ dɒʔ dawɔ/ *and I got Star Wars*
3.	monkey	/mʌʔbəɪ/	/də mʌnti/ (unintelligible)
4.	snake	/meɪʔ/	/neɪ ɹaʊ ɪ nek/ *snake round his neck*
5.	box	/bɒʔt/	/den deɪ ɪ dɪ bɒʔ ɪ də beʊt/ *then they in this box in the boat*

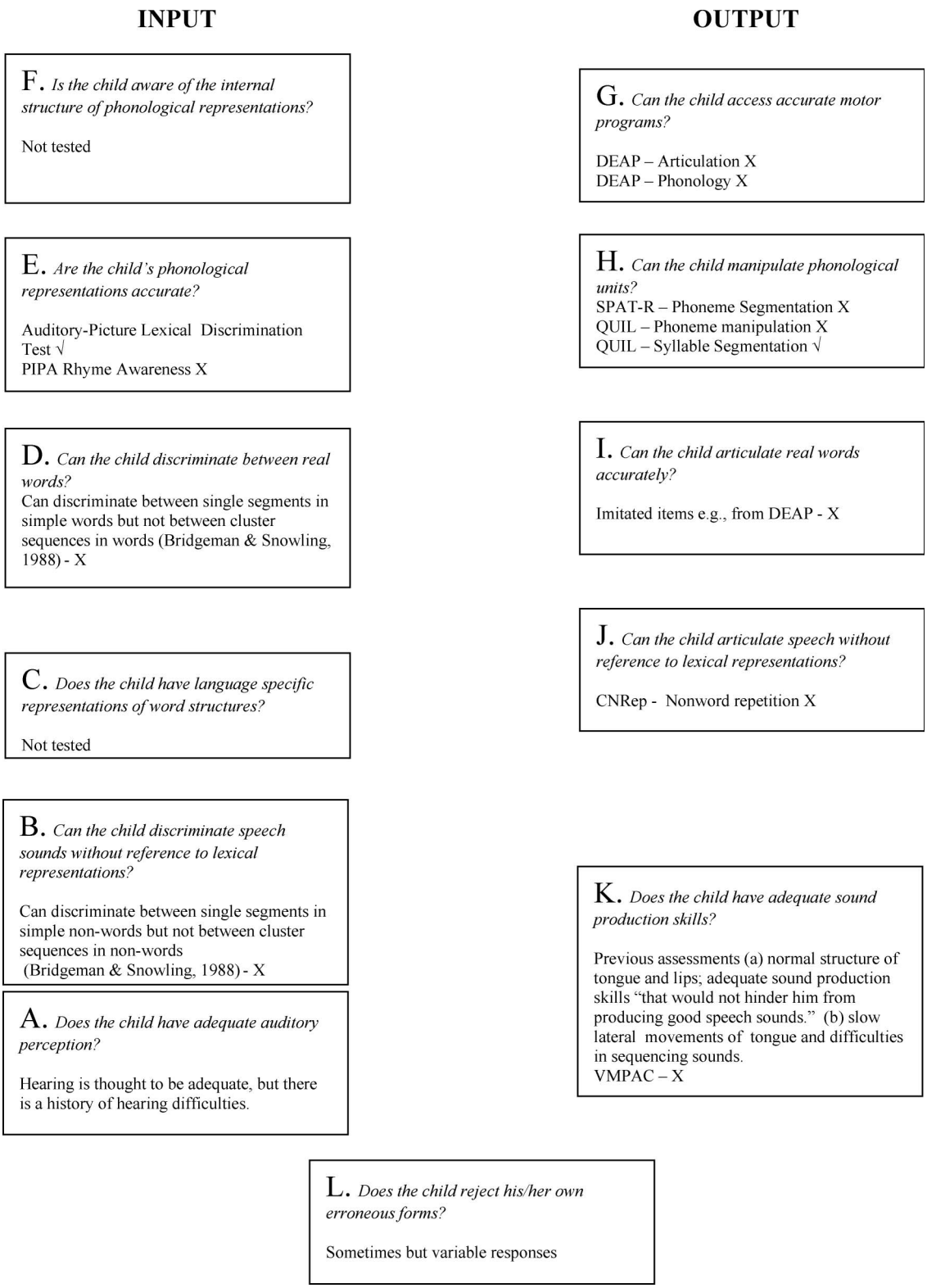

Figure 3. Jarrod's speech processing profile at CA: 7;0 (based on Stackhouse and Wells, 1997). Key: √ Age-appropriate performance. X Below-age performance (more than ISD below the mean for his age).

mask input difficulties. The real word and non-word pairs from Bridgeman and Snowling (1988) were therefore administered. These not only include stimuli with a CVC structure (*loss/lot*; *vos/vot*) but also more complex CVCC items (*lost/lots*; *vost/vots*).

Jarrod performed age appropriately on this task when the items were simple CVC stimuli and there was no difference in his performance on real vs. non-word conditions (see Bridgeman & Snowling, 1988; Stackhouse, Wells, Vance, & Pascoe, forthcoming, for normative data). However, he scored at chance level only when he was required to discriminate between cluster sequences in real words (25% correct); for example, *lost/lots*, and non-words (50% correct);

for example, *vost/vots*. This suggests that Jarrod does not have auditory discrimination difficulties with segments per se since he can discriminate between simple words perfectly well, but that he has specific segment sequence discrimination difficulties. Further, being familiar with the material presented did not help him, i.e. there was no real word advantage. His difficulties with producing /s/ clusters, are therefore not restricted to the output domain; he also has difficulties discriminating between them and therefore it is likely that he has stored "fuzzy" representations of cluster sequences—patterns which are not yet clear. This may explain why stimuli that trigger top-down processing (i.e. familiar words) are not produced better than nonwords.

Phonological awareness tasks can also be interpreted within the profile, not as a separate area of skill but selectively to address questions posed. For example, when answering Question D. we can also draw on results from the rhyme judgment/awareness/detection tasks because these are also discrimination tasks but with the focus on the rime rather than on the onsets; for example, *pin/bin* are not the same on a traditional auditory discrimination task where the child is attending to the onsets but are the same on a rhyme judgment task where the child is asked to attend to the rime. The spoken rhyme recognition test on the *Queensland University Inventory of Literacy* (QUIL, Dodd, Holm, Oerlemans, & McCormick, 1996) is such a rhyme judgement procedure; the child is asked to say if two words rhymed or not (e.g. *rang/sang; beg/bag*). Jarrod scored 7/12 on this task indicating that he has some concept of rhyming words. However, when this was extended to an "odd one out" rhyme detection task comprising four items (e.g. *car*, *jar*, *fan*, *star*), as on the rhyme awareness task in the *Preschool and Primary Inventory of Phonological Awareness* (PIPA, Dodd, Crosbie, McIntosh, Teitzel, & Ozanne, 2000), Jarrod only scored 4/12 correct suggesting a difficulty working with an increased number of items.

The findings from this battery of auditory tests suggest that Jarrod can detect differences between real words at both a segmental and rime level but that this skill breaks down if clusters are introduced into the stimuli (as in *lots/lost*) or if the number of items to process are increased (as in the rhyme detection task). Both of these limitations may be a consequence of his speech output difficulties; holding verbal items in memory in order to make judgements requires articulatory reflection and rehearsal (Vance & Mitchell, 2006).

E. Are Jarrod's phonological representations accurate?
One way of tapping the representations at the top of the model is to show the child a familiar picture and label it for the child correctly or incorrectly to see if s/he can detect when the tester has said it wrong, i.e. a mismatch with what was expected. The test of auditory-picture lexical decision administered to Jarrod manipulated the vowels; for example, child looking at a picture of a brush and is asked "Is it a brush?"; "is it a brish?" Jarrod scored at ceiling on this (46/48 correct) suggesting he can detect differences in vowels that result in changing a word from a real to a nonword. To investigate his representations of segments in words that he can and cannot say, his own productions of target segments or words can be fed back to him to see if he recognizes incorrect vs. correct productions. If he cannot detect a difference when an item is named wrongly then there is a problem with input and stored representations. If he can detect a difference, but still produces it wrongly, his difficulties are more likely to be at an output level.

F. Is the child aware of the internal structure of phonological representations?
No specific tests have been administered to address level F. As at level D, we can look at his performance on phonological awareness tasks to develop our understanding of his skills. For example, we could modify the procedure of the Rhyme Awareness subtest from the PIPA (Dodd et al., 2000) by presenting the pictures as discussed above (e.g. *rake*, *snake*, *cake*, *corn*) but without naming them. Jarrod would then have to decide which is the odd one out based on his own knowledge of the internal structure of words; thus a different level of the profile is tapped by not giving the names of the pictures.

Output skills

G. Can Jarrod access accurate motor programmes?
Jarrod's naming performance on the DEAP (Dodd, Hua, Crosbie, Holm, & Ozanne, 2002); and the HAPP-3 (Hodson, 2004), as well as his spontaneous connected speech, indicates major difficulties with accessing/using accurate motor programmes for speech. The aim of comparing performance at levels G–K is to establish if these difficulties are arising at one or more levels on the output side (see Stackhouse & Wells, 1997, pp. 44–48). Jarrod's variable responses suggest fuzzy representations of words stored and/or difficulties with motor programming. Administering speech tasks of naming, real word and nonword repetition that involve phonetically matched items across tasks helps to compare performance quantitatively and qualitatively across levels (Vance, Stackhouse, & Wells, 2005).

As with the input side of the profile, a lot can be learned about Jarrod's speech processing skills by examining his responses on phonological awareness tasks. The phoneme isolation task in the QUIL (Dodd et al., 1996) asks the child to look at a picture and to identify the "first sound" of it. Similarly with the "final phoneme identification" task on the *Sutherland Phonological Awareness Test-Revised* (SPAT-R, Neilson, 2003) where Jarrod correctly

produced the codas of the 4 items presented (*duck*, *sad*, *roof*, *watch*).

Although these are not pure tests of level G, as the items were named by the tester, the data can still be used to think through some hypotheses about Jarrod's stored motor programmes. Jarrod was able to identify and produce the onsets of the words *fish*, *cake*, *mouse*, *turtle* and *shoe*. On the SPAT-R he scored 4/4 correct when detecting the onsets of *man*, *goat*, *leaf* and *shark*. This suggests that not only does he "know" these single segment onsets but that he can produce more onsets in this task than he produces spontaneously in his speech. However, he did not produce any vowel onsets (e.g. *elephant* and *igloo*) and had trouble with cluster onsets. Although he produced /fl/ as the onset of *flower*, he said "don't know" for onset of *plane*. He produced /s/ for the onset of *spoon* indicating either he does not have a clear representation and programme for "s" clusters or that his speech production difficulties with "s" clusters prevented him producing the answer correctly. Similarly, he produced /ʃ/ as the onset for both *shoe* and *chair*, and [j] for the onset of *lion*. Further investigation of his representations of fricatives and glides/liquids is necessary to establish if his difficulties are at the output level only or also within the stored phonological representations and motor programmes.

H. Can Jarrod manipulate phonological units?

Although Jarrod had some skills in identifying onsets and codas, he found manipulation of segments difficult. He scored 0/4 on all 5 of the SPAT-R tests of this; for example, segmenting CVC words (for the segments of *seat* he produced "j-t-p"; and for *laugh* just "l"); segmentation of the elements in a cluster "tr, sp, nt, scr"; and consonant deletion tasks. He scored 2/4 on the rhyme production task on the SPAT-R but his errors indicated significant problems with rhyme output e.g. given *cap*, *tap* he produced *ring* as a rhyming word.

However, Jarrod achieved 9/12 correct (age-appropriate performance) on the syllable segmentation task from the QUIL (Dodd et al., 1996). This task required him to segment and count the number of syllables in given words; for example, *table*, *hospital*, *economy*, *investigation*. He scored 3/3 on 1 and 2 syllable words, but 1/3 on 4 syllable, and 2/3 on 5 syllable words. This collection of test results indicates that Jarrod can manipulate phonological units at the syllable level but not segments within syllables or within a cluster. Given his age this is a serious barrier to his literacy development, and in particular his spelling which depends on accurate identification of segments in words onto which letters can be matched (Stackhouse, 2006).

I. Can Jarrod articulate real words accurately?

Jarrod cannot spontaneously name words accurately (level G) so by asking him to repeat words (level I) his performance when he is not so dependent on drawing on his own lexical representations can be examined. For example, his production of /dʒ/ in *jam* and /ʃ/ in *fish* was better when it was a repeated response. Taking a right/wrong scoring approach would reveal no significant difference between repeated and spontaneous productions because he makes errors on both. However, there is some indication that hearing the adult model first does cue him and support his production skills.

Another test of this level is to examine Jarrod's skill at blending sounds given by the tester into real words. On the SPAT-R test of blending Jarrod scored 0/4 correct. His strategy was to maintain the vowel but then he was not able to attach other segments to it accurately; for example, given f-ar-m he produced *arm* (correct vowel and kept the rime); s-ur-f was *her* (correct vowel plus a different onset though marked the friction); b-a-ke was *kay* (correct vowel plus coda as onset); l-igh-t was *eye* (correct vowel). His performance suggests that he is likely to have reading difficulties; even if he was able to crack the code by segmenting the sounds of an unfamiliar word himself he would not be able to blend the segments back together to produce a target word.

J. Can the child articulate speech without reference to lexical representations?

To address this question we need to examine Jarrod's responses on a nonword repetition task (e.g. *Children's Nonword Repetition Test*, CNRep, Gathercole & Baddeley, 1996) or look at how he tackles unfamiliar words. Although he can produce the syllable pattern of a new word he finds the production of segments within these syllables very difficult particularly in 3+ syllable words suggesting that he cannot programme his articulators easily for speech production. Part of this may be because of auditory discrimination problems particularly when the new words involve clusters (see level B), or a lack of awareness of segments in the word (see level E), or because of lower level articulatory difficulties (see level K). Whatever the cause(s) the effect will be the same: Jarrod will be disadvantaged not only because of his unintelligible speech but also because he will not be able to learn new words as fast as his peers who may be more able to listen, discriminate, reflect on the word structure and programme their speech quickly and consistently. Repeated spoken rehearsal of an item allows a motor programme to be established for a new word and facilitates vocabulary development, speech and spelling.

K. Does the child have adequate sound production skills?

Jarrod does not have any structural abnormality to explain his speech difficulties. However, the *Verbal Motor Production Assessment for Children* (VMPAC, Hayden & Square, 1999) revealed some functional constraints; for example, tongue movement

difficulties that might affect articulation place change, particularly in longer and more complex words. Reduced swallowing and oral difficulties when speaking have been noted and the indications are that Jarrod has some motor difficulties that are affecting his articulatory performance on more complex words and connected speech in particular. However, the speech processing profile suggests that Jarrod's speech difficulties cannot be explained by poor performance at level K alone.

L. Does Jarrod reject his/her own erroneous forms?
There is no test to administer at this level; rather one observes how a child reacts to their own speech output and then analyses the response, for example:

1. Is there spontaneous speech correction indicating not only self-monitoring skills but also an ability to change speech behaviour at level K?
2. Are there spontaneous attempts at speech correction but these are not always successful because of difficulties elsewhere in the profile?
3. Is any change to speech output only in response to the listener clearly misunderstanding the child's speech output?
4. Can the child change their speech only if directed to do so in therapy?
5. Is there a mixture of responses to Question L and is this related to certain structures, lexical items or contexts?

Jarrod appears variable in his performance at this level which may indicate that he is trying to change his speech output. This level needs monitoring through further observation of him in different contexts and with a range of listeners. The findings on the speech processing profile can now be related to models of speech processing in an attempt to develop hypotheses about the specific nature of Jarrod's difficulties and how best to support him in intervention.

Applying theoretical models

A speech processing model

Speech processing models (e.g. Dodd, 2005; Hewlett, 1990; Stackhouse & Wells, 1997) aim to show the different levels involved in speech processing and production, and how information flows through the system. They are also another means of locating where a child's level(s) of difficulty might be. On Stackhouse and Wells's (1997) model, Jarrod's multi-level speech difficulty is apparent (see Figure 4). He has some difficulties on the input side with his phonological recognition particularly with cluster sequences and further investigation of his phonological representations for segments he can and cannot produce is needed. On the output side, Jarrod has difficulties with online motor programming, i.e. creating motor programmes for new words, and his stored motor programmes are also inaccurate. Difficulties with both stored and online motor programming may explain aspects of the assessment data which suggest no significant difference between his repetition and spontaneous naming skills. Jarrod's jerky production of connected speech indicates motor planning difficulties and his difficulties with oral movements and sound production imply problems at the level of motor execution.

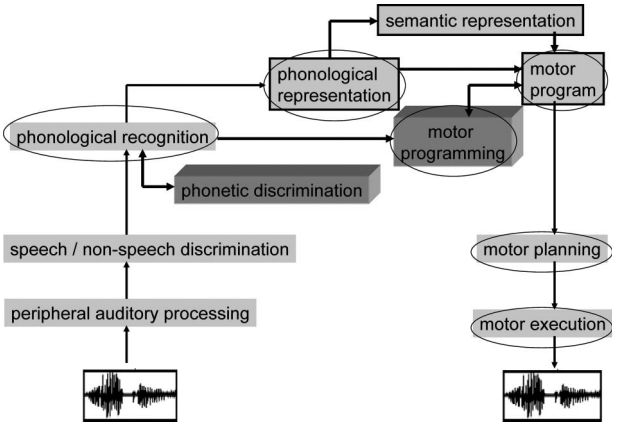

Figure 4. The Speech Processing Model from Stackhouse and Wells (1997) with Jarrod's areas of difficulty circled. Copyright John Wiley & Sons. Reproduced with permission.

Jarrod's intervention needs to address his areas of difficulty by presenting him with carefully-designed tasks that provide opportunities to use his strengths to support his weaknesses.

A developmental phase model

Developmental phase models provide an alternative view to box-and-arrow models when attempting to understand developmental speech difficulties and how they might change over time. The phase model of speech development from Stackhouse and Wells (1997) presents five phases:

1. *Prelexical*: includes babbling, up to around 1 year of age.
2. *Whole word*: first word learning as gestalts, up to around 2 years of age.
3. *Systematic simplification*: characterized by emergence of simplifying processes in speech output between 2;06 and 4 years of age.
4. *Assembly*: mastering connected speech around 3–4 years of age.
5. *Metaphonological*: development and use of phonological awareness skills (needed by around 5 years of age to take advantage of literacy instruction at school).

Inevitably, this is a simplistic view and these phases will overlap rather than follow in a rigid sequence. The principles, however, are helpful when trying to

understand the nature of speech and literacy difficulties in children and how they might be treated. First, typical children move through these phases. Second, typical development involves moving from larger to smaller chunks and from tacit to explicit phonological awareness (Stackhouse & Wells, 1997, p. 55). Third, these principles do not just apply to speech development but are equally true of literacy development. For example, Frith's (1985) developmental phase model of literacy development illustrates how children first read by whole word recognition (the logographic phase) and can only break through to the alphabetic phase of literacy development when they have some skills for cracking the code. This involves understanding the letter-sound relationship and being able to reflect on the segments of speech in order to map the letters on to those segments for spelling. Children therefore need to be in at least the systematic simplification phase of speech development to begin to reflect on speech patterns in a meaningful way, i.e. inconsistent speech output militates against the development of phonological awareness because there is not a stable pattern of speech output for reflection and comparison with letter sounds. The third phase of literacy development is a more efficient way of tackling literacy by applying phonological and morphological knowledge to chunks of words; for example, recognizing that ''tion'' is pronounced ''shun'' in *addition*, and *subtraction*. Figure 5 illustrates the links between these phase models of speech and literacy development.

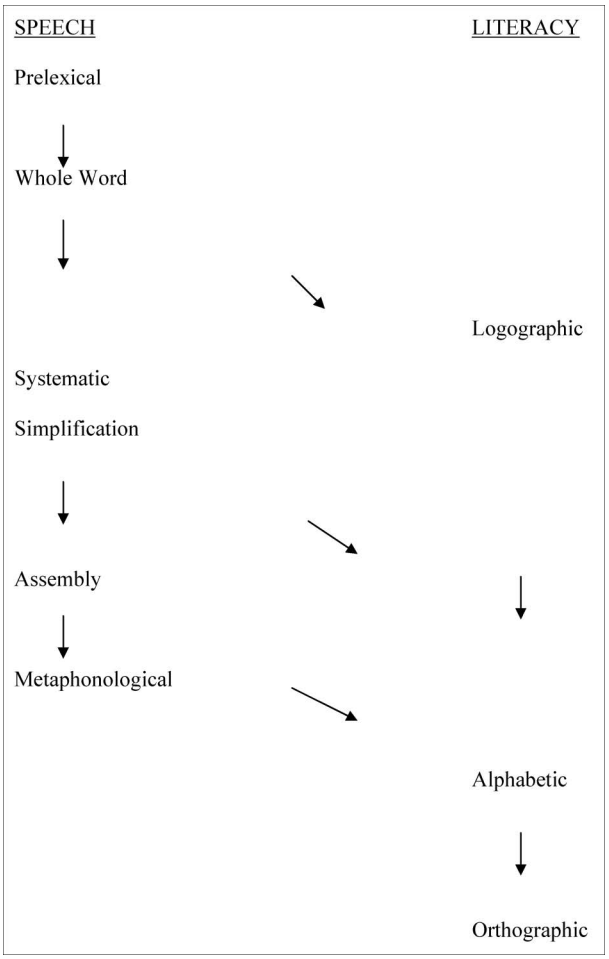

Figure 5. The relationship between the phases of speech and literacy development (from Stackhouse & Wells, 1997, p. 331). Copyright John Wiley & Sons. Reproduced with permission.

Jarrod's inconsistent speech output suggests that he might still be functioning in the whole word phase of speech development. Although he is using some simplification processes; for example, stopping and prevocalic voicing, his pervasive speech output difficulties militate against moving on through this phase into the assembly and metaphonological phases suggesting that he may experience literacy difficulties. One of the best early predictors of literacy development is letter knowledge (Muter, 2006; Nathan et al., 2004) and Jarrod underperforms on this task in the PIPA (17/32 correct). His errors included /r/ for m and w; /v/ for y; /f/ for th; /j/ for l and j (he also substitutes /j/ for /l/ in speech); /b/ for d; /b-f/ for br; /f-l/ for fl; /s-w/ for sw; /ae/ for e and ''don't know'' for u. This is limited letter knowledge for his age and does not bode well for reading and spelling performance. He would not attempt nonword reading or spelling on the SPAT-R test. On the QUIL non-word reading test he read *acked* as /ae-k/; *slet* as /s-l-ae-t/ and *sord* as /s-/ confirming our observation on the profile (level I) that even if he could segment the letters and apply letter-sound rules he may not be able to blend his response to produce the target. His nonword spelling comprised an isolated letter for each of five targets: two responses were a reversed letter ''f''; one was a reversed letter ''s''; the other two comprised ''lt'' and ''w''. In summary, Jarrod has not broken through to the alphabetic stage of literacy development and does not have the skills (speech production and phonological awareness), or the tools (sound-letter knowledge and use) to do this. Jarrod's intervention will need to help him consolidate the early literacy skills he has and move forward to the subsequent stages of literacy.

Psycholinguistic approach to intervention

With children like Jarrod who have such complex speech difficulties it is often difficult to know what to do first! A psycholinguistic approach helps to consider what a child *can* do as a basis for intervention. Referring back to Jarrod's speech and literacy data, and the information assembled in the speech processing profile, it can be seen that Jarrod's strengths include:

(a) awareness of syllable structure;
(b) auditory discrimination of simple words;
(c) some use of simplifying processes;
(d) some alphabetic knowledge;
(e) imitated attempts better (e.g. produced voiceless plosives on imitation); and
(f) becoming aware of need to change speech output.

Priorities can now be set for Jarrod's intervention programme by identifying what is contributing most to his difficulties. For example, the contributing factors to Jarrod's unintelligible speech are:

(a) limited use of segments and clusters in syllable initial word initial position;
(b) omission of syllable final word final segments;
(c) inconsistent production of longer words;
(d) jerky connected speech.

The contributing factors to Jarrod's limited speech processing skills are:

(a) Poor auditory discrimination of sound sequences,
(b) Possible fuzzy phonological representations,
(c) Speech output difficulties: programming, planning and execution,
(d) Limited phonological memory.

The contributing factors to Jarrod's literacy difficulties are:

(a) incomplete grapheme-phoneme knowledge;
(b) limited alphabetic skill;
(c) poor phonological awareness skills, particularly "sound" segmentation;
(d) handwriting?

Devising intervention tasks for Jarrod

Taking into account Jarrod's strengths and weaknesses, tasks need to be devised that will fulfil the general aim for Jarrod: to improve his intelligibility and literacy performance. These tasks will involve both input and output skills and include phonological awareness. Together the speech data and psycholinguistic models suggest a range of possible tasks. One suggestion is that motor programming of multisyllabic words and planning of connected speech be targeted. Motor programming and motor planning were areas of difficulty circled in Figure 4, and multisyllabic words and connected speech were aspects highlighted in the discussion of Jarrod's speech data (see Table I). For some children starting with connected speech rather than sounds in isolation is helpful (Pascoe, Stackhouse, & Wells, 2005).

Specific intervention objectives for Jarrod are to:

1. expand use of onsets to include fricatives;
2. mark codas with fricatives or plosives;
3. attempt more clusters;
4. stabilize 2+ syllable words;
5. reduce glottalization across word boundaries;
6. develop phonological awareness of segments;
7. link speech skills with letter knowledge.

To work on objectives 1–5 above a range of tasks can be designed which also address objectives 6 and 7. More than one area at once can be targeted to establish how Jarrod responds to therapy and what strategies he prefers. His response will determine the next phase of intervention planning. Different tasks also need to be sampled in order to decide which one(s) need to be carried out by a speech-language pathologist and which, with training, could be carried out by others, such as parents, assistants or by the teacher in the language group he attends. Any of the following activities might be a helpful starting point.

1. Expand use of onsets to include fricatives

By using coda position to get fricative onsets. Although Jarrod is not producing fricatives in onset position of words, he has occasionally used /ʃ/ as a coda (e.g. he said "wush" for *splash*) and he has produced /ʃ/ at the end of *fish* in an imitation of the word. He also knows the grapheme for this sound. Rather than asking Jarrod to produce onsets in single words beginning with fricatives, it may be more helpful to him to produce two words where the first ends in a fricative and the second starts with a vowel. For example, by making up two scenarios with him, (a) a meal, and (b) a robbery, he could work on the production of set phrases e.g. (a) *fresh egg*, *dish up* (the dinner), *wash up* and (b) *dish out* (the money), *rush over*, *push off*. This could be extended to production of /s/ by introducing characters; for example, teachers whose name begin with a vowel—*Miss Allen* and *Miss Owen* or playing a board game where *miss out* or *miss a turn* is a frequent production.

An alternative strategy is to use two words where the first ends with a fricative and the second begins with the same fricative to encourage the production of fricatives across word/syllable boundaries. These items can be incorporated into popular games; for example, a picture pairs memory game. First, a small number of picture pairs focusing on one fricative might be used (e.g. /ʃ /: *posh shoe*; *fish shop*), and then more pairs gradually introduced to expand the use of fricatives, (e.g. /v/: *five vans*; *five vases*; /s/: *mouse singing*; *house sign*. All the picture cards are placed face down on the table and players take it in turns to select two, naming each card as it is turned over. Initially if Jarrod remembers where matching cards are, and makes a reasonable attempt to produce the fricative targets he keeps the pair. As he progresses he must not only select two cards the same but also produce the fricatives accurately. The other player must do the same and can introduce saying the pictures right or wrong for Jarrod to detect if the words are pronounced correctly or not, thus also working on his stored phonological representations. By producing the words with a glottal at the word boundary or with a distorted fricative—perhaps what Jarrod produces himself—his awareness of what is an acceptable vs. incorrect production can be increased. This activity therefore works on production

(articulation and motor planning), auditory discrimination and phonological representations. Ideally, the written words will be on the picture cards too with the fricatives underlined or highlighted in a different colour so phrases like *mice singing* should be avoided to begin with as although phonetically useful, they are orthographically confusing. By selecting targets with one-to-one sound-letter correspondence, orthography can be used to support Jarrod's onset production by building on the letter knowledge he has.

By using letter knowledge. Jarrod can produce more letter sounds when asked than he uses spontaneously in onset position in his speech output. For example, he does not use any fricatives in initial position on naming tasks but he knew the sounds of the letters: ''f'', ''s'', and digraph ''sh''. To encourage Jarrod's use of fricatives in onset position, while at the same time developing his sound blending skills to the onset-rime level (e.g. sh-op) as a step towards ''sound'' segmentation (sh-o-p), Jarrod could be presented with a written rime on a card; for example, ''op'', with possible onsets written on separate cards; for example, s and sh. The aim is to move the onset card to the beginning of the rime card and blend the onset with the rime smoothly, without any jerkiness (e.g. ssssssop; shhhhhhhhop), thus producing a word with a fricative onset. By reflecting on and discriminating between the two possible onsets, Jarrod can decide which onset resulted in a real word and match it to a picture of the word; for example, *shop*. If this task is too difficult because of confusion between the fricatives (s, sh), then dissimilar onsets could be used e.g. ''b'' and ''sh'' to begin with.

Gradually this activity can be expanded, for example by presenting the written rime ''un'' or ''and'' via wooden/plastic letters then place a small rainbow shape of individual letters above it for him to pull down into the onset position (see Figure 6). This task not only taps onset production and blending skill but also letter-sound knowledge, phonological awareness at the onset/rime level, lexical decision, and semantic and orthographic representations. If any speech errors Jarrod makes in this task are played back to him by his partner in the game, then the task can also tap auditory discrimination and phonological representations (see Hatcher, 2000, 2006 for further ideas about sound linkage with letters and blending). An alternative strategy is to introduce ''s'' clusters in onset position in these activities as a means of facilitating singleton fricative onsets (see Hodson, 2006). This can be linked with suggestions in 3, below.

2. Expand use of codas

By using onsets. Although Jarrod can produce /b, d, ɡ/ in onset position he omits these in coda position. Again, by carefully selecting two word phrases as Jarrod's speech targets, he can be supported to produce plosives in coda position by his ability to produce them in onset position. For example, stimuli such as: *big girl*, *red door*, *red deer*, *fab ball* can be used in various games (see Pascoe, Stackhouse, & Wells, 2006 for further discussion about stimuli design).

3. Develop use of clusters

Through orthography and other forms of cueing. Although clusters are often left until later in a programme, working on clusters can facilitate more single segment use (Gierut, 1999; Hodson, 1997; Pascoe et al., 2006). Given his auditory discrimination difficulties with ''s'' cluster sequences introducing sound symbol cards (e.g. from the *Nuffield Centre Dyspraxia Programme* (Williams & Stephens, 2004) or *Cued Articulation* (Passy, 1993) may be helpful. The teacher should first confirm what symbols are being used in class and how clusters (or blends) are being taught in the curriculum to avoid any confusion.

4. Stabilizing 2+ syllable words

By building on Jarrod's ability to maintain syllable structure in simple two and three syllable words. A set of carefully selected words can be used to help Jarrod practice motor programmes and stabilize his inconsistent productions. He can rehearse how many syllables are in given words by putting a brick in a

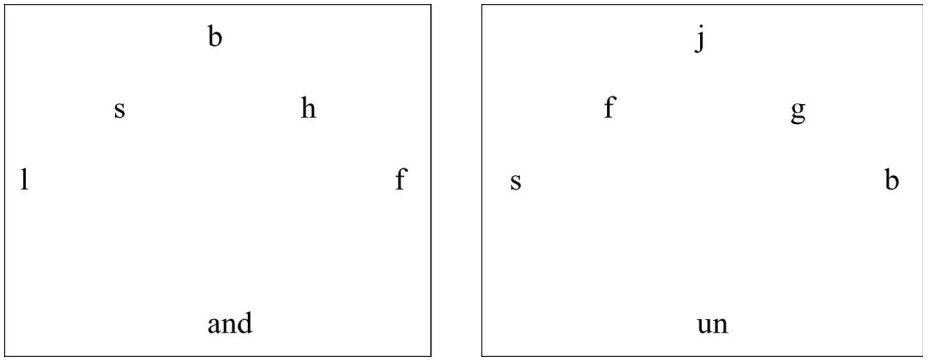

Figure 6. An onset speech task for Jarrod with orthography and blending.

sequence from left to right to mark the beats in the word; for example, two bricks for *baby* and three for *potato* (e.g. see Lindamood & Lindamood, 1998). To help him programme the correct segments within the syllable he can look at the picture of the target and the written word and point to the grapheme that begins each syllable as he says it; for example, b and b in *baby*; t and b in *table*. This is a particularly important strategy with longer words, for example he omits the onset in *tomato* (-omato). This set of words should be useful for him and be phonetically controlled to avoid four syllable words, words with clusters and complicated fricative sequences to begin with. It would also be helpful at this stage to have simple letter-sound correspondences. If this strategy of targeting set words is successful, then other people can be involved in carrying out practice at home or at school and the items can be expanded to work on more complex high frequency words (see Dodd, Holm, Crosbie, & McIntosh, 2006; Crosbie, Pine, Holm, & Dodd, 2006, for a similar "core vocabulary" approach).

5. Connected speech

By building on the work across word boundaries (see 1 and 2 above) and Jarrod's willingness to talk. Phonetically controlled phrases can be extended and used to practice management of word boundaries (see Pascoe et al., 2006, for examples of this). Role play involving exaggerated intonation or introducing different accents can be fun and can support the rhythm and flow of speech. Singing and drama sessions at school which develop breathing and voice production in connected speech can also be used to good effect.

Principles of psycholinguistic intervention

It is clear from these examples of possible therapy activities that a psycholinguistic approach does not involve novel games or materials. Rather, it is about analysing task demands from a psycholinguistic perspective and matching these to a child's needs. Each task in an intervention programme will comprise: some materials, a procedure, feedback to the child, and sometimes additional support or a "technique" (e.g. colour coding, cued articulation, picture symbols for sounds). By analysing tasks in this way, it can be established what psycholinguistic skills are being tapped in a task, which skills can be manipulated within the task, and how to make a task easier or harder depending on the child's response. Holding the psycholinguistic variables in mind also allows the presenter to change elements of the task *at the time of the presentation*—this is skilled psycholinguistic working: a dynamic manipulation of task presentation in order to develop a child's skills in both speech and literacy (see Rees, 2001, for a framework for psycholinguistic task analysis).

This feature of psycholinguistic intervention is also its built in assessment; there is no need for ongoing administration of tests if performance on intervention tasks is interpreted with reference to a psycholinguistic profile or model. Also embedded in the approach is a means of evaluating the intervention. A baseline of measures is established at the beginning for "macro" comparison, for example, assessments can be readministered to compare speech processing profiles over time. However, most importantly with children with persisting and severe speech difficulties are more qualitative "micro" evaluations. These include having sets of phonetically controlled non-treated stimuli to examine generalization and also measures of intelligibility at set points in time (see Pascoe et al., 2006).

The psycholinguistic approach is also an active means of extending knowledge about intervention. In the case of Jarrod, specific research questions can be posed which his intervention outcomes would address. For example,

1. Does intervention on output, bring about changes in input processing; for example, auditory discrimination?
2. Will better motor planning, have "knock-on" effects to other aspects of the speech processing system; for example, upward into motor programmes as measured by increased accuracy in single word production, and downwards into motor execution?
3. Does working on clusters improve segmental production?
4. Does work on letter knowledge and phonological awareness generalize to both speech and literacy development?

There is still one essential ingredient to highlight in a psycholinguistic approach and that is the child's monitoring of his/her own output and how this output changes in response to listeners' reactions, i.e. level L on the speech processing profile in Figure 3 (see Stackhouse & Wells, 1997, pp. 413–419, for further discussion of this level).

Child-listener interaction

However good an intervention programme is on paper, or however attractive the materials, the interaction between the child and the speech-language pathologist is key to a successful outcome. In addition to careful consideration of psycholinguistic and phonological factors, the third aspect of the integrated model of intervention is interaction.

> It is argued that a major part of an SLT's [speech and language therapist's] skills lies in the handling of the interactional sequence as much as in the choice of therapeutic approach or phonological targets for remediation. (Gardner, 2006, p. 28)

This skill is not necessarily present in parents of children with speech difficulties (Gardner, 2004) or in assistants/teachers (Ridley, Radford, & Mahon, 2002). How to work with parents collaboratively on phonological therapy has been demonstrated by Bowen and Cupples (1999, 2006). Training assistants to work with speech sound difficulties is also important. Gardner (2006) bases training of assistants and speech-language pathology students on a ''talking about speech'' model and has demonstrated positive effects of working through others for children's speech outcomes. By teaching the special features of therapy-like interaction to assistants, opportunities to tackle speech within the school day will be far greater than in therapy sessions alone which may not be on a regular basis. How the adult tackles setting the targets, how the child's attempts are rewarded and repaired is crucial to the effectiveness of an intervention programme and to the child's understanding of what s/he is aiming to achieve. Where possible filming of an early speech-language pathologist-led session can be used as a basis for analysis of a sequence of talk. From this the types of stimuli responses and scaffolding with prompts and cues which lead to a level of success can be recorded, using observation checklists as a guide for the assistant(s) involved. A possible trajectory of progress over time and the developments necessary in the interaction sequence can then be discussed. For example, an important progression that routinely occurs in ''therapy talk'' is where the child is encouraged to carry out self-repair (i.e. working on Level L in the profile) as their facility with the target increases. In the case of Jarrod, an assistant would need to know what s/he could expect Jarrod to repair and not push him beyond his capabilities. As well as training in the understanding of the concepts behind the interaction in therapy, an assistant needs to be given structured activities involving set targets where s/he is able to shape the behaviour appropriately. It is essential that the therapist is on hand for queries about this programme and that it is reviewed on a regular basis (see Pascoe et al., 2006, for further discussion about service delivery issues).

Summary

This paper has made use of the psycholinguistic framework developed by Stackhouse and Wells (1997, 2001) to investigate the relationship between Jarrod's spoken and written language difficulties and to start planning intervention for him. To do this other perspectives were needed; in particular the linguistic one to select and design appropriate targets. Implementing this programme is a dynamic interaction between listener and child, and analysis by a trained listener is essential. However, this does not preclude others carrying out tasks with Jarrod following appropriate training, neither does a psycholinguistic approach have to be carried out on a one to one basis; many of the activities suggested lend themselves to group work. There is no special equipment to carry out a psycholinguistically motivated intervention programme. All assessments and intervention materials have psycholinguistic properties which will change depending on how they are presented. Thus, a psycholinguistic approach is a particular way of thinking about a child's speech and literacy difficulties and ensures active questioning about how and why we do what we do.

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