Children with persisting speech difficulties: Exploring speech production and intelligibility across different contexts

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Chapter Seven

Case Study: Hamish

7.1 Background

At the beginning of the study Hamish was 6;7; he was first referred for speech and language therapy assessment by the health visitor when he was 2;4 because he used only two words ("more" and "mine") in spite of age appropriate receptive language, and excellent use of vocalisation and gesture to communicate. He had regular speech and language therapy intervention from this time. As his speech emerged it was described as both delayed and disordered, and he was subsequently diagnosed with CAS (referred to as verbal dyspraxia in his case notes). Hamish is the middle child in his family; his older sister's speech developed typically; his younger brother had treatment for a severe phonological disorder which did not resolve until the age of six and half. Hamish's development was typical in all areas except speech and language; there was a suggestion of an early bout of glue ear but all subsequent hearing tests were normal. At the time of this study there were emerging and significant concerns about the development of Hamish's literacy skills and at this point he was unable to read or spell anything independently.

7.2 Initial observations T1 (CA 6;7)

The first and overwhelming impression of Hamish was of his severely impaired intelligibility. After some initial shyness, he was responsive and communicative but his speech was very difficult to understand, even in context. He answered questions and responded to activities appropriately; a language assessment five months later confirmed that his receptive language skills were typical for his age, although his expressive language showed significant delay particularly in syntactic development (see appendix 7.1). Hamish frequently put his hands to his mouth, and during naming tasks sometimes displayed whole body movements (for example, head, neck and upper body moving forwards) with the apparent effort of word production in this context; conversationally he was more relaxed. Asked what he thought about his speech he said "bad"; his response to a question about whether people could understand him was "no, I hate it".

The initial impressionistic assessment of Hamish's speech at this preliminary examination was that it was characterised by having a limited consonant system especially in word-final and within word positions with widespread use of glottal stops. He was not using word-

initial consonant clusters and his production of vowels also appeared atypical with a reduced number of contrasts.

7.3 Initial assessment T1

Hamish's input processing skills and speech output skills in single words and multi-word utterances were assessed following the approach described in Chapter Three, Methods (see appendix 7.2 for his speech processing profile and 7.3 for the mapping of this profile to the speech processing model).

7.4 Input processing skills T1

The investigation of Hamish's input processing skills included assessment tasks from Stackhouse, Vance, Pascoe and Wells (2007) and other non-standardised activities. In June 2009 (CA 6;4), three months before the start of the study Hamish's speech and language therapist had completed the Phonological Awareness Assessment (North & Parker, 1993) and this formed the basis of the input processing assessment. Results are given in table 7.1 (note, norms not given).

Table 7.1 Hamish: Results of the Phonological Awareness Assessment (North & Parker, 1993)

Task	Example	Hamish's results	Comments
Syllable clapping	Clap the word: table, cat, elephant	11/12, 91.66% correct	Syllable clapping accurate
Auditory discrimination: segments	Same/different : real words-chip/ship; let/met Non-words: bup/dup; min/nin	Real words, 11/13, 84.61% correct Non-words, 8/9, 88.88% correct	Able to judge similarity/difference broadly at whole-word level
Auditory discrimination: sequence	Same/different: real words beast/beats; pit/tip Non-words: sost/sost; flest/flets	Real words, 5/8, 62.5% correct Non-words, 4/8, 50% correct	Results at chance level
Onset awareness	Does ball begin with b? Does shoe begin with d?	5/8, 62.5% correct	Therapist comment: "said yes to all items" Results at chance level
Onset awareness	What sound does "horse" begin with?	5/10, 50% correct	Results affected by output difficulties e.g. "sun" begins with [d]
Onset awareness	Look at this picture (cat); can you find another picture that starts with the same sound? (choice: car/banana)	4/8, 50% correct	Results at chance level. Unable to inhibit rehearsal, so results affected by output difficulties.

Coda awareness	Look at this picture (duck); can you find another picture that ends with the same sound? (choice: hat/sock)	0 correct	Unable to do task
Sound blending	What am I saying? "s-o-ck"	With pictures, 6/6, 100% correct Without pictures: output difficulties interfered with task, only 1/10 definitely correct	Able to identify CVC words from heard segments when the response was to select a picture Identified "key" i.e. a CV word

In summary, Hamish showed good syllable awareness; his speech perception was sufficiently developed so that he was able to tell whether two simple real words or non-words were the same or different. He was able to accurately match pictures to CVC words divided into segments (e.g. p-i-g), suggesting that his underlying phonological representations for those words were adequate for the purposes of identification. He had difficulty in the discrimination of both real and non-words where the difference was based on segmental sequence (i.e. more complex items). He was not reliably able to identify word-initial segments and was not able to identify word-final segments at all, suggesting difficulties in segmenting within a word. He found it very difficult to complete input tasks without rehearsing out loud and his own realisations appear to have interfered with the activities. The speech and language therapist also noted that his attention span for input tasks was quite limited.

Assessment at T1 was 3 months after the North and Parker assessment was completed. Hamish's speech discrimination was examined through the judgements between same/different SFWF single features and /s/ cluster sequences in real words and non-words (for example, lot/loss; vot/vos; lots/lost; vots/vost) (Bridgeman & Snowling, 1988; in Stackhouse et al., 2007). Hamish's overall number of responses correct was 24/36, compared with a mean score of 33/36 (S.D. 4.83) for a typical 6-year-old. His z-score was -1.86 indicating a mild level of difficulty with the task as a whole but examination of items within the activity revealed some differences between the types of stimuli. Hamish's discrimination of both types of stimuli in real words (z=-1.25) was better than non-words (z=-2.27). His discrimination between single sound features (z=-1.44) was better than

cluster sequences (z=-2.15). He showed most difficulty with cluster sequences in non-words (z=-3.51) in comparison with cluster sequences for real words (z=-0.65).

Hamish's perception of word onset and coda was further explored through informal activities as a precursor to an intervention plan (see table 7.2).

Table 7.2 Hamish: onset and coda perception T1

Task	Onset	Coda
Minimal pairs, with pictures: "point to the one I say"	Plosive/fricative contrast: tea vs. sea; pat vs. fat Cluster/singleton contrast: snail vs. nail; please vs. peas Hamish was 100% accurate in discriminating onset contrasts with picture support	Open/closed syllable contrast: bee vs. bean; buy vs. bike. Plosive/fricative/nasal contrasts: right vs. rice; teeth vs. team Hamish had no difficulty in discriminating coda contrasts with picture support
Mispronunciation detection supported by pictures	Target: sea-"is it tea/fee/me/pea?" Hamish had no difficulty in judging whether the heard word matched the picture	Target: bike-"is it buy/bite/bide?" Hamish had no difficulty in judging whether the heard word matched the picture
Sorting pictures by onset/coda with and without an adult model	Hamish was able to accurately sort words by onset given an adult model. Without a model he frequently made errors which related to his segmental difficulties but given targets that he could realise e.g. /m/, /d/ he could sort them reliably.	Hamish was sometimes able to sort words by coda given a careful adult model. Visual support was helpful but he frequently lost focus in terms of what part of the word he needed to segment. Without a model he was not able to sort pictures with any reliability.

These activities confirmed the findings from the North and Parker assessment. Taken together Hamish's performance on input processing tasks was significantly below the level expected for a child of his age and might have implications for his speech production skills. For example, Hamish had more success with segmenting onset sounds if the target phonemes were in his production repertoire but his ability to identify and segment coda segments was very poor. A phonological process analysis of Hamish's speech (see section 7.10) indicated limited use of SFWF consonants. Any conclusions about Hamish's speech should take into account his processing skills in terms of both input and output performance.

7.5 Speech output skills T1

Hamish's speech output skills were assessed using a range of single word tests; the Picture Naming Task (Stackhouse et al., 2007), the Non-Word Repetition Task (Stackhouse et al.,

2007) and subtests of the DEAP (Dodd et al., 2002). The single word (SW) analysis was based on 111 items collected during these tasks (appendix 7.4). The multi-word data are from the analysis of T1 conversational speech (CS) samples 1-7 (appendices 7.5 to 7.10) and selected imitated sentences from the Connected Speech Processes (CSP) Repetition Task (Stackhouse et al., 2007), (appendix 7.11); there are occasional examples from other conversational speech, which are indicated in the text.

The Picture Naming Task (Stackhouse et al., 2007) allowed comparison of the accuracy of Hamish's whole word production with the expected score for a child of his age (see table 7.3); scoring is based on the number of whole words that match the adult target. His overall score across all word lengths was 1/60 (1.66%), z=-11.93, compared with the mean score for a 6-year-old of 51.35/60 (85.58%), indicating a severe level of difficulty in comparison with a typically developing peer group. His scores for 1 syllable (0/20, z=-14.00), 2 syllable (1/20, z=-11.00) and 3/4 syllable (0/20, z=-5.04) words were all at a similar level of difficulty. The one word named accurately was MONEY.

Table 7.3 Hamish: Scores for Picture Naming Task & Non-Word Repetition Task T1

	Picture naming task (real words)		**Non-Word Repetition Task**	
Word structure	Norms age 6 years: mean (S.D.)	Hamish's score (z-score)	Norms age 6 years: mean (S.D.)	Hamish's score (z-score)
1 syllable (N=20)	18.35 (1.31)	0 (-14.00)	16.7 (1.22)	0 (-13.91)
2 syllable (N=20)	17.50 (1.50)	1 (-11.00)	16.05 (1.23)	2 (-11.42)
3 & 4 syllable (N=20)	15.50 (3.07)	0 (-5.04)	15.00 (2.7)	0 (-5.55)
Total (N=60);	51.35 (4.22)	1 (-11.93)	47.75 (4.22)	2 (-10.84)

Hamish completed the Non-Word Repetition Task (Stackhouse et al., 2007), (see table 7.3). His score across all word lengths was 2/60 (3.33%), z=-10.84, compared with a mean score of 47.75 (S.D. 4.22) for typical 6-year-olds indicating a severe level of difficulty; Hamish performed equally poorly across all word lengths as can be seen in table 7.3. The credited non-words were the match to MONEY, (accurate in the naming task) /ˈmɛnə/ which Hamish realised as [ˈmæni] which is correct based on consonant production, and /ˈtɛɪlət/ realised as [ˈtɛɪlə?]; in real word naming Hamish realised the matched word TOILET as [ˈlɔɪlə?] with consonant harmony.

The Real Word Repetition Task (Stackhouse et al., 2007) was also completed and Hamish's performance was similar to the naming and non-word repetition tasks, with a total score of 1/60 (1.66%), z=-17.59, across all word lengths, compared with a mean of 53.95/60, (89.91%), S.D. 3.01, for a typical 6-year-old. He scored 0/20, z=-13.81 for 1 syllable words; 1/20, z=-9.97 for 2 syllable words; 0/20, z=-8.81 for 3/4 syllable words. The one accurately repeated item was MONEY, which was also the one word accurately named.

In summary, Hamish's performance across all three tasks, naming and both real word and non-word repetition were equally poor suggesting that similar motor and perceptual constraints affected Hamish's output of both previously known and novel words. Stackhouse and Wells (1997, p. 47) suggest that this may reflect "generalized articulatory difficulties" and Hamish's responses to a stimulability task (see section 7.8) confirmed that his ability to repeat single segments and CV syllables for sounds not in his inventory was limited.

7.6 Oro-motor assessment and diadochokinesis (DDK) T1

Hamish's oro-motor skills were assessed using items from the DEAP (Dodd et al., 2002). Hamish's non-speech movements in isolation (for example, tongue elevation) and in sequences (for example, tongue elevation then blowing) were accurate and performed at an appropriate rate according to the description in the test manual. There was no evidence of oro-motor difficulties.

Hamish's DDK skills were assessed in a non-standardised way through repetition of a sequence of single segments [p], [t], [k] (see Methods, Chapter Three). He was asked to do this 10 times after being given an adult model and three practise attempts. Hamish was unable to produce the sequence accurately at all, unsurprisingly given his difficulties with the production of velar plosives. Voice and place of articulation were variable throughout and his velar plosives were often realised with uvular placement. He frequently hesitated between segments.

Although articulatory factors in relation to the production of the velar plosive were in evidence in this task, Hamish's performance was nevertheless suggestive of difficulties over and above this constraint. His variable and hesitant output was consistent with his having difficulties with motor planning (Stackhouse et al., 2007).

7.7 Phonetic inventory T1

Hamish's phonetic inventory, based on single word and utterance level analysis, is listed in table 7.4.

Table 7.4 Hamish: phonetic inventory (consonants) in SW and CS at T1

	Bi-labial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	V/p*	Glottal
Plosive	p b			t d			g		ʔ
Ejective	p'								
Nasal	m			n			ŋ		
Fricative		f v	ð	s				ɱ	h
Approxi-mant	w	ʋ		l		j			

*V/p: velopharyngeal

Hamish's vowel inventory included all vowels expected for his accent of English (see Chapter Three, Methods) except the diphthong [ɛə]. In this analysis the realisation of /t/ as a glottal stop in SFWW and SFWF positions and the vocalisation of SFWF /l/ to [ʊ] (Grunwell, 1987) are judged as typical for Hamish's accent of English.

7.8 Stimulability T1

Stimulability was assessed using the DEAP items (Dodd et al., 2002). Hamish was stimulable for [k] and [s] in isolation and in CV syllables, but not for any other sounds that were not in his inventory (i.e. [θ, z, ʃ, ʒ, ʧ, ʤ, ɹ] and not for those two phones in VC syllables. Other targets not stimulable in VC were [g] and [f] and although he had used [g] once in the data he struggled to produce it on demand. There was evidence of struggle with other sounds in the stimulability task so, for example, for both [p] and [b] in CV syllables (PIE and BUY) his first attempts were realised as [faɪ]. A potential difficulty in interpretation of these results is the possible confounding factor of both (in effect) real and non-words being used as stimuli in the same task.

7.9. PCC T1

Hamish's PCC was 31.07% and his PVC was 73.57 %, giving a PPC of 52.32%. Scores were derived from 112 SW. This PCC puts Hamish's speech into the Shriberg and Kwiatkowski (1982) category of severe difficulties for consonant production (49% or lower).

7.10 Phonological process analysis T1

A phonological process analysis was completed using data primarily from single words and conversational speech, supplemented by data from imitated sentences. There was

evidence both in SW and multi-word data of structural and systemic processes, as well as word level assimilatory errors (see table 7.5). The structural process most in evidence in all word contexts was cluster reduction; there were occasional examples of final consonant deletion (although glottal stop realisation was the dominant pattern in coda contexts) and weak syllable deletion. Systemic processes included glottal stop realisations, velar fronting, stopping, deaffrication, gliding, and voicing. Hamish also presented with atypical nasal realisation patterns which are examined in section 7.11.1.

Table 7.5 Hamish: Phonological processes (consonants) T1

	Target (SW)	**Hamish's realisation**	**Target (conversational speech, CS)**	**Hamish's realisation**
Structural processes				
Cluster reduction	TRACTOR	[ˈfæʔɑ˜]	AND IT IN THIS SCHOOL (CS 1, T1)	[ʔæ˜n ɪʔ ˈɪ˜n dɪʔ ˈləʊʊ]
Final consonant deletion	CARAVAN	[ˈtʰæwəvʌ˜˘]	IN THAT CLASS (CS 1, T1)	[ʔɪ˜n^ ˈnæ˜..ʔ ˈlɑ]
Weak syllable deletion	SPAGHETTI	[ˈt^s..ɛ.ʔi]	IT WAS AT THE BEGINNING OF THE TERM (CS 7, T1)	[ˈɪʔ wɒʔ ˈeɪʔ ˈdɪ˜ŋɪ˜n ɒʔ ə ˈt"ɜ˜m]
Systemic processes				
	Target (SW)	**Hamish's realisation**	**Target (conversational speech, CS)**	**Hamish's realisation**
Glottal replacement	ROOF TRACTOR HAIRDRESSER	[wəʊʔ] [ˈfæʔɑ˜] [ˈʔæfæʔə]	AND IT-IT A HOUSE (CS 7, T1) SHE IS LOOKING AFTER IT (CS 1, T1)	[ə˜n ˈɪʔ ɪʔ ə ˈʔɑ˜ʊʔ] [ˈiʲ əʔ ˈlʊʔɪ˜n ˈɑʔəʷ ɛ..ʔ]
Velar fronting	HELICOPTER	[ʔælə ˈdɒʔʌ..]	AND THEN WE WENT AGAIN (CS 7, T1)	[n. n. wi ˈwɛ.˜nʔ əˈdɛ.˜n]
Stopping	FOOT	[bʊʔ]	BUT MY DAD GOT A SWORD (i.e. saw) (CS 5, T1)	[bə maɪ ˈd..æd¬^ dɒʔ ə ˈtɔd]
Deaffrication	JELLY	[ˈfæliː]	I HAD SOME SUGAR WITH MY CHIPS (CS 2, T1)	[ɔɪʲ æʔ ˈdə˜ɱ ˈfʊʔə wɪb.ɪʔ (.) mãɪ ˈfɪʔpɪʔ]
Voicing	PIG	[bɪʔ]	IT WAS ON FRIDAY (CS 7, T1)	[ˈɪʔ wə ˈɒ˜n ˈvaɪdeɪ]
Gliding	RAIN	[weɪ˜n]	EDWARD'S ROOM (CS 3, T1)	[ˈʔæʔwəʔ ˈwʊ˜m]
Word level assimilatory errors				
Reduplication	COMPUTER	[ˈfuʔʌʔʌʔ]		

Consonant harmony	TOILET	[ˈlɔɪlə?]	AND KATIE'S ROOM (CS 3, T1)	[æ˜n (.) ˈneɪ?i ˈmɜ˜m]

7.10.1 Structural processes T1

The most frequently occurring structural process in Hamish's speech was cluster reduction but his speech output as a whole was characterised by simplification processes. Phonotactic analysis shows that Hamish's syllable structure was largely CV (?V), CVC (CV?) and CVCC (CVC?) in monosyllabic words and strings of these syllable types in multisyllabic words. For example: CAR [dɑ] (CV); CRAB [fæp'] (CVC); FROG [fɒ?] (CV?); JUMP [fʌ˜ˌmp'] (CVCC); PYJAMAS [ˈlɑ˜mijə] (CVCVCV); HAIRDRESSER [?æˈfæ?ə] (?VCV?V). The realisation of adult targets as a glottal stop was frequent, demonstrating "extreme simplification" both structurally and systemically (Grunwell, 1987, p. 240).

7.10.1.1 SIWI and SIWW clusters in single words

In the SW sample there were 26 SIWI consonant clusters and 6 SIWW possible, making 30 in all, 2 (7.69%) of which were realised in a typical form. The patterns used by Hamish were the same for both SIWI and SIWW contexts so they will be discussed together.

- /l/ clusters: Hamish's realisation of /l/ clusters included the only 2 accurate examples of clusters in the data set, i.e. /fl/ in FLOWER [ˈflɑʊwə] and /gl/ in GLOVES [ˈglʌ?bˌɪ?], meaning that just 6.66% (2/30) of clusters were typically produced. Given the rarity of these occurrences both in SW and conversational speech these clusters could be regarded as "exceptional" forms (Grunwell, 1987 p. 101). The 5 other /l/ clusters were realised as [l] alone, for example, /gl/ in GLOVE [lʌːpˀ] and /fl/ in BUTTERFLY [bˌʌ?əˌˌlaɪ] or, with /pl/, as a labial segment [b] or [w] for example, PLATE realised as [bˌeɪ?] and AEROPLANE realised as [ˈ?æweɪ˜].

- Hamish's 1 /w/ and 12 /r/ clusters were all realised as [f]; for example, CRAB as [fæp'], PRAM as [fæ˜m] and QUEEN as [fiːn]. This pattern of using a labiodental fricative for complex targets which had some labial features was common in Hamish's speech.

- Realisation of /s/ clusters (33.33%, 10/30 of the sample) followed similar patterns to those already described where, for example, SPLASH (which includes the /l/ segment) was realised as [læ?] and STRAWBERRY (which includes the /r/ segment)

as [ˈfɔbi]. However, /sl/ in SLIPPER was produced as [n] in [ˈnɪʔpˆfɑ˜], /sp/ was realised both as [b] in SPIDER [ˈbaɪdə˛] and [f] in SPONGE [fʌ˜nt']. The cluster /st/ was not elicited in the data sample but in conversational speech he realised STOP IT as [ˈdɒbɪʔ]. The cluster /sw/ in SWING was realised, predictably because of its labial features, as [f] in [fɪ˜ŋ]. /sm/ and /sn/ were realised as single nasal segments so, for example, SNAKE [ne˜ɪʔ] and SMILE, in a conversational sample, [mãɪʊ]. The target /sk/ varied so that although it was fronted as in SCARF realised in conversation as [dɑʔ], Hamish realised SCHOOL as [lɒʊ˛], suggesting anticipatory assimilation of SFWF /l/ which was vocalised. Hamish also produced SCOOTER as [ˈfuʔɑ˛˛h], suggesting an interaction between the cluster target and the rounded vowel resulting in [f].

7.10.1.2 SIWI and SIWW clusters in multi-word utterances

In the conversational speech data there were 13 SIWI consonant clusters and 1 SIWW adult targets. The realisation of these clusters followed the same patterns seen in the single word data; /l/ clusters were realised as single lateral segments so, CLASS was [lɑ] and AEROPLANE [ˈʔɛ˛wəˈleɪ˜n̩] (interestingly this example had a more mature syllabic structure than in SW, where it was realised as [ʔæˈweɪ˜]). In imitated sentences there was one example of epenthesis in an utterance produced with a very slow rate and open juncture, JOHN PLAYED TENNIS realised as [ˈwɒ˜n (...) pəˈleɪ (.) ˈtʰæ˜nɪ˜h], but there were no other examples of SIWI clusters in multi-word utterances. The /r/ clusters in CS (and imitated sentences) were realised as [f] or [v] as in ONE OF MY FRIENDS [ˈwʌ˜n ə mə˜ ˈvæ˜nd̩ɪʔ] and AND WE WENT ON A TRAIN [ə˜mˆ mɪ˘ ˈvɛ˜nʔ ɒ˜n ə ˈfˇe˛ɪ˜n̩]. There were three examples of /s/ clusters which were all realised as a single segment as in A SPARE ROOM [ə ˈbæ ʊʊ˜m].

7.10.1.3 SFWW and SFWF clusters in single words and multi-word utterances

In SW Hamish realised just one SFWF cluster accurately, /mp/ in JUMP. ELEPHANT may evidence the realisation of the nasal cluster appropriately as nasal plus glottal stop but the addition of a SFWF velopharyngeal fricative [ˈʔæ˛˛ləˌˌʔhəˌˌ˜nʔfɲ] slightly complicates interpretation, as does the addition of an extra syllable in SFWF position in plural words (discussed in section 7.11.2) where SFWF clusters might be expected, for example, LEGS realised as [ˈlæːʔt˛ɛ]. There were two occurrences of nasal plus affricate clusters in

ORANGE realised as [ɔˈjɪ˜n] with FCD, and SPONGE [fʌ˜nt'] with SFWF stopping. No SFWW consonant clusters occurred in the data.

In CS SFWW and SFWF clusters were rare apart from AND and WENT which were usually produced as nasal plus or minus glottal stop as in AND IN THE MORNING WE WENT ON AN AEROPLANE [æ˜n (.) ˈɪ˜n ə ˈmɔ˜nɪ˜mː (.) i ˈwɛ˜nʔ ɒ˜n ə ˈʔɛˌwəˈleɪ˜n̩]. In other examples the entire cluster was realised as a glottal stop as in PAST OTHER BATHROOM [ˈpʰ ɑʔ ˈæʔə ˈbɑʔwʊ˜m].

7.10.1.4 Final consonant deletion

Final consonant deletion occurred in just 2 of the 63 (3.17%) possible positions in the SW sample; both of these were nasals i.e. CARAVAN realised as [tʰæwəvʌ˜˘] and AEROPLANE realised as [ʔæˈweɪ˜]. The fact that the vowels were nasalised raises a question about whether this was truly final consonant deletion since a major feature of the 'deleted' segment was realised (Bernhardt & Gilbert, 1992; Bernhardt, 1992a). In conversational speech there were a few examples of FCD, again with nasal targets as in AND IT MINE realised as [æ˜n ɪʔ mãɪː] but in all types of word contexts, the glottal replacement of adult targets was the major process affecting both SFWF and SFWW segments.

7.10.1.5 Weak syllable deletion

Hamish sometimes deleted weak syllables particularly in SIWI position, for example, in the utterance, AT THE BEGINNING OF THE SUMMER HOLIDAYS (CS 7), the first syllable of BEGINNING was omitted (and the velar plosive fronted) [ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈdˌʌ˜mə ˈʔɔwə˘deɪ]. However, weak syllable realisation more often appeared to involve a reduction to a single syllable with the SIWI onset being retained and SIWW onset deleted. For example, SPAGHETTI where the /s/ remained evident in the first sound but the velar was deleted [ˈt͡sˌɛˌʔi]; GIRAFFE realised as [fɑːʔ], where the SIWI /ʤ/ segment was realised as [f] and the SIWW /r/ was deleted. Explanation of this particular example relies on the observation that affricates were always realised as a labiodental fricative but the post-alveolar approximant was typically realised as [w] or [ʊ] (and the SFWF segment would be realised as a glottal stop).

7.10.2 Systemic processes T1

Hamish's speech production was affected by several systemic processes including glottal stop realisations; velar fronting; stopping of fricatives; deaffrication; voicing; and gliding.

The overall patterns reflected the simplification seen in the structural elements of Hamish's output.

7.10.2.1 Glottal replacement

As previously mentioned, Hamish's obstruent segments in SFWF position, but also SFWW, were frequently realised as a glottal stop in both SW and multi-word utterances; examples occurred with all plosives, fricatives and affricates sampled in the data (see table 7.5). In the SIWW position the voiced bilabial and alveolar plosives [b] and [d] were often realised in the target form, as were nasals and approximants. In SFWF positions nasals and bilabial plosives were the only consonants where the target manner and place were regularly realised in a target form, for example, SHEEP realised as [fip'] and QUEEN as [fɪ:n]; I GOT ONE OF THEM ONES realised as [aɪ ˈnɒ˜ʔ wʌ˜n ə ˈlɛ˜m ˈwʌ˜nə].

An occasional pattern observed in Hamish's speech was the occurrence of glottal stops at a syllable boundary not as a replacement segment but as an additional one, for example, GLOVES was realised as [ˈglʌʔb.ɪʔ] with a glottal stop before [b] (which is the stop segment used for the adult target /v/). This may be relevant in relation to the discussion about syllable templates (see section 7.26.1.1.1). Other examples include SLIPPER realised as [ˈnɪʔp͡fɑ˜]; ELEPHANT realised as [ˈʔæ..lə..ʔhə..˜nʔfŋ], with a glottal stop before [h], which appeared to be the realisation of the adult target /f/.

7.10.2.2 Velar fronting

The process of velar fronting was examined in single word and conversational speech.

7.10.2.2.1 Single words

Hamish's productions of velar plosives in SW were fronted in both SIWI and SIWW positions. There were 9 possible occurrences of /k/ and 88.88% (8/9) were fronted; 5 were realised as [d] and 4 as [t], as in CAT [dæʔ] and CATERPILLAR [ˈtʰæ..ʔəfɪ..lə]. (The ninth token was the /k/ in COMPUTER which appeared to have been deleted as part of the weak onset syllable; the word was realised as [ˈfuʔʌʔʌʔ]). There were 6 possible occurrences of /g/ and 66.66% (4/6) of these were fronted, as in GUITAR [dəˈtsɑ..ː]. The other 2 were realised as approximants in TIGER [ˈdaɪjə] and HAMBURGER [ʔæ˜mbɜwə]. The entire data sample (SW, conversational speech and imitated sentences) included just one example of a velar plosive successfully realised in the word GLOVES [ˈglʌʔb.ɪʔ]. There were no realisations of SFWF velar plosives because all 8 possible segments were

produced as glottal stops; word-final velar nasals were realised as [n] in 3/4 (75%) examples, RING was [ʊɪ˜n] and as [ŋ] in SWING realised as [fɪ˜ŋ].

7.10.2.2.2 Conversational speech

The patterns of velar production in MWU were similar to those in single words with one significant difference. Hamish fronted SIWI velar plosives as in KITCHEN, realised as [ˈdɪʔɪ˜n] [ˈdɪʔn̩] and [ˈtɪʔɪ˜n] and GOT in the utterance I GOT ONE [ˈaɪ dɒʔ ˈwʌ˜n]; in SIWW and SFWF position these segments were realised as glottal stops as in IT LOOK LIKE THAT [ɪʔ ˈlʊʔ laɪʔ wæʔ]. However, in conversational speech he sometimes used [n] for /g/ and, for example, his realisation of the word GOT varied between [dɒʔ] and [nɒʔ]; he also used /n/ in the name KATIE as in AND KATIE'S ROOM (CS 3) [æ˜n (.) ˈneɪʔi ˈmɜ˜m]. These realisations occurred only in high frequency words, particularly GOT and KATIE (the name of his sister). Data recorded when Hamish was 3;9 included SUN realised as [nʌn], CARS as [nɑ], TEETH as [niʔ] and CUP as [nʌʔ]. Nasal realisation of velar targets at T1 thus appeared to be a remnant of much wider use of the alveolar nasal.

Although Hamish did not use velar plosives in MWU, on one occasion, where he was frustrated at not being understood, he attempted to modify his production of the name KATIE and realised the SIWI /k/ as a voiced uvular plosive [ɢ] in [ˈɢeɪʔi]. This particular sequence is explored in more detail later in section 7.11.3.

7.10.2.3 Stopping

The process of stopping was examined in both single word and multi-word utterances.

7.10.2.3.1 Single words

Hamish's realisation of fricatives in SIWI positions in SW varied; labiodental fricatives were realised as stops in 43% (3/7) of instances (FISH realised as [bɪʔfŋ]), FISHING as [ˈbɛʔɪ˜n] and FOOT as [bʊ̈ʔ]); given the widespread use of [f] as a realisation of clusters and affricates this was perhaps a surprising finding. Realisation of alveolar fricatives in SIWI and SIWW singleton contexts also varied; /s/ was either stopped as in SAUSAGE [ˈtˢ ɒʔəʔ] (60%, 3/5) or realised in an immature, affricated form /t͡s/ as in SEESAW [ˈt͡sitɔ] and SANDWICH [ˈt͡sæ˜mbwʊʔ] (40%, 2/5) (Ingram, 1975). There was only one example of a target /z/, in the word ZEBRA, which was realised as /v̩/ [ˈv̩.æʔbʌ]; with the labiodental realisation possibly anticipating the following bilabial [b]. The SIWI post alveolar fricative /ʃ/ was realised as [f], for example as in SHARK [fɑ̟ː?].

SIWW targets /ʃ/ was realised both as [f] in PARACHUTE [ˈpˆfæwəfəʊʔ], perhaps influenced by the onset segment, and as a glottal stop in FISHING [ˈbɛʔɪ˜n]. SFWW and SFWF fricatives were typically realised as a glottal stop rather than an alveolar or bilabial stop, for example, KNIFE realised as [nãɪʔ] and HOUSE as [ʔɑʊʔ] although occasionally these targets were also stopped as in GLOVE realised as [lʌːp˜].

Fricatives in the SIWW position were sometimes realised as stops so, for example, DINOSAUR [ˈdaɪ˜nətʰɑ˘] and TELEVISION [t‿æ‿ləˈbɪʔə˜n] (although note, TELEPHONE [ˈtʰɛləvə˜m˜]) but were more likely to be realised as a glottal stop as in SCISSORS realised as [ˈtʰ ɪʔəwəʔ].

7.10.2.3.2 Multi-word utterances

In CS the data showed similar stopping patterns as in single words although there were only six instances of /s/ being the target in SIWI position; 66.66% (4/6) were realised as a stop, for example, AT THE BEGINNING OF THE SUMMER HOLIDAY (CS 7) [ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈd‿ʌ˜mə ˈʔɔwə˘deɪ] and 33.33% (2/6) were realised as [tˆs] as in I GOT EXACTLY THE SAME (CS 5) [aɪ nɒʔ ˈtæ˜ʔli ə ˈtˆseɪ˜n]. This pattern was the same in imitated sentences, for example, the target SAM ATE AN ORANGE VERY SLOWLY was realised as [ˈd‿æ˜m ˈnɛ˜‿ʔ əʔ ɔˈjɪ˜n wɛwi ˈlɜli] with SIWI /s/ realised as a voiced dental stop [d‿]. There were no examples of SIWW fricative targets in the CS data. The examples in imitated sentences followed the pattern seen in SW, for example, WE WATCHED TELEVISION ALL DAY [wɪ̯ ˈwɒʔ (.) ˈtʰɛ‿ləbɪʔə˜n ɔ ˈdeɪ].

7.10.2.4 Deaffrication

In SIWI position in all types of utterance Hamish realised the affricate /ʤ/ as [f], for example, JUMP as [fʌ˜‿mp']. The only exception to this was that in the imitated sentences the SIWI affricates in the names JANE and JOHN were realised as the labial-velar approximant /w/. The voiceless segment /ʧ/ varied between [f] and a stop so that CHAIR was realised as [dæ˜‿] and CHIPS (with an extra syllable marking the plural morpheme) as [ˈfɪʔpˆɪʔ]. There were very few SIWW targets but /ʧ/ was realised as a glottal stop in KITCHEN [ˈdɪʔɪ˜n]. Hamish's realisation of /ʤ/ and /ʧ/ as [f] would appear to be similar to that of /r/ and /l/ clusters with the labial and continuant features of the adult targets being realised without the involvement of tongue movement. (Note: use of the term deaffrication strictly speaking denotes loss of the fricative element as in

KITCHEN [ˈdɪʔɪ˜n]. Here in this section its use is broader to cover all changes to the realisation of affricate segments).

7.10.2.5 Voicing

Hamish also showed evidence of voicing processes throughout the data. SIWI voiceless plosives tended to be voiced for example, PIG realised as [bɪʔ] and TEETH as [diʔ] but there were some examples of emerging maturity, so that although CAT was realised as [dæʔ], CATERPILLAR was realised as [ˈtʰæ̤ʔəfɪ̤lə]. It was not the case that voicing was the default feature (although this may have been the case at an earlier stage) but that there was variability in the realisation of voiceless segments which was not predictable by target or context.

7.10.2.6 Gliding

Gliding of /r/ was fairly consistent as in RABBIT [ˈwæ̝bəʔ] although a labiodental variant also occurred as in RING [ʊɪ˜n] and THE SPARE ROOM-EDWARD'S ROOM (CS 3) [ə ˈbæ ʊʊ˜m (.) ˈʔæʔwəʔ ˈwʊ˜m].

7.10.2.7 Vowels

Scrutiny of the data already presented demonstrates that Hamish's realisation of vowels was not like that of typically developing children, who have acquired a full range of vowels by the age of 36 months (Pollock, 2002). A percentage of children who have speech difficulties present with both consonant and vowel difficulties but the incidence figures given in studies vary depending on the criteria used. Pollock and Berni (2003), examining the occurrence of vowel errors in children who had speech sound difficulties (aged 30-81 months), suggested the figure is between 11 and 32%. It is also recognised that problems with vowels are more likely to occur in children who have severe difficulties with consonant production (Stoel-Gammon & Pollock, 2008). Difficulties with vowels are associated with CAS (Pollock & Hall, 1991) and in fact are quoted as being one of the diagnostic markers associated with this condition (Davis, Jacks, & Marquardt, 2005; Peter & Stoel-Gammon, 2008).

The literature would suggest that the severity of Hamish's speech difficulty, with multiple consonant errors and a suggested diagnosis of CAS increased the likelihood of him having vowel difficulties, and this was indeed the case. As already noted, his PVC in single words

was 73.06% and he presented with both delayed and atypical patterns of vowel production (see table 7.6).

Analysis of Hamish's vowels showed some regularly occurring patterns but overall they were not predictable. Lowering (with or without accompanying fronting) was the most frequent process and in the literature is described as the most common feature change impacting on vowel production (Pollock & Hall, 1991; Reynolds, 2002). The target most affected by lowering was /ɛ/ which was sometimes perceived as [æ], but the realisation of the vowel was variable. This may have been due to variations in the degree of lowering, suggesting that Hamish's realisations were unstable; this might be attributed to perceptual and/or articulatory factors affecting his output. It might also be due to the phonetic context of the vowel affecting listener perception (Howard & Heselwood, 2013; Howard & Heselwood, 2002), where potentially small differences in vowel lowering affected categorical perception.

Table 7.6 Hamish: Phonological processes (vowels) T1

Target vowel	Hamish's realisation	Examples from SW	Examples from MWU
Lowering			
/ɛ/	[æ]	BREAD [fæʔfŋ]; FEATHER [ˈfæ˜ʔɑ˘..]	FRIENDS [ˈvæ˜ndɻɪʔ] (CS 7, T1); EDWARD [æʔwəʔ] (CS 3, T1); LEFT [læʔ] (NS 39)
/ʊ/	[ʌ˘]	BOOK [bʌ˘ʔ]	
/ɪ/	[ɛ]	FISHING [ˈbɛʔɪ˜n]; PIG [p‴ ɛʔ]	
Lowering and fronting			
/ʌ/	[æ]		OTHER [ˈæʔə] (CS 3, T1)
/u/	[ɜ]	MOON [mɜ˜n]	ROOM [ˈʊɜ˜mʰ] (CS 3, T1); SPOON [p̈ɜ˜nʰ] (NS 21)
Diphthong reduction			
/ɛə/	[æ]	AEROPLANE [ˈʔæweɪ˜]; HAIRBRUSH [ˈʔæʔfʌʔ(fŋ˘)]	HAIR [ˈʔæːʔ] (NS 18); BEAR [bæ] (NS 9)
/aʊ/	[æ]	MOUSE [mæ˜ʔʊ̯ʔ]	MOUNTAINS [ˈmæ˜nʔɪ˜nɛ˘ə] (CS 7, T1); BROWN [f˘æ˜n] (NS 9)
/əʊ/	[ɜ]		SLOWLY [ˈlɜli] (NS 27); HOME [ɜ˜m] (conv.)
/ɪə/	[ɪː]	EAR [ʔɪː]	
Diphthongisation			

/u/	[əʊ]	PARACHUTE [pˆfæwəfəʊʔ]; ROOF [wəʊʔ]	SCHOOL [ˈləʊ] (conv.)

Another process which is described in the literature as commonly occurring is the reduction of diphthongs to a single element. This pattern can be likened to consonant cluster reduction in that it involves simplification of a complex segmental sequence (Reynolds, 1990). Typically the first element of the diphthong is preserved so that the resulting realisation is a monophthong corresponding to that initial segment (Reynolds, 2013). This can be seen in Hamish's speech output where diphthong reduction affected his production of several targets (see table 7.6) but the realisation of the vowel was predictable from the initial vowel of the adult target. One exception to this was where the vowel that was produced was affected by more than one process so, for example, his realisation of /ɛə/ as [æ] appeared to be linked to his lowering of /ɛ/ (i.e. /ɛə / was simplified to /ɛ/ which was lowered to [æ]). Another exception was the realisation of /əʊ/ as [ɜ]; the first element of the diphthong is the neutral vowel schwa which is not used in stressed syllables. The vowel [ɜ] has the same mid centre placement as schwa and in stressed syllables appeared to be a substitution for it for example in SLOWLY [ˈlɜli] and HOME [ɜˇm].

Contrary to diphthong reduction there were also instances of diphthongisation in Hamish's speech with /u/ being realised as [əʊ]; ROOF [wəʊʔ]; PARACHUTE [ˈpˆfæwəfəʊʔ]; this only occurred before a glottal stop or in an open syllable. Diphthongisation is reported as particularly occurring with long vowels (Donegan, 2002, p. 15). Interestingly, where the /u/ was followed by a nasal segment it was realised as a long central vowel [ɜ] as in MOON [mɜˇn] and ROOM [ˈʊɜˇmʰ]. Directionality was right-to-left, i.e. the vowel change was linked to the following segment (Bates et al., 2013). This might suggest a context-sensitive realisation in relationship to SFWF nasal consonants because in other phonetic contexts there are examples of /u/ being realised in a typical form, TOOTHBRUSH as [ˈduʔfˇʌʔ]; SCOOTER as [ˈfuʔɑ̟ːh].

Not all of Hamish's vowel realisations were captured by process analysis descriptions, for example, the realisation of word-final open syllables as in SCOOTER, with the target form having a neutral schwa, was realised without vowel neutralisation as [ɑ̟ːh]. This was another variable pattern so LADDER and ZEBRA for example, were realised as [ˈlæʔːʌ] and [ˈv̩.æʔbʌ] respectively but TIGER and HAIRDRESSER were realised as [ˈdaɪjə] and [ʔæˈfæʔə] with an appropriately neutral SFWF vowel. Another distinctive production

because of the frequency of use of the word was an idiosyncratic production for the word YOU, the monophthong [o:], with omission of the SIWI [j] and lowering of the adult target vowel. Occasionally Hamish produced an utterance where the vowel did not conform to any of the patterns described above as in his imitation of /ɜ/ in HURTS in the SI MY LEFT LEGS HURTS [ˈmãɪ˜ ˈlæʔ ˈlæʔ ˈɵː̰].

Finally, there was variability in Hamish's vowel production which was evident both in single words and multi-word utterances. The realisation of PIG both as [bɪʔ] and [p˭ ɛʔ] has already been mentioned in table 7.6 but similarly the vowel in FISH(ING) was realised both as [ɛ] and [ɪ], [ˈbɛʔɪ˜n] and [fɪʔɸŋ].

7.10.3 Word level assimilatory errors

Hamish produced occasional instances of consonant reduplication, and frequent occurrences of consonant harmony.

7.10.3.1 Consonant harmony

Both in single words and multi-word utterances Hamish's speech showed evidence of consonant harmony which usually involved anticipatory assimilation, for example, SCHOOL was realised as [lʊʊ̰] (already mentioned) and TOILET realised as [ˈlɔɪləʔ]. These highly immature forms appeared to occur only in high frequency words.

In conversational speech there were frequent examples of anticipatory assimilation across word boundaries. For example, in AND KATIE'S ROOM (CS 3) realised as [æ˜n (.) ˈneɪʔi ˈmɜ˜m], there was anticipatory consonant harmony in the realisation of ROOM seen also in the example YOU CAN READ MY BOOK (imitated sentence) realised as [ˈʔəʊ˜n ə ˈmĩ mãɪ ˈbʌʔ] where the SIWI glide in READ was affected by the onset segment in MY and produced as [m]. There were also examples of /n/ for /g/ occurring in imitated sentences, for example, with the target GOOD GIRLS ARE NICE, Hamish's first imitation was [ˈwʊʔ ˈnɜ næ˜ʔ ˈnaɪʔ], where the first SIWI velar was realised as a glide, the second as /n/ which was then also added to the vowel onset in ARE, suggesting anticipatory planning for the final /n/ in NICE. He was given the model again and his second attempt resulted in nasal realisation of both SIWI /g/ targets [nʊ˜ʔ nɛ˜ʊʷ ɔ ˈnãɪʔ].

Other examples occurred in the utterance AND WE WENT ON A TRAIN [ə˜m͡ mĩ ˈvɛ˜nʔ ɒ˜n ə ˈf˘ḛɪ˜n̰] with consonant harmony at the word boundary between AND and WE (this was

WE and not an immature pronoun ME) and also the anticipatory realisation of the SIWI onset of WENT as [v] ahead of [f] in the onset of TRAIN.

7.10.4 Summary of phonological process analysis T1

The phonological process analysis showed the occurrence of a significant number of processes impacting on the structure and segmental content of Hamish's speech. His realisation of adult targets was constrained by simplification patterns characterised by reduced phonotactic structure and glottal replacement. This was most often in word-final positions but within-word obstruent segments were also frequently realised as a glottal stop. A labiodental fricative [f] was used for the post-alveolar fricative, affricates and consonant clusters which had features of labiality; this further reduced the range of contrasts signalled in Hamish's speech.

The presence of vowel processes was an important factor in Hamish's speech production. The effect of atypical vowel on intelligibility is significant (Speake et al., 2012) and variability in vowel realisation was another potential source of confusion for listeners. However, this analysis so far had not captured all the data which might be important in providing a full description of Hamish's speech patterns.

7.11 Features not captured through phonological process analysis T1

The assessment process revealed that there were other features of Hamish's speech which could not be accounted for through a traditional phonological process analysis. These features were examined through further analysis of which included exploration of his nasalisation patterns and the production of morphological markers. In addition, variability, voice quality and word juncture behaviours in multi-word utterances were considered with a view to understanding factors which might impact on the intelligibility of his speech.

7.11.1 Nasalisation patterns

Nasalisation patterns were examined in single word and multi-word utterances.

7.11.1.1. Single words

In the single word data Hamish showed two types of atypical nasalisation patterns which occurred in particular contexts; the first was the production of a velopharyngeal fricative at the end of a word after a glottal stop, which occurred 7 times, for example, FISH realised as [fɪʔfŋ] and BRIDGE also as [fɪʔfŋ]. There was an example of nasal emission once with the SFWF alveolar nasal target in JAM realised as [ˈfæwə˜ˌn̥]. The second context was

with nasalisation of a vowel where an oral airstream would be expected, for example, CHAIR realised as [dæ˜ˌ]. Both types of nasalisation patterns occurred only in words where the adult target word contained fricative or affricate segments, apart from the word BREAD realised as [fæʔfŋ].

7.11.1.2 Multi-word utterances

Similar patterns were noted in multi-word utterances although in conversation only one occurrence of the velopharyngeal fricative was heard, at the end of the utterance TWO TIMES TO FRANCE (CS 7) [ˈdu ˈtʰaɪ˜mɪʔ du ˈf˜ɑ˜nʔfŋ]. Nasalisation of the vowel was more common in the conversational data sample, for example, AND IT-IT A HOUSE (CS 7) realised as [ə˜n ˈɪʔ ɪʔ ə ˈʔɑ˜ʊʔ]. In the imitated sentences both patterns occurred. For example; ALICE PUT GLOVES ON HER HANDS realised as [ˈʔælɪʔ bʊʔ ˈlʌʔɪʔ ɒ˜n ə˜ ˈæ˜nfŋ]; JOHN COLLECTS STAMPS [ˈwɒ˜ːn əˈlæʔ ˈdæ˜nʔfŋ]. Nasalisation of the vowel was evident in FISH in the sentence THE BROWN BEAR EATS FISH [ə ˈf˜æ˜n (.) ˈbæ iʔ ˈbɪ˜] and in the word SQUARE in THIS SHAPE IS A SQUARE [vɪʔ ˈfeɪp ɪʔ ə ˈfæ˜ː].

There were very rare examples of nasal turbulence in utterances where its occurrence was not apparently linked to affricate or fricative targets. For example, UNDER MY BED (I) GOT A MATTRESS, realised as [ˈʌ˜nə˜ mæ ˈbæ˜ʔ nɒ˜ʔ ə˜ fŋː ˈmæ˜ (.) ʊə]. Here Hamish produced a long velopharyngeal fricative between GOT A and MATTRESS. This may have been the result of a timing issue in coordinating velopharyngeal closure during the transition from the vowel in A and the SIWI bilabial nasal in MATTRESS.

This atypical pattern was not produced universally; it occurred in 12.6% (14/111) of single words, in 20.26% (14/69) of those that had possible fricative or affricate adult targets. However, its occurrence was frequent enough to be of interest.

7.11.2 Morphological markers

The relationship between the development of phonology and morphological markers is well documented (Johnson & Morris, 2007) and children with speech difficulties frequently present with immature morphology (Hoffman & Norris, 2002). Difficulty in the realisation of morphemes in the coda position is thought to be related to the complexity created by their presence, for example, plural "s" or regular past tense "ed" (Theodore, Demuth, & Shattuck-Hufnagel, 2012) although in young typically developing children there is a suggestion that phonological complexity is not the only factor since 2-year-olds realise

plural "s" sooner than third person singular "s" (Theodore, Demuth, & Shattuck-Hufnagel, 2011).

Hamish showed an unusual pattern in that he added an extra syllable to denote both plurals and past tenses. Examples of plurals include, in SW, GLOVES realised as [ˈglʌʔb̥.ɪʔ], BISCUITS as [ˈbɪʔnɜ˜(ʔ)ə˜n] and SCISSORS as [ˈtɪʔəwəʔ] (the plural implied by "a pair" of scissors). The target PYJAMAS [ˈlɑ˜mijə] showed what appeared to be an interaction between several processes; PY /pə/ omitted through weak syllable deletion; JAMAS /ˈʤaməz/ realised as [ˈlɑ˜mi]; [jə] added to signal plurality. Examples from the CS data include CHIPS [ˈfɪʔpɪʔ], which was also elicited in the naming task, and MOUNTAINS [ˈmæ˜nʔɪ˜nɛ˜ə]. In the imitated sentences there were two examples of plural nouns imitated without an extra syllable (but not with a plural "s") but otherwise Hamish usually signalled plurality with an additional syllable. For example, in the phrase ALICE PUT GLOVES ON HER HANDS he firstly used an extra syllable in the target GLOVES but then in the target HANDS produced a SFWF velopharyngeal fricative [ˈʔælɪʔ bʊʔ ˈlʌʔɪʔ ɒ˜n ə˜ ˈæ˜nfŋ].

When signalling past tenses, production of an extra syllable was not consistently applied but it occurred frequently enough to be recognised as a pattern. Hamish used high frequency past tenses such as WENT, WAS and GOT but for regular verb forms ending in –ED and for lower frequency irregular verbs he tended to add the extra syllable as described. An example is given in Extract 7.1, where LOST is realised as [luwɪʔ], DREW as [ˈfɔwɪʔ] and WON as [ˈwɪ˜nɛ˜..]; these immature forms "losed" "drawed" and "winned" were realised with an extra syllable to indicate tense. Hamish also did this occasionally in imitation, for example, THEY ARGUED ALL DAY was realised as [ðɛ˜m (.) ˈʔɑduʊɪʔ ɔl ˈdeɪ].

Extract 7.1

1.1 H. Well we losed this week
[wʌ˜ ˈwi luwɪʔ ˈdɪʔ ˈwiʔ]
1.2 H. We drawed last week
[wi ˈfɔwɪʔ lɑʔ ˈwiʔ]
1.3 H. And last week after that we losed and we winned
[ˈæ˜n (.) ˈlɑʔ wiʔ ˈɑʔə ˈðæʔ wi ˈluwɪʔ æ˜n wi ˈwɪ˜nɛ˜..]

Grunwell (1987) discusses syllable addition in the context of reduplication describing how very young children may reduplicate syllables in target single syllable words; this may

particularly be seen in children who delete SFWF segments with the second syllable in effect (by implication) acting as place marker for the missing phone. Although in the context of plurals and past tenses Hamish is not reduplicating syllables, he is adding an extra syllable to signal meaning.

7.11.3 Variability

Hamish's speech production showed variability across all types of utterances (see table 7.7); examples included SOCK being realised as [dɒʔfŋ] and [ˈtʰɒʔɒ˜ʔ]; in both instances the SIWI alveolar fricative segment was stopped, once with a voiced plosive and once with a voiceless aspirated one. In the first example the SFWF glottal stop was followed by a velopharyngeal nasal and in the second the glottal stop was followed by another VC syllable (vowel plus glottal stop), possibly an erroneous pluralising of the singular target. Variation in word onset position was typically related to voicing or manner of articulation (as with BATHROOM realised as [ˈfɑʔʊʊ˜m] and [ˈbɑʔwʊ˜m]; variation in coda position was more related to the presence or absence of velopharyngeal fricatives (as with KNIFE realised as [nãɪʔ] and [nãɪʔfŋ]. His variants of a particular token usually included one which was more typical of patterns seen in young children with immature speech.

Table 7.7 Hamish: Variability in speech productions T1

Target	Realisations
BOOK (SW)	[bʌ˜ʔ]; [bʌʔn̩ː]
FEATHER (SW)	[ˈfæ˜ʔɑ˜ˌ]; [ˈbæʔːə˜nʔ]; [ˈfæʔə]
KNIFE (SW)	[nãɪʔ]; [nãɪʔfŋ]
SOCK (SW)	[dɒʔfŋ]; [ˈtʰɒʔɒ˜ʔ]
PIG (SW)	[bɪʔ]; [pʲ ɛʔ]
KITCHEN (Conversational speech)	[ˈdɪʔɪ˜n]; [ˈdɪʔn̩];[ˈtʰɪʔɪ˜n]
BATHROOM (Conversational speech)	[ˈfɑʔʊʊ˜m]; [ˈbɑʔwʊ˜m]

Hamish's variability was not typically related to any obvious factors so, for example, it was not possible to predict his realisation of the examples given nor did he produce sequential attempts to get closer to the target. The one exception in the data was the production of the name KATIE towards the end of a conversation where Hamish was frustrated by not being intelligible. Three turns before this example began he had said [ˈne˜ɪʔʊ͡i] and not been understood; his first attempt in this sequence included one of the only velar plosives in the data which was produced as voiced and strongly articulated in line 2.1 [ˈg̈e˳ɪʔi]. In his next attempt he returned to his default realisation in line 2.3 [ˈne˜ɪʔi] but then attempted the velar again when he produced a uvular plosive in line 2.5

[ˈgeɪʔi]. Having successfully realised a segment with a back articulatory position he repeated this once more in line 2.7 (these data are given in full in Extract 7.2).

Extract 7.2

2.1→H. It a (x) Katie
[ɪʔ ə (wɪ) (.) ˈgë̞ˌɪʔi]
2.2 J. It stays here?

2.3→H. X X X no. You know Katie
[XXX (.) nə˜ʊ (.) u nũ ˈne˜ɪʔi]
2.4 J. Mm
2.5→H. Katie
[ˈgeɪʔi]
2.6 J. Yeh
2.7→H. Katie in that class
[ˈgeɪʔi ɪ˜n ˈnæʔ lɑ]

7.12 Speech behaviours in multi-word utterances

Hamish's speech production was examined in conversational speech and imitated sentences. Firstly, through carrying out an assessment of the characteristics of his speech at word boundaries and how this compared to the multi-word utterances of other children of the same age; secondly, through an exploration of some observations of the prosodic aspects of his multi-word speech.

7.12.1 Word juncture in multi-word utterances T1

Hamish's use of assimilation, elision and liaison, and close versus open juncture was examined in sentence repetition and in conversational speech.

7.12.1 1 Sentence imitation

The Newton Sentences Connected Speech Processes (CSP) Task (Stackhouse et al., 2007), (see table 7.8) was carried out to examine word juncture behaviours in imitated sentences. The task was significantly affected by the pervasive realisation of SFWF consonants as glottal stops which left limited opportunities for typical word juncture behaviours. Typical adult speakers may use a glottal stop for SFWF /t/ but Hamish's glottal replacement affected the majority of SFWF segments.

The only connected speech process that Hamish used frequently during this task was liaison. Although this occurred less frequently than in the speech of the age matched children, he was using both the palatal and labial approximants appropriately; the post-alveolar approximant was realised as a [w] but also was used in appropriate contexts.

There were also two examples of elision with SFWF [d]: FOUND PRESENTS realised as [ˈpæːˀn ˈfɛˌʔəˀnʔ] and GOLD BOX realised as [dəʊː ˈbɒʔɪʔ]. Both of these examples are where [d] formed the second element of a nasal or approximant cluster, [nd] and [ld] respectively.

Table 7.8 Hamish: Scores on Connected Speech Processes (CSP) Repetition Task T1

	Score expected at age 6	Hamish's score	Examples of Hamish's realisations (target word boundaries are underlined)
Assimilation			
t#	91.57%	0%, (0/4)	SHE CUT MY HAIR [i ˈdʌʔ mʌˀ ˈʔæːʔ]
n#	77.48%	0% (0/4)	JOHN PLAYED TENNIS [ˈwɒˀn (.) ˈpəleɪ (.) ˈtʰæˀnɪˀh]
d#	38.1%	0% (0/4)	GOOD GIRLS ARE NICE [ˈnʊˀʔ ˈnɛˀʊʷ ɔ ˈnãɪʔ]
#ʃ	74.16%	0% (0/2)	MARY'S SHOES ARE CLEAN [ˈmɛˀwi ˈluʔɪʔ ɑ ˈvĩːn]
Elision			
Ct#C	84.54%	0% (0/4)	MY LEFT LEG HURTS [ˈmãɪˀ ˈlæˀʔ ˈlæˀʔ ˈəːˌ]
Cd#C	59.83%	0% (2/10)	SAM LOVED TO DANCE [ˈdæˀn ˈlʌʔ ə ˈdɑˀn]
Liaison			
j-liaison	88.44%	50% (2/4)	HE GAVE ME A BANANA [i ˈdeɪ miʲə ˈnɑˀˈnɑˀˌˌ]
w-liaison	93.47%	50% (1/2)	SOME SMOKE BLEW OUT OF THE CHIMNEY [θ ʌˀn ˈməʊʔ ˈbluʷ ɑʊʔ ɒʔ ʌ ˈɸɪmːi]
r-liaison	88.36%	75% (3/4) (/r/ realised as [w])	YOU MUST STIR IN THE SUGAR [oˆmʌ ˈdæːʷ ɪˀn ə ˈfʊˌˌʔəˌˌ]
Articles			
Indefinite	No norms given	0% (0/2)	SAM ATE AN ORANGE VERY SLOWLY [ˈdˌæˀm ˈnɛˀˌʔ əʔ ɔˈjɪˀn wɛwi ˈlɜli]
Definite	No norms given	0% (0/2)?	I GAVE THE ELEPHANT A BANANA [aɪ ˈdeɪ ə ˈʔæləʔɪˀn ə ˈnɑˀˈnəˀ]

7.12.1.2 Word juncture in conversational speech

In conversational speech there was evidence that Hamish was also using liaison, as in SHE IS LOOKING AFTER IT [ˈiʲəʔ ˈlʊʔɪˀn ˈɑʔəʷ ɛˌˌʔ], with /j/-liaison between SHE and IS, and /w/-liaison between AFTER and IT. However, there was no other evidence of the between-word processes of assimilation or elision found in typical speech, and frequent use of open juncture was characteristic of his speech. This could be largely attributed to the high

occurrence of SFWF glottal stops already described with its impact on the realisation of obstruent consonants and thus open juncture affected not only word boundary contexts but also syllabic boundaries within words. This resulted in more widespread prosodic disturbances which are described in the next section.

7.12.2 Prosodic characteristics

In conversation, as in sentence imitation, one of the striking features of Hamish's speech was the impact on his prosody of the pervasive use of glottal stops as realisations of the majority of within-word and word final obstruent segments. This interaction between prosodic and segmental features gave the impression of a rather staccato style of speaking. However, open juncture also occurred at word boundaries where assimilation or liaison might occur in typical speakers and not every instance was marked with a glottal stop. There were also examples of utterances where Hamish's use of stress, rate and rhythm was entirely appropriate and at times he showed a level of sensitivity and skill in manipulating suprasegmental features. Examples of these behaviours can be seen in the following Extract 7.3 (CS 7, appendix 7.10). Open juncture is marked O and close juncture C, after Wells (1994).

Extract 7.3 Holiday

```
                O   O  O      O  O    O          O  O   O       O
7.3.1→H. It was on Friday at the beginning of the summer
                  O   O          O   O   O
      holiday and everybody else was here
     [ˈɪʔ wə ˈɒ˜n ˈvaɪdeɪ ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈd‿ʌ˜mə ˈʔɔwə˜deɪ n‿
   ˈʔæ‿ʔibɒʔi ˈʔɛ‿ʊʔ wɒʔ ˈɪːʔ]
7.3.2 J. Oh-so you missed the end of term did you?

7.3.3 H. Yeh
7.3.4 J. Yeh
            O  O   O          O  O  O
7.3.5→H. No-it was beginning of the term
              [ˈnə˜ʊ ˈɪʔ wɒʔ ˈeɪʔ(.)ˈdɪ˜nɪ˜n ɒʔ ə ˈt"ɜ˜m]
7.3.6 J. It was at the beginning?

7.3.7 H. Yeh

7.3.8 J. OK
               O   C   C        O   C    O  C  O
7.3.9 →H. And in the morning we went on an aeroplane
             [æ˜n (.) ˈɪ˜n ə ˈmɔ˜nɪ˜nː (.) i ˈwɛ˜nʔ ɒ˜n ə ˈʔɛ‿wəˈleɪ˜n‿]
```

The beginning of the extract (line 7.3.1) began with an utterance which had open juncture at each word boundary, which gave the impression of a slightly slowed speech rate

followed by a staccato sounding stretch everybody else was here which demonstrated the impact of pervasive glottal stop replacement. It also showed open juncture at syllable boundaries, affecting the integrity of the word everybody. Examination of the extract reveals that occurrences of close juncture are mainly within words where nasal or approximant segments are realised at syllable boundaries. For example, summer holiday (line 7.3.1); in the morning (line 7.3.9). This was particularly so in the high frequency word combinations in the, realised as [ˈɪ˜n ə] and on an, realised as [ɒ˜n ə]. The presence of nasal segments did not invariably lead to close juncture as with the word boundary between beginning and of which was realised with open juncture on two occasions (lines 7.3.1 and 7.3.5).

Use of open juncture meant that Hamish's speech rate could be perceptually slow but he also showed frequent pauses which had a longer duration than those which typically appear in word boundary contexts. This appeared to be related to linguistic context where in narrative speech he was recalling, describing and retelling events in an appropriate sequence; an example is given in Extract 7.4. Hamish's narrative was characterised by frequent, sometimes quite lengthy pauses both between and within words while he recalled what had happened and described it. Note for example, the pauses in line 4.4 and in MATTRESS (line 4.6) where there was a 0.6 second pause between the two syllables and SLEEPOVER (line 4.3) where the pause was slightly shorter. Guo, Tomblin and Samelson (2008) suggest that silent pauses in the speech of typical children are most likely to occur at phrase boundaries so in this respect Hamish's use of pauses may be unusual. However, in a case study of a child called Zoe who had speech difficulties, Wells (1994) reported this type of within-word pausing used by Zoe at turn-end, for example, she realised the word CUPBOARD with open juncture mid-word. He suggested that this may reflect an immature pattern since very young children may not have established adult-like stress patterning.

Extract 7.4: Hamish: Pauses in narrative speech T1

```
4.1  We went to (?town) in (the) (.) after Friday morning
4.2  And then (1.4) we (0.9) done the (XX) at home
4.3  Then Austin comed (0.5) come for a sleep (.) over
4.4  And then (1.3) and after then (.) we went (1.0) to
Tesco's (1.0)
4.5  And (.) when Austin comed we maked a big (0.6) nn (.)
tent under my bed
4.6  nn (.) what Austin had to do and I got a (1.3) little
     (.) under my bed got a (.) ma (0.6) tress
```

4.7 And I (will) pull that out and Austin (.) and Austin nn (0.5) Austin (0.98) was sleeping on (.) there (.) I was sleeping on the top

(Note: all times given in seconds; (.) denotes pause of under 0.5 seconds).

Another situation where Hamish's speech rate was perceptually relatively slow because there were frequent pauses was in sentence imitation task. There were several examples of Hamish pausing, thus creating atypical open junctures at word boundaries, for example, WE WATCHED TELEVISION ALL DAY was realised as [wɪ̯ ˈwɒʔ (.) ˈtʰɛˌləbɪʔəˀn ɔ ˈdeɪ] with a pause between WATCHED and TELEVISION. With the item JOHN PLAYED TENNIS, realised as [ˈwɒˀn (1.4) pəˈleɪ (...) ˈtʰæˀnɪˀh] each word was produced separately with a long pause between JOHN and the consonant cluster [pəl/] onset to PLAYED. It appears that the pause preceding the consonant cluster may have facilitated Hamish's attempt at realisation of both of the consonant segments in the adult target, possibly by allowing more planning time. This is one of the few SIWI consonant clusters in the data.

7.13 Voice quality T1

One further observation of Hamish's speech was that his voice quality was a little breathy and hoarse. This was not a major clinical feature but it has been reported in children who have CAS and is considered indicative of coordination and motor planning at a laryngeal level (Davis, Jakielski, & Marquardt, 1998).

7.14 Summary of findings T1

Hamish's input processing skills and speech output skills at T1 were summarised as follows: (see also his speech processing profile in appendix 7.2 and 7.3 for the mapping of this profile to the speech processing model).

- Input processing skills were limited: able to identify word onsets if targets within production repertoire but identification of coda segments very poor
- Able to identify pictures when given segmented phonemes (e.g. p-i-g) suggesting phonological representations "good enough" for recognition (already evident in good receptive language skills)
- Discrimination between sequences of sounds in real words better than in non-words; discrimination between single sounds better than sequences

- Performance on input tasks affected by output difficulties: not able to inhibit rehearsal
- Able to segment words into syllables (clapping) but not phonemes
- The Picture Naming Task, Non-word Repetition Task and Word Repetition Task showed similar levels of severely impaired performance across all three types of stimuli
- No evidence of oro-motor difficulties
- Impaired performance on DDK task suggested difficulties with motor planning
- Limited stimulability for sounds not in phonetic inventory both as single segments and in CV syllables
- Very low PCC in SW data, which was reflected in MWU
- Restricted system of SIWI phonemes; very restricted SIWW and SFWF consonant systems
- Pervasive effects of structural and systemic simplification and glottal replacement in all types of context
- Some emerging sounds in data i.e. /s/ and possibly /l/ clusters, mainly in SW
- In multi-word utterances (but not SW) there was evidence of the alveolar nasal occurring in SIWI position of high frequency words which appeared to be a residual pattern from when Hamish was younger
- Vowel realisation affected by several processes including lowering, diphthongisation and diphthong reduction
- Unusual use of velopharyngeal fricative in SFWF positions and nasalisation of vowels in CV words which had an adult target of SIWI fricative or affricate
- Variability with repeated naming of tokens both at SW level and in CS
- Unusual use of an extra syllable for plural and past tense morphemes

- In multi-word utterances word juncture was affected by glottal stops and the only connected speech process in evidence was liaison; there were frequent pauses not predictable by context

It appeared that Hamish had difficulties at all levels of both input and output processing which impacted on his speech production in all contexts. However, relationships between processing levels are likely to be complex. For example, Hamish's difficulty in identification of segments in a coda position in an input task might be influenced by his inability to realise these targets in output or vice versa.

The impact of these difficulties on Hamish's intelligibility as experienced by the listeners who participated in the study was explored.

7.15 Intelligibility T1

Hamish's intelligibility was measured through listener responses to an orthographic write-down task for single words, imitated sentences and conversational speech (as described in Chapter Three, Methods); results are presented in table 7.9. Stimuli from Hamish's speech output that were presented for intelligibility rating are given in full in appendix 7.12 and in tables 7.15, 7.16 and 7.17.

Table 7.9 Hamish: Intelligibility outcomes T1: Percentage (and number) of items correctly identified by listeners

Data type	Mean % (No.)	S.D. % (No.)	Minimum score % (No.)	Maximum score % (No.)
Single words (max no. = 10)	13.33 (1.33)	10.86 (1.08)	0 (0)	40 (4)
Imitated sentences (max no. = 25)	25.69 (6.42)	12.57 (3.14)	8.00 (2)	56.00 (14)
Conversational speech (max = 100%)	45.30	13.52	10.00	73.33

Analysis of results using the Wilcoxon Signed Ranks Test demonstrated that the listeners' identification of Hamish's single words was significantly poorer than that of multi-word utterances. There were significant differences between SW and imitated sentences ($Z=-6.246$, $p<.0001$) and between SW and conversational speech ($Z=-7.038$, $p<.0001$). There was also a significant difference between imitated sentences and conversational speech, with conversational speech being the more intelligible type of utterance ($Z=-6.354$, $p<.0001$).

The range of listener responses for multi-word utterances was wider than for single words (range 0-4/10). The lowest percentage score for an individual listener for imitated sentences was 8.00% of words and the highest was 56.00%. The lowest percentage score for a listener for conversational speech was 10.00% and the highest was 73.33%.

In terms of the individual stimuli items, in SW FEATHER, FISHING, SWING and TOOTHBRUSH were least well recognised, with no listeners identifying any of them; SPIDER was best recognised with 40/66 correct responses. The least intelligible imitated sentence was YOU MUST CLEAN YOUR TEETH with 0.30% of words identified (1 of 330 words in the whole sample was correctly identified). The most intelligible was HE GAVE ME (A) BANANA with 60.91% of words identified. In conversational speech TWO TIMES TO FRANCE was least intelligible, with 8.33% of words identified; the best was I WENT ON HOLIDAY with 71.21% of words correctly identified. These intelligibility results are discussed in section 7.26.5.

7.16 Intervention T1 (6;7) to T2 (7;7)

Between T1 and T2 an intervention plan was devised and delivered (see table 7.10); Hamish was seen at school weekly in term time for 26 individual speech and language therapy sessions through the year.

Table 7.10 Hamish: Intervention targets T1 to T2

	Target	Rationale
1.	Perception of SFWF consonants in VC syllables and words	Hamish was not able to reliably identify SFWF consonants without an adult model
2.	Production of SFWF consonants in VC syllables and words	Hamish was not producing SFWF obstruents in his speech
3.	Perception and production of /s/ clusters (sm, sn, sl)	/s/ clusters were stimulable with a good quality /s/ produced (whereas /s/+ vowel was not).
4.	Production of CVCV words (paper, tidy, funny, morning etc)	Hamish frequently glottalised the second consonant in CVCV words: the aim was to produce both consonants without a glottal stop.

Hamish's tolerance for intervention activities was limited at the start of the year but this did improve and his ability to remain focused was observed to improve. (Distractibility usually manifested itself through him initiating conversation). None of the targets were easy to achieve and other activities such as syllable clapping and rhyme games were regularly included so that Hamish could achieve success; he also enjoyed repetition of CV syllables such as those from the Nuffield programme (pea/tea; bow/buy; pear/fair) where

he could have some independence and fluency in the task. It proved difficult to establish reliable follow-up to intervention sessions; a school based teaching assistant was working with Hamish to support his much delayed literacy skills but was not able to attend sessions. Her time with Hamish was, therefore, used to develop vocabulary skills in association with sound-symbol correspondence and learning to read high frequency words. Hamish's family were very supportive but it was not possible to arrange regular attendance of a family member at sessions. During sessions Hamish made some progress; his ability to discriminate and produce SFWF consonants and /s/ clusters improved in practise but there was no evidence of generalisation to spontaneous speech.

7.17 Assessment at T2 (age 7;7)

Twelve months after the first assessment at T1 Hamish's input processing skills and speech output skills in single words and multi-word utterances were reassessed (see appendix 7.13 for his new speech processing profile and 7.14 for the mapping of this profile to the speech processing model). The aim of this reassessment was to collect sufficient data to describe any significant changes in Hamish's skills and also to examine his intelligibility at T2 as judged by the listeners (see Chapter Three, Methods).

7.18 Input processing skills T2

The investigation of Hamish's input processing skills included assessment tasks from Stackhouse et al., (2007) and other, non-standardised activities.

Hamish's speech perception was examined again through the judgements of same/different SFWF single feature and /s/ cluster sequences in real words and non-words, for example, lot/loss; vot/vos; lots/lost; vots/vost, (Stackhouse et al., 2007).

The overall score was 27/36 compared to a score of 35.25/36 (S.D. 0.79) for a typical 7-year-old, z=-10.44 indicating a severe level of difficulty. This z-score was much lower than at T1 (because the skills of typical children were better at age 7 than at age 6) when overall number correct was 24/36, z=-1.86. Hamish's responses were slow and he was observed to use rehearsal as a strategy; the limited accuracy of his production is likely to have contributed to his poor performance in this perception task because he was reflecting on his own inaccurate output rather than the adult model.

When the overall score was broken down to examine the discrimination of single feature and cluster differences in real and non-words, it appeared that Hamish had particular

difficulties in discriminating cluster sequences in real words, 4/9, z=-9.79 (T1 z=-0.65). At T1 he had found cluster sequences in non-words most difficult. The z-score for these stimuli was now -1.2 (T1 z=-3.51). Scores for single feature discrimination were z=-3.77 (T1 z=-1.85) for real words and z=-2.0 (T1 z=-0.95) for non-words. Because the real word cluster sequence discrimination was so poor, overall real words were less well judged (z=-8.86) than non-words (z=-3.2) which was the opposite of the outcome at T1.

The accuracy of Hamish's phonological representations were examined using a mispronunciation detection task (Stackhouse et al., 2007); this task was not done at T1. The task involves the child looking at a picture and judging whether the word heard is an accurate realisation of the target or not, for example, CATERPILLAR is given both accurately and as /ˈkæpətɪlə/, with metathesis; BUTTERFLY is given accurately and as /ˈbʌtəfaɪ/ with cluster reduction. Hamish's overall score across all word lengths was 111/120, z=-1.16, compared with a mean score of 114.7/120 for typical 7-year-olds, and was in the normal range. His scores for 1 syllable, z=-0.12 and 2 syllable. z=-0.71 word were also in the normal range. His score for 3/4 syllable words (z=-1.74) indicated a mild level of difficulty. His errors involved three acceptances of metathesis (for example, accepting /gæŋkæɹu/ for KANGAROO); two acceptances of changes in place of articulation (for example, accepting /jif/ for LEAF); one change in manner of articulation (accepting /maʊt/ for MOUSE); one change in voicing (accepting /gɪʧn̩/ for KITCHEN); on two occasions he rejected a real word, FISHING and CARAVAN.

Comparison of the results on these two very different tasks suggested that Hamish's underlying phonological representations, with the visual and semantic support of a picture, were good enough to make fine-grained judgements of accuracy. However, he found it more difficult to manage the task of comparing two similar words or non-words with auditory input only, and his strategy of using rehearsal to remember the words long enough to make a judgement actively interfered with accuracy. By T2 Hamish's phonological awareness skills in activities such as identification of coda were improving, for example, given a choice of 2 sounds he was better able to say which one was at the end of a given word, but he was inconsistent in his responses, and still heavily reliant on adult support in terms of keeping focus on the coda of words rather than the onset, and repetition of stimuli.

7.19 Speech output tasks T2

Hamish's speech production was reassessed with the aim of exploring what changes there had been in the period between T1 and T2. Given the difficulties, as described, in establishing regular practise between the weekly speech and language therapy sessions, and observations of limited goal generalisation during intervention, it was predicted that test results would show little improvement. Hamish's speech output skills were reassessed using the same range of tasks as at T1. Single word tests; the Picture Naming Task (Stackhouse et al., 2007) and subtests of the DEAP (Dodd et al., 2002) giving 101 items collected from these tasks for single word (SW) analysis compared with 111 at T1 (the DEAP Inconsistency Assessment was not repeated) (appendix 7.4). Real word and non-word repetition tasks were not repeated. The multi-word data are from the analysis of T2 conversational speech (CS) (appendix 7.15) and selected imitated sentences from the Connected Speech Processes (CSP) Repetition Task (Stackhouse et al., 2007), (appendix 7.11); there are occasional examples from other conversational speech, which are indicated in the text.

Hamish's performance on the Picture Naming Task (Stackhouse et al., 2007) was scored and compared to that expected in the speech of typical 7-year-olds; scores were also compared with T1 (see table 7.11). Hamish's overall score across all word lengths was 1/60 (1.66%), z=-13.53. His total correct was the same as at T1 but the z-score had worsened (as with the input skills, age matched peers were performing better at age 7 than at age 6). This was true for all word lengths and the only word realised with complete accuracy was MONEY as it had been at T1. All results continued to indicate a severe level of difficulty and the prediction of little progress held true on this assessment of whole-word accuracy.

Table 7.11 Hamish: Scores Picture Naming Task T1 compared with T2

Word structure	Hamish's scores (z-score) T1	Hamish's score (z-score) T2	Norms age 7 years: mean (S.D.)
1 syllable (N=20)	0 (-14.00)	0 (-15.66)	18.8 (1.20)
2 syllable (N=20)	1 (-11.00)	1 (-13.63)	18.45 (1.28)
3 & 4 syllable (N=20)	0 (-5.04)	0 (-7.27)	16.95 (2.33)
Total (N=60)	1 (-11.93)	1 (-13.53)	54.2 (3.93)

Although the overall scores on the naming task had not changed, segmental level analysis did demonstrate a small amount of progress. Hamish's PCC was 37.71% and his PVC was 83.33% (PPC: 60.52 %) compared with PCC 31.07% and PVC 73.57% (PPC: 52.32 %) at T1.

These changes are summarised and described in following sections; 7.21, 7.22 and 7.23. Hamish's phonetic inventory for consonants was unchanged; with the emergence of the diphthong /ɛə/ his vowel inventory now included all vowels typical for his accent.

7.20 Oro-motor assessment and diadochokinesis (DDK) T2

It had previously been established that Hamish did not have oro-motor difficulties. By contrast, his responses to a DDK task indicated that his underlying motor planning difficulties were unchanged and still significant. He still had great difficulty in producing any accurate repetitions of [p], [t], [k] and his fluency was impaired with slow and hesitant attempts.

7.21 Phonological process analysis T2

A phonological process analysis was again completed using data primarily from single words and conversational speech, supplemented by data from imitated sentences where appropriate.

7.21.1 Structural processes T2

Structural processes in Hamish's speech were essentially unchanged. There were a few examples of the realisation of a SFWF nasal in single words which had been deleted at T1 (see table 7.16) and one example of a SIWI consonant cluster. This was /pl/ in the word PLATE realised as [p^{n} leɪʔ].

There was a single example of structural development where a previously omitted consonant in a word initial unstressed syllable was realised in the imitated sentence SAM LOVED TO DANCE, TO was realised as [ə] at T1 but as the appropriate [tə] at T2. However, in conversational speech there was no evidence of any positive structural changes affecting Hamish's speech.

7.21.2 Systemic processes T2

The changes in Hamish's single words, which resulted in changes to PCC and PVC, were mainly in two areas; firstly in the realisation of SIWI voiceless plosives and secondly in the realisation of vowels. There were also a small number of changes in manner of articulation in individual words but these were not generalised patterns of change, for example a reduction in stopping, (see table 7.12). Changes in consonant voicing and vowel realisation were seen to a much lesser degree in multi-word utterances than in SW.

Table 7.12 Hamish: Changes in single words T1 to T2

Process(es) T1	Target word	Realisation T1	Realisation T2	Change(s) T2
Voicing of SIWI plosive; neutralised vowel not realised in coda syllable	PARROT [ˈpæɹət]	[ˈbæwɪʔ]	[ˈpʰ æʊəʔ]	Voicing matches adult target
Voicing of SIWI plosive	PIG [pɪg]	[bɪʔ]	[pʰ ɪʔ]	Voicing matches adult target
Stopping of fricative; lowering of vowel; glottal replacement; fronting of velar nasal	FISHING [ˈfɪʃɪ˜ŋ]	[ˈbɛʔɪ˜n]	[ˈfɪʔɪ˜n]	SIWI fricative and vowel realisations match adult target
Lowering of vowel	BOOK [bʊk]	[bʌ˜ʔ]	[bʊʔ]	Vowel realisation matches adult target
Diphthong reduction; lowering of vowel	HAIRDRESSER [hɛəˈdɹɛsə]	[ʔæˈfæʔə]	[ʔɛəˈfɛˌʔʌ]	Vowel realisations more closely match adult target although second vowel slightly lowered /ɛˌ/ & schwa not used in final unstressed syllable
Diphthong reduction; WSD; CR; FCD	AEROPLANE [ˈɛəɹəple˜ɪn]	[ˈʔæweɪ˜]	[ˈʔɛəwəleɪ˜n]	All target vowels realised; syllable structure accurate; SFWF consonant accurate
Diphthongisation	ROOF [ɹuf]	[wəʊʔ]	[wuʔ]	Vowel realised appropriately as a monophthong

Voicing changes resulted in Hamish's realisation matching the adult target as in TIGER realised as [ˈtaɪdə] rather than [ˈdaɪjə]; in other examples the target was not realised with an adult place of articulation but the voicing matched the adult realisation as in KANGAROO realised as [ˈtʰæ˜ndəʊu] and KITCHEN as [ˈtʰɪʔə˜nɱ] (previously [ˈdˌæ˜ndəʊəu] and [ˈdɪʔɪ˜n] respectively). Observations of variable speech output at T1 showed that one of the sources of variability had been in the voicing of SIWI plosives (see table 7.7) suggesting that this aspect of Hamish's speech, beginning to reflect the adult target at that time, had generalised by T2.

In the imitated sentences task these voicing changes were also evident, for example, the SIWI alveolar fricative in the sentence SAM LOVED TO DANCE, realised as [ˈdæ˜n ˈlʌʔ ə ˈdɑ˜n] at T1 but [ˈtʰæ˜m ˈlʌʔ tə ˈdɑ˜n] at T2; the SIWI fronted velar plosive in SHE CUT MY HAIR realised as [i ˈdʌʔ mʌ˜ ˈʔæːʔ] at T1 but [i ˈtʰʌʔ mãɪ ˈʔæ˜ː] at T2.

Hamish's vowel system showed more realisations that matched the adult target, although nearly 17% did not. He had acquired /ɛə/ as in AEROPLANE [ʔɛəwəˈleɪ˜n], although this was not consistent, for example, SQUARE still showed the diphthong reduction [p͡fæ˜]. The use of the diphthong /aʊ/ had emerged with more consistency so that for example, MOUSE, [mæ˜ʔʊ̯ʔ] at T1, was realised as [mãʊʔ] at T2. There were fewer examples of vowel lowering and fronting, and the diphthongisation of /u/ had resolved so that, for example, PARACHUTE previously [ˈp͡fæwəfəʊʔ] was realised as [ˈpʰ æwəfuʔ]. The vowel /ɛ/ showed a reduction in instances of lowering although this was variable and sometimes Hamish produced a vowel where the perceptual quality could be described as being between /ɛ/ and /æ/; there was no indication that this was linked to phonetic context and his realisation of [æ] reliably matched the adult form. Evidence of similar vowel changes were noted in imitated sentences , for example, in the sentence CLARE ATE ALL HER LUNCH, Hamish realised the target vowels in CLARE and ATE as [ɑ] and [æ] at T1 [ˈlɑ ˈʔæʔi ˈɔ ʷə ˈlʌ˜n] but as [ɛə] and [ɛ] at T2 [ˈlɛəʷ ˈɛʔiʔ ˈɔ ʷi ˈlʌ˜n (.) ts].

Other changes were few in number but may be interpreted as indicators of progress; these included examples of manner of articulation changes in SW where the bilabial plosive had replaced the labiodental fricative, for example, PRAM realised as [fæ˜m] at T1 was realised as [p̼æ˜m̥] at T2, and SPONGE realised as [fʌ˜nt'] at T1 was realised as [pʰʌ˜nd̥.'] at T2. There was no evidence of this happening in imitated sentences. He was also able to change his realisation of the SIWI voiceless alveolar fricative if asked. So, for example, for SAUSAGE Hamish said [ˈtʰ ɒʔɛʔ] but when queried he responded with a realisation that matched the adult model more closely [ˈsɒʔɛʔ]. At T1 he had not been able to change his production in this way.

In conversation (see appendix 7.12) Hamish's speech was essentially unchanged. There were some minor vowel differences, for example, in the utterance AN AIRBOAT-WE DO IT ON A AIRBOAT, the diphthong /ɛə/ was realised with a slightly lowered [ɛ] followed by [ə] rather than a lengthened [æ]; [n̩ ˈɛ̝ə̝bəʊʔ (.) ˈwi duʷ ˈɪʔ ɒ˜n ə ˈɛ̝ə̝bəʊʔ]. The

other structural and systemic phonological processes and patterns observed in conversational speech at T1 were the same including pervasive glottal replacement.

7.22 Features not captured through phonological process analysis T2

As at T1, the phonological process analysis revealed a wealth of information which contributed to the description and explanation of Hamish's speech patterns and intelligibility. However, it was apparent that the other features such as nasalisation patterns observed and the production of morphological markers which could not be accounted for through a traditional phonological process analysis were still present. These features were examined through further analysis of Hamish's speech patterns. In addition variability, voice quality and word juncture behaviours in multi-word utterances were explored.

The patterns of nasalisation were unchanged so that Hamish used vowel nasalisation and SFWF velopharyngeal fricatives as he had at T1. This is demonstrated in the following examples from conversational speech. In example 1 the utterance final word FIRST is realised with a nasalised vowel; in example 2 the word MARSHMALLOWS has a velopharyngeal fricative also in SFWF position.

1). WE WENT TO NEW YORK FIRST: [wi ˈwɛ̰˜nʔ tʰu ˈnū ˈjɔʔ ˈfɑ̰˜ː?]

2). AND ATTACK MARSHMA-ALLIGATORS WITH MARSHMALLOWS: [ə˜n əˈtæʔ ˈmɑ˜ʔmæ˜ (.) ˈælɪdeɪʔə wɪ ˈmɑ˜mæləʊɱ]

There was still evidence of variability, so for example, in that same conversation he later referred to MARSHMALLOWS as [ˈmɑ˜ʔmæˈləʊwɪ] with an extra syllable denoting the plural. This also illustrates that the production of plural 's' morphological marker was still much in evidence. Examples from the SW tasks include GLOVES realised as [ˈlʌʔbɪʔ]; LEGS as [ˈlæʔɪt̪]; PYJAMAS as [ˈlɑ˜mijə]; SCISSORS as [ˈtʰ ɪʔəwəʔ]. However, there were no examples at T2 of Hamish using an extra syllable to denote the regular past tense morpheme -ED either in the CS samples transcribed or when listening to wider samples of recorded conversation. At T1 this had not been used consistently and by T2 it had apparently disappeared.

Although, as seen in the example beginning the last paragraph, variability was still evident in Hamish's conversational speech, in the SW assessments it had reduced. The SW stimuli in the different tasks meant that Hamish was asked to name the same item more than once

and his responses at T2 showed that his realisations of tokens in these naming tasks was consistent whereas at T1 there had been some variability (as described in section 7.11.3). An example of this consistency in SW but not in MWU was seen with the word SPIDER. Hamish named this as [ˈtʰaɪd̪ə] on two separate occasions but after one item immediately said WE GOT A SPIDER LIKE THAT IN OUR HOUSE realised as [wi ˈdʊʔ ə ˈfaɪdə laɪʔ ˈðæʔ ɪ˜n ɑʷ aʊ].

One brief observation at T2 was that Hamish's voice quality was unchanged and was still slightly breathy and hoarse.

7.23 Word juncture in multi-word utterances T2

As at T1, Hamish's use of assimilation, elision and liaison, and close versus open juncture was examined in sentence repetition and in conversational speech. This was first explored using the Newton Sentences Connected Speech Processes (CSP) Task (Stackhouse et al., 2007), (see table 7.13). Results were compared to those of other 7-year-olds and to Hamish's scores at T1.

Hamish's use of word juncture was unchanged at T2. In the CSP sentence imitation task he used liaison in similar contexts to those demonstrated at T1. For example, the sentence WE SAW AN ELEPHANT AT THE ZOO, designed to elicit an indefinite article, was realised as [ʔi ˈtɔʷ ə ˈʔɛlɪʔɪ˜nʔ æ n (.) ˈtʰ u] with appropriate use of /w/-liaison between SAW and A. The two examples of elision were the same as at T1.

Table 7.13 Hamish: Scores on Connected Speech Processes (CSP) Repetition Task T1 & T2

	Score expected at age 7	Hamish's score T1	Hamish's score T2
Assimilation			
t#	92.40%	0% (0/4)	0% (0/4)
n#	80.43%	0% (0/4)	0% (0/4)
d#	43.18%	0% (0/4)	0% (0/4)
#ʃ	83.83%	0% (0/2)	0% (0/2)
Elision			
Ct#C	86.94%	0% (0/4)	0% (0/4)
Cd#C	72.63%	10% (2/10)	0% (2/4)
Liaison			
j-liaison	91.49%	50% (2/4)	0% (0/4)
w-liaison	95.35%	50% (1/2)	50% (1/2)
r-liaison	86.15%	75% (3/4) (/r/ realised as [w]	50% (2/4) (/r/ realised as [w]
Articles			
Indefinite	No norms given	0% (0/2)	0% (0/2)

Definite	No norms given	0% (0/2)	0% (0/2)

Word boundaries designed to examine processes of assimilation and liaison were almost all affected by glottal replacement of SFWF plosive and fricative consonants. For example, the sentence THE RED CAR WENT AWAY, would typically elicit assimilation of the SFWF voiced alveolar plosive in RED to the SIWI velar in CAR. Hamish's realisation of this word juncture was [ˈwæʔ tʰ ɑ]. Although the presence of velar fronting potentially impacts on interpretation of this example, had Hamish been using assimilation the pattern (assuming a target of RED TAR) would typically involve an unreleased voiced alveolar plosive before the voiceless alveolar plosive, i.e. [ˈwæd˺ tʰ ɑ]. In another example, the sentence JOHN COLLECTS STAMPS might elicit SFWF assimilation of the alveolar segment in JOHN to the SIWI velar in COLLECTS. In Hamish's realisation there was no velar assimilation because the SIWI velar was fronted, and he realised it as [ˈfɒ˜n dəˈlæʔ ˈtʰæ˜mbˌɪʔfŋ̟].

Similar examples were found in items designed to elicit elision at word boundaries. The utterance I WASHED MY HAIR LAST NIGHT was realised as [tˢə kə˜n ˈwɒʔ maɪʲ ˈæə˜ ˈlɑ˜fŋ̟ ˈnːaɪʔ] with glottal stops resulting in open juncture. Another example was MY LEFT LEG HURTS, designed to elicit elision of the SFWF consonant in LEFT which was realised as [ˈmaɪ ˈlæ˜ʔ lˌæʔ ˈʌː].

In conversational speech the same pattern was found with some mature liaison forms but glottal stop realisations resulted in no examples of assimilation or elision. The utterance AND THAT WHY THEY DO IT WITH MARSHMALLOWS was realised as [ə˜ læ ˈwæ li ˈduʷ ɪʔ wɪ ˈmɑ˜ʔmæˈləʊwɪ] with /w/ liaison between DO and IT. Another similar example was seen with /ɹ/–[w] liaison in WHAT HAD A BIG PROPELLER ON THE BACK realised as [wɒʔ ˈæʔ ə bɪʔ ˈpɛləʷ ɒ˜n ə ˈbæʔ]. Still in evidence was that close juncture occurred within and between words where nasal or approximant segments occurred such as MARSHMALLOWS realised as [ˈmɑ˜ʔmæˈləʊwɪ].

At T2 Hamish's multi-word utterances continued to show open juncture with pauses between words which would not necessarily be predicted by segmental content or prosodic boundaries. An interpretation of these pauses in conversational speech as at T1 was that they were related to sentence formulation issues. For example, AND THEN – WE-WENT- WENT TO NEW YORK FIRST realised as [æ˜n ˈðæ˜n (.) ˈwi (.) ˈwæ˜nʔ (.) wi ˈwɛˌ˜nʔ tʰu ˈnɯ̈ ˈjɔʔ ˈfɑ˜ˌːʔ]. Hamish had been asked about his holiday which

involved staying in three different places. He appeared to be planning how to sequence events which resulted in the pauses in the utterance. As at T1 open juncture was still in evidence in the imitated sentences for example, WE WATCHED TELEVISION ALL DAY realised as [i ˈwɒʔ (.) ˈtʰɛˌləbɪʔəˆn ɔ ˈdeɪ]. Hamish's continuing atypical management of word juncture was reflective of the severity of his persisting speech difficulties.

7.24 Summary of findings T2

Analysis of Hamish's input processing skills and speech output skills at T2 showed the following:

- The input processing tasks carried out were limited in scope; those that were completed (for example, the discrimination of features and sequences in coda positions) suggested that there had been little change between T1 and T2 so that his performance in comparison to typical children had worsened.
- Hamish's PCC and PVC showed quantitative improvement with a PCC of 37.71% (31.07% at T1) and a PVC of 83.33% (73.57% at T1)
- Hamish's performance on the Picture Naming Task (Stackhouse et al., 2007) indicated no change in the number of whole words correct; he scored 1/60 at T1 (z=-11.93) and T2 (z=-13.53)
- Phonological process analysis showed positive changes in realisation of appropriate voicing for voiceless plosives and in vowel production but these generally occurred in SW; structural and systemic systems were largely unchanged in multi-word utterances
- Variability in SW had reduced but was still a factor in multi-word utterances
- Word juncture behaviours at T2 were the same as those seen at T1

Hamish's difficulties remained profoundly severe at T2. The impact on the intelligibility of his speech as experienced by listeners was explored through the intelligibility task.

7.25 Intelligibility T2

Hamish's intelligibility at T2 was measured in the same way as at T1 (see Chapter Three, Methods). The same 10 SW and 5 imitated sentences recorded at T1 were recorded again at T2 and edited for the intelligibility task; the conversational speech samples from T2 were obviously different. Results for T1 and T2 were compared (see table 7.14).

Table 7.14 Hamish: Intelligibility outcomes T1 compared with T2: Percentage (and number) of items correctly identified

Data type	**T1 Mean % (No.)**	T1 S.D. % (No.)	T1 Min score % (No.)	T1 Max score % (No.)	**T2 Mean % (No.)**	T2 S.D. % (No.)	T2 Min score % (No.)	T2 Max score % (No.)
Single words (max no. = 10)	**13.33 (1.33)**	10.86 (1.08)	0 (0)	40 00 (4)	**24.39 (2.41)**	13.02 (1.27)	0 (0)	60.00 (6)
Imitated sentences (max no. = 25)	**25.69 (6.42)**	12.57 (3.14)	8.00 (2)	56.00 (14)	**41.21 (10.30)**	13.10 (3.27)	16.00 (4)	76.00 (19)
Conversational speech (max = 100%)	**45.30**	13.52	10.00	73.33	**46.14**	12.62	20.00	82.86

Results indicated that recognition of Hamish's single words at T2 (see table 7.15) had improved significantly (Z=-5.821, p=<.0001). Results for the imitated sentences also showed significant improvement (see table 7.16) (Z=-6.352, p=<.0001). By contrast, conversational speech showed no significant change (see table 7.17), (Z=-.345, p<.730). There remained significant differences between the different types of stimuli as found at T1; words in imitated sentences were better recognised than SW (Z=-6.263, p<.0001); words in conversational speech were better recognised than in imitated sentences (Z=-2.716, p<.007); conversational speech was better recognised than SW (Z=-6.821, p<.0001). These results indicated that Hamish's multi-word utterances continued to be more intelligible than SW and although conversational speech was better recognised than imitated sentences the difference between the two types of MWU was smaller than at T1 (T2: Z=-2.71, p<.007; T1: Z=-6.354, p<.0001).

Table 7.15 Hamish: Analysis of individual single words from intelligibility task T1 and T2

Word	Adult target	**Hamish's realisation T1**	Number of listeners identifying word T1	**Hamish's realisation T2**	Number of listeners identifying word T2
feather	/ˈfɛðə/	[ˈbæ˜ʔɑ˜ˌ]	0/66	[ˈpʰæ˜ʔə˜nʔ]	0/66
fishing	/ˈfɪʃɪ˜ŋ/	[ˈbɛʔɪ˜n]	0/66	[ˈfɪʔɪ˜n]	9/66
pig	/pɪg/	[bɪʔ]	2/66	[pʰ ɪʔ]	14/66
snake	/sneɪk/	[neɪʔːt̚]	26/66	[neɪʔ]	56/66
spider	/ˈspaɪdə/	[ˈbaɪdəˌ]	40/66	[ˈʦaˌˌɪdə]	47/66

square	/skwɛə/	[fæ˜]	1/66	[p͡fæ˜]	0/66
strawberry	/ˈstrɔbri/	[ˈfɔbi]	17/66	[ˈfɔbi]	7/66
swing	/swɪ˜ŋ/	[fɪ˜ŋ]	0/66	[fˈɪn]	2/66
teeth	/ti θ /	[di?]	2/66	[tʰ i?]	12/66
toothbrush	/ˈtu θ brʌʃ/	[ˈdu?f˘ʌ?]	0/66	[ˈt̪ʰu̪..?fʌ˜?]	14/66

The most intelligible single word was SNAKE, 56/66 listeners understood this; the least intelligible were SQUARE and, as at T1, FEATHER (0/66) (see table 7.15). Closer examination of individual stimuli showed some observable effects of segmental change on listeners' identification of items. For example, PIG, TOOTHBRUSH and TEETH were all realised at T2 with voiceless plosive onsets in comparison compared to voiced plosive onsets at T1. As can be seen this resulted in an increase in the number of words recognised. The word FISHING showed a similar change with the onset syllable realised accurately. However, beyond those obvious examples of positive change it is difficult to identify any other patterns. SNAKE, with a minimal difference (a barely perceptible ejective /t/) and STRAWBERRY, transcribed identically at T1 and T2 showed very different listener responses, with SNAKE having an positive change from 26 to 56/66 tokens identified and STRAWBERRY decreasing from 17 to 7/66.

With the imitated sentences the best and least well recognised were the same as at T1 with HE GAVE ME A BANANA at 85.45% (60.91% T1); YOU MUST CLEAN YOUR TEETH 6.06% (0.30% T1) (see table 7.16). The best interpreted conversational utterance was WE WENT TO NEW YORK FIRST (89.39%) and the least was AND THAT'S WHY THEY DO IT WITH MARSHMALLOWS (13.94%); (see table 7.17). To measure how well MWU were recognised the total number of words in each utterance was multiplied by the number of listeners and the percentage of correctly identified words was calculated (see table 7.16 and 7.17).

Table 7.16 Hamish: Analysis of individual imitated sentences from intelligibility task T1 and T2

Target sentence	**Hamish's realisation T1**	**Percentage of words recognised by individual listeners T1**	**Hamish's realisation T2**	**Percentage of words recognised by individual listeners T2**
He gave me a banana	[i ˈdeɪ ͡mɪʲə ˈnɑ˜nə..]	60.81%	[i ˈdeɪ? ˈmi ə ˈnɑ˜nə..]	85.45%
She wrapped the parcel	[i ˈʊæ˜? ə ˈbɑ˜?əʊ]	9.09%	[i ˈʊæ? bə.. ˈpʰ ɑ?əʊ]	23.11%

They argued all day	[ðə˜m ˈʔɑdʊʊɪ ˈʔɔ deɪ]	42.42%	[ðeɪ ˈʔɑtʰ ʊwɪ ˈɔʊ deɪ]	62.42%
We saw an elephant at the zoo	[wi ˈdɔʷ ə ˈʔæləʔɪ˜nʔ ˈæʔ ə ˈdu]	14.65%	[wi (.) ˈtʰ ɔʷ ə ˈʔæləʔɪ˜nʔ ˈæʔ n̩ ˈtʰ u]	28.03%
You must clean your teeth	[ð̃ ˈmæʔ ˈlĭn͡ nɔ ˈdi]	0.30%	[ð̃ ˈmʌ˜ʔ ˈlĭʔ ˈɔ ˈtʰ i]	6.06%

The range of listener responses remained very wide for all types of stimuli, for example, four listeners recognised none of the single words but one listener (L46) recognised 6 of them. Overall, conversational speech was still the most intelligible type of utterance but although one listener (L23) interpreted 82.86% of the sample, 6/66 listeners interpreted less than 30%.

Table 7.17 Hamish: Analysis of conversational speech samples from intelligibility task T1 and T2

Target sentence	T1 or T2	Hamish's realisation	Percentage of words identified by individual listeners
AT (THE) BEGINNING OF (THE) SUMMER HOLIDAY	T1	[ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈd̩ʌ˜mə ˈʔɔwə˜deɪ]	19.70%
I WENT ON HOLIDAY	T1	[ʌ ˈwɛ˜nʔ ɒ˜n ˈɒwədeɪ]	71.21%
IN THE MORNING WE WENT ON (A) AEROPLANE	T1	[ˈɪ˜n ə ˈmɔ˜nɪ˜mː (.) i ˈwɛ˜nʔ ɒ˜n ə ˈʔɛ̩wəˈleɪ˜n̩]	59.09%
ONE OF MY FRIENDS LIVES IN LONDON	T1	[ˈwʌ˜n əʔ maɪ˜n ˈvæ˜nːɪʔ ˈlɪʔ ɪ˜n ˈlʌ˜ndə˜n]	50.84%
TWO TIMES TO FRANCE	T1	[ˈdu ˈtʰaɪ˜mɪʔ du ˈf˜ɑ˜nʔfŋ̩]	8.33%
AND I WAS AT (THE) FRONT SO (THE) WATER (WENT) AT ME FIRST	T2	[n̩ ˈʔaɪ wə ʔæʔ ə ˈfʌ˜n təʊ ˈwəʊʔəʊ ˈwɛ̩˜nt̩ ʔæʔ ˈmi fɑʔ]	23.94%
AND THAT'S WHY THEY DO IT WITH MARSHMALLOWS	T2	[ə˜ læ ˈwæ li ˈduʷ ɪʔ wɪ ˈmɑʔmæˈləʊwɪ]	13.94%
IT WENT ON (THE) BOAT	T2	[ˈʔɪʔ wɛ̩˜nʔ ˈɒ˜n də ˈb̥əʊʔn̩ ʔ]	53.64%
QUITE (A) LOT WE FED ON (THE) BOAT	T2	[ˈwaɪʔ ə ˈlɒʔ wi ˈfæʔ ɒ˜n ə ˈbəʊʔfŋ̩]	61.69%
WE WENT TO NEW YORK FIRST	T2	[wi ˈwɛ̩˜nʔ tʰ u ˈnū ˈjɔʔ ˈfɑ˜̩ːʔ]	89.39%

Following the detailed study of Hamish's speech output and intelligibility, the research questions were considered in relationship to the findings. The discussion is focused mainly on findings from T1 unless otherwise indicated, apart from section 7.26.6.

7.26 Discussion

The aim of this chapter has been to give a detailed description and analysis of Hamish's speech in single words and multi-word utterances, and to consider the impact of his speech production difficulties on his intelligibility as judged by a group of adult listeners. At T1 at the age of 6;7 years Hamish's PCC was 32.00% and on the Picture Naming Task (Stackhouse et al., 2007) he produced only 1/60 whole words (1.66%) that matched the adult form. On both of these quantitative measures the accuracy of his speech production was well below the level expected of a typical six-year-old, and suggested that his speech was severely impaired. He could therefore be confidently included in that group of children described as having "persisting speech difficulties" (Pascoe et al., 2006).

7.26.1 What does a traditional phonological process analysis based on detailed perceptual phonetic investigation reveal about Hamish's speech output? What features revealed by perceptual investigation are not captured by a traditional phonological process analysis?

7.26.1.1 Phonological process analysis

The examination of Hamish's speech first focused on a phonological process analysis, described by Dodd (2005) as "surface speech error patterns" (p. 35). Dodd writes that these output patterns may be at the level of the syllable (i.e. structural) or be "substitution" (i.e. systemic) errors. Further, building on the work of Ingram (1976) and Grunwell (1987) she describes how non-adult realisations may be categorised as being developmentally appropriate to the child's age and stage (seen in at least 10% of children), show a delayed pattern (used by at least 10% of younger children but not age-matched peers) or be unusual (used by fewer than 10% of children at any age). Hamish's speech showed both delayed and unusual patterns.

7.26.1.1.1 Structural processes

The analysis of Hamish's speech showed pervasive structural simplification in all types of utterance. For example, there were only 2 occurrences of SIWI consonant clusters in the whole data set, both in single words. Reduction of clusters to a single element is an atypical pattern for a child of Hamish's age (McLeod & Arciuli, 2009) as is his use of the

labiodental fricative for /r/ clusters and also /s/ clusters where the target included bilabial segments. This frequent use of [f] resulted in the collapse of possible contrasts across a set of consonant clusters compounding the impact of structural changes. As an example, if Hamish was to produce the adult targets BREAD, SPREAD, FRED, THREAD, SHRED, TREAD and DREAD, they would all be realised as [fæʔ]. One possible explanation for the use of [f] is that the labial features of the adult target, for example, lip rounding in the /r/ element of /r/ clusters or bilabial placement for the voiceless plosive in /sp/ were combined with the continuant features of the targets to produce a segment both labial and continuant. These realisations bear similarity to those of a child reported by Howard and Heselwood (2002) where "Alison", aged 4;4 produced plosive plus /r/ clusters with harmonisation of the plosive with the labiality of the approximant resulting in tokens such as [pfʷ ːas] for CRASH (p. 234). Given Hamish's reduced phonetic inventory, [f] approximates to these feature criteria so may represent a solution within a highly constrained system. What is not clear is whether there was any covert tongue movement accompanying the auditory and visual perception of labial harmony. Howard and Heselwood (2011), in a paper exploring the complementary use of perceptual and instrumental analysis report one such example in an adult who had severe apraxia, who realised the onset target in the word 'jaw' with a SIWI bilabial plosive which was accompanied by a silent lingual gesture. They argue that it is important for the clinician to know if this is happening and clearly this would be relevant for a child like Hamish. If clusters were realised with covert elements of more typical articulatory gestures, planning for effective intervention could involve shaping and supporting these patterns. As it was, this information was not available for Hamish. McLeod, Van Doorn and Reed (1997) purport that realisation of clusters with coalescence indicates that "children have an underlying representation of the consonant cluster but fail to produce the elements separately" (p. 103). Rees (2001) suggests using relatively stronger skills to support the development of weaker areas. For Hamish, drawing his attention to already established phonological representations in input might be a way to establish more accurate motor programmes for output.

The structural simplification patterns seen in Hamish's speech, and exemplified by his limited phonotactic range, may reflect over-dependence on particular word shapes or templates. Vihman and colleagues (Velleman & Vihman, 2003; Vihman & Croft, 2007) argue that templates emerge early in speech development and reflect the individual child's lexical and phonetic preferences. Initially these may match the adult model quite closely

(being selected on that basis) but as vocabulary develops, constrained by the child's still limited output skills, intelligibility may decrease due to homophony (Stoel-Gammon, 2011). In typically developing children this phase must be transitory since children are generally intelligible by the age of four (Coplan & Gleason, 1988). For children like Hamish the persistence of simplified templates, reflecting highly constrained speech production skills, continues to impact on intelligibility far beyond the stage where it has resolved in typical children.

7.26.1.1.2 Systemic processes

Systemic processes are considered in terms of consonants and then vowels.

7.26.1.1.2.1 Consonants

Hamish's consonant system was characterised by the pervasive use of glottal stops particularly within words and in word-final position. Although he also showed a range of other common processes, for example, fronting and stopping, glottal stop realisations arguably had the greatest impact on intelligibility because the frequency of their occurrence which affected so many segments considerably reduced the number of phonological contrasts available in his word production.

Ball (2003) in a case discussion based on combining Bybee's cognitive approach to phonology (Bybee, 2001) with gestural phonology (Browman & Goldstein, 1992) describes a child "Susan" who used glottal stops extensively. Ball sets out the view that glottal stops are "the most simple of gestures, as all other gestures (velum, tongue tip, tongue body, and lips) can be ignored" (p. 28). This notion of extreme articulatory simplification is appealing in the explanation of Hamish's speech difficulties. His motor planning deficits reduced his ability to produce velar plosives and apical fricatives and affricates, suggesting the possibility of difficulties in planning and coordination of movements of the tongue body and tip. His inaccurate realisation of vowels may also be explained by difficulties in managing to shape his vocal tract in the precise way needed for the consistent production of the full range of vowel segments. Of course this does not imply that perceptual difficulties in input processing are not important, but there was some evidence to suggest that in spite of having demonstrable difficulties with some input processing tasks (as described in section 7.4), Hamish had good awareness of aspects of segmental and morphological features which he attempted to realise, even though his production was not typical. However, it appeared that there was a complex interaction between articulatory constraints and the establishment of well-defined, accurate motor programmes. It was

significant that there were no differences in the production of words in the word naming, word repetition and non-word repetition tasks. The same performance across all three types of stimuli suggested that there were limitations in output processing and that these were articulatory in nature. The rationale for this view is that since non-words do not have an already stored motor programme, the imitation of novel material might allow for the production of more mature speech patterns if the child's articulatory skills are in the process of developing. This is the argument made by Bryan and Howard (1992) in a case study of a five-year old child whose non-word repetition was much better than his real word naming. Intervention was targeted towards updating stored phonological representations, matching the capacity shown in output patterns for non-words with production of real words. For Hamish there was no such mismatch. There is, however, a note of caution because Stackhouse and Wells, 1997 and Stackhouse et al., 2007, suggest that children may use analogy to deal with novel material thus accessing established representations or they may lexicalise non-words and repeat the matched real word target. There were no obvious examples of lexicalisation in Hamish's responses to non-word repetition and it did appear that his speech output was subject to significant articulatory constraints and that extensive glottal replacement might be symptomatic of these.

The impact of the frequent use of glottal replacement was a reduction in contrast with the consequent risk to intelligibility. An additional loss of contrast resulted from Hamish's atypical realisation of the post-alveolar fricative [ʃ] and affricate targets [ʧ] and [ʤ] as the labiodental fricative [f]. Because [f] was being used for some consonant clusters (as described in the previous section 7.26.1.1.1) production of fricatives and affricates in this labiodental manner compounded the effects of homonymity. As with the clusters, the labial and continuant features of [ʃ], [ʧ] and [ʤ] appear combined in Hamish's output patterns for these segments.

Although Hamish frequently used [f] for so many adult targets, there were occasions when words with a SIWI target of [f] were instead realised with a stop. One such example was FISHING realised as [ˈbɛʔɪ˜n] in contrast to FISH realised as [fɪʔfɲ]. This may be symptomatic of the motor planning difficulties shown for instance in the DDK task, where the intended articulatory gesture was achieved broadly in terms of labial placement but lacked precision. This argument is strengthened through the variability noted in output, for example, FEATHER realised both as [ˈfæ˜ʔɑ˜ˌ] and [ˈbæʔːə˜nʔ] and also examples where the target bilabial plosive and the labiodental fricative were both

articulated, for example, PARACHUTE realised as [ˈpˆfæwəfəʊʔ]. From a listener perspective both variability in production and atypical phonetic realisations potentially increase the likelihood of the intended targets not being recognised.

7.26.1.1.2.2 Vowels

Hamish's vowel production could be described at least partially in terms of commonly occurring vowel processes such as lowering and diphthong reduction, although Reynolds (2013) cautions that in spite of lowering being frequently mentioned in the literature the evidence that it is common is not unequivocal. Reynolds does, however, suggest that there may be a stronger case for describing diphthong reduction as commonly occurring. He also expresses the view that both lowering and diphthong reduction represent different aspects of simplification processes. Lowering by perceptually maximising acoustic contrast, which might be assistive in a system operating within the constraints of phonological or articulatory difficulties and diphthong reduction by reducing the complexity of target realisation. Reynolds expresses the view that:

> "The overall result is to maximise the use of the simplest canonical form consonant-vowel-consonant-vowel (CVCV), with simple open syllables" (Reynolds, 2013, p. 238)

The explanatory appeal of Reynolds' description links to the previous discussion about structural simplification being a major factor in Hamish's speech output. Reynolds is arguing the case principally from a phonological perspective but it could equally be applied in articulatory terms. Hamish had been diagnosed with childhood apraxia of speech (CAS) before the study began; vowel lowering and diphthong reduction have been described in children who have CAS (Grigos & Kolenda, 2010). Irrespective of any diagnostic categorisation, Hamish showed difficulties in motor planning and motor programming and it may be that application of an articulatory/phonetic framework was most appropriate in conceptualising his vowel difficulties. However, Hamish's significant difficulties with input processing could not be discounted in influencing the realisation of vowels; examination of the existing data did not provide evidence that could be unequivocally applied to explain all instances of vowel production that were different to the adult target. Additional data collection designed to address the specific roles of input and output processing in vowel segments would have provided further insights. This could then have enabled the refinement of Hamish's intervention targets.

Considerations about the roles of input and output processing skills in Hamish's vowel production can be considered in the broader context of the relationships between phonetics and phonology. Donegan (2013) states that:

> "Phonological features can be viewed, not as abstract categories, but as the links of motor and proprioceptive aspects of production, on one hand, to perceptual properties (auditory, acoustic, or sometimes visual) on the other." (p. 34)

For children like Hamish it is possible to speculate that difficulties in developing typical articulatory gestures may impact on the development of both the phonological and perceptual systems. Children are unable to shape their output to match the patterns they hear so their processing systems adapt (or "mis-adapt") to operate within a highly constrained system. It could be predicted that some adaptations would be phonological, for example, Hamish's nasalisation of vowels in CV syllables to signal the presence of a fricative or affricate in the adult target. However, some would be phonetically based, for example, perhaps the realisation of /u/ as a long central vowel [ɜ] before a nasal segment, as in MOON [mɜ˜n]. It would also be possible to view phonetic differences in the context of gestural phonology and motor planning deficits. The moment-to-moment processing demands of a particular utterance might influence the realisation of the vowel depending on the consonantal environment. Motor planning difficulties may result in relatively small differences in vocal tract shaping which will change the realisation of the vowel. This could in turn influence the categorical perception of the listener as happened with Hamish's production of /ɛ/ and [æ].

Significantly for Hamish vowel difficulties have an impact on intelligibility (Fletcher, Dagenais, & Critz-Crosby, 1991; Pollock & Hall, 1991; Speake et al., 2012) and in the context of his highly constrained consonantal system the impact would be predicted to be considerable. Although Hamish's intelligibility was significantly impaired at both points in time, there were improvements at T2 and the percentage increase in segmental accuracy was more evident with vowels than with consonants. Item-by-item analysis of listener responses might have allowed for closer examination of evidence to support that improved intelligibility was linked with vowel realisation.

7.26.1.2 Features not captured through phonological process analysis

Aspects of Hamish's speech production not captured through phonological process analysis relate principally to nasalisation patterns and his morphology in the realisation of plurals and past tenses.

7.26.1.2.1 Nasalisation patterns

Nasalisation patterns are described in section 7.11.1; they include production of a nasopharyngeal segment in SFWF position in a word such as WITCH realised as [wɪʔfŋ] and SOCK as [dɒʔfŋ] and nasalisation of a vowel in an open syllable word where the adult target contained a fricative or affricate such as CHAIR realised as [dæ˜..]. These patterns were used just over 20% of the time in single words which had a fricative or affricate target, rather less in multi-word utterances where they were usually produced in utterance final position. As described in the section 7.26.1.1.2.1, Hamish's early speech output apparently favoured a pattern of nasal replacement for both plosive and fricative segments. One possible explanation of his use of either a velopharyngeal fricative or vowel nasalisation is that at the point in his development where fricatives emerged, he was not able to articulate adult target fricative segments. However, he may have found a creative solution to this by using airflow through the nasal cavity. In the context of a CVC word the presence of friction in the adult target could be signalled by the production of a syllable with the form "consonant plus vowel plus glottal stop plus velopharyngeal fricative": [CVʔfŋ]. In an open syllable word the vowel was nasalised. This echoed in Hamish's production of words where the SFWF nasal was deleted but the vowel was nasalised as in CARAVAN realised as [ˈtʰæwəvʌ˜˘]. It also suggests that Hamish perceived sound patterns that he was unable to produce and that he actively (although not consciously) used the resources that were available to him to solve this problem (see similar patterns in Chapter Five). This is reminiscent of the strategies reported in the speech of children who have velopharyngeal dysfunction or cleft palate (Grunwell & Harding, 1996; Hutters & Bronsted, 1987).

7.26.1.2.2 Morphology

Hamish's realisation of plural and past tense morphological markers was distinctive. As described in section 7.11.2, he marked their presence by the addition of an extra word-final syllable as in CHIPS realised as [ˈfɪʔpɪʔ] and ARGUED in THEY ARGUED ALL DAY realised as [ðɛ˜m (.) ˈʔɑduʊɪʔ ɔl ˈdeɪ]. Hamish's segmental patterns in SFWF position were very limited with frequent glottal replacement. Given that he was not able to use word-final segments with ease or reliability, his response appears to have been to add an extra syllable to signal his intended meaning, typically [ɪʔ]. From a listener perspective this addition of a syllable, especially in plurals was enormously disruptive. One example of this was in an early conversation the word FRIENDS in the utterance ONE OF MY FRIENDS LIVE(ED) IN IT realised as [ˈwʌ˜n ə mə˜ ˈvæ˜nd̪ɪʔ ˈlɪʔ ɪ˜nɪʔ]. This word was initially

orthographically transcribed as "family" (not an unreasonable guess with the combination of an atypical vowel and additional syllable) but in later discussion Hamish clarified the intended target as FRIENDS.

Although Hamish's marking of morphemes was atypical, the absence of the complex segmental sequences required for tenses and plurals could be predicted from his patterns of reduction of consonant clusters to one element and final consonant glottal replacement for single consonants (Bernhardt & Stemberger, 2000). Children whose speech contains both final consonant deletion and cluster reduction produce fewer tense and agreement morphemes (Tyler & Haskill, 2010). Although there is an association between language delay and phonological development (Haskill & Tyler, 2007), Hamish's patterns may be sufficiently explained by the severe constraints on speech sound production. Indeed his realisation of morphological markers suggests that his approach to language production is compatible with the view expressed by Leonard (1985):

> "The child is viewed as an active learner who creates knowledge from the environmental input...The stored information does not necessarily preserve all of the characteristics of the adult form.....rules are both motivated and restricted by severe output constraints" (Leonard, 1985, p. 50-51)

Hamish appeared to be attempting to express grammatical information relating to plural and past tense markers (his "motivation" in Leonard's words) , but this was restricted by his ability to realise, for example, SFWF alveolar fricatives or the SFWF segmental sequences necessary for past tense morphology. He was however, able to produce two and three syllable words so the syntactic information could be signalled with an additional syllable.

7.26.2 What does comparison of the patterns in Hamish's speech data reveal across three speech elicitation conditions (1: single word production; 2: connected speech in sentence imitation; 3: connected speech in spontaneous conversation)

The comparison of Hamish's speech output across the three different sampling conditions (with one exception discussed in the next paragraph) did not reveal any convincing evidence of structural or systemic segmental differences that were related to whether the words were, for instance, in a naming task or conversational speech. This might be explained by the severity of Hamish's difficulties at T1. Variability in segmental accuracy between single words and MWU (with SW being more accurate) may be the result of the increased linguistic loading of multi-word utterances (Tyler, Williams, & Lewis, 2006) which includes phonological complexity. Variable realisation of segments can be related to the emergence of new sound patterns (Tyler & Lewis, 2005) and SW allow for more planning

time for the realisation of, what are for the child, novel phonetic combinations. However, if children's SW production is already highly constrained as Hamish's was, with no strong evidence at T1 of newly emergent patterns, any potential differences resulting from a SW-MWU competence-performance gap are likely to be reduced.

The one exception demonstrating contextual differences was the evidence of a residual pattern of use of the alveolar nasal [n], principally seen where Hamish used [n] for /g/ and his realisation, for instance, of the word GOT varied between [dɒʔ] and [nɒʔ]. Notes in Hamish's case record indicated that this had been more pervasive at earlier stages of his speech development but at T1 it only occurred in multi-word utterances. Examples of this are given in section 7.10.1.4. The historical explanation can be found in examination of speech data recorded when Hamish was much younger where [n] was used extensively for a variety of segments, a pattern not found in immature but typically developing speech. SW data recorded at 3;9 includes SUN realised as [nʌn], CARS as [nɑ], TEETH as [niʔ] and CUP as [nʌʔ]. At T1 this pattern of [n] replacement, occurring now only in high frequency words in multi-word utterances, was possibly a relic of this earlier process. In the context of a usage-based model of speech production, it may be that longer-established forms of high frequency lexical items were more readily available to Hamish. The absence of the pattern in SW thus signalled the emergence of still immature but developmentally more typical realisation of, for example, velar plosives.

In addition, this pattern of nasal replacement appeared to apply particularly in the artificial context of sentence imitation. In these repeated utterances Hamish showed occasional instances of long domain harmony with nasal realisation across several words as in GOOD GIRLS ARE NICE realised as [nʊ˜ʔ nɛ˜ʊʷ ɔ ˈnãɪʔ]. Given the other unusual nasalisation patterns noted in his speech (and explored further in section 7.26.1.2.1), it is interesting to speculate that at an early stage he may have found it easier in articulatory terms to realise segments with a nasal rather than oral airstream.

Although with this one exception there was no real evidence of an effect of sampling type on speech output in terms of segmental content, the inclusion of multi-word speech in the data analysis revealed phonological and prosodic information which was not evident from the SW data alone.

Hamish's word juncture was both immature and atypical. The only type of connected speech process used which occurred in both the sentence imitation task and conversational

speech was liaison, although these were two examples of elision in the CSP task. Word boundary transitions were affected by pervasive glottal stops in SFWF positions which resulted in his MWU being characterised by open juncture. This is not typical of adult speech (Wells, 1994) and children of Hamish's age would be expected to use more mature patterns closely matching the adult model (Newton & Wells, 1999). Examination of the phonetic detail of Hamish's word junctures provided convincing evidence that his patterns of open juncture were directly related to his constrained segmental capacity. Newton (2012) explored between-word processes in three children with PSD. She commented that in contexts where coda clusters contained a nasal or approximant segment, unlike with other consonants, glottal replacement for the whole cluster never occurred. This preservation of SFWF nasal segments was evident in Hamish's speech, for example, [ˈwɛ˜nʔ ɒ˜n], resulting in a typical realisation of the coda cluster in WENT. Although this did not always result in close juncture, the presence of nasals and approximants at word boundaries was more likely to facilitate the occurrence of this. The most developed form of close juncture in Hamish's speech was liaison where approximants linked abutting vowels but there were also two examples of elision at sites where a nasal and approximant consonant cluster occurred.

For children like Hamish, persisting limitations in segmental output impact on utterance level cohesion as well as single word accuracy and examination of speech data in different types of sampling conditions provides a more complete profile of speech output skills.

Another aspect of Hamish's speech output evidenced in MWU was his frequent pauses both between and within words in imitation and in conversational speech. Silent pauses in narrative speech were explored by Guo, Tomblin and Samelson (2008) who concluded that these silences may be diagnostic when assessing children's language skills; their SLI group showed silent pauses that were like those of language matched rather than age matched controls. These silent pauses reflect the processing time needed to retrieve and use lexical and syntactic representations and this explanation appeared relevant for Hamish. The authors also suggested that children who also have speech difficulties might show stammering behaviours related to difficulties in retrieving phonological forms but there was no evidence that this was the case for Hamish. However, in the context of a diagnosis of CAS, delayed retrieval of phonological forms or motor programmes, or difficulties in motor planning (Nijland, Maassen, van der Meulen, et al., 2003) might result in within-

word pauses in speech output. These may be related to segmental rather than syllable or word level planning.

7.26.3 Does Hamish's speech output show phonetic variability within individual speech elicitation conditions?

The phonetic variability in Hamish's speech was shown sometimes when comparing production of the same single words on more than one occasion (see table 7.8) but not particularly when comparing a word in isolation and in the context of a multi-word utterance. Variability might be expected in typical speech when comparing the same words produced in different linguistic and phonetic environments (Holm et al., 2007) but Miller (1992), when discussing a clinical population of adults with acquired dyspraxia, suggests that variability is best considered in the context of token to token comparison in the same context, for example, repeated productions of a single word. This type of repeated production was assessed using the DEAP (Dodd et al., 2002) but Hamish did not meet the criterion of 40% variability in the realisation of test items for the diagnosis of inconsistent phonological disorder (IPD) (Dodd, 2005). This assessment was not used with the intention of making a diagnosis of IPD and if the diagnostic category of CAS already recorded in his clinical notes was correct there was no reason to assume that Hamish would meet this criterion. However, Crosbie, Holm and Dodd, (2005) describe another criterion for IPD being that a child produces three examples of a given token, all incorrect with at least two different realisations, which does occur in Hamish's data. In the same volume Broomfield and Dodd (2005) present data from a child, Ben, who has IPD (p. 224). The type of phonetic variations presented by Ben and those seen in Hamish's output appear qualitatively similar with differences, for example, in voicing or placement. The concept of IPD was somewhat problematic in the context of Hamish's data primarily because of the quantitative criterion but Marquardt, Jacks, and Davis (2004) point out that the nature of variability is such that children's scores may vary from day-to-day, a point also made by Pollock and Hall (1991).

The study by Marquardt et al., (2004) was of three young children diagnosed with dyspraxia using data collected from single word naming tests, and assessment of consonant and vowel production in conversational speech. The authors reported that the highest level of variability in tokens was found in the child who had the most severe speech difficulties. This approach may be more conceptually useful in relation to the inconsistency of Hamish's speech than consideration of IPD. The authors suggest that "variability may be attributed

to instability of the neural processes responsible for the programming and execution of phonetic sequences" (p. 128). They note differences in segmental accuracy between single word testing and conversational speech, although comment that variability is frequent in the speech of typically developing young children, which suggests that it is also a product of an immature system. Taking a developmental perspective, children like Hamish may in some respects present with speech patterns seen in very young children and variability may be one aspect of this presentation.

7.26.4 Does the psycholinguistic speech processing profile provide explanations of Hamish's speech output patterns?

Hamish's speech processing profile showed difficulties with both input and output skills and the patterns shown have some explanatory power in relation to his speech output. For example, Hamish had particular difficulties with input in identifying segments in a coda position, and the phonological process analysis of his speech indicated limited use of SFWF consonants. However, his performance on the Bridgeman and Snowling (1988) subtest, also based on identifying single segments but additionally clusters in a coda position, suggested that discrimination between SFWF single sounds was significantly better than coda cluster sequences and that discrimination between cluster sequences was better in real words than in non-words. Examination of the different tasks which formed the basis of these observations shows that Hamish found it more difficult to answer questions such as "what is the last sound in this word?" (North & Parker, 1993) or to match two pictures with the same final sound than to say whether two words were the same or different (Bridgeman & Snowling, 1988). His performance was influenced by his speech output difficulties in that he found it difficult to inhibit (impaired) repetition of stimuli. The identification tasks required him to segment and isolate phonemes within the word, tapping into phonological awareness skills as distinct from the speech perception skills (Rvachew, 2006) which tapped into word identification. These examples highlight the importance of understanding task requirements when carrying out the assessment and then interpreting the profile (Stackhouse, Wells, Pascoe, & Rees, 2002). Furthermore, because Hamish's identification of coda clusters was better in real words than non-words, it is likely that speech perception was supported by previously stored phonological representations (Stackhouse & Wells, 1997).

The output levels of the speech processing profile indicated significant performance impairments; these were predicted by the initial observations of Hamish's speech and his

poor intelligibility. However, comparison of the different types of output (naming, real word repetition and non-word repetition) revealed a clinically important factor, namely that Hamish's performance was similar across all three types of stimuli (in this respect he is like Lily, as indicated in Chapter Six, section 6.26.4). In explanatory terms this suggested that the same articulatory constraints were operating across all tasks, reflecting "generalized articulatory difficulties" (Stackhouse & Wells, 1997). However, again, this cannot be viewed in isolation and it might be the case, also suggested by Stackhouse and Wells (1997), that the similarities in output performance reflected multi-level "pervasive phonological processing difficulties" (p. 47). This would mean that Hamish's speech patterns were reflective of his significant input processing deficits. A counter-argument is found in Hamish's impairments in DDK rates and accuracy which were indicative of motor level difficulties. Indeed there is circularity in these reflections because it appeared that Hamish's ability to successfully complete input processing tasks was affected by his difficulty in inhibiting rehearsal out loud, and he was not able to reliably reflect on words or segment them without an adult model. The pervasive nature and the complexities of interactions between different levels of speech processing were illustrated through the use of the psycholinguistic profile. Its explanatory role was in demonstrating both the nature and severity of Hamish's difficulties. This particularly applied to the underpinning role of problems in input processing in conceptualising the severe limitations of his intelligibility.

7.26.5 Does the intelligibility of Hamish's speech vary across different speech elicitation conditions?

The results of the intelligibility task at T1 indicated that the listeners found Hamish's speech significantly more intelligible in MWU than in SW, with conversational speech being the most intelligible type of utterance. In this respect his intelligibility outcomes are like those of Lily and the discussion in section 6.26.5 is relevant to Hamish. Even given the selection bias for conversational speech (described in Chapter Three, Methods), the difference between SW and imitated sentences still favoured MWU. It may be that his combination of typical intonation patterns possibly together with atypical open juncture to signal word boundaries allowed for recognition of at least some words in context, although the mean for imitated sentences was only 25.69% so the effect was small.

One further observation of Hamish's intelligibility was that all types of utterance showed a wide range of listener responses. For example, the responses to Hamish's conversational

speech ranged from 10.00% to 56.00% of words recognised. As previously stated, the wide range of responses is discussed in section 6.26.5.

7.26.6 Are any changes in Hamish's speech output evident between two points in time and do any changes impact on the intelligibility of his speech?

There were some changes in Hamish's speech between T1 and T2 with quantitative measures of PCC (T2, 37.71%; T1, 31.07%) and PVC (T2, 83.33%; T1, 73.57%) showing improvements. These were judged to be quite small in clinical terms and progress in achieving the intervention targets was slow and showing minimal impact on speech output in therapy sessions. However, the reassessment at T2 showed positive changes in the realisation of voiceless plosives in SIWI positions and in vowel production, particularly in SW, although neither had been directly targeted in intervention. However, observation of variable realisations at T1 showed voicing was one of the elements that showed variability in output; this was perhaps a predictor of change. Improvements in vowel realisation would be predicted to improve intelligibility (Fletcher et al., 1991; Higgins & Hodge, 2002; Reese & O'Hanlon, 2004; Speake et al., 2012).

The results of the intelligibility task at T2 indeed showed that listeners' recognition of SW had improved significantly, as had imitated sentences; in comparison the outcome for conversational speech was similar to T1. Overall MWU were still much better identified than SW but understanding Hamish's speech in all types of utterance continued to present listeners with considerable challenges and the range of outcomes remained very wide. There was an observable positive impact on word recognition resulting from changes to the production of SIWI voiceless plosives but otherwise any direct relationship between segmental change and intelligibility was not apparent.

In a study by Speake et al., (2012) on the effects of vowel difficulties on the intelligibility of two 10-year-olds who had PSD the authors report that even when the children's PVC improved after intervention, this was not always sufficient to improve intelligibility even when the adult target vowel was appropriately used. Although for Hamish, with the exception of the word FISHING, vowels were not at issue in the single words sampled through the intelligibility task, it may be the case more generally that when children's speech is so impaired there are subtle phonetic differences which impact on listener perception. However, where impressionistic transcription does not highlight any obvious changes, it is not possible to explain these results. Further acoustic or instrumental

measures such as EPG might support more informative assessment of changes to phonetic or gestural patterns, especially but not only in MWU.

7.27 Summary and conclusions

A comprehensive phonological process analysis (PPA) of Hamish's speech identified a range of processes with pervasive effects of structural and systemic simplification and glottal replacement in all types of context. However, as with the other three children, analysis of MWU revealed segmental and prosodic features which were not evident from a traditional single word naming test. These observations collected from each of the four case studies evidenced that investigation of the speech output of children with PSD should include MWU as well as SW and that the scope of this assessment should encompass details of phonetic, phonological and prosodic features. Hamish's MWU showed frequent open juncture with glottal stops and pauses being characteristic of his output. Like Lily there were instances of open juncture within words at syllable boundaries as well as between words although this was more frequent in Hamish's speech than Lily's. In the Connected Speech Processes task Hamish was the child who showed most frequent use of liaison across word boundaries. Like the other children Hamish also showed considerable variability in speech output but unlike the others there were fewer instances of this being progressive i.e. being closer to the adult target. However, this may be because Hamish showed the most severe level of impairment with the lowest PCC of the four cases presented. There were examples of variability between extremely immature and less immature forms, as with his long domain nasal harmony, so in this sense he was demonstrating progression.

Psycholinguistic assessment indicted that Hamish's speech processing skills showed significant impairment in input tasks, and, like Harry and Lily he had more difficulty in activities involving non-words than real words. His difficulties in output tasks were severe, with comparison with normative data suggesting a level similar to that of Lily, but PCC analysis and observations by the author indicating that his speech was the most profoundly impaired. Hamish's output patterns were similar in non-word repetition and picture naming, to those of Harry and Lily. Tallulah was the child whose processing skills were the least impaired and the only one who showed a positive difference between real word naming and non-word repetition; this might suggest that better non-word repetition might be an indicator of maturing motor planning and execution skills. Hamish's performance on a DDK task indicated that he had difficulties in motor planning, as did all the children, but

his oro-motor skills were not observed to be impaired. The findings of this study, even given the limitations of the assessment carried out on DDK and oro-motor abilities, suggests that children with poor DDK skills might be at risk of PSD but there is no such association with oro-motor skills.

Hamish presented with severe and persisting speech difficulties at T1 which affected the intelligibility of his speech in all types of utterance although listeners were better able to recognise words in MWU than as single items. This suggested that the listener experience of Hamish, Tallulah and Lily's speech where MWU were more easily identified than SW might be more typical than the patterns shown in response to Harry's speech.

By T2, Hamish's speech output and his intelligibility showed slight improvement but he continued to have severe and pervasive difficulties reflecting those identified at T1. Observations of the changes in Hamish's speech suggested that as the differences were in vowel realisation and the more mature production of devoiced segments these aspects of speech output may be important in intelligibility.

The case studies have presented the investigation and findings of the study in relationship to the four individual children. The final chapter is Chapter Eight; the purpose of this is to discuss the broader themes that emerged which might apply to all the children, and which might have implications more widely applicable to PSD and for intelligibility.

Chapter Eight

Discussion

8.1 Introduction

This study was designed to examine the speech of four children who had severe and persisting difficulties, and to explore the impact of their persisting speech difficulties (PSD) on the intelligibility of their speech as judged by unfamiliar adult listeners. In the case study chapters the research questions have been explored in relation to the data of each individual child. The detailed perceptual phonetic investigation of the each child's speech revealed that although many of the presenting patterns could be captured and described in terms of a traditional phonological process analysis, there were many features which were essential in understanding and describing their speech output which PPA did not encompass. These included speech patterns seen in multiword utterances. Exploration of speech patterns in the three types of data sampling showed both quantitative and qualitative differences between speech production in single words, imitated sentences and conversational speech. The psycholinguistic speech processing profiles provided possible explanations of the children's speech output patterns and a way of describing the complex nature of these processing difficulties. The measure of intelligibility showed that the children's intelligibility varied across the three types of data samples and also that the listeners showed variability in their responses both within and between each child's data. Between T1 and T2, all four children showed progress in speech production as measured by, for example, PCC and there were positive changes in their intelligibility. However, their speech output showed persisting difficulties and these continued to influence how much of their speech the listeners recognised.

In the course of this exploration, several key themes have emerged. The purpose of this chapter is to discuss these themes. The discussion is centred on the nature and complexity of the speech processing difficulties of children with PSD, and the application and limitations of phonological process analysis in relation to capturing the entirety of the presenting data. Consideration is given to the issues that were identified in relation to the children's production of multi-word speech, and to variability in speech output. Themes related to intelligibility are also discussed. Finally, some of the limitations and then the overarching theoretical and clinical implications of the study are described.

8.2 The nature and complexity of speech processing difficulties in children with PSD

The children in this study, identified as having PSD, all showed evidence of extensive speech processing difficulties affecting input, representational and output levels (Pascoe, Stackhouse, & Wells, 2006). Their individual psycholinguistic profiles, and the mapping of these to the speech profiling model at T1 (Stackhouse & Wells, 1997, see appendices 4.2, 4.3, 5.2, 5.3, 6.2, 6.3, 7.2 and 7.3), showed different combinations of difficulties in terms of task performance but their shared presentation was that of complex and multi-level processing impairments. In addition, the children all presented difficulties at times which appeared to reflect difficulties in speech processing capacity (Crystal, 1987). This resulted in complex data, not easily forced into neat categories for interpretation but proving to be an essential element in conceptualising PSD.

The multi-level impairments shown in this study are commensurate with the findings of other studies. Conclusions from the ALSPAC study (Wren et al., 2012), which was based on the assessment results of children with PSD, led to the hypothesis that children with PSD show pervasive speech processing problems. They have both cognitive-linguistic and oro-motor difficulties, as measured through performance on non-word repetition and DDK tasks. It has also been suggested that children who present with "problems with words" have impaired interactions between levels of processing (Chiat & Hunt, 1993, p. 200) evidenced by variability in the realisation of phonological and lexical targets. During this current study, it was observed that all the children at times showed slow word retrieval and occasional semantic naming errors, which Chiat and Hunt (1993) highlighted as symptomatic of impairments at multiple levels of processing. Preston and Edwards (2009) found that children with PSD were less accurate and slower than age-matched controls in a rapid naming task. They were also more impaired in phonological awareness activities (Preston & Edwards, 2007) and DDK tasks; the difficulties evidenced again suggested pervasive and multi-level processing problems. The children in this current study all showed some difficulty with both phonological awareness and DDK tasks. In addition, three of the children (all except Tallulah) presented with significant impairments in input processing skills.

The profiles of Harry, Lily and Hamish showed some similarities in performance on input tasks; in particular they all had more difficulties with discrimination of speech sounds in non-words than real words. They were more successful in demonstrating competencies in tasks which tapped the accuracy of their phonological representations. This finding in

regard to phonological representations was not unexpected since they all had receptive language and vocabulary skills that were in the typical range. This must mean that they had stored lexical representations that were sufficiently specified for the purposes of recognition (Hewlett, 1990; Stackhouse & Wells, 1997). However, other studies have found that children who have speech difficulties perform less well than typical peers on real word tasks requiring detection of mispronunciations, thus indirectly suggesting that the quality of stored phonological representations is compromised (Rvachew & Grawburg, 2006; Sutherland & Gillon, 2005, 2007). The discrepancy between the findings of these reported studies and this current study might be explained by the ages of the children. Rvachew and Grawberg (2006), and Sutherland and Gillon (2005; 2007) assessed children aged 3 to 5 years in comparison to the 6 and 7-year-olds in the current study. Findings from another 6-year-old who had PSD, "Katy", were reported by Pascoe et al., (2005); the authors concluded for Katy that "phonological representations are a *relative* strength" (p. 198). Katy's speech processing profile in input was similar to that of Harry, Lily and Hamish. Vance (1995) reported normative data from a mispronunciation detection task for the five age bands of typical children aged 3 to 7 years, with between 17 and 20 participants in each group. She describes significant improvements in performance relative to age, and in a short form of the task children reached ceiling by the age of six. Harry, Lily and Hamish did not generally perform at ceiling level but their relative strength with real words appeared to reflect the developmental progression seen in typical peers.

It was hypothesised that Harry, Lily and Hamish used already established phonological representations and top-down semantic knowledge to support their speech perception skills (Rvachew & Brosseau-Lapre, 2012) in real word discrimination tasks. However, in non-word activities the absence of this top-down support revealed their poor perception, particularly in making judgements about finely graded phonetic differences and sound sequences. Task performance might also be influenced by other factors such as limitations in verbal short-term memory (Alloway, Gathercole, Willis, & Adams, 2004). The presentation of activities such as auditory lexical decision or mispronunciation detection requires children to make a judgement on a single word, but the discrimination tasks require listening to two real or non-words and then making a comparison between one or two segments of those words. Harry, Lily and Hamish performed poorly in comparison to a typical peer group (evident from norms given with the published tasks) and difficulties with speech perception are well documented in children who have speech difficulties (Lof, 1996; Rvachew, Ohberg, Grawburg, & Heyding, 2003; Shiller, Rvachew, & Brosseau-Lapre, 2010).

However, although poor performance on auditory input tasks may be of indicative of difficulties in speech perception, it may also be symptomatic of a processing system that is generally inefficient or impaired.

The only child who did not have input difficulties was Tallulah who also presented with other differences which demonstrated that her processing skills overall were stronger. Tallulah was the only child whose outcomes on the non-word repetition task were in the typical range and she had the highest PCC, both of which suggested greater overall proficiency.

The most obvious areas of similarity in the speech profiles of the children were in speech output, with difficulties in accessing (and by implication, establishing) accurate motor programmes, and articulating real words accurately. The children also had poor skills in the DDK task demonstrating poor motor planning and/or motor execution for speech production. Although DDK was assessed in a limited way, and so must be interpreted with caution, it was evident that none of the children could produce repeated sound sequences accurately or consistently. It has been found that typical children are able to repeat sequences of syllables with accuracy and consistency from the age of 5 years (Williams & Stackhouse, 2000); the children in this study were aged 6 and 7 years. Furthermore, at T2, their performance on these DDK tasks was essentially unchanged.

Two of the children (Lily and Harry) had difficulties with non-speech oro-motor movements in that they were unable to elevate their tongue tip; this may have no direct significance in relation to their speech output since among typical 3 to 5-year-olds there are many children who are unable to perform this task (Williams & Stackhouse, 2000). This finding about children who have typical speech suggests, therefore, that it is unclear how tasks involving tongue tip elevation relate to speech production. The inability to carry out this action may be the output of an immature motor system or reflective of a difference that occurs in the general population.

The processing profiles provided a snapshot of the children's skills at the time of the assessment but did not give a developmental perspective on their abilities at a younger age, or predict future development. For example, at T1 Tallulah did not present with input processing difficulties as measured through tasks done at that time, and her ability to carry out tasks requiring the manipulation of speech sounds, such as phoneme deletion, were judged appropriate for her age. However, at T2 her performance on segmentation and

deletion tasks was unchanged and her phonological awareness skills appeared to be arrested at that stage of development (Stackhouse & Wells, 1997). The ongoing presence of input difficulties was evident for Harry, Lily and Hamish; although they all showed some progress, their performance on tasks continued to be impaired both in terms of numerical scores but also qualitatively, for example, with frequent requests for repetition of stimulus items. These ongoing difficulties with input, and the impaired DDK performance of all the children at T2, suggested that although they all showed improvements in varying degrees in segmental use and intelligibility, their speech processing systems remained significantly impaired (see appendices 4.13, 4.14, 5.13, 5.14, 6.13, 6.14, 7.13 and 7.14). Constraints in any part of the speech processing system may interact with others to limit the development of skills. For example, the motor theory of speech perception (Galantucci, Fowler, & Turvey, 2006; Liberman & Mattingly, 1985) suggests that an individual's speech output directly informs how speech is perceived. Studies have shown in typical adult speakers that there is activation in the speech musculature of a listener which mirrors the patterns of a speaker (Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995; Watkins, Strafella, & Paus, 2003). It is possible, for example, that delay or difficulty in the development of speech motor skills will impact on the children's speech perception resulting in a processing system where feedback between levels operates around a loop of impairment.

The ongoing and persisting nature of processing impairments was illustrated by Kenney, Barac-Cikoja, Finnegan, Jeffries and Ludlow (2006) who carried out a small study of nine adults who had a history of speech difficulties as children. When the participants were compared with a group of typical matched controls they showed significant deficits in speech perception and short-term memory (and also presented with mild speech differences). A systematic review of the long-term impacts of speech difficulties in childhood revealed a range of consequences for adult life related to academic and social outcomes (McCormack, McLeod, McAllister, & Harrison, 2009). The complex relationships between speech perception and output difficulties may be conceptualised through bi-directional interactions where children "must know the articulatory movements required to produce a given acoustic output" (Munson, Edwards, & Beckman, 2005, p. 193) but also where phonetic output is shaped progressively through matching between the utterances that the child both hears and says (the "auditory-articulatory 'feedback loop'", Stoel-Gammon, 2011, p. 9). A primary deficit in any aspect of the speech processing system may render a child at risk of difficulties; risk might be mitigated by individual resilience factors, for example, cognitive style or early intervention. Conversely, their manifestation and

persistence may be triggered or maintained by factors such as intermittent hearing loss (Shriberg et al., 2010) or a severe difficulty at one level of processing, such as motor planning, which impacts across the whole system.

8.3 Phonological process analysis: application and limitations

This study explored the application and limitations of phonological process analysis (PPA) as a framework for the description and analysis of the children's speech production. PPA is proven to be a useful tool in clinical practice, is widely used and offers enduring appeal to clinicians. However, PPA does not and cannot be used to capture all aspects of speech production data collected through observation and transcription. The theory underpinning phonological process analysis is grounded conceptually in an approach that predicts that children's speech can be described in terms of universal, innate simplification patterns (Miccio & Scarpino, 2008). These patterns are seen in the immature speech of very young children (Dodd et al., 2003) and in the atypical speech of children who have SSD (Stoel-Gammon et al., 2002). A long-standing debate in the area of child speech is whether children who have difficulties present with delay ("protracted phonological development", Bernhardt & Zhao, 2010, p. 163) or whether they represent separate populations (Shriberg et al., 2010). Another view is that they are a different population because they show persisting speech delay which is underpinned by a "chronological dislocation" due to a "deficient system" (Grunwell, 1988, p. 235). An extension of this discussion is whether the group who have speech difficulties show homogeneity and there is a consensus that they do not (Waring & Knight, 2012). Although in clinical practice there is recognition of group differences, assessment tends to be fairly uniform i.e. a phonological process analysis based on single word naming (Skahan, Watson, & Lof, 2007), almost to the exclusion of any other form of examination. One exception is the DEAP assessment (Dodd et al., 2002) which offers a range of tasks designed to establish differential diagnosis in subgroups of children, such as phonological delay or inconsistent phonological disorder. Although these tasks present stimuli in different ways (for example, repeated productions of the same token) they are nevertheless largely based on single word naming. This general dependency on single word naming is in spite of the design limitations of all speech assessments, none of which include a full range of consonants and vowels (Eisenberg & Hitchcock, 2010). The unquestioning use of a phonological process approach for all children shows a disjuncture between theory, i.e. phonological processes are universal simplifications, and clinical observation, i.e. children present with individual patterns in

speech, which sometimes show features which are neither universal nor simplifications. Children with PSD who present with poor intelligibility may fall into this group.

The phonological process analysis completed for the children in this study was more detailed than a traditional approach based on a typical single word naming assessment carried out in clinical practice because it included both single words and conversational speech. Examination of the results shows that it was possible to describe many of the speech patterns of all four children using a process approach (see appendix 8.1 for a summary of the speech output of all four children). Several different phonological process systems are in use internationally, with differing numbers of processes described and differing terminology (Miccio & Scarpino, 2008). The processes in this study were based on Grunwell's influential approach in the UK described in *"Phonological Assessment of Child Speech"* (Grunwell, 1985). There were some commonalties across the children in the structural and systemic processes which are described as frequently occurring in both young and speech delayed children (Dodd et al., 2003; Stoel-Gammon et al., 2002). For example, all the children had cluster reduction, velar fronting and gliding. In this respect, apart from in relation to their ages, their speech was unremarkable for children from a clinical population.

The phonological process analysis provided a framework in this study for the description of much of the single word data and this pattern-based approach has benefits in identifying targets for intervention (Miccio & Scarpino, 2008). Indeed this method of describing children's speech and successfully delivering treatment has been validated though empirical studies (Almost & Rosenbaum, 1998; Baker & McLeod, 2004; Williams & Chiat, 1993). It was also possible to identify patterns that occurred consistently in both single words and conversational speech (for example, gliding). Armed with an awareness that the transcriber needs to be aware of the potential pitfalls of making assumptions about what is or might be heard (Howard & Heselwood, 2002), the analysis was effective in dealing with data which could be perceived and transcribed[1] as a linear segmental sequence.

The application of a linear analysis assumes a one to one correspondence between what is produced, perceived and transcribed and is heavily influenced by alphabetic notation (Müller & Papakyritsis, 2011). However, not all data can be forced through this narrow

[1] The assumption here is that perception and transcription are adequate for purpose but it is acknowledged that both are interpretations of the speech signal which may be influenced by many factors (Mu¨ller, Damico, & Guendouzi, 2006).

conceptual/perceptual aperture, and attempts to do so are difficult, resulting in awkward, hard to interpret, transcriptions. This can be illustrated, for example, by the realisation of the word SPAGHETTI by all four children: Hamish [ˈt͡sˌɛˌʔi]; Harry [sʌˈbɛʔi]; Lily [ˈtʰɛʔiˌˌ]; Tallulah [ɪ˜ɱˈgɛtʰ i]. There are some common features that can be identified in all four words, for example, vowel segments are similar and the SIWW alveolar plosive is produced either as [t] or as a glottal stop, both of which occur in typical adult speech. However, the citation form of the word begins with the cluster /sp/ and also contains a SIWW voiced velar plosive /g/ which in phonological process analysis terms might be realised with, for example, cluster reduction and velar fronting respectively. In the children's realisations of SPAGHETTI it is difficult to be sure how to map the production of even the syllable shape of the target word in a linear way. This then poses a dilemma in analysis which may lead to these types of data being consigned to an "other" category or ignored. Whilst this may be a legitimate way to manage occasional examples or even to categorise them as "exceptional forms" (Grunwell, 1987, p. 101), if this happens more frequently the integrity of the analysis begins to become questionable. Indeed, Crystal (1987) argues that some speech will prove impossible to transcribe but this is an important clinical feature, usually indicative of severity, and should not be ignored.

Apart from these considerations about the linearity of phonological process analysis, another issue is the assertion that processes are universal and natural (natural in this context does not equate to normal, but to phenomena that may be accounted for by "articulatory physiology, acoustic phonetics or perceptual psychology", Harris & Cottam, 1985, p. 73), and that they serve to simplify speech output (Dinnsen, Gierut, Morrisette, Green, & Farris-Trimble, 2011). If the universality and naturalness of speech patterns has a basis in reality, it might be expected that researchers would agree on the number and type of processes found in children's speech. Although there are many similarities in approach, there are both quantitative and qualitative differences (Stoel-Gammon et al., 2002). One of the difficulties is in having certainty about what occurs in the typical speech of very young children (Ingram, 1989). It is possible that even "exceptional forms" may appear transiently at early phases of development but that they have not been recorded since the numbers of detailed analyses of output at this stage reported in the literature are limited. If it was the case that exceptional forms represented an extreme form of immaturity, it would suggest that children with speech difficulties were manifesting development that was arrested at an early stage (Stackhouse & Wells, 1997). It also appears from the literature that terminology such as exceptional or atypical forms can be used to describe

any data that does not conform to the researchers' approach; this may be convenient, but brings into question that core concept. It is also the case that some atypical processes, for example, initial consonant deletion (found in Lily's speech) and glottal stop replacement (found in the speech of all four children) have been described as "the most common 'atypical' processes" (Stoel-Gammon et al., 2002, p. 6). This is on the basis of their rare occurrence in typical speech and their relatively frequent occurrence in atypical speech, but again brings into question the classification of what constitutes a natural process.

The concept of simplification in children's speech is also somewhat problematic. It can feasibly be argued that structural processes may simplify word production through, for example, cluster reduction or final consonant deletion (although the presence or absence of coda segments may be subject to debate, for example, when features of a "deleted" nasal consonant are realised with nasalisation of the adjacent vowel (Bernhardt & Gilbert, 1992; Bernhardt, 1992). However, when applied to systemic processes this argument about simplification may be less secure. For example, velar plosive fronting is commonly described with an inherent assumption that the production of segments requiring velar placement is more difficult. Conversely, backing of alveolar targets is also recognised but is a less common process; in this case the alveolar placement by implication might be harder. However, where these are recorded in the speech of the same child ("conflicting processes", Miccio & Scarpino, 2008, p. 416) the explanation cannot rely on a simple harder/easier interpretation. This can be illustrated with examples of Hamish's realisations of SIWI consonants in FISHING [ˈbɛʔɪ˜n], BREAD [fæʔfŋ] and PARACHUTE [ˈp͡fæwəfəʊʔ]. An explanation of the production of the adult targets /f/, /bɹ/ and /p/ does not lend itself to a straightforward description of the realisations as simplification.

The concept of simplification is brought further into question by evidence to suggest that children's phonetic inventories are directly affected by the frequency with which segments are used in their environment so that, for example, Italian children acquire the voiced labiodental fricative /v/ much earlier than their English-speaking counterparts (Bortolini & Leonard, 1991). This segment /v/ appears to present difficulties for typically and atypically speaking children acquiring English in that it appears relatively late and is subject to the process of stopping. Yet, it cannot be inherently harder to articulate otherwise young Italian children would not be producing it easily at such a young age. Examination of Tallulah and Hamish's output revealed use of a velopharyngeal fricative; although this was not categorised as part of the process analysis, it would be counter-intuitive to describe

this segment as a simplification. There is an interaction implied, but not necessarily clearly stated, that although phonological processes operate at a cognitive-linguistic level, their occurrence is motivated by immaturities or constraints in the child's articulatory-motor system, i.e. at a phonetic level (Hewlett, 1990). All children present with their own individual processing strengths and difficulties (Baker & McLeod, 2004), it is therefore unsurprising to find that speech output also shows individual patterns and what is termed "intersubject variability" has often been described (Bates, Watson, & Scobbie, 2013, p. 291). For children with PSD these patterns are underpinned by significantly impaired speech processing systems and responses to this impairment may be varied and unusual in speech output, although still, importantly, systematic (Ingram, 1989). Tallulah and Hamish's velopharyngeal fricatives may demonstrate their "active and creative role" (Grunwell, 1987, p. 244) in managing constrained processing systems.

The limitations of the phonological process framework in effectively capturing essential speech production data can be demonstrated through the findings in this study both for segmental and prosodic features. It is argued that children who have PSD frequently present with unusual or complex speech behaviours which may not be compatible with a traditional phonological process analysis. The first example concerns the children's atypical nasal realisations.

The SSD literature makes almost no reference to unusual nasality; references are confined to the speech patterns of children who have velopharyngeal dysfunction (see for example, Harding & Grunwell, 1998; Henningsson et al., 2008). However, Tallulah and Hamish both had systemic atypical nasal realisations of oral segments, and both Harry and Lily showed occasional short bursts of audible nasal airflow, which appeared to be the result of gestural mistiming (Hamish and Tallulah also showed instances of this). It appeared to be the result of a timing issue in coordinating velopharyngeal closure during transitions between segments, but was not always in proximity to nasal consonants. There was no suggestion that any of the children had velopharyngeal dysfunction. It could be argued that Tallulah and Hamish used atypical nasality contrastively (i.e. for Tallulah as a realisation of fricative segments and for Hamish in signalling the presence of fricative consonants) and as such this feature could be described as a phonological process. However, there could be no convincing argument for the naturalness of their nasal realisations, so one of the primary theoretical tenets of the phonological process approach does not hold true. An alternative explanation may be found by considering the relationship between phonetics and

phonology very early in speech development, and how that relationship might develop in children who have speech difficulties.

Vihman and Velleman (2000) reviewed the speech development, in a cross-linguistic study, of 15 English, French and Finnish children. In summary, they argue that children's early words are shaped by their linguistic environment, and also by their own perception and proprioception, developed through babble. Children gradually match their output patterns to adult input, and thus produce identifiable words. Once the child has established a sufficient number of individual words (or exemplars, (Bybee, 2001)), said to be approximately 50 in number, he or she is able to extrapolate more abstract representational information to form "word templates" (p. 334). These become the basis for the establishment of a phonological (i.e. cognitive-linguistic) system. The authors argue strongly that phonology "can be seen to emerge out of phonetic structure" (p. 305), and, importantly, phonological rules, far from being innate, derive from the individual experience of the child. Lindblom (2000) also argues that phonological structure emerges from the child's (phonetic) motor experience:

> "There is no split between phonetics and phonology because, from a developmental point of view, phonology remains behaviour. Phonology differs qualitatively from phonetics in that it represents a new, more complex and higher level of organisation of that behaviour. For the child, phonology is not abstract. Its foundation is an emergent patterning of phonetic content." (p. 312).

For children who have speech difficulties, the developmental experience will include accommodation to the individual motor or perceptual constraints imposed by their impaired speech processing systems. Thus, for children like Tallulah and Hamish, atypical nasal realisations may represent solutions to perceptual or proprioceptive difficulties. There may be no need to categorise these either as atypical phonological or phonetic features as long as they are fully recognised, investigated and described. In clinical practice the danger of taking a phonological process approach is that these behaviours are not recognised, investigated and described, rather they are consigned to "unusual or other" processes and ignored in favour of more usual and developmentally typical phenomena.

A further example of data which may be allocated as an "unusual or other" process was that identified in the children's speech output where they all had what appeared to be lexically specific "frozen" forms (Bryan & Howard, 1992). For example, at T1 Lily's realisation of THANKYOU was [ˈmːɛ˜nʔjuː]; Harry persistently realised SUPPOSED as [smə˜ʊs]. These might be interpreted as signs that the generalisation of, for example,

maturation in phonological processes was not complete. However, a different interpretation might be a failure in the updating of motor programmes for these specific, high frequency exemplars.

Interactions between phonetic features and phonology, and the sometimes awkward separation of what Lindblom refers to as "phonetic substance" and "linguistic form" (Lindblom, 2000, p. 298) can be illustrated by the children's production of consonant clusters which had labial features such as /r/ or /w/. All four children showed instances of labial harmony and these often involved some frication (for example, Tallulah, TRACTOR [ˈpˆɸwæʔtˢ ə]); and coalescence (for example, Lily, BUTTERFLY [ˈbʌʔəβaɪ]); Hamish, CRAB [fæpˀ]; Harry, SQUARE [fɛə]). In a study of consonant cluster development in typical children aged 5-12 years McLeod and Arciuli (2009) did not report this as occurring (although /r/ being realised as [w] and categorised as gliding, was common). In contrast, Yavas and McLeod (2010) in a study of /s/ clusters in children who had phonological disorders, reported on 33 realisations of /sw/ and 24 (72.72%) of these were realised as [fw] or [ɸw]. These features of labial harmony could be categorised as an "other" process. However, if children have difficulty with the articulatory demands of complex sound sequences (clusters) and/or coordination or control of lingual movements, a solution might be to use early established labial patterns (MacNeilage, Davis, Kinney, & Matyear, 2000) together with later developed fricative gestures to realise the complexity of the cluster. This would appear to be a phonetic solution to motor constraints.

One further point concerns prosodic analysis. "Speech prosody...is essentially rhythmic" (Howard, Perkins, & Sowden, 2012, p. 893); children need to learn how to manage the coordination of rhythm, rate, stress, pitch and loudness. This is in conjunction with the organisation of stress and syllable timing, and smooth transitions at word boundaries and simultaneous with organising articulatory movements for segmental production. All of the children showed difficulties in the management of syntagmatic fluency as well as paradigmatic accuracy (Wells, 1994). The phonological process approach is heavily biased towards segmental articulation and pays much less attention to aspects of suprasegmental organisation so that, for example, features such as Hamish's atypical pauses or Lily's unusual segmental transitions would not be captured though a process-based description. However, the limitations of this almost universal clinical approach are rarely questioned or discussed in clinical practice (although see Miccio & Scarpino, 2008, for a critical evaluation). The phonological process approach has been used for over thirty years. There

seems no likely successor on the immediate horizon although, for example, nonlinear phonology is taught as the preferred approach by Rvachew[2] at McGill University in Canada. She also makes the case that phonological process analysis is not adequate for the needs of all children but recognises that full nonlinear analysis may not be achievable within the time constraints in everyday clinical practice (see also Rvachew & Brosseau-Lapre, 2012, figure 6-8, p. 437, where a shortened analysis form is available). The challenge for researchers in child speech is to present alternatives or more current theoretical models which will inform and change clinical practice.

8.4 Multi-word utterances

A central theme for this study was the analysis of the children's speech in multi-word utterances. Much of the work exploring the speech of children who have SSD has focused at the level of single words (Flipsen, 2006) although it is recognised that children must learn to produce both "words *and phrases* in an adult-like manner" (Stoel-Gammon & Sosa, 2007, p. 238). It is also the case that children with typical speech and language development produce multi-word utterances from the age of 18 months (Crystal, 1972) so there is no developmental imperative to focus on single words. Multi-word speech production requires the integration of the processes of articulation and prosody (Howard, Wells, & Local, 2008), managing paradigmatic accuracy and syntagmatic fluency (Wells, 1994). It also requires the speaker to recognise and realise change and reduction in the phonetic patterns of words depending not only on the phonetic and phonological environment, but on the entire linguistic, sequential, interactional and pragmatic context of the utterance (see, for example, Shockey, 2003). It is therefore unsurprising to find that children who have PSD, underpinned by a variety of significant limitations in their input and output processing systems, present with patterns in multi-word utterances that are different to those found in their peers (Faircloth & Faircloth, 1970; Howard, 2004, 2007, 2013; Newton, 2012; Pascoe et al., 2005; Wells, 1994). Klein and Lui-Shea (2009) make the important point that, to date, assessment of connected speech has been largely for the purpose of comparison with single words rather than for the exploration of the particular segmental and prosodic features of multi-word utterances. The current study did comparatively examine segmental output in different sampling conditions but also focused on conversational speech with the express purpose of examining phenomena not found in single words.

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[2] (http://developmentalphonologicaldisorders.wordpress.com/teaching-dpd-2/

The segmental features of the children's multi-word speech were examined to explore whether their patterns matched those reported in other children. The literature predicts that there will be segmental differences between single word and multi-word utterances (Faircloth & Faircloth, 1970; Klein & Lui-Shea, 2009; Morrison & Shriberg, 1992) referred to by Morrison and Shriberg (1992) as the difference between "citing" and "talking" (p. 259). This relationship is generally reported as being in favour of greater accuracy in single words (although Wolk & Meisler, 1998, found the opposite). All four children in this current study produced more adult target forms in single word naming tasks than in conversational speech. Broadly speaking, every child presented with the structural and systemic phonological processes in all sampling conditions that are typically found in children with speech difficulties (as described in section 8.3). However, there were differences in these, particularly in the frequency of the occurrence of some features. For example, both Harry and Tallulah realised consonant clusters more frequently in single words than in conversational speech; Lily's realisation of velar plosives was more likely to be fronted to alveolar plosives in conversation than in a naming task. These examples can be linked to the greater linguistic processing demands of connected speech (Howard, 2007) and to how well particular segmental patterns are established. Variation between the realisation of a single word and that same token in multi-word speech has been described as a "trade-off" (Holm et al., 2007, p. 470); one possible attribution of this is to constraints in the number of phonological elements a child can manage at one time (see also the "bucket theory" Crystal, 1987). It also seems likely that the realisation of more recently acquired motor programmes requires more attention, since these are not yet the most strongly established and therefore automatically accessed exemplars. The processing load of multi-word utterances may increase the likelihood of older, less accurate but more easily accessed motor programmes driving the realisation of the word. It might also be the case that high frequency lexical items are stored as constituents of motor programmes for whole utterances. Generalisation of new segmental patterns may occur more slowly for these since the updating process must be applied across an entire stretch of words. Thus, in the more complex linguistic environment of multi-word utterances, children are more likely to produce words using a platform of familiar motor programmes so that old patterns may persist for some time. For example, Hamish showed remnants of what appeared to be the relic of an earlier, highly individual, developmental pattern with nasal segments realised with long domain harmony across stretches of an utterance, for instance, AND KATIE'S ROOM (CS 3) realised as [æ˜n (.) ˈneɪʔi ˈmɜ˜m]. Although Hamish had segmental realisations

affected by nasality in single words, by T1 these were only affecting fricative and affricate consonants. Examples of the widespread use of nasal consonants across all manners of articulation were only seen in multi-word utterances.

The finding that the children's multi-word utterances showed the same features as their single words but that there were quantitative differences was not unexpected. However, exploration of multi-word utterances also revealed qualitative differences which were not apparent from a comparison of single words and connected speech, but were aspects identified in what Howard (2007) refers to as "real talk" (p. 34). As such, these features may not have been identified through a traditional, single word, phonological analysis; these include word juncture and other prosodic behaviours associated with the production of typical connected speech.

In the current study word juncture was examined through the Connected Speech Processes (CSP) Repetition task (Newton, 2007) and analysis of conversational speech (see appendix 8.2 for a summary of results for all four children at T1 and T2,). At T1, none of the children showed consistency in the use of typical speech behaviours at word boundaries in the CSP task and although each child used some typical juncture processes, the profile of use was different for each of them. In this respect they resembled the four children described by Howard, (2007) who each presented with "an individual profile of prosodic and articulatory behaviours" (p. 32). So, for example, at T1 in the CSP task Tallulah showed some use of assimilation and elision but almost no liaison but Hamish presented with several instances of liaison but no assimilation and infrequent elision. In conversational speech the only process seen in all four children was liaison, and Tallulah also used assimilation and elision. There are several possible factors which could explain the children's word juncture behaviours. It may be that the children presented with delayed patterns that are found in much younger children who have typical speech development (Newton & Wells, 1999, 2002; Stemberger, 1988; Thompson & Howard, 2007) and/or that their use of CSP reflected the phonological and phonetic constraints of their speech output and were related to such measures as PCC. It could be that they were using individual and idiosyncratic processes and that their patterns were not explainable by either of these factors or that there were other lexical or prosodic features to be considered.

The small numbers of published studies describing CSP in children with typical speech do not present unequivocal findings, as described in Chapter Two. Although the published reports are on a small scale, they suggest that if the children in the current study were

following a typical developmental trajectory they might, at the very least, show elision at word boundaries since this was a common finding in all the young typically developing children. In the CSP task Tallulah, Harry, Lily and Hamish all used elision but in conversational speech only Tallulah showed any examples of this type of juncture. For Hamish all possible sites for elision and assimilation were affected by glottal replacement of word final consonants apart from two examples where a nasal and approximant cluster occurred; Harry and Lily also had frequent glottal stops but Tallulah did not. This frequent occurrence of glottal stops is not a typical pattern in adult speech although it does occur in some accents of English in specified contexts (Shockey, 2003). In the young typically developing children already described it was not common but one of Thompson and Howard's 2-year olds used glottal stops as did CW (Newton & Wells, 2002), also at the age of two. For Hamish, Harry and Lily, glottal stop use can be explained most cogently in the context of the constraints of their segmental systems and more particularly by the drive for articulatory simplification, which might also be true in the developing systems of 2-year-olds. In conversational speech at T1 only Tallulah used elision and this is partly explained by the absence of possible sites for elision in the language of the other children, as was also the case at T2. Within the framework of this study there was no detailed analysis of the lexis and grammar systems of the children but this might prove valuable since, for example, brief examination suggests that there were few examples of regular past tense verbs where elision might be used. Newton and Wells (1999) found that children aged 3-7 years used word juncture processes most often in spontaneous speech (more so than in the CSP task) but this was not the case at T1 for any of the children in this current study.

Comparison of the results for assimilation in the CSP task shows a slightly different profile, with Tallulah and Lily both demonstrating bilabial and/or velar assimilation (and Tallulah one instance between /s/ and /ʃ/) but Harry, like Hamish, did not assimilate at any possible sites. Lily's use of assimilation typically involved bilabial targets, and sites where nasal segments were used were almost all assimilated. This reflects the pattern reported in typical two-year olds by Thompson and Howard. Tallulah's pattern was less predictable than Lily's, but an important difference between these two children was that Lily's realisations were affected by velar plosive fronting whereas Tallulah's were not. Hamish used glottal stops at potential assimilation sites and Harry's output was affected by both glottal stops and velar fronting. Klein and Lui-Shea (2009), in a study of four boys aged 4;0 to 5;5 who had SSD, reported frequent omission of coda consonants at between-word boundaries but did not mention the occurrence of glottal stop use at all. In conversational

speech only Tallulah showed examples of assimilation but again there were very few potential assimilatory sites in the children's spontaneous speech. This reduction in possible sites for interaction between segments at word boundaries had a significant effect on all types of connected speech processes. Newton (2012), in her study of the between-word processes of assimilation and elision in three 11 to 12 year-old-boys, reported that although all three sometimes used adult-like processes, the frequency of use was less than that seen in typical speech. The boys particularly showed glottal replacement for coda consonants clusters in contexts where elision might occur. The higher frequency of adult-like realisations in the Newton study compared with the current study might suggest that children with PSD become more proficient at managing word boundary contexts as they get older, but that difficulties in the production of mature forms will persist. Newton, following the work of Bybee (2001) suggested that the children's between-word processes represented an extreme form of lenition which minimises the gestural effort required. Further, she proposed that "the abnormal patterns are extreme versions of the behaviours which are exhibited by adults and children without speech disorders...or what might be termed here "hyperlenition"" (p. 724).

The only between-word process showed by all four children was liaison (although there were individual differences in the type of liaison used; /r/was always realised as a glide [w], a common finding in much younger children (Thompson & Howard, 2007). This was true of both the CSP task and conversational speech. The child who showed the most instances of liaison was Hamish; comparisons of the percentage of use of liaison in the CSP task at T1 showed that Hamish used it at 60% of possible sites, Lily 50%, Harry 20% and Tallulah 10%. There was a tantalising inverse relationship between liaison and PCC, with Hamish who had the lowest PCC showing the most instances of liaison and Tallulah who had the highest PCC the least number of examples. This was not the case with other between-word processes and it may be that there is no simple unifying explanation for the quantitative difference in liaison use between the children. Newton and Wells (2002) suggest that in young children with typical speech /j/ and /w/ liaison result from phonetic factors (i.e. the articulatory output of moving from one vowel shape to another) whereas /r/ liaison reflects phonological learning. It is also suggested that /r/ liaison may develop later (although still by the age of three). There is a choice available to speakers in whether they employ liaison to realise the word boundary as close juncture, although if an articulatory gesture involves moving from a high front or back vowel to another vowel, production of [j] or [w] would seem to be an almost inevitable coarticulatory effect.

However, this was not the case for these children since their use of [j] and [w] liaison was highly variable. In adult speakers use of intrusive /r/–type liaison "is less easy to argue on purely coarticulatory grounds and appears to be optional in some contexts and also shows intra-speaker variation" (Howard, 2013, personal communication). It seems likely that children develop mature use of /r/–type liaison in a way that reflects the patterns of use in their linguistic community. It also appears that in Southern British English (the accent of the children in this study) the realisation of the /r/ linking form mirrors the development of /r/ in other contexts, typically the labial [w] then the labiodental variant [ʋ] and then the mature [ɹ] (Knight, Villafana Dalcher, & Jones, 2007).

For Hamish and Lily /r/ liaison (realised as a glide) was the most consistent between-word liaison type. Both children produced /w/ and /j/ with ease, but these were less often realised. This seems a rather unexpected finding, given that /r/ liaison is a later feature in children with typical speech. However, these children are considerably older than the typical 2 and 3-years-olds described in published studies, and do not have typical speech development therefore they may present with different patterns, not yet described in the literature. There might also be a sampling effect because in the CSP task there are only 4 stimulus items each for /r/ and /w/, and just 2 for /j/; more extensive assessment with judicious selection of the vowels at word boundaries might have revealed different quantitative and/or qualitative data.

The production of typical multi-word utterances depends not only on a set of phonetic, phonological and prosodic behaviours at word boundaries but also on realising words with the appropriate segmental, structural or rhythmic emphasis or reductions in accordance with the interactional requirements of any given situation (Johnson, 2004; Shockey, 2003). All the children showed instances of appropriate reduction, especially in high frequency phrases. Ellis (2002) highlights the role and importance of frequency in language learning, and Bybee (2002, 2010) argues that high frequency utterances are stored as multi-word exemplars. This would have the benefit of increasing the efficiency and speed of output. There is an associated reduction in the muscular effort required for articulatory gestures (Browman & Goldstein, 1992) leading to greater overlap of gestures and increased coarticulation which results in the acoustic and perceptual effects of reduction. The children's production of appropriately reduced utterances was potentially a positive feature since reduction is an important factor in the perceptual acceptability of speech (Speake, Howard, & Vance, 2011). However, the combination of typical reduction with the

children's highly constrained, atypical segmental systems resulted in hyperelision, which had a significant negative effect on their intelligibility (see section 8.6). This was particularly true for Harry who had the most evident use of reduction, and who was the only child whose single words were better recognised by listeners than words in conversational speech. Assessment of the role of reduction in children's speech is not available through traditional single word assessment tasks. If the main purpose of eliciting multi-word speech samples is to compare the segmental output frequency in the two different conditions, clinicians may not readily consider beyond this to the wider explanatory potential of multi-word utterance analysis.

The exploration of multi-word utterances revealed a range of other phonetic, phonological and prosodic factors, as described in detail the children's case studies; for example, difficulties with the production of multisyllabic words; segmental harmonisation across utterances; interferences in phonological assembly; atypical pauses between and within words. The nature and extent of these behaviours was only evident in multi-word speech. However, in the sentence imitation task the children showed instances of features that were both quantitatively and qualitatively different to those in conversational speech. This would suggest that, at least for children with severe and persistent speech difficulties, it is important to carry out both types of sampling. It has been suggested that assessments using sentence repetition tasks are as effective as spontaneous speech analysis in determining the severity of a child's speech difficulty in terms of PCC (Johnson, Weston, & Bain, 2004). While this may be the case for PCC (which in itself is a limited type of measurement), the findings of the current study would suggest that other descriptive and explanatory features would not be evident if only imitation tasks were carried out. "Conversational speech is the most socially-valid context for evaluating speech intelligibility" (Flipsen, 2006, p. 303), but more than that it is perhaps the most valid context for the assessment of speech output as a whole.

8.5 Variability

In this study all the children showed variations in speech output. This is a predicted finding since variability in production is a feature of typical speech in both children and adults (McLeod & Hewett, 2008; Shockey, 2003; Vick et al., 2012). However, the factors underlying this variability in different aged populations are not the same. In very young children variability reflects neuromuscular, cognitive or linguistic immaturity (Davis, 2012) which resolves over time. This resolution results in the emergence of new speech patterns

leading to gradual changes in production (Ferguson & Farwell, 1975). While these changes take place, speech may appear inconsistent. Mature speakers have variable production in response to a variety of phonetic, linguistic, and pragmatic factors (Shockey, 2003). One of the aspects of speech production to be mastered by children is to learn the types and functions of acceptable, and indeed necessary, typical variations of their language.

It was observed that all the children in this study showed variability in their speech, however, assessment findings showed that none met the criterion of 40% token-to-token inconsistency on the DEAP assessment to meet a diagnosis of Inconsistent Phonological Disorder, IPD, (Dodd, 2005). Children with IPD have been described as having a deficit in output at the level of phonological assembly, (which is also referred to as motor planning, Stackhouse & Wells, 1997). Dodd, Holm, Crosbie, & McCormack, (2005) define this deficit as problems in "selecting and sequencing phonemes (i.e. in assembling a phonological template for the production of an utterance)" (p. 58). Analysis of the output data suggested that all four children presented with difficulties at this level of processing, but as already described they did not realise words in the DEAP task with sufficient variability to be classified in this way. However, in every type of output task (DDK, single words and multi-word utterances) the children showed a mixture of both type and token variation. This leads to questions about the source and nature of the variability in these children.

The literature suggests that in children with PSD variability may result from several different factors. Their speech patterns may be positively changing (progressive variability) (McLeod & Hewett, 2008); their speech processing systems may be very immature (Rvachew et al., 2007); they may have fuzzy phonological representations (Forrest, Elbert, & Dinnsen, 2000); they may have difficulties in motor planning/phonological assembly (Dodd, Holm, Crosbie, & McCormack, 2005; Preston & Koenig, 2011). Variability may also reflect difficulties in managing the multiple linguistic demands of, for example, conversational speech (Tyler, Williams, & Lewis, 2006). It could be suggested that all these sources of variability might simply be the product of immaturity at different levels of the speech processing system. However, the degree of variability in the children in this study was unusual for their age, since variability between immature and mature forms decreases with age (Holm et al., 2007). Observations of the individual children, described in the case study chapters, indicated that their variable speech output was related to more than one factor, and was both progressive and non-progressive; occurrences required an analysis of

individual instances and contexts to explain the patterns that occurred, when they occurred.

It may be that children with PSD do represent a different group to those children with IPD, and that the variability of the children in this study is symptomatic of their severe deficits at multiple levels of processing, whereas children with IPD have a clearly defined level of impairment. (This assumes that the IPD group do indeed form a separate and stable diagnostic category and not, as suggested Rvachew & Brosseau-Lapre (2012), that the diagnosis is a reflection of the developmental stage and severity of the child's speech difficulty). Instances of type or token variation may be ascribed to particular, sometimes competing, factors. For example, the productions of novel motor programmes realising velar plosive targets over more strongly established motor programmes with alveolar plosive segments. However, apart from this progressive type of inconsistency, variability may be overspill behaviour resulting from inefficient, noisy and poorly coordinated speech processing systems. As the children with PSD progressed in segmental accuracy, variability in output generally decreased but did not entirely disappear. As described in section 8.2, their underlying processing systems remained atypical; variability in speech output and in the type of inconsistency shown was another outward sign of the children's continuing processing constraints.

8.6 Intelligibility

This study provided detailed information about the impact of children's PSD on the intelligibility of their speech as judged by 66 adult listeners. The children were selected for the study because they were assessed by their own speech and language therapist, and subsequently by the author, to have poor speech intelligibility. The experience of 66 listeners confirmed that this was indeed the case and, as described in the children's chapters, that reduced intelligibility occurred in all sampling conditions; single words, imitated sentences and conversational speech (see appendix 8.3 for a summary of T1 and T2 results for all four children). Furthermore, the mean percentage of recognised words at T1 across all three sampling conditions (in order of severity, Hamish 28.10%, Lily 33.30%, Harry, 59.37% and Tallulah 67.27%), corresponded with the order of severity as measured by the PCC (i.e. Hamish 31.07%; Lily 44.90%; Harry 62.11%; Tallulah 70.92%).

There is a link between severity and intelligibility (Brancalioni, Magnago, & Keske-Soares, 2012; Gordon-Brannan, 1994; Pascoe et al., 2006) but it is not a simple association (Barnes et al., 2009; Ertmer, 2010); examination of the data in this current study confirms the

complexities underlying the relationships between these two core dimensions. Complexity is illustrated through the particular data relating to the ability of listeners to recognise words in the three different sampling conditions, and the variability of word identification within each type of sampling condition.

For Tallulah, Lily and Hamish's speech the listeners' word recognition was better for multi-word utterances than for single words but for Harry's speech the opposite was found, with single words being the most easily recognised. It has been suggested that there is a correlation between single word intelligibility and conversational speech (Gordon-Brannan & Hodson, 2000) and between the recognition of single words and imitated sentences (Chin, Finnegan, & Chung, 2001) but the findings of the current study do not support this view. For example, Hamish's single words were least well recognised but the listeners identified less of Lily's conversational speech than Hamish's. Harry's single words were more intelligible than either type of multi-word utterance, and Tallulah's imitated sentences were significantly better than either single words or conversational speech. It may be the case, as described by Gordon-Brannan and Hodson (2000), that relationships between intelligibility in different sampling conditions are subject to more individual variation in children who have severe speech difficulties. This further strengthens the argument that children with PSD need assessments of multi-word utterances as well as single words since judgements about intelligibility cannot be made on assumptions which are based on any one type of speech sample. It may also be the case that children's intelligibility varies as the result of both the paradigmatic demands of different tasks and the children's syntagmatic response to these demands. For example, for Harry, single word naming might both allow time to access more accurate motor programmes but also inherently encourage citation forms, particularly in a child who is so used to carrying out word naming assessments. Children may also respond with "best speech" (Klintö, Salameh, Svensson, & Lohmander, 2011) as Tallulah appeared to in the sentence imitation task (similar to the child SB, decribed by Howard, 2013), where open juncture plus the contextual support of a complete sentence meant that listeners identified 80% of her words compared with 66.71% of her conversational speech.

The findings of this study also suggest that intelligibility cannot be measured through the judgement of any one individual listener; there was a wide range of responses in what was recognised by different listeners within each different sampling type. This was true for every child with single words, imitated sentences and conversational speech both at T1 and

T2. It was also the case that listeners varied across the types of samples so that, for example, for Harry at T1 Listener 58 (L58) was the only person who understood 100%, all ten single words. However she/he recognised 67.86% of imitated sentences and 68.75% of conversational speech which was considerably below the maximum identified by other listeners of 100% and 87.5% respectively. For Hamish L28 identified 73.33% of conversational speech but only 2 single words; L56 recognised the highest number of single words with 4/10 but only 24% of imitated sentences (and the maximum from another listener was 56%). McHenry, (2011) points out that the role of the listener in identification of spoken words in an intelligibility task is very different to that experienced in real communication situations. Most obviously in this current study, listeners were making judgements based on auditory input alone; it has been documented that being able to see the speaker improves intelligibility (Hunter, Pring, & Martin, 1991; Hustad, Dardis, & McCourt, 2007). However, beyond such significant environmental factors it appears that individual listeners have varying degrees of skill in word identification which are, as yet, unexplained (McHenry, 2011). No detailed examination of the profiles of the individual listeners was carried out in this current study, but following an exploration of the intelligibility of three adults with dysarthria as judged by 228 listeners, McHenry (2011) concludes "it is always apparent who translated effectively, but it is rarely evident why" (p. 122). Although the responses of listeners was so wide, as found in other studies (for example, Speake et al., 2012), this does not invalidate the experience of each individual listener. In everyday situations children with PSD will meet a variety of people who will be faced with the challenges posed by their intelligibility difficulties. The listeners in an intelligibility task reflect that process in a focused, but unnatural, context. It is divorced from "intelligibility in interaction" (Müller, 2003, p.318) or what is also termed "comprehensibility" (Yorkston, Strand, & Kennedy, 1996, p. 55). These tenets are underpinned by the concept that any interactive process has the potential for being intelligible but that the verbal content is supported by a wide range of speaker and listener variables. It is these variables or joint processes which determine the success of an interaction, and although speech accuracy is a major factor, it is just one of those variables. For judging intelligibility in real-life and real-time interactions it may be that an approach such as that described by (McLeod, Harrison, & McCormack, 2012), where information gathered by parents from a variety of other people known to the child, can serve to "triangulate" a collective experience of the child's speech. This could ensure an ecological and efficient measure in clinical situations (Hustad, 2012).

One of the purposes of this study was to examine why the speech of children with PSD is unintelligible. At one level the explanation was obvious; poor intelligibility was the result of the phonological and articulatory difficulties described in section 8.3. Intelligibility was also linked with severity; it is likely that there is a point where the integrity of the speech output is so compromised that the listener is unable to extract sufficient acoustic information, even in context, to understand the intended message. This is what Klein & Flint (2006) refer to as "the ceiling effect for unintelligibility" (p. 195). As shown by the measures carried out, the children in this study had severe as well as persisting speech difficulties and that may prove a sufficient account of their unintelligible speech. By T2, all the children showed significant improvements in segmental output and their intelligibility had also improved (see appendix 8.3). Structural and systemic changes directly impacted on the listeners' recognition of the children's speech. However, the link between the speech processes and intelligibility is not a simple quantitative equation since sometimes children who realise more adult targets accurately, as measured through phonetic transcription, may be less intelligible than those with less accurate word production (Barnes et al., 2009; Konst, Weersink-Braks, Rietveld, & Peters, 2000). In addition, the presence of many and complex variables in multi-word utterances (Howard, 2007) suggests that the explanation of children's intelligibility in connected speech output merits further exploration.

The study showed that, for three of the four children, the contextual semantic and syntactic support available in multi-word utterances meant that imitated sentences and conversational speech were more intelligible than single words. No detailed examination of the intelligibility of different word classes was carried out to see whether, for example, function words were better recognised than nouns or verbs. This might have revealed that MWU were more intelligible in overall percentage terms but that content words were no more intelligible than the single words which were (largely) nouns. This would mean that in real-life, real-time conversations children's intelligibility would be subject to the same constraints regardless of the type of utterance; superficial examination of these data does not suggest that this was the case but further analysis would be needed to confirm this observation. Furthermore, reports of differences between listener identification of single words and multi-word utterances in a range of studies (Osberger, 1992; Pascoe et al., 2006) supports the view that the type of sampling condition is relevant.

One of the issues in understanding the speech of children with PSD is that, like listening to an unfamiliar language, the word boundaries are not easily identified. Flipsen (2006) describes how speech in conversation:

> "consists largely of a continuous stream of acoustic information. Listeners parse the speech stream into word units in their heads by identifying the boundaries between words from the available acoustic information, their knowledge of the language, and the context of the conversation" (p. 305).

In a study based on the experiences of children with SSD and their families, McLeod, Daniel, & Barr (2012) quote the mother of one of the children: "all his words run together, there are no spaces in between so it can be very hard to understand what he is saying" (p. 73). This might seem to suggest that children are realising word boundaries with close juncture in the way that adults typically do (Howard et al., 2008) but it may also be that word juncture behaviours of children with SSD are actually not like those of typical speakers. For some children at least, atypical between-word processes might result in a reduction or distortion in segmental or prosodic information, affecting the listener's ability to parse the speech stream. The perceptual difficulties in detecting word boundaries may give listeners the impression of faster speech. It is perhaps no accident that children with poor intelligibility are asked to slow down their speech rate and that parents and teachers report that the children "talk really fast". As described in section 8.4, the children in this study presented with atypical word boundary behaviours but most of this atypical behaviour resulted in open juncture which serves to keep words apart (Howard et al., 2008). This impacted to varying degrees on their prosody, and at times, resulted in perceptually unusual utterances. However, as with Tallulah's imitated sentences, open juncture may have served to improve intelligibility. Conversely, the children, particularly Lily and Hamish, had frequent open juncture due to the realisation of SFWF consonants as a glottal stop (similar to the children described by Newton, 2012). The consequence of this was a reduction in segmental information resulting from a loss of contrast, with the potential effect of reducing intelligibility. This was perhaps the more significant factor at the word boundary rather than the open juncture itself. The perceptual impact of atypical word juncture may be another unpredictable variable in explaining the intelligibility of the speech of individual children.

Of all the children, Harry was the only one who, at T1, was more intelligible in single words than in multi-word utterances. This profile of intelligibility has been reported in case studies of children who have PSD (for example, Faircloth & Faircloth, 1970). It also occurred in two 10-year-old children who had vowel difficulties described by Speake et al.,

(2012) where, after intervention, the children's intelligibility in single words was better than in multi-word utterances, the opposite of their profiles before treatment. In conversational speech Harry's use of close juncture was like that in the speech of typical adults. Other typical reduction behaviours (Johnson, 2004; Shockey, 2003) were also observed. However, as described in section 8.4, the combination of typical word juncture and speech reductions in multi-word utterances with the significantly constrained word structure and segmental patterns found in his speech sometimes resulted in "a continuous stream of acoustic information" (Flipsen, 2006, p. 305) where word boundaries were not identifiable. This resulted in hyperelision, particularly in high frequency utterances, but also in stretches of discourse, after he had introduced a topic and before he reached the closing stages of his conversational turn. Hyperelision had a negative impact on Harry's speech in multi-word utterances meaning that stretches of his conversational speech were unintelligible. In this respect he is similar to the child JO described by Howard (2013) who says:

> "typical adult connected speech reductions are not compatible, from the perspective of intelligibility, with significant levels of segmental misarticulations" (p. 219).

Hyperelision occurred with the other children too, although to a much lesser degree and only with high frequency utterances. Because reduction is a feature of typical speech, its presence should be a positive indicator in the output of children who have PSD. Paradoxically, it may compound the difficulties with intelligibility caused by the losses of contrast resulting from the children's structural and segmental limitations. Consideration of the impact of reduction behaviours on multi-word utterances for children with PSD provides a basis for the description and explanation of intelligibility difficulties which is absent from traditional approaches to children's speech. It can only be available through close scrutiny of multi-word speech.

This study was not focused on intervention, but between T1 and T2 all the children participated in regular speech and language therapy sessions and at T2 all showed improvements in speech measures such as PCC/PVC. The main aim of the intervention was to improve intelligibility (Dodd & Bradford, 2000) and all the children showed significant gains across most sampling types (see case chapters for details). However, one of the most striking aspects of the T2 intelligibility outcomes was the continued wide range of listener responses (see appendix 8.3). In spite of the evident quantitative changes (even for Hamish, whose speech remained profoundly impaired), the listeners' experience of the same speech extracts were very different. This raises several issues. Measures such as PCC

come from speech data which have been subject to analysis and transcription. Although this process was carried out with best attempts at integrity and faithfulness to the children's output, inevitably some fine detail may have been lost as the author's "listener-oriented perspective" (Howard, 1993, p. 304) lead to "cleaning-up" or "phonemicising" data when "small, seemingly insignificant phonetic details" are obscured (*ibid*, p. 315). This is most clearly seen in the single word data where the T1 and T2 words were transcribed identically but the listener responses were either significantly better or worse at the two time points. It may be that listeners, confronted with raw data, have a more ecologically valid response than someone trained in transcription (and outcome measures such as improvements in PCC may be validated through listener responses). This is not to suggest that the two tasks are at all the same but rather that they are both types of interpretation of speech data. However, this does not explain the wide variation in listener responses at T2 and why the same individual utterances have such range of possible interpretations. As discussed earlier in this section, it is currently not possible to offer an explanation of this but it is important that clinicians are aware that an improvement in quantitative measures of children's speech does not automatically lead to speech that is always intelligible to every listener.

8.7 Limitations of the study

This section describes the limitations of this study in relation to its design and execution. The first limitation is the number of children who were included; single case studies are valuable because they allow for detailed examination of the data of an individual child and there is a tradition of this, particularly in intervention studies (Bryan & Howard, 1992; Pascoe et al., 2005; Stackhouse, Pascoe, & Gardner, 2006) but also in studies that explore the nature of presenting difficulties (Chiat & Hunt, 1993; Howard, 2007; Wells, 1994). However, single case studies do not provide data which can be applied to whole groups of children and understanding how findings can be interpreted for clinical practice can be problematic. Nevertheless, one of the issues for evidence-based practice in speech and language therapy is the heterogeneity of individual clients, and there is an argument that suggests it is only by careful and detailed individual case description that common patterns will emerge (Dodd, 2007; Pring, 2004).

The study had methodological limitations. The time spans between T1 and T2 were all slightly different and for Lily was 20 months in comparison with (more or less) 12 months for the other three children. If progress in all four children was going to be compared it

would have been important that the time between the two points of assessment were controlled. Although this comparison was not part of the study it does limit use of the data in this way. Direct comparisons between the children's performance on the psycholinguistic tasks were somewhat limited because there were slight differences in which tasks were used with the four children at the two points in time, both between the children and for each individual child at T1 and T2. There was also an issue related to the reliability of the administration of the DDK tasks; the procedure for this task did not follow that outlined in any standardised test manual, such as that in the DEAP, (Dodd et al., 2002) and so the children's performance could not be compared with normative data. The tasks were not carried out in a rigorous manner which was unfortunate because the children all showed persisting motor planning difficulties. Better reliability would have made for more certainty in interpretation of test findings and comparison to available norms.

One major and potentially important factor was the potential bias in the selection of the conversational speech samples. In order to measure the ability of listeners to identify words in the intelligibility task, the conversational speech had to be intelligible to the author so that the task could be scored. By the time the samples were chosen (after T2) the author, on the basis of familiarity, found the children's speech was almost always intelligible, particularly in conversation. However, as can be seen in the transcribed examples of conversational speech in the appendices, there were occasions where words were not recognised by the author. These items were not selected for the intelligibility task. The stimuli for the intelligibility rating did not, therefore, contain some of the material that was potentially least intelligible, and the data collected during the intelligibility task may suggest that the children's speech was more intelligible than was the case.

Much of the exploration in the study was based on perceptual analysis and transcription of the data. The use of perceptual transcription as a tool for research has been criticised on the basis that it is subject to errors in measurement, affected by subjectivity on the part of the transcriber and has issues related to reliability (Kent, 1996; Howard & Heselwood, 2002), although the latter are arguably at least in part the product of measures which demand strict symbol-to-symbol matching (Cucchiarini, 1996). However, in spite of these concerns perceptual analysis is considered to be the gold standard in clinical practice (Heselwood & Howard, 2008; Sell, 2005). In the study approximately 10% of the data were reviewed by the author and study supervisor together using a consensus approach, with

discussion and also recourse to acoustic analysis (Kent, 1996; Shriberg, Kwiatkowksi & Hoffmann, 1984), but given the reservations expressed in the literature no point-to-point agreement metrics were calculated (Cucchiarini, 1996; Heselwood, in press).

Another limitation was in the scoring of the intelligibility data. Scores for multi-word utterances were based on counting all the words produced apart from determiners "a" and "the". It is possible that a systematic examination of content and function words might have revealed that recognition of noun and verb vocabulary was no better than that in single words i.e. that identification of content words, more easily guessed from context, might have suggested that the children's speech was rated as more intelligible than it really was. Time and space prohibited the detailed examination of listener responses which might have shown whether or not this was the case but the data are available for future analysis. The intelligibility stimuli, being in part taken from spontaneous speech, were not controlled for features such as segmental content or word shape, which might also have revealed factors which made items more or less easy to identify.

8.8 Theoretical and clinical implications

This final section describes the theoretical and clinical implications of the study. These include factors related to risk and identification of PSD, assessment, the importance of multi-word utterances in the description and explanation of the children's severe and persisting speech difficulties and considerations regarding intervention. Issues about intelligibility and future areas of research for children with PSD are also outlined.

PSD in children are relatively rare, affecting likely less than 5% of children (Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997; Wren et al., 2012) and the percentage of these children presenting with poor intelligibility is not known. Speech delay is relatively common in young children; Bowen, 2009 reports that the Waisman Phonology Project suggests around 15% of three-year-olds have speech difficulties which affect intelligibility. However, anecdotally, clinical experience suggests that the severity of the child's speech delay at, for example, three-years-old, does not give a reliable indication of whether difficulties are likely to persist, although information such as Bowen's (2009, p. 57) "red flags" for speech impairment may guide clinical observations. This includes features such as the persistence of initial and final consonant deletion, glottal replacement and vowel errors, all of which occurred in the speech of the children in this study. An awareness of the speech and non-speech risk factors for PSD will be important for clinicians when making decisions about intervention. All four of the children in this study were referred in early childhood; there

was a family history of difficulties in speech and literacy for all of them except Harry; the most convincing evidence of this was for Hamish but his younger brother, who had a severe phonological disorder, was not born when Hamish was first seen by a speech and language therapist. For these children the risk of persistence might be observed in their individual patterns of speech production, not only in terms of severity which was clearly a significant factor, but in their unusual segmental and prosodic output. For example, pervasive glottal stops (Harry, Hamish and Lily) and atypical nasal realisations (Tallulah) were obvious manifestations of atypical development. The persistence of open juncture and limited use of between-word processes were further indications. In order to identify children at risk of PSD at an early stage, clinicians require carefully transcribed information about the detail of the presenting speech so that atypical features can be recognised and described. This is not to suggest that every child referred with speech difficulties will need this type of detailed assessment but that it is considered for children who have poor intelligibility.

One question that arose in the course of this investigation was whether these four children represented a coherent clinical group, distinct from children diagnosed with, for example, CAS or inconsistent phonological disorder (IPD). Group coherence was established through the identification of the children as having PSD and the purpose of the study was not to explore diagnostic categories. However, it was observed that none of the children met the criterion of 40% inconsistency on the DEAP subtest that measures inconsistency (Dodd et al, 2002) and which is designed to aid identification of IPD. As described in the case chapters all four children showed significant variability in speech output but this appeared to be symptomatic of the severity of their speech difficulty rather than diagnostic of IPD. The issue of CAS is somewhat more problematic and this diagnosis is not without controversy. Many of the characteristics described in children with CAS are seen in other children who have speech difficulties (Ozanne, 2005) and it is suggested that the presentation of the disorder changes over time (Strand, 2002). Of the four children, only Hamish had been previously diagnosed with CAS (by his previos speech and language therapist) and he also presented with the most severe speech output difficulties. However, Lily also showed severe speech difficulty and there is no suggestion of CAS in her clinical records. For the purposes of this study, the unifying factors between the children were that at T1 they all presented with multiple and significant speech processing difficulties, as evidenced on their profiles, and all had motor planning and motor programming difficulties. By T2 they all showed varying degrees of improvement but also had persisting difficulties which were qualitatively similar to those at T1. PSD may prove to be a useful

descriptive label for these children, avoiding the controversies of a CAS or IPD diagnosis, as long as the clinician has profiled the needs of the individual child to plan effective intervention.

The recognition of severity and risk in young children might indicate that clinicians should consider the child's processing skills. As already described, children with PSD represent a particular subgroup with pervasive processing problems in input and output, "multiple levels of difficulty" (Pascoe et al., 2005, p. 192). This being the case, assessment of speech perception, the quality of phonological representations and an investigation of speech motor skills will form part of the investigation. This does not mean exhaustive and lengthy testing but that the clinician is able to explore the child's response to a range of different tasks, often in an iterative way as part of the early stages of intervention. Psycholinguistic assessment may be based on activities such as those listed in the *Compendium of Auditory and Speech Tasks* (Stackhouse, Vance, Pascoe, & Wells, 2007). However, the main principle of this approach is that the clinician applies principles of hypothesis-driven investigation in a systematic way which is replicable for the individual child. The advantage of published tests which have peer group norms for comparison is to make this process more reliable. The disadvantage is that published tests may not probe the actual errors made by an individual child. Tasks which are based on children's own speech output errors may provide insight into processing skills not evident from generic assessment and be more sensitive to individual processing strengths and weaknesses. For example, published materials may include vocabulary that is unfamiliar to the child, resulting in lexical items which tap into non-word rather than real word processing skills (Stackhouse & Wells, 1997). The children in this study might have benefitted from tasks which were individually designed; for example, Tallulah may have demonstrated more subtle input processing difficulties if stimuli for input tasks contained only items that reflected the errors made in speech production. Individual designed sets of stimuli would also be useful for effective intervention planning.

Assessment of children at risk of, or who have PSD should include data from single words, imitated sentences and conversational speech. The findings from this study demonstrate that each type of data sample contributes complementary insights towards a full description and analysis of the speech of an individual child. It is not possible to draw reliable conclusions about segmental or prosodic features, or about intelligibility based on only one type of data, and certainly not on a single word naming assessment alone.

Phonological process analysis has a place in clinical practice, and for many children the approach will prove both sufficient and effective in the description of their speech difficulties and in planning intervention. However, children with PSD will benefit from a descriptive framework which is not constrained by traditional phonological processes. These children do use common developmental processes but require an analysis of their speech which allows the effective description of individual segmental and prosodic patterns which are sometimes consigned to the category of "other" in traditional assessment. One such framework may be the Phonetic/Phonological Systems Analysis (PPSA, Bates & Watson, 2012). Data are collected from the speech samples which the clinician judges to be the most appropriate for the individual child. The child's output is charted to assist in the identification of patterns and also variability in production and, unusually, vowel analysis is included. The authors aim to provide clinicians with a way of collating information clearly and succinctly which directly supports decision-making for intervention, and encourages further investigation as needed. It offers a flexible approach to assessment which could be fit for a variety of purposes, including for children with PSD, although the authors state that analysis of between-word processes is outside the scope of the data collected.

This study adds to the (limited) information already available about the multi-word utterances of children who have PSD (Howard, 2007, 2013; Newton, 2012; Wells, 1994). It confirms that the study of multi-word utterances not only allows for comparison of segmental realisation between, for example, conversational speech and single words (Klein & Lui-Shea, 2009; Morrison & Shriberg, 1992) but also, and importantly, reveals both segmental and prosodic information which is not evident in naming tasks.

> "Connected speech is qualitatively different from single words, in terms of its phonology and therefore its phonetics" (Howard, Wells, & Local, 2008, p. 583).

This unequivocally means that clinicians should aim to include analysis of connected speech in order to fully describe the children's output. There are interactions between segmental and prosodic features in MWU which need further investigation in children who present with severe speech difficulties. An example might be the exploration of the impact of pervasive glottal stops on the development of the typical realisation of connected speech processes. This interface may have implications for intelligibility but currently the importance of it is unknown.

It is possible to establish some sense of chronology in the development of connected speech processes from the studies of typical young children (Newton & Wells, 1999;

Stemberger, 1988; Thompson & Howard, 2007) although with the paucity of information available this can only be tentatively sketched out. It may be possible to begin to outline a developmental progression in children who have PSD using data from this study and those from other published reports (for example, Howard, 2004, 2013; Klein & Lui-Shea, 2009; Wells, 1994). It does seem, unsurprisingly, that increasing age is an important factor, with older children showing more adult-like behaviours. However, detailed examination of the type and nature of between-word behaviours and factors such as PCC might reveal more individual features about the children's speech output and the impact of, for example, glottal replacement.

This study was not an intervention study but the exploration of the children's speech has implications for treatment. There are many types of intervention for SSD (Bowen, 2009; Williams, McLeod, & McCauley, 2010) and these will be appropriate for children with PSD as they are for other children. However, approaches to speech therapy on the basis of connected speech production are rarely described (Howard, 2013). The authors of a small number of investigations have made suggestions, for example, Wells (1994) posits that work on the child's awareness of rhythmic contrasts in multisyllabic words and utterances may be a vehicle for developing close juncture between words. Newton (2012) describes how focusing on hyperlenition at word boundaries may be productive and also reminds clinicians that working on single word citation forms may inadvertently lead to the child using hyperarticulation in connected speech, a point raised by Wells (1994) in relation to atypical open juncture. The children in this study, Tallulah in particular, were very aware of the implicit (and sometimes explicit) requirement to produce "best speech" (Klintö et al., 2011) which sometimes resulted in unusual open juncture. Pascoe et al. (2005) describe a single case study where intervention for final consonant deletion was designed in the context of both single words and connected speech. Both Newton (2012) and Ball (2003) suggest that a usage-based approach, coupled with observations from gestural phonology (Bybee, 2001; Bybee, 2006) may prove a productive way of developing intervention approaches. The role of frequency could be considered in developing improved speech output and intelligibility in multi-word utterances, drawing children's attention to phonetic contrasts in a systematic and focused way. This might, for example, include careful selection of high frequency exemplars of targeted segmental or prosodic patterns both in single words and longer constructions with activities involving repeated productions by the clinician through play or listening tasks (already familiar in clinical practice through the technique of auditory bombardment). Ota and Green, (2013) reported that the

development of word-initial consonant clusters in young children appears to be related to the frequency with which exemplars are used in maternal speech. This is not to suggest that simply increasing the exposure of children with SSD to particular words will lead to a resolution of their intelligibility problems, but that this might be a variable to be carefully managed in intervention. Principles of motor learning (Maas, Robin, Austermann Hula et al., 2008), carefully graded feedback (Rvachew & Brosseau-Lapre, 2012) and using processing strengths to support areas of difficulty (Rees, 2001) are all factors which could be successfully employed at the level of connected speech. Also, traditional single word interventions may be adapted by the clinician, mindful of the importance of careful stimuli selection, to include input and output varying the length and complexity of utterances.

Intelligibility could be one of the main outcome measures in treatment for children with PSD since "intelligible speech is the long term goal for most intervention approaches for children with speech disorders" (Dodd & Bradford, 2000, p. 191). However, it is rarely considered in a systematic way, and it is difficult to establish reliable and time-effective ways to manage this in clinical settings. It is possible to record children's speech and ask listeners to identify what has been said but the range of responses shown by different listeners means that more than one listener must be used (and there is no indication of how many listeners would be enough for the result to be sufficiently representative). It may be that diagnostic testing, using lists of words (a picture naming task for children) designed to explore particular sound contrasts could be an effective type of single word stimulus (Miller, 2012). However, this would not deal with the issue of listener variability; it may be in the future that the development of speech recognition software could be refined enough that the listener variable could be eradicated (*ibid*). This type of measurement would be far removed from the everyday experience of both the speaker and listener but might serve a defined purpose in quantification of outcomes. However, the introduction of any type of system dependent on recording equipment seems unlikely to be available in public services in the UK on the basis of time and cost. More immediately available are scaling-type measures. Although these have been criticised as unreliable (Samar & Metz, 1988; Whitehill, 2002), the *Intelligibility in Context Scale* (McLeod, Harrison, et al., 2012) which collects a rating from several people in the child's environment has been shown to have reliability and validity in measuring the intelligibility of four and five-year-olds with speech difficulties. Development of this approach for older children would provide a practical and accessible way of measuring intelligibility which triangulates the opinions about the child's speech, and allows repeated measures. This is very different to

the type of open-set task used in this study but the widespread use of listener transcription tasks in clinical practice is unlikely to be achievable. It may be that a validated rating scale would provide a method for more consistent measurement of intelligibility, and therefore more rigorous consideration of how the concept is considered and applied. Another advantage of this approach is that naïve listeners who are in everyday contact with a child are likely to be basing their estimates on the comprehensibility of his or her speech (and these listeners are not naïve in relation to the individual child, although degrees of familiarity will vary). This broader concept may have more ecological validity than empirical intelligibility tasks and thus be of greater value in terms of the child's success as a communicator.

At the beginning of the study Harry and Hamish both commented on their own speech Hamish said his speech was "bad" and his response to a question about whether people could understand him was "no, I hate it" and Harry said that he was "fed-up" when people did not understand him ("it's boring") and that this happened "lots of times every day, a thousand times a day". These reflections on how it feels to experience difficulties in being intelligible are important from a social and emotional standpoint but also from a clinical perspective. The children did not experience PSD through factors such as cluster reduction or velar fronting but through the percept of not being understood. The children's own views were not a focus of this study but in retrospect this was a missed opportunity. In all aspects of speech and language therapy but particularly in intervention, the child's participation is essential and clinicians need to be clear about the benefits of involving children in their own care. For young children this may be a reward in a game but for children with PSD, very aware of their poor intelligibility, supported and sensitive reflections on the potential social benefits participating in therapy tasks could be more motivating. Being intelligible is the major goal of intervention (Dodd & Bradford, 2000) and "The fitness of the person of the 21st century will be defined, for the most part, in terms of his or her ability to communicate effectively" (Ruben, 2000, p. 245). The "ability to communicate effectively" is experienced and judged by both the child and by his or her communication partners.

The investigation of the production of multi-word utterances in both typical and atypical speech production is still in its early stages and much more investigation is needed to reliably establish what all children do in "real talk" (Howard, 2007, p. 20). However, this study has demonstrated the value of capturing the rich and complex data available through

the exploration of multi-word utterances. There is a real challenge in finding ways to apply this approach in clinical practice in terms of time and also in the confidence of therapists in using perceptual transcription for the analysis of poorly intelligible speech. If it is acknowledged that children need to learn "both words and phrases" (Stoel-Gammon & Sosa, 2007, p. 238), clinicians would benefit from being supported in learning what this means for speech production both in assessment and in intervention. The exploration of the phonetics, phonology and prosody of multi-word utterances could lead to a better understanding of speech difficulties and intelligibility. Analysis of children's speech in interaction, how being unintelligible might impact on the development of conversational skills, and how children manage in contexts where they are not understood could lead to more effective intervention. The psycholinguistic approach offers accessible methods that might yet be better adapted to assess the speech processing skills underpinning multi-word utterances and the usage-based theory provides new and interesting ideas of how therapy tasks might be developed. Ultimately, as Howard (2004) says

> "Focusing on single words may be both misleading and ultimately unhelpful for both the description and treatment of developmental speech impairments." (p. 416)

There is a clearly role for all types of utterance to be incorporated into assessment and intervention, but for children with severe and persisting speech difficulties, improvements in intelligibility must be actively supported and established in multi-word utterances, and ultimately sustained in conversational speech.

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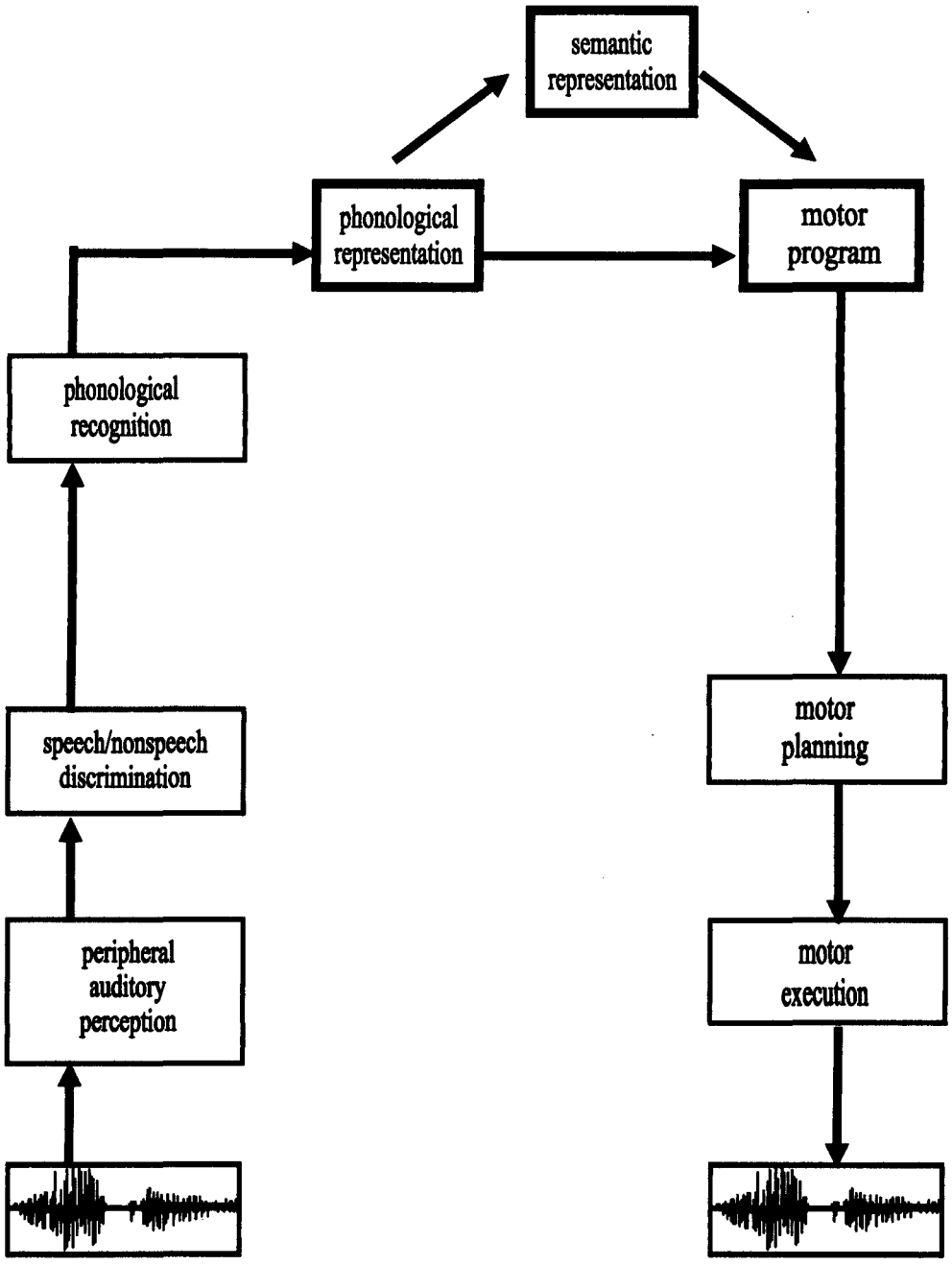
Appendix 1.1: Psycholinguistic Speech Processing Model (Stackhouse & Wells, 1997)



Appendix 3.1: Research Ethics Committee

06 February 2008

Miss Jane Speake

Dear Miss Speake

Full title of study: **Children with persisting speech disorders: the effects of intervention on intelligibility**

REC reference number: **07/H0308/203**

Thank you for your letter of 08 December 2007, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Ethical review of research sites

The favourable opinion applies to the research sites listed on the attached form.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Application	AB/104549/1	24 July 2007
Investigator CV : Jane Speake		21 July 2007
Investigator CV : Dr Sara Howard		01 July 2007
Summary/Synopsis	1	22 July 2007
Covering Letter		26 July 2007
Protocol	2	04 Nov. 2007
Letter of invitation & Information: Children (Younger)	1	04 Nov. 2007
Letter of invitation & Information: Parent/Carer	3	08 Dec. 2007
Letter of invitation & Information: Mainstream Children	2	03 Nov. 2007
Letter of invitation & Information: Mainstream Parent/Carer	2	03 Nov. 2007

Letter of invitation & Information: Control Parent/Carer	1	04 Nov. 2007
Letter of invitation & Information: Control Child	1	04 Nov. 2007
Letter of invitation & Information: Control Child (Younger)	1	04 Nov. 2007
Letter of invitation & Information: Children	2	03 Nov. 2007
Participant Information Sheet: Mainstream Teachers	1	03 Nov. 2007
Participant Consent Form: Mainstream Parents/carers	2	03 Nov. 2007
Participant Consent Form: Mainstream children	2	03 Nov. 2007
Participant Consent Form: Parents/Carers	3	08 Dec. 2007
Participant Consent Form: Children (Younger)	1	04 Nov. 2007
Participant Consent Form: Children	2	03 Nov. 2007
Participant Consent Form: Control Child (Younger)	1	04 Nov. 2007
Participant Consent Form: Control child	1	04 Nov. 2007
Participant Consent Form: Control Parent/Carer	1	04 Nov. 2007
Response to Request for Further Information: Covering letter from Jane Speake		08 Dec. 2007

R&D approval

All researchers and research collaborators who will be participating in the research at NHS sites should apply for R&D approval from the relevant care organisation, if they have not yet done so. R&D approval is required, whether or not the study is exempt from SSA. You should advise researchers and local collaborators accordingly.

Guidance on applying for R&D approval is available from http://www.rdforum.nhs.uk/rdform.htm.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Website > After Review

Here you will find links to the following
a) Providing feedback. You are invited to give your view of the service that you have received from the National Research Ethics Service on the application procedure. If you wish to make your views known please use the feedback form available on the website.
b) Progress Reports. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
c) Safety Reports. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
d) Amendments. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
e) End of Study/Project. Please refer to the attached Standard conditions of approval by Research Ethics Committees.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nationalres.org.uk .

07/H0308/203	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely

Chair

Enclosures: Standard approval conditions
Site approval form

Copy to: Dr Sara Howard
Department of Human Communication Sciences
University of Sheffield
Sheffield S10 2TN

Appendix 3.2: Favourable opinion letter PCT

Address & PCT details (removed to preserve confidentiality)

XXX

Dear Ms Jane Speake

Re: Project Title Speech Disorders: effects of intervention on intelligibility. Re: Project Number L00814

The research project has been reviewed for XXX PCT in accordance with the Department of Health Research Governance Framework and in compliance with Standards for Better Health.

Please accept this letter as confirmation of Primary Care Trust's positive governance review. This review is subject to the enclosed terms and conditions and unless we hear within a month from the date of this letter, we assume you are abiding by these conditions.

This approval is subject to ethics approval. Research must not start until full ethical approval has been granted. Please ensure that a copy of the ethics approval letter is sent to the RD Project Manager at XXX.

We would welcome feedback about your experience of this review process to help us improve our systems. May we take this opportunity to wish you well with your research and we look forward to hearing the outcomes.

Yours Sincerely

Medical Director

Xxx PCT

Appendix 3.3: Auditory Discrimination Task

Complex Non-words (from Stackhouse, 1989)

Name: _____ **Date:**_____ **Age:**____ **Investigator:** _____

Instructions: 'I'm going to say some words and I want you to tell me if the two words sound the same or different. The words are silly, made-up words. If they are the same, then you must say "same" (or yes). If they sound different, then you must say 'different' (or no, or not the same). First we'll practise some (practise using child's own name, e.g. PETE/BEAT). Let's do some more practice words.' Administer P1-P4 below and then the test items. Feedback can be given on the practice items, but not for the test items. One repetition of each test item is permitted if the child requests it or is not attending. The investigator should casually cover his or her mouth to avoid use of visual cues.

Scoring: Record the child's response, by circling S or D; **BOLD** CAPITALS indicate correct responses. Add up correct responses to obtain child's score. Circle incorrect responses in final column to indicate contrasts of difficulty. Add number of same and number of different responses correct and total responses correct. Calculate the percentage correct for all items, and for same responses and for different responses.

Normative data for this task can be found in the *Compendium of Auditory and Speech Tasks*

Appendix 3.4: Auditory Discrimination Score Sheet

Name:
Date:
Age:
Investigator:

REDUCED VERSION NON-WORDS

	STIMULI	RESPONSES			
		Feature change		Sequence change	
PI	/vɒs / - /vɒt/	s	d		
P2	/fɛst/ - /fɛts/			s	d
P3	/vɒst/ - /vɒts/			s	d
P4	/tɛt/ – /tɛt/	s	d		
1	/kɛst/ - /kɛts/			s	D
2	/bleɪs/-/bleɪt/	s	D		
3	/zɛt/ - /zɛt/	S	d		
4	/fɒt/ - /fɒs/	s	D		
5	/kɛs/ - /kɛt/	s	D		
6	/dits/ - /dist/			s	D
7	/vɪt/ - /vɪs/	s	D		
8	/pəʊts/ - /pəʊts/			S	d
9	/zɛts/ - /zɛts/			S	d
10	/fɒts/ - /fɒst/			s	D
11	/vɪts/ - /vɪst/			s	D
12	/bɪs/ -/bɪs/	S	d		
13	/jeɪts/ - /jeɪst/			s	D
14	/dɪt/ - /dɪs/	s	D		
15	/pəʊt/ - /pəʊt/	S	d		
16	/jeɪs/ - /jeɪt/	s	D		
17	/bɪst/ - /bɪst/			S	d
18	/bleist/ - /bleits/			s	D
		/3	/6	/3	/6
	TOTAL SCORE		/18		

REDUCED VERSION REAL WORDS

	STIMULI	RESPONSES			
		Feature change		Sequence change	
		Same	Different	Same	Different
19	kit / kit	**S**	d		
20	hits / hissed			s	**D**
21	messed / messed			**S**	d
22	guess / get	s	**D**		
23	race / rate	s	**D**		
24	mitts / missed			s	**D**
25	plate / place	s	**D**		
26	guessed / gets			s	**D**
27	kissed / kissed			**S**	d
28	rates / raced			s	**D**
29	tots / tossed			s	**D**
30	tot / toss	s	**D**		
31	miss / mitt	s	**D**		
32	hit / hiss	s	**D**		
33	goats / goats			**S**	d
34	met / met	**S**	d		
35	placed / plates			s	**D**
36	goat / goat	**S**	d		
		/3	/6	/3	/6
	TOTAL SCORE	/18			

			TOTAL FEATURE OR CLUSTER
	WORDS	NON-WORDS	
FEATURE CHANGE	/9	/9	/18
CLUSTER SEQUENCE	/9	/9	/18
TOTAL WORD TYPE	/18	/18	
TOTAL ALL			/36

Appendix 3.5: Auditory Discrimination Task

Complex Non-words (from Stackhouse, 1989)

Name: _____ Date:_____Age:____ Investigator:,

Instructions: 'I'm going to say some words and I want you to tell me if the two words sound the same or different. The words are silly, made-up words. If they are the same, then you must say "same" (or yes). If they sound different, then you must say 'different' (or no, or not the same). First we'll practise some (practise using child's own name, e.g. PETE/BEAT). Let's do some more practice words. Administer P1-P4 below and then the test items. Feedback can be given on the practice items, but not for the test items. One repetition of each test item is permitted if the child requests it or is not attending. The investigator should casually cover his or her mouth to avoid use of visual cues.

Scoring: Record the child's response, by circling S or D; **BOLD** CAPITALS indicate correct responses. Add up correct responses to obtain child's score. Circle incorrect responses in final column to indicate contrasts of difficulty. Add number of same and number of different responses correct and total responses correct. Calculate the percentage correct for all items, and for same responses and for different responses. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*

Appendix 3.6 Auditory Discrimination Score Sheet

Name:
Date:
Age:
Investigator:

	PRACTICE SET	RESPONSES		CIRCLE IF INCORRECT
PI	/nʌst/ /nʌst/	s	d	
P2	/gɪl/ /dɪl/	s	d	
P3	/skɑθ/ /stɑθ/	s	d	
P4	/kɔit/ /kɔit/	s	d	
	TEST ITEMS SET A	RESPONSES		CIRCLE IF INCORRECT
1	/wɛsp/ /wɛps/	s	D	Cluster sequence
2	/'snɪmɒn/ /'snɪmɒn/	S	d	(Same)
3	/wib/ /jib/	s	D	Place of articulation
4	/'ləthaɪs/ /'ləuthaɪf/	s	D	Place of articulation
5	/dæks/ /dæks/	S	d	(Same)
6	/'skəkreɪ/ /'stətreɪ/	s	D	Place of articulation
7	/gə'tɔ/ /tə'gɔ/	s	D	Metathesis
8	/'pɪnsəl/ /'pɪnsə/	S	d	(Same)
9	/'ɪbɪkəs/ /'ɪkɪbəs/	s	D	Metathesis
10	/'bɛskət/ /'bɛksət/	s	D	Cluster Sequence
	TEST ITEMS SET B			
11	/stɛmp/ /stɛmp/	S	d	(Same)
12	/beɪt/ /peɪt/	s	D	Voicing
13	/'rɛkət/ /'rɛtək/	s	D	Metathesis
14	/smaɪk/ /smaɪk/	S	d	(Same)
15	/'ræliskəuts/	s	D	Metathesis
16	/'drɪgən/ /'drɪgən/	S	d	(Same)
17	/'bɪkʌt/ /'bɪtʌk/	s	D	Metathesis
18	/'kɪrɪvɪn/ /'kɪrɪvɪm/	s	D	Place of articulation
19	/'ærɪnʤ/ /'ærɪʒ/	s	D	Place of articulation
20	/'spəudə/ /'spəudə/	S	d	(Same)
	TEST ITEMS SET C			
21	/bʌg/ /bʌg/	S	d	(Same)
22	/'slɛpə/ /'slɛtə/	s	D	Place of articulation
23	/'pɛpi/ /'tɛpi/	s	D	Place of articulation
24	/ˈkʌsl/ /ˈkʌsn̩/	s	D	Manner of articulation
25	/tænt/ /tɪnt/	s	D	Vowel
26	/ʧʌps/ /ʧʌsp/	S	d	(Same)
27	/ˈbæskɔɪts/	s	D	Voicing
28	/dæl/ /dæl/	S	d	(Same)
29	/dæsk/ /dæks/	s	D	Cluster sequence
30	/'tj'ɪkɪləut/	S	d	(Same)

	TEST ITEMS SET D	RESPONSES		CIRCLE IF INCORRECT
31	/sti/ /ski/	s	D	Place of articulation
32	/bei/ /bei/	S	d	(Same)
33	/spəʊb/ /spəʊd/	s	D	Place of articulation
34	/ˈtrɪʒa/ /ˈtrɪða/	s	D	Place of articulation
35	/krɛb/ /krɪb/	s	D	Vowel
36	/ˈbagli/ /ˈbadli/	s	D	Place of articulation
37	/ʧʌsp/ /ʧʌps/	s	D	Cluster sequence
38	/tɒlɒˈvʌʒn̩/	S	d	(Same)
39	/spəʊd/ /spəʊd/	S	d	(Same)
40	/ˈmɪtɪbəʊk/	s	D	Metathesis
TOTAL SAME / DIFFERENT		/14	/26	
% SAME / DIFFERENT		%	%	
TOTAL SCORE		/40	% Total correct:	

Appendix 3.7: Auditory Lexical Discrimination Task

Mispronunciation Detection - Full Version (from Vance, 1995)

Name: _____Date:_____ Age:_____ Investigator

Instructions: The child should be asked to name each of the pictures first. This provides a vocabulary check and allows the child's speech production to be recorded as for a naming task and compared with his or her performance on this auditory task, if required. If the child doesn't know the name of the picture it can be supplied.

The child is asked to look at each picture in turn and to decide if the name of the picture has been said correctly or not. A soft toy monkey can be used to explain the task. The child is told that the monkey is going to say some words, sometimes he is 'clever', and sometimes 'silly', or sometimes the monkey says the words 'right' and sometimes 'wrong' (the investigator can decide which best suits the child). There are two practice items during which corrective feedback can be given. Only general encouragement is given during the main part of the task. One repetition of a test item is allowed if the child fails to respond to a stimulus or he or she requests a repetition. The investigator should cover his or her mouth to avoid use of visual cues.

Scoring: Record the child's response, by circling Y or N. **BOLD** CAPITALS indicate correct responses. Add up the correct responses to obtain the child's score. Remember that items marked with * and appearing in brackets are administered but not scored. Circle incorrect responses in final column to look for difficulty with specific contrasts. Total number of items correct at each word length and number correct overall. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*

Appendix 3.8 Auditory Lexical Discrimination Score Sheet

Name:
Date:
Age:
Investigator:

FULL VERSION: LIST A

	PICTURE	STIMULUS	1SYLL		2SYLL		3-4 SYLL		CIRCLE INCORRECT
PI	table	table			y	n			
		table			y	n			
		/sleɪbl̩/			y	n			
		/teɪʃl̩/			y	n			
		table			y	n			
P2	house	/spaʊs/	y	n					
		house	y	n					
		/faʊs/	y	n					
		/haʊf/	y	n					
		house	y	n					
1	brush	brush	Y	n					
		*(brush)	y	n					
		/brʌs/	y	N					Place of articulation
2	sponge	/spʌndz/	y	N					Place of articulation
		sponge	Y	n					
		*(sponge)	y	n					
3	glove	/glʌb/	y	N					Manner of articulation
		glove	Y	n					
4	duck	/gʌk/	y	N					Place of articulation
		duck	Y	n					
		*(/gʌk/)	y	n					
5	leaf	/jif/	y	N					Place of articulation
		leaf	Y	n					

	PICTURE	STIMULUS	1 SYLL		2 SYLL		3-4 SYLL		CIRCLE INCORRECT
6	sock	sock	Y	n					
		/zɒk/	y	N					Voicing
		*(sock)	y	n					
7	cat	/tæt/	y	N					Place of articulation
		cat	Y	n					
		*(/tæt/)	y	n					Place of articulation
8	book	book	Y	n					
		/mʊk/	y	N					Manner of articulation
9	torch	/dɔʧ/	y	N					Voicing
		torch	Y	n					
10	mouse	/maʊt/	y	N					Manner of articulation
		mouse	Y	n					
11	knife	knife	Y	n					
		/maɪf/	V	N					Place of articulation
		*(/maɪf/)	y	n					
12	snake	snake	Y	n					
		/neɪk/	y	N					Cluster reduction
13	train	/teɪn/	y	N					Cluster reduction
		train	Y	n					
14	van	/zæn/	y	N					Place of articulation
		van	Y	n					
		*(van)	y	n					

	PICTURE	STIMULUS	1SYLL		2SYLL		3-4 SYLL		CIRCLE INCORRECT
15	watch	/rɒʧ/	y	N					Metathesis
		watch	Y	n					
16	plate	/peɪt/	y	N					Cluster reduction
		*(/peɪt/)	y	n					
		plate	Y	n					
17	roof	roof	Y	n					

		*(roof)	y	n					
		/rus/	y	N					Place of articulation
18	fish	/vɪʃ/	y	N					Voicing
		fish	Y	n					
19	chair	chair	Y	n					
		/tseə/	y	N					Place of articulation
20	thumb	/ðʌm/	y	N					
		thumb	Y	n					
21	sandwich	/' fæmwɪʤ/			y	N			Place of articulation
		sandwich			Y	n			
22	toilet	/' dɔilət/			y	N			Voicing
		toilet			Y	n			
23	money	/' nʌmi/			y	N			Metathesis
		money			Y	n			
24	feather	feather			Y	n			
		/' dɛfə/			y	N			Metathesis
25	yellow	/' lɛləʊ/			y	N			Place of articulation
		yellow			Y	n			
26	kitchen	kitchen			Y	n			
		/' gɪʧn̩/			y	N			Voicing
27	ladder	ladder			Y	n			
		/' jædə/			y	N			Place of articulation
28	flower	/' slaʊwə/			y	N			Place of articulation
		flower			Y	n			
		*(/' slaʊwə/			y	n			
29	dustbin	dustbin			Y	n			
		/' bʌsdɪn/			y	N			Metathesis
30	jelly	/' dzɛli/			y	N			Place of articulation
		jelly			Y	n			
	TOTAL CORRECT LIST A		/40		/20				

FULL VERSION: LIST B

	PICTURE	STIMULUS	1 SYLL		2 SYLL		3-4 SYLL		CIRCLE INCORRECT
1	tractor	/ˈ dræktə/			y	N			Voicing
		tractor			Y	n			
2	fishing	fishing			Y	n			
		*(fishing)			y	n			
		/ˈ ʃɪfɪŋ/			y	N			Metathesis
3	biscuit	/'biksit/			y	N			Metathesis
		*(/ˈ bɪksɪt			y	n			
		biscuit			Y	n			
4	scooter	/ˈ stukə/			y	N			Metathesis
		scooter			Y	n			
		*(/ˈ stukə/			y	n			
5	parrot	/ˈ bærət/			y	N			Voicing
		parrot			Y	n			
6	seesaw	/ˈ sɪtɔ/			y	N			Manner of articulation
		seesaw			Y	n			
		*(seesaw)			y	n			
7	slipper	/ˈ lɪpə/			y	N			Cluster reduction
		slipper			Y	n			
8	sausage	sausage			Y	n			
		/ˈ sɒʤɪs/			y	N			Metathesis
		*(/ˈ sɒʤɪs/			y	n			
9	guitar	/tɪˈ gɑ/			y	N			Metathesis
		guitar			Y	n			
10	spider	spider			Y	n			
		/ˈ staipə/			y	N			Metathesis
		*(spider)			y	n			
11	caterpillar	caterpillar					Y	n	
		/'kæpətɪlə/					y	N	Metathesis
		*(caterpillar)					y	n	
12	spaghetti	/ˈ gəspɛti/					y	N	Metathesis
		spaghetti					Y	n	
		*(spaghetti)					y	n	
13	elephant	/ˈ ɛfilənt/					y	N	Metathesis

		elephant					Y	n		
14	caravan	/' kævəræn/					y	N	Metathesis	
		caravan					Y	n		
		*(/' kævəræn/)					y	n		
15	crocodile	/' krɒdəkaɪ/					y	N	Metathesis	
		crocodile					Y	n		
16	umbrella	umbrella					Y	n		
		/' ʌmblɛrə/					y	N	Metathesis	
17	helicopter	helicopter					Y	n		
		*(helicopter)					y	n		
		/' hɛlɪtɒpkə					y	N	Metathesis	
18	kangaroo	/' gæŋkəru/					y	N	Metathesis	
		kangaroo					Y	n		
19	television	/' tɛvəlɪʒn,					y	N	Metathesis	
		*(/' tɛvəlɪʒ n, /)					y	n		
		television					Y	n		
20	hospital	/' hɒstɪpl, /					y	N	Metathesis	
		hospital					Y	n		
21	telephone	telephone					Y	n		
		/' dɛlɪfəʊn/					y	N	Voicing	
		*(/' dɛlɪfəʊ n/)					y	n		
22	parachute	/' pærəsut/					y	N	Place of articulation	
		parachute					Y	n		
23	butterfly	/' bʌtʌfaɪ/					y	N	Cluster reduction	
		butterfly					Y	n		
		*(butterfly)					y	n		
24	computer	computer					Y	n		
		/' gəmpjutə/					y	N	Voicing	
		*(computer)					y	n		
25	roundabout	/' wəʊndəbaʊt/					y	N	Place of articulation	
		roundabout					Y	n		
26	hairdresse	hairdresser					Y	n		
		/' hɛədrɛtə/					y	N		
27	aeroplane	/' ɛərəpreɪn/					y	N	Place of articulation	

		aeroplane					Y	n	
28	pyjamas	pyjamas					Y	n	
		/pə'ʤɑbəz/					y	N	Manner of articulation
		*(/					y	n	
29	hamburger	/'hæmbɜdə/					y	N	Place of articulation
		hamburger					Y	n	
30	dinosaur	/'daɪnəzɔ/					y	N	Voicing
		*(/'daɪnəzɔ					y	n	
		dinosaur					Y	n	
LIST B TOTALS					720		/40		
WORD LENGTH TOTALS			/40		/40		740		
OVERALL TOTAL					/120				

Appendix 3.9: Auditory Lexical Discrimination Task

Without Pictures (from Constable, Stackhouse & Wells, 1997)

Name: _____ Date:_____ Age: _____ Investigator:,

Instructions: The child is given instructions along the following lines: 'I'm going to say some words, some of the words you will know, but some you won't: they will sound strange or silly. When you hear a word that you think is said right, you can say "yes", but if you don't know the word, you can say "no". OK, let's practise that. What if you heard the word "butterfly"? /ˈdeɪsənə/? /ˈsɛntɪtid/? The investigator should cover his or her mouth to avoid use of visual cues.

Scoring: Note the child's response, by circling Y or N. **BOLD** CAPITALS indicate correct responses. Add up correct responses for each type of stimulus, to obtain child's scores and calculate the percentage correct. Distractor items marked with * and appearing in brackets are administered but not scored. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

Appendix 3.10 Auditory Lexical Discrimination Score Sheet

ALD Without Pictures (from Constable, Stackhouse & Wells, 1997)

	STIMULUS	*REAL WORD*		*NON-WORD TYPE A (PERSEVERATION)*		*NON-WORD TYPE B (SEQUENCE)*	
1	elephant	Y	n				
2	*(eskimo)	y	n				
3	/ˈhelɪkɒpkə/			y	N		
4	*(president)	y	n				
5	/ˈkæpətɪlə/					y	N
6	*(competition)	y	n				
7	crocodile	Y	n				
8	/ˈɛstəleɪkə/					y	N
9	/ˈelilant/			y	N		
10	*(porcupine)	y	n				
11	helicopter	Y	n				
12	/ˈmaɪfrəkəʊn					y	N
13	*(calculator)	y	n				
14	/ˈtɛlɪlɪʒn,/			y	N		
15	/ˈɒʔ tətəs/			y	N		
16	hospital	Y	n				
17	/ˈɛfɪlənt/					y	N
18	/bɪˈnɒkjunəz			y	N		
19	/ˈkrɒkəkaɪl/			y	N		
20	*(radiator)	y	n				
21	*(rhinocerous)	y	n				
22	*(octagon)	y	n				
23	/ˈhɒstɪpl,/					y	N
24	/ˈmaɪkrəkəʊn			y	N		
25	caterpillar	Y	n				
26	/ˈɛskəleikə/			y	N		
27	binoculars	Y	n				
28	*(alligator)	y	n				

29	/ˈhɛlɪtɒpkə/					y	N
30	octopus	Y	n				
31	/ˈtevlɪɜn̩/					y	N
32	/ˈhɒspipl̩/			y	N		
33	microphone	Y	n				
34	/ˈkrɒdəkaɪl/					y	N
35	escalator	Y	n				
36	*(telephone)	y	n				
37	/ˈkætətɪlə/			y	N		
38	/ˈɒʔ pətəs/					y	N
39	television	Y	n				
40	/bɪˈlɒkjunəz					y	N
	SCORES	/10		/10		/10	
	% SCORES	%		%		%	

Appendix 3.11: ALD Words in Sentences Task

Auditory Lexical Discrimination Task Words in Sentences

(from Cassidy, 1994)

Name: _____ Date:_____Age: _____Investigatory

Part 1: Single Word Naming
Instructions: Present a pair of pictures and ask the child to name each of them. Transcribe the response. If the child is unable to name a picture, say the word and ask him or her to point to the one named, indicate this on the score sheet.

Scoring: Circle 1 if the picture is named correctly and 0 if incorrectly, and calculate total number of accurate responses. If child does not name the picture, put a tick or a cross in the 'Pointed to Picture' column to indicate if he or she correctly identified the picture.

Part 2: Single Word Discrimination Task
Instructions: Present a pair of pictures to the child and ask him or her to point to the one you name. The order of presentation is given on the score sheet. One repetition can be given for each item if the child requests this, or if he or she fails to respond. The investigator should casually cover his or her mouth to avoid use of visual cues.

Scoring: Circle the appropriate score for each item: 0 for an incorrect or no response, 1 point for a correct response following one repetition and 2 points for a correct response. Add the total points for each pair, and enter these on the summary sheet.
Normative data for this task is found in the *Compendium of Auditory and Speech Tasks*.

Part 3: Words in sentences

Instructions: Present a pair of pictures. Tell the child, "you will hear the name of one of these pictures in a sentence: point to the picture that you hear. Listen to the whole sentence before pointing to one of the pictures. Some of the sentences may sound a bit funny, but listen carefully and point to the picture you hear". The order of presentation of sentences is given on the score sheet. One repetition is allowed for each test item, if necessary. The investigator should cover his or her mouth to avoid use of visual cues. 3-year-old children should be presented with the neutral sentences only.

Scoring: Circle the appropriate score for each item: 0 for an incorrect or no response, 1 point for a correct response following one repetition and 2 points for a correct response. Add the total points for each pair for each sentence type, and then enter these on the summary sheet. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

Appendix 3.12: ALD Words in Sentences Score Sheet

Name:
Date:
Age:
Investigator:

Score sheet 1: single word naming

PICTURE STIMULUS	TRANSCRIPTION	PICTURE NAMED CORRECTLY	POINTED TO PICTURE
coat		0 1	
goat		0 1	
lock		0 1	
log		0 1	
tea		0 1	
key		0 1	
mouse		0 1	
mouth		0 1	
bat		0 1	
mat		0 1	
head		0 1	
hen		0 1	
glass		0 1	
grass		0 1	
clown		0 1	
crown		0 1	
	SCORE	/16	

SCORE SHEET 2: SINGLE WORD DISCRIMINATION

PRACTICE ITEMS					
pear 012	bear 012	bear 012	pear 012	pear 012	bear 012
tin 012	tin 012	bin 012	tin 012	bin 012	bin 012
TEST ITEMS					
key 012	tea 012	key 012	tea 012	tea 012	key 012
	key-tea		TOTAL SCORE	/12	

mouse 012	mouse 012	mouse 012	mouth 012	mouth 012	mouth 012
	mouse-mouth		TOTAL SCORE	/12	
bat 012	bat 012	mat 012	mat 012	mat 012	bat 012
	bat-mat		TOTAL SCORE	/12	
head 012	hen 012	head 012	head 012	hen 012	hen 012
	head-hen		TOTAL SCORE	/12	
glass 012	glass 012	grass 012	grass 012	glass 012	grass 012
	glass-grass		TOTAL SCORE	/12	
clown 012	crown 012	crown 012	clown 012	clown 012	crown 012
	clown-crown		TOTAL SCORE	/12	
coat 012	coat 012	goat 012	coat 012	goat 012	goat 012
	coat-goat		TOTAL SCORE	/12	
log 012	lock 012	lock 012	lock 012	log 012	log 012
	log-lock		TOTAL SCORE	/12	

SCORE SHEET 3: WORDS IN SENTENCES

	PRACTICE SENTENCES
pear/ bear	The girl put the PEAR in her bag I put the BEAR on my bed The boy ate the PEAR for lunch The boy ate the BEAR for lunch The girl put the BEAR in her bag I put the PEAR on my bed
tin/bin	The TIN is empty We keep the TIN outside the door I ate the BIN of fruit The BIN is empty We keep the BIN outside the door I ate the TIN of fruit

TEST SENTENCES		NEUTRAL	BIASED	NONSENSE
coat/ goat	I think your COAT is lovely	012		
	Mum put her GOAT in the cupboard			012
	Mum put her COAT in the cupboard			012
	I liked the COAT with long fur		012	
	I think your GOAT is lovely	012		
	Mum put her COAT in the cupboard			012
goat / coat	Set 1 score	/4	/2	/6
		NEUTRAL	BIASED	NONSENSE
tea/key	Mum put the TEA on the table.	012		
	I dropped the TEA on the biscuits.		012	
	I dropped the TEA on the biscuits.		012	
	Mum put the KEY on the table.	012		
	The girl used the TEA to open the door.			012
	The girl used the KEY to open the door.			012
tea/key	Set 1 score	/4	/4	/4

		NEUTRAL	BIASED	NONSENSE
mouse/ mouth	My teacher drew a MOUSE in my book.	012		
	The boy's MOUSE was full of food.		012	
	My teacher drew a MOUTH in my book.	012		
	The boy's MOUSE was full of food.		012	
	The cat chased the MOUSE around the house			012
	My teacher drew a MOUTH in my book.	012		
mouse/mouth	Set 1 score	/6	/4	/2
lock/log	The woman used the LOCK to light the fire.			012
	I put the LOCK in the cupboard.	012		
	The man put the LOCK beside the key.		012	
	The woman used the LOG to light the fire.			012
	I put the LOG in the cupboard.	012		
	The man put the LOG beside the key.		012	
lock/log	Set 1 score	/4	/4	/4
goat/ coat	I think your GOAT is lovely.	012		
	I liked the GOAT with long fur.		012	
	Mum put her GOAT in the cupboard.			012
	I think your GOAT is lovely.	012		
	I liked the COAT with long fur.		012	
	Mum put her COAT in the cupboard.			012
goat/coat	Set 2 score	/4	/4	/4

		NEUTRAL	BIASED	NONSENSE
mat/bat	I threw the BAT down the stairs.	012		
	The boy used the BAT to hit the ball.			012
	I put the MAT outside the door.		012	
	The boy used the MAT to hit the ball.			012
	I put the BAT outside the door.		012	
	The boy used the BAT to hit the ball.			012
mat/bat	Set 1 score	/2	/4	/6
key/tea	Mum put the KEY on the table.	012		
	I dropped the KEY on the biscuits.		012	
	The girl used the KEY to open the door.			012
	Mum put the TEA on the table.	012		
	The girl used the TEA to open the door.			012
	I dropped the KEY on the biscuits.		012	
key/tea	Set 2 score	74	/4	/4
coat/ aoat	I think your COAT is lovely	012		
	I liked the COAT with long fur.		012	
	Mum put her GOAT in the cupboard.			012
	I liked the GOAT with long fur.		012	
	I think your COAT is lovely.	012		
	I liked the GOAT with long fur.		012	
coat/goat	Set 3 score	/4	/6	/2
log/lock	I put the LOG in the cupboard.	012		
	The man put the LOG beside the key.	_	012	

		NEUTRAL	BIASED	NONSENSE
	The man put the LOCK beside the key.		012	
	The woman used the LOCK to light the fire.			012
	The woman used the LOG to light the fire.			012
	I put the LOG in the cupboard.	012		
log/lock	Set 2 score	/4	/4	/4
key/tea	I dropped the KEY on the biscuits.		012	
	The girl used the KEY to open the door.			012
	The girl used the TEA to open the door.			012
	Mum put the TEA on the table.	012		
	Mum put the KEY on the table.	012		
	I dropped the TEA on the biscuits.		012	
key/tea	Set 3 score	14	14	/4
hen/ head	The farmer's HEN has run away.			012
	The farmer's HEAD has run away.			012
	The girl saw the HEAD in the picture.	012		
	The girl saw the HEN in the picture.	012		
	The boy rested his HEN on the pillow.		012	
	The farmer's HEN has run away.			012
hen/head	Set 1 score	/4	/2	/6
crown/ clown	We looked at the CROWN in the picture book.	012		
	We looked at the CROWN in the picture book.	012		

		NEUTRAL	BIASED	NONSENSE
	The king put the CLOWN on his head.			012
	We looked at the CROWN in the picture book.	012		
	The children watched the CROWN on television.		012	
	The king put the CROWN on his head.			012
crown/clown	Set 1 score	/6	/2	/4
glass/ grass	The girl dropped the GLASS on the ground.	012		
	The man sat on the GRASS in the garden.		012	
	The man sat on the GLASS in the garden.		012	
	The girl filled the GLASS with lemonade.			012
	The girl dropped the GRASS on the ground.	012		
	The girl filled the GRASS with lemonade.			012
glass/grass	Set 1 score	/4	14	/4
mouse/ mouth	My teacher drew a MOUSE in my book.	012		
	My teacher drew a MOUTH in my book.	012		
	The boy's MOUTH was full of food.		012	
	My teacher drew a MOUSE in my book.	012		
	The boy's MOUSE was full of food.		012	
	The cat chased the MOUTH around the house.			012
mouse/mouth	Set 2 score	/6	/4	/2
lock/	I put the LOCK in the cupboard.	012		

Appendix 3.12 Auditory Lexical Discrimination: words in sentences score sheet

		NEUTRAL	BIASED	NONSENSE
log	The man put the LOCK beside the key.		012	
	The man put the LOG beside the key.		012	
	The woman used the LOG to light the fire.			012
	The woman used the LOCK to light the fire.			012
	I put the LOCK in the cupboard.	012		
lock/log	Set 3 score	/4	/4	/4
mat/ bat	I threw the MAT down the stairs.	012		
	I put the BAT outside the door.		012	
	I threw the MAT down the stairs.	012		
	I put the MAT outside the door.		012	
	The boy used the MAT to hit the ball.			012
	I threw the BAT down the stairs.	012		
mat/bat	Set 2 score	/6	/4	/2
mouse/ mouth	The cat chased the MOUSE around the house.			012
	The boy's MOUTH was full of food.		012	
	The cat chased the MOUTH around the house.			012
	The boy's MOUTH was full of food.		012	
	The cat chased the MOUSE around the house.			012
	The cat chased the MOUTH around the house.			012
mouse/mouth	Set 3 score		/4	/8

		NEUTRAL	BIASED	NONSENSE
hen/ head	The girl saw the HEAD in the picture.	012		
	The girl saw the HEN in the picture	012		
	The boy rested his HEAD on the pillow.		012	
	The girl saw the HEN in the picture.	012		
	The boy rested his HEN on the pillow.		012	
	The boy rested his HEAD on the pillow.		012	
hen/head	Set 2 score	/6	/6	
mat/ bat	I threw the MAT down the stairs.	012		
	I put the MAT outside the door.		012	
	I put the BAT outside the door.		012	
	The boy used the BAT to hit the ball.			012
	The boy used the MAT to hit the ball.			012
	I threw the BAT down the stairs.	012		
mat/bat	Set 3 score	/4	/4	/4
clown/ crown	The king put the CLOWN on his head.			012
	We looked at the CLOWN in the picture book.	012		
	The children watched the CROWN on television.		012	
	The king put the CROWN on his head.			012
	The children watched the CLOWN on television.		012	

		NEUTRAL	BIASED	NONSENSE
	The king put the CLOWN on his head.			012
clown/crown	Set 2 score	/2	/4	/e
glass/ grass	The girl dropped the GLASS on the ground.	012		
	The man sat on the GLASS in the garden.		012	
	The girl dropped the GRASS on the ground.	012		
	The man sat on the GRASS in the garden.		012	
	The girl filled the GRASS with lemonade.			012
	The girl filled the GLASS with lemonade.			012
glass/grass	Set 2 score	/4	/4	/4
head/ hen	The farmer's HEAD has run away.			012
	The boy rested his HEN on the pillow.		012	
	The farmer's HEN has run away.			012
	The girl saw the HEAD in the picture.	012		
	The boy rested his HEAD on the pillow.		012	
	The farmer's HEAD has run away.			012
head/hen	Set 3 score	/2	/4	/6
grass/ glass	The girl dropped the GRASS on the ground.	012		
	The man sat on the GRASS in the garden.		012	
	The girl filled the GLASS with lemonade.			012
	The girl dropped the GLASS on the ground.	012		

		NEUTRAL	BIASED	NONSENSE
	The man sat on the GLASS in the garden.		*012*	
	The girl filled the GRASS with lemonade.			*012*
grass/glass	*Set 3 score*	*/4*	*/4*	*/4*
clown/ crown	*We looked at the CLOWN in the picture book.*	*012*		
	The children watched the CROWN on television.		*012*	
	The king put the CROWN on his head.			*012*
	The children watched the CLOWN on television.		*012*	
	We looked at the CLOWN in the picture book.	*012*		
	The children watched the CLOWN on television.		*012*	
clown/crown	*Set 3 score*	*/4*	*/6*	*/2*

SUMMARY SHEET: AUDITORY LEXICAL DISCRIMINATION TASK (WORDS IN SENTENCES)

	SINGLE WORDS	*NEUTRAL CONTEXT*			*BIASED CONTEXT*			*NONSENSE CONTEXT*		
		Set 1	*Set 2*	*Set3*	*Set 1*	*Set 2*	*Set3*	*Setl*	*Set 2*	*Set3*
COAT/GOAT	*/12*									
LOCK/LOG	*/12*									
TEA/KEY	*712*									
MOUSE/ MOUTH	*/12*									
BAT/MAT	*/12*									
HEAD/HEN	*/12*									
GLASS/ GRASS	*/12*									
CLOWN/ CROWN	*/12*									
		/34	*736*	*/26*	*/26*	*/34*	*/36*	*/36*	*/26*	*/34*
TOTAL SCORES	*/96*	*/96*			*/96*			*/96*		

Appendix 3.13: Picture Naming Task

Full Version (from Vance, Stackhouse & Wells, 2005)

Name:_____ Date:_____Age:____ Investigator:

Instructions: Present the pictures and ask the child to name them. If a child fails to name the picture or responds with a different lexical item, use cues such as semantic, gap fill or first sound to prompt him or her. If a cue is used then, after a brief pause, the child should be asked to name the picture again and the second response recorded and scored. No further help should be given.

Scoring: Transcribe the child's response phonetically. Circle 1 if child's production is correct, 0 if incorrect. The production of the consonant sounds in each response is examined. For each word to be scored as correct the production of the consonants within the word should be an accepted adult realisation. (See Appendix E.3 for guidelines on appropriate realisations for this stimulus set.) Any words in which consonants deviate from accepted adult realisations are scored as incorrect, including words in which consonants have been added or omitted by the child. Add total number correct at each word length, and calculate total overall. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

FULL VERSION: SET A

Appendix 3.14 Picture Naming Score Sheet

PICTURE STIMULI	CHILD'S RESPONSE	1 SYLLABLE	2 SYLLABLE
PRACTICE ITEMS			
light			
sofa			
stickerbook			
TEST ITEMS			
brush		0 1	
sponge		0 1	
glove		0 1	
duck		0 1	
leaf		0 1	
sock		0 1	
cat		0 1	
book		0 1	
torch		0 1	
mouse		0 1	
knife		0 1	
snake		0 1	
train		0 1	
van		0 1	
watch		0 1	
plate		0 1	
roof		0 1	
fish		0 1	
chair		0 1	
thumb		0 1	
sandwich			0 1
toilet			0 1
money			0 1
feather			0 1
yellow			0 1
kitchen			0 1
ladder			0 1
flower			0 1
dustbin			0 1
jelly			0 1
ONE SYLLABLE SCORE		/20	
TWO SYLLABLE SCORE - LIST A			/10

FULL VERSION: SET B

PICTURE STIMULI	*CHILD'S RESPONSE*	*2 SYLLABLE*	*3-4 SYLLABLE*
tractor		*0 1*	
fishing		*0 1*	
biscuit		*0 1*	
scooter		*0 1*	
parrot		*0 1*	
seesaw		*0 1*	
slipper		*0 1*	
sausage		*0 1*	
guitar		*0 1*	
spider		*0 1*	
caterpillar			*0 1*
spaghetti			*0 1*
elephant			*0 1*
caravan			*0 1*
crocodile			*0 1*
umbrella			*0 1*
helicopter			*0 1*
kangaroo			*0 1*
television			*0 1*
hospital			*0 1*
telephone			*0 1*
parachute			*0 1*
butterfly			*0 1*
computer			*0 1*
roundabout			*0 1*
hairdresser			*0 1*
aeroplane			*0 1*
pyjamas			*0 1*
hamburger			*0 1*
dinosaur			*0 1*
TWO SYLLABLE SCORE - LIST B		*/10*	
THREE / FOUR SYLLABLE SCORE			*/20*

Appendix 3.15: Word Repetition Task

Full Version (from Vance, Stackhouse & Wells, 2005)

Name: _____ Date:_____Age:_____ Investigator:

Instructions: The child is asked to repeat the word that he or she hears. Three practice items are presented at the start of the task. Corrective feedback can be given if the child fails to repeat any of these practice items, but only general encouragement can be given during the main part of the task. Each test item can be presented again, once only, if the child does not respond or asks for the word to be repeated.

Scoring: Transcribe the child's response phonetically. Circle 1 if child's production is correct, 0 if incorrect. Production of the consonant sounds in each response is examined. For each word to be scored as correct the production of the consonants within the word should be an accepted adult realisation, taking into account regional accent variation. (See Appendix E.3 for guidelines on appropriate realisations for this stimulus set.) Any words in which consonants deviate from accepted adult realisations are scored as incorrect, including words in which consonants have been added or omitted by the child. Add total number correct at each word length, and calculate total overall. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

Appendix 3.16 Word Repetition Score Sheet Score Sheet

Name: ***Date:*** ***Age:*** ***Investigator:***

FULL VERSION: LIST A

STIMULI	*CHILD'S RESPONSE*	*1 SYLLABLE*	*2 SYLLABLE*
PRACTICE ITEMS			
light			
sofa			
stickerbook			
TEST ITEMS			
brush		*0 1*	
sponge		*0 1*	
glove		*0 1*	
duck		*0 1*	
leaf		*0 1*	
sock		*0 1*	
cat		*0 1*	
book		*0 1*	
torch		*0 1*	
mouse		*0 1*	
knife		*0 1*	
snake		*0 1*	
train		*0 1*	
van		*0 1*	
watch		*0 1*	
plate		*0 1*	
roof		*0 1*	
fish		*0 1*	
chair		*0 1*	
thumb		*0 1*	
sandwich			*0 1*
toilet			*0 1*
money			*0 1*
feather			*0 1*
yellow			*0 1*
kitchen			*0 1*
ladder			*0 1*
flower			*0 1*
dustbin			*0 1*
jelly			*0 1*
1 -SYLLABLE SCORE		*/20*	
2-SYLLABLE SCORE LIST A			*/10*

FULL VERSION: LIST B

STIMULI	*CHILD'S RESPONSE*	*SCORE*	
		2 SYLLABLE	*3-4 SYLLABLES*
TEST ITEMS			
tractor		*0 1*	
fishing		*0 1*	
biscuit		*0 1*	
scooter		*0 1*	
parrot		*0 1*	
seesaw		*0 1*	
slipper		*0 1*	
sausage		*0 1*	
guitar		*0 1*	
spider		*0 1*	
caterpillar			*0 1*
spaghetti			*0 1*
elephant			*0 1*
caravan			*0 1*
crocodile			*0 1*
umbrella			*0 1*
helicopter			*0 1*
kangaroo			*0 1*
television			*0 1*
hospital			*0 1*
telephone			*0 1*
parachute			*0 1*
butterfly			*0 1*
computer			*0 1*
roundabout			*0 1*
hairdresser			*0 1*
aeroplane			*0 1*
pyjamas			*0 1*
hamburger			*0 1*
dinosaur			*0 1*
2-SYLLABLE SCORE LIST B		*/10*	
3-4-SYLLABLE SCORE			*/20*

SUMMARY SHEET: WORD REPETITION, FULL VERSION

1-SYLLABLE WORDS (FROM LIST A)	*/20*
2-SYLLABLE WORDS (FROM LIST A + B)	*/20*
3-4-SYLLABLE WORDS (FROM LIST B)	*/20*
TOTAL SCORE	*/60*

Appendix 3.17: Non-Word Repetition Task

Full Version (from Vance, Stackhouse & Wells, 2005)

Name: _____ Date:_____Age:_____ Investigator:

Instructions: Pronounce the non-words with the same stress pattern as the matched real word. The child is told that he or she is going to say some funny words that he or she won't have heard before, and is asked to repeat the non-word that he or she hears. For younger children, a soft toy, e.g. a monkey, is used to demonstrate the task. The child is told that the monkey says 'made up, monkey words' and that he or she will not know these words. He or she is then asked to say each word like the monkey said it.

Three practice items are presented at the start of the task. Corrective feedback can be given if the child fails to repeat any of these practice items. If the child lexicalises any of these words, i.e. produces a real word, he or she should be encouraged to say the word 'just like the monkey says it'. Only general encouragement can be given during the main part of the task. A further presentation of an item can be given if the child fails to respond to a stimulus or requests a repetition.

Scoring: Transcribe the child's response phonetically. Circle 1 if child's production is correct, 0 if incorrect. The production of the consonant sounds in each response is examined. For each word to be scored as correct the production of the consonants within the word should be an accepted adult realisation. (See Appendix E.3 for guidelines on appropriate realisations for this stimulus set.) Any words in which consonants deviate from accepted adult realisations are scored as incorrect, including words in which consonants have been added or omitted by the child. Add total number correct at each word length, and total overall. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

Appendix 3.18 Non-Word Repetition Score Sheet

Name: ***Date:*** ***Age:*** ***Investigator***

FULL VERSION: SET A

STIMULI	CHILD'S RESPONSE	SCORE	
		1 SYLL	2 SYLL
PRACTICE ITEMS			
/saɪp/			
/ˈgɔɹɛʤ/			
/ˈnaɪzpəʊpi/			
TEST ITEMS			
/bɹɪʃ/		0 1	
/spænʤ/		0 1	
/glɛv/		0 1	
/dæk/		0 1	
/lɔf/		0 1	
/sɔk/		0 1	
/kɛt/		0 1	
/bɔk/		0 1	
/tuʧ/		0 1	
/mɔɪs/		0 1	
/nəʊf/		0 1	
/snaɪk/		0 1	
/tɹɔɪn/		0 1	
/vɪn/		0 1	
/wɔʧ/		0 1	
/pləʊt/		0 1	
/ɹɔf/		0 1	
/fɛʃ/		0 1	
/ʧi/		0 1	
/θɒm/		0 1	
/ˈsɪmwəʤ/			0 1
/ˈteɪlət/			0 1
/ˈmɛnə/			0 1
/ˈfæðɪ/			0 1
/ˈjæləɪ/			0 1
/ˈkʊʧən/			0 1
/ˈlɛdi/			0 1
/ˈfluw/			0 1
/ˈdæsbən/			0 1
/ˈdzʌlə/			0 1
1-SYLLABLE SCORE - LIST A		/20	
2-SYLLABLE SCORE - LIST A			/10

Name: ***Date:*** ***Age:*** ***Investigator:***

FULL VERSION: SET B

STIMULI	CHILD'S RESPONSE	SCORE	
		2SYLL	3-4 SYLL
PRACTICE ITEMS			
/saɪp/			
/'gɔɹɛʤ/			
/'naɪzpəʊpi/			
TEST ITEMS			
/'tɹɛktɪ/		0 1	
/'fɒʃɪŋ/		0 1	
/'bɒskɛt/		0 1	
/'skitə/		0 1	
/'pʌɹɪt/		0 1	
/'sɑsi/		0 1	
/'slɔpə/		0 1	
/'sɛsəʤ/		0 1	
/gɛ'tɔ/		0 1	
/'speɪdɪ/		0 1	
/'kɪtəpælə/			0 1
/spʌ'gɪtə/			0 1
/'ælɪfɒnt/			0 1
/'kʌɹɒvɪn/			0 1
/'kɹɪkədaʊl/			0 1
/æm'bɹæli/			0 1
/'hiləkæptə/			0 1
/'kɒŋgɪɹɑ/			0 1
/'tʊləvægən/			0 1
/'hæspətɪl/			0 1
/'tɒləfaɪn/			0 1
/'pɛɹəʃit/			0 1
/'bætəfləʊ/			0 1
/kɛm'pjaʊti/			0 1
/'ɹəʊndəbaɪt/			0 1
/'hɔɪdɹæsɪ/			0 1
/'ɒɹəpləɹn/			0 1
/pɪ'ʤamɪz/			0 1
/'hɪmbɑgi/			0 1
/'deɪnɪsɑ/			0 1
1-SYLLABLE SCORE (LIST A)		/20	
2-SYLLABLE SCORE (LIST A + B)		/20	
3-4-SYLLABLE SCORE (LIST B)			/20
TOTAL SCORE		/60	

Appendix 3.19: Connected Speech Task: Connected Speech Processes (CSP) Repetition Task

(from Newton, 1999)

Name:_____ **Date:** _____ **Age:** _____ **Investigatory**

Instructions: The child is asked to repeat a sentence that he or she hears, just as it was spoken. Responses should be audio-recorded using a good-quality recorder and microphone. Read the sentences to the child with the prescribed intonation pattern, with stress on the syllable in bold, and using the appropriate CSP. The investigator should produce each sentence adhering to the following guidelines: where possible, the stimuli should be presented in an accent that is close to that of the child; each item is presented with an intonation pattern that is unmarked for declarative statements in English; the tonic syllable is the final lexically stressed syllable of the sentence or phrase, marked below in bold. The targeted juncture, underlined below, should be produced with the appropriate process, transcribed below in phonetic transcription. The child's production of the target words should be transcribed on the score sheet and can then be checked from the recording.

Scoring: Code the child's responses according to juncture type produced: c for production of adult-like close juncture; o for open juncture (i.e. no assimilation, elision or liaison); and n for non-adult like realisation of the juncture. Circle the appropriate letter on the score sheet. On the summary sheet, for each c (i.e. adult-like) response, score through one of the tallies (1) for that particular CSP. Total the number correct for each different CSP and calculate the percentage correct. Numbers of (o) open junctures and (n) non-adult like realisations of the junctures can also be recorded.

An important feature of normal adult connected speech to note when scoring a child's repetitions is the common realisation of word-final /t/ as a glottal stop, e.g. FAT–[fæʔ], so that FAT PIG may be as likely produced [fæʔpɪg] as [fæppɪg]. Therefore a similar production of word-final /t/ as [ʔ] in assimilation environments should be coded as adult-like close juncture. **Normative data** for this task can be found in the *Compendium of Auditory and Speech Tasks*.

Appendix 3.20 CSP Score Sheet

	TARGET SENTENCE	CHILD'S PRODUCT-ION OF JUNCTURE	ASSIMILATION	ELISION	LIAISON	INDEFINITE ARTICLE	DEFINITE ARTICLE
1.	You must clean your **teeth.** [ˈmʌsklin]			Ct#C con			
2.	I gave the elephant a **banana** [ðəˈ ˈɛləfənt]						con
3.	Mary's shoes are **clean.** [ˈmɛəɹiz ʃuz]		#sh con				
4.	Claire ate all her **lunch.** [ˈklɛəˌ ɛt]				r con		
5.	My uncle is a **farmer.** [maɪˈʌŋkl̩]				ɹ con		
6.	The redcar went **away.** [ˈɹɛɑˈ kɑ]		d# con				
7.	They robbed the bank **yesterday.** [ˈɹɒbðə]			Cd#C con			
8.	This shape is a **square.** [ðɪʃˈʃeɪɒ]		#sh con				
9.	The brown bear eats **fish.** [ˈbɹaʊmbɛə]		n# con				
10.	I live near a big **wood.** [ˈniəˌ ə]				r con		
11.	We saw an elephant at the **zoo.** [ənˈ ɛləfənt]					con	
12.	John collects **stamps.** [ˈʤɒŋkəlɛks]		n# con				
13.	Sam loved to **dance.** [ˈlʌvtə]			Cd#C con			
14.	She wrapped the **parcel.** [ˈɹæpðə]			Ct#C con			
15.	You can read my **book.** [ˈɹibˈ maɪ]		d# con				
16.	Good girls are **nice.** [ˈgʊggəlz]		d# con				
17.	My mum hugged me when I was **sad.** [hʌgmi]			Cd#C con			

18.	I washed my hair last **night.** [ˈwɒʃmaɪ]			Cd#C con			
19.	He judged the **competition.** [ˈʤʌʤðə]			Cd#C con			
20.	I **wore a jumper.** [wɔˑ ə]				r con		
21.	You eat pudding with a **spoon.** [ˈipˈ pʊdɪŋ]		t# con				
22.	The gold box was **heavy.** [ˈgəʊlbɒks]			Cd#C con			
23.	John played **tennis.** [ˈʤɒmpleɪd]		n# con				
24.	He gave me a **banana.** [ˈmiˑ ə]				j con		
25.	We saw a tent by a river. [ˈtɛmˈ baɪ]			Ct#C con			
26.	She picked some **flowers.** [ˈpɪksəm]			Cd#C con			
27.	Sam ate an orange very **slowly.** [ənˈɒɹɪnʤ]					con	
28.	Some smoke blew out of the **chimney.** [ˈbluʷ aʊt]				w con		
29.	He sneezed very **loudly.** [ˈsnizvɛi]			Cd#C con			
30.	We found presents under the **tree.** [ˈfaʊmpɹɛzənts]			Cd#C con			
31.	Tom hit Claire very **hard.** [hɪkˈ klɛə]		t# con				

32.	You must stir in the **sugar.** [ˈstɜɹ ɪn]				r con		
33.	The toy elephant was **broken.**				j con		
34.	The yellow aeroplane **crashed.** [ˈjɛləʊʷ ɛɹəplɛɪn]				w con		
35.	She cut my **hair.** [ˈkʌpˀmaɪ]		t# con				
36.	He watched television all			Cd#C			
37.	Jane made some **soup.** [ˈʤeɪmmeɪd]		n# con				
38.	She gave the orange to **Sam.** [ðɪ ˈɒɹɪnʤ]						con
39.	My left leg **hurts.** [ˈlɛflɛg]			Ct#C con			
40.	They argued all **day.** [ˈðɛɪ ɑgjud]				J con		
41.	Alice put gloves on her **hands.** [ˈpʊʔglʌvz]		t# con				
42.	We had bacon for **lunch.** [ˈhæbˀbeɪkən]		d# con				

SUMMARY SHEET

		Adult-like close (c) junctures	*Number correct*	*% correct*	*No. of open (o) junctures*	*No. of non-adult (n) junctures*
Assimilation	*t#*	*1 1 1 1*	*/4*	*%*		
	n#	*1 1 1 1*	*/4*	*%*		
	d#	*1 1 1 1*	*/4*	*%*		
	#sh	*1 1*	*/2*	*%*		
Elision	*Ct#C*	*1 1 1 1*	*/4*	*%*		
	Cd#C	*1 1 1 1 1 1 1 1 1 1*	*/10*	*%*		
Liaison	*/j/*	*1 1 1 1*	*/4*	*%*		
	/w/	*1 1*	*/2*	*%*		
	/r/	*1 1 1 1*	*/4*	*%*		
Indefinite article		*1 1*	*/2*	*%*		
Definite article		*1 1*	*/2*	*%*		

Listener number (office use only)

Appendix 3.21 Intelligibility Task Response Sheet

Intelligibility Outcomes

Response Sheet

Name	
Profession (please circle)	Teaching Assistant Teacher Physiotherapist Occupational Therapist Speech and Language Therapist Speech & Language Therapy Assistant Doctor Other: (please state)
Age group (please circle)	Under 21 21-30 31-40 41-50 51-60 Over 60
Work base	
Experience of working with children who have speech difficulties (please circle the one that best describes this for you)	• I have very little experience of working with children who have speech difficulties • I have some experience of working with children who have speech difficulties • I have lots of experience of working with children who have speech difficulties
Is English your first language?	Yes/no If not, please tell me what it is

Practise items

1.
2.
3.

List 1

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Appendix 4.1 Tallulah: Results of standardised language assessment T1, CA 6;6: CELF-4 UK

Subtest	Scaled score	Percentile rank
Receptive language		
Concepts & Following Directions	9	37
Word Classes: Receptive	9	37
Sentence Structure	N/A	N/A
Understanding Spoken Paragraphs	8	25
Expressive language		
Word structure	12	75
Recalling Sentences	7	16
Formulated Sentences	8	25
Word Classes: Expressive	11	63
Expressive Vocabulary	N/A	N/A
Working memory		
Number Repetition: Forwards	11	63
Number Repetition: Backwards	8	25
Number Repetition: Total	8	25
Composite Scores		
Core Language	94	34
Receptive Language	N/A	N/A
Expressive Language	95	37

Additional testing: Test of Word Knowledge

Receptive Vocabulary	15	95
Expressive Vocabulary	14	91

Appendix 4.2 Tallulah: Speech Processing Profile T1 (age 6;5)

KEY
Standardised scores
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

INPUT

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset
⇔Silent sorting CVC words by coda

E Are the child's phonological representations accurate
✓ ALD (no picture), real words: z=0.95
✓ Non-words list A: z=-0.2
✓ Non-words list B: z=-0.25
⇔Syllable/word/rhyme/identification

D Can the child discriminate between real words?
✓ B&S real words: z=0.24

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
✓ B&S non-words: z=-0.26
✓ Complex non-words-same: z=0.72
✓ Complex non-words- diff: z=-0.38

A Does the child have adequate auditory perception?
⇔No concerns

OUTPUT

G Can the child access accurate motor programmes?
XXX Naming 1 syllable words: z=-7.13
XXX Naming 2 syllable words: z=-6.33
✓ Naming 3/4 syllable words: z=-1.46
XXX Naming total: z=-5.53

H Can the child manipulate phonological units?
⇔Rhyme generation
⇔Segmentation of multisyllabic words into syllables
⇔Segmentation of CVC words

I Can the child articulate real words accurately?
⇔Blending of C-V-C into words
⇓ improved output following imitation inconsistent

J Can the child articulate speech sounds without reference to lexical representations?
Non-word repetition:
✓ 1 syllable items z=0.24
X 2 syllable items: z=-3.29
✓ 3/4 syllable items: z=0.37
✓ Total: z=-0.65

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇔Oro-motor skills

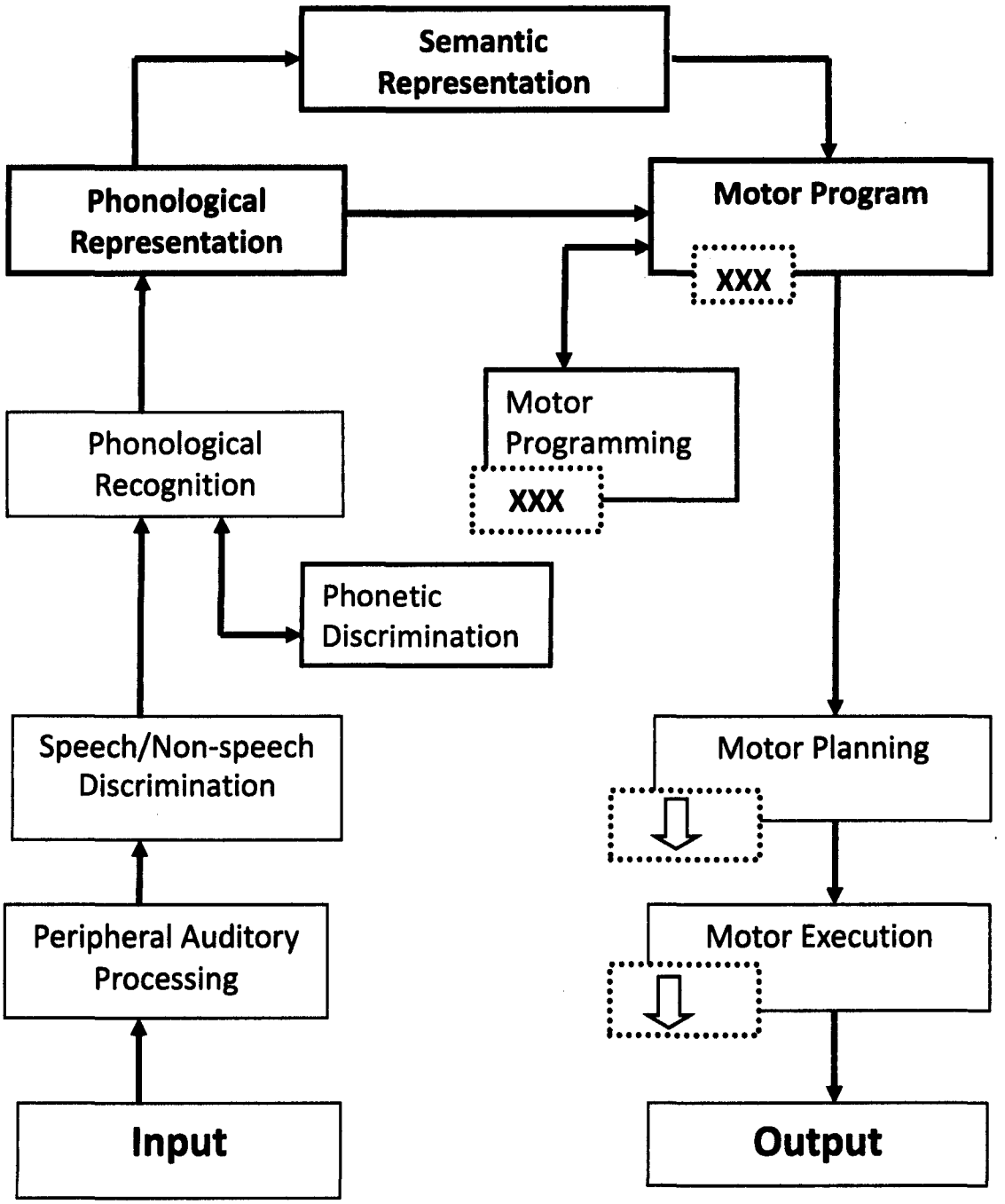
L Does the child reject his/her own erroneous forms? Sometimes

Appendix 4.3 Tallulah: Speech Processing Model T1

Speech Processing Model
(Stackhouse & Wells, 1997):
Tallulah suggested areas of difficulty, T1

KEY
Level of difficulty hypothesised from normed tasks
X or XX or XXX

Presence of difficulty hypothesised from weak/poor performance on informal tasks



Appendix 4.4 Tallulah: Single word naming T1 (6;5) and T2 (7;4)
(taken from DEAP Phonology, DEAP Articulation and Stackhouse & Wells Naming Task)

	Word	Adult realisation	C score	V score	Tallulah's realisation T1 (6;5)	C score	V score	Tallulah's realisation T2 (7;4)	C score	V score
1.	aeroplane	/ɛərəˈpleɪn/	4	3	[ɛəʊəˈpˠleˠɪˌn]	3	3	[ʔɛəɹəˈpleˠɪn]	4	3
2.	apple	/ˈæpəl/	2	2	[ˈæpəˇʊ]	2	2	[ˈæpəʊ]	2	2
3.	bird	/bɜd/	2	1	[bɜːdˌ]	2	1	[bɜdˌ]	2	1
4.	birthday cake	/ˈbɜ θ deɪˈkeɪk/	5	3	[ˈbʌfˠdeɪ kˆxɪkʼ]	3	1	N/A	N/A	N/A
5.	biscuits	/ˈbɪskɪts/	5	2	[ˈbɪ θˠɸŋ kˠ ɪʔɸŋ]	2	2	[ˈbˌʰ ɪskˠ ɪts]	5	2
6.	boat	/bəʊt/	2	1	[bəʊtʼ]	2	1	N/A	N/A	N/A
7.	book	/bʊk/	2	1	[bʊˌkˆx]	1	1	[bʊkʼ]	2	1
8.	boy	/bɔɪ/	1	1	[bɔːɪ]	1	1	[bɔɪ]	1	1
9.	bread	/brɛd/	3	1	bwɛdˌ	2	1	[bɹɛdˌ]	3	1
10	bridge	/brɪʤ/	3	1	[bɹɪʧˌ]	2	1	N/A	N/A	N/A
11	brush	/brʌʃ/	3	1	[bɹʌʃː]	3	1	[bɹʌʃ]	3	1
12	butterfly	ˈbʌtəflaɪ	4	3	[ˈbʌˌtʰ əflaɪ]	4	3	[ˈbʌtʰ əflaɪ]	4	3
13	car	/kɑ/	1	1	[kʰɑˌ]	1	1	[kʰ ɑ]	1	1
14	caravan	/ˈkærəvæn/	4	3	[ˈkʰæˠməvˌæˠn]	3	3	[ˈkʰæːvæˠn]	3	2
15	cat	/kæt/	2	1	[kʰ ætʼ]	2	1	[kʰ ætʼ]	2	1
16	caterpillar	/ˈkætəpɪlə/	4	4	[ˈkʰ ætəpʰ ɪlə]	4	4	[ˈkʰætˌəˇpʰ ɪlə]	4	4
17	chair	/ʧɛə/	1	1	[ʧˌɛːəˇ]	1	1	[ʧɛə]	1	1
18	chips	/ʧɪps/	3	1	[ʧˠɪʔ(Cˍˇ)]* *Fricative	1	1	N/A	N/A	N/A

					(?dental) +turbulence					
19	computer	/kəmˈpjutə/	5	3	[ˈpjut̪ʰ ə]	3	2	[kʰ əmˈpjutʰ ʌ̃]	5	3
20	crab	/kræb/	3	1	[kʰəˈwæb̥]	2	1	[kɹæb̥]	3	1
21	crocodile	/ˈkrɒkədaɪl/	5	3	[ˈɸwɒkˆxəgaɪʊ̈]	1	3	[ˈkʰ ɒkʰ ədɑʊ]	4	3
22	dinosaur	/ˈdaɪnəsɔ/	3	3	[ˈdaɪ˜nə˜t̪ˑɔ̰]	2	3	[ˈda̪ɪ˜nəsɔ̰]	3	3
23	door	/dɔ/	1	1	[dɔ]	1	1	[dɔ]	1	1
24	duck	/dʌk/	2	1	[dʌ̰k']	2	1	[dʌk']	2	1
25	dustbin	/ˈdʌsbɪn/	4	2	[ˈd̈ʌm̰ˑbɪ˜n]	3	2	[ˈdʌm̰ˑbɪ˜n]	3	2
26	ear	/ɪə/	0	1	[ɪʲ ə]	0	1	[ɪːᵊ]	0	1
27	egg	/ɛg/	1	1	[ʔɛg̰]	1	1	[ɛg]	1	1
28	elephant	/ˈɛləfənt/	4	3	[ˈɛl̰əf̰ˇə˜nʔ]	4	3	[ˈɛləfə˜nːt]	4	3
29	feather	/ˈfɛðə/	2	2	[ˈfɛvə̰]	1	2	[ˈfɛvə]	1	2
30	fish	/fɪʃ/	2	1	[fɪʃː]	2	1	[fɪʃ]	2	1
31	fishing	/ˈfɪʃɪŋ/	3	2	[ˈfɪ̰ʃɪ˜ŋ̰]	3	2	[ˈfɪʃɪ˜ŋ̰]	3	2
32	five	/fɑɪv/	2	1	[fa̰ɪv̰]	2	1	[fɑɪv]	2	1
33	flower	/ˈflɑʊwə/	3	2	[ˈflɑʊwə]	3	2	[ˈflɑʊwə]	3	2
34	foot	/fʊt/	2	1	[fːʊtˈ]	2	1	[fʊt]	2	1
35	frog	/frɒg/	3	1	[f̰wɒg˜]	2	1	[fɒg]	2	1
36	giraffe	/ʤəˈrɑf/	3	2	[ʤəˈʋɑf]	2	2	[ʤə˜ˈɹɑf]	3	2
37	girl	/gɜl/	2	1	[gɜʊ]	2	1	[gɜʊ]	2	1
38	glove	/glʌv/	3	1	[gəˈlʌv̰]	3	1	[glʌv]	3	1
39	guitar	/gɪˈtɑ/	2	2	[ʔɪˈtʰɑ̰ʔ]	1	2	[gəˈtɑ]	2	2
40	hairdresser	/ˈhɛədrɛsə/	4	3	[ˈhɛəbɹɛ˜n̪ˑˑə̤]	2	3	[ˈhɛə.ˈdɹɛsə]	4	3

41	hamburger	/ˈhæmbɜgə/	4	3	[ˈhæ˜ˌmːbɜgə]	4	3	[ˈhæ˜mbɜgəˌ]	4	3
42	helicopter	/hɛləˈkɒptə/	5	4	[hɛliˈkʰ ɒpt‿ ə]	5	4	[ˈhɛləˈkɒpt‿ ə]	5	4
43	hospital	/ˈhɒspɪtəl/	5	3	[ˈhɒ˜m̥.p‿ ɪtʰ əʊ]	4	3	[ˈhɒ˜m̥.p‿ ɪtʰ əʊ]	4	3
44	house	/haʊs/	2	1	[haʊ θ̊]	1	1	[haˌʊs]	2	1
45	jam	/ʤæm/	2	1	[djæ˜m]	1	1	[ʤæ˜m]	2	1
46	jelly	/ˈʤɛli/	2	2	[ˈʤɛli]	2	2	[ˈʤɛli]	2	2
47	jump	/ʤʌmp/	3	1	[ʤʌ˜mpʰ]	3	1	N/A	N/A	N/A
48	kangaroo	/ˈkæŋgəru/	4	3	[ˈkʰæ˜ŋgəɹuː]	4	3	[ˈkʰæ˜ŋgəʊũ]	3	3
49	kitchen	/ˈkɪʧɪn/	3	2	[ˈkʰɪʧə˜n]	3	2	[ˈkʰɪʧɪ˜n]	3	2
50	knife	/naɪf/	2	1	[naˌɪsˌ̊]	1	1	[naɪf]	2	1
51	ladder	/ˈlædə/	2	2	[ˈlːædə]	2	2	[ˈlædˌə˜]	2	2
52	ladybird	/ˈleɪdibɜd/	4	3	[ˈleɪd̥ibɛˌt’̥]	3	2	N/A	N/A	N/A
53	leaf	/lif/	2	1	[l̥iv]	1	1	[lif]	2	1
54	legs	/lɛgz/	3	1	[lɛg̊‿ ɱ̩ ː]	2	1	[lɛgzˌ]	3	1
55	lighthouse	/ˈlaɪthaʊs/	4	2	[ˈlaɪthaʊ˜ɱ̩]	3	2	[ˈlaɪthaʊs]	4	2
56	money	/ˈmʌni/	2	2	[ˈmʌ˜ˌni˜ˌ]	2	2	[ˈmːʌ˜ˌni˜ˌ]	2	2
57	monkey	/ˈmʌŋki/	3	2	[ˈmʌ˜ŋki]	3	2	[ˈmʌ˜ŋki]	3	2
58	moon	/mun/	2	1	[mɪ˜ʊ˜n]	2	0	[mũn]	2	1
59	mouse	/mɑʊs/	2	1	[maʊsˌ(‾)*] *possibly loud in-breath shortening previous segment	2	1	[mːaʊs]	2	1
60	orange	/ˈɒrɪnʤ/	3	2	[ˈɒwɪ˜nʧˌ̊]	1	2	[ˈɒwɪ˜nʤ]	2	2
61	parachute	/ˈpærəʃut/	4	3	[ˈpʰ æɹəʃut’]	4	3	[ˈpʰæɹəʃũt’]	4	3

62	parrot	/ˈpærət/	3	2	[ˈpʰæɹɪt̪ˑ]	3	2	[ˈpʰ æʊʌt']	3	2
63	pig	/pɪg/	2	1	[pʰ ɪːx]	1	1	[pʰɪgˠ]	2	1
64	plate	/pleɪt/	3	1	[pleɪt']	3	1	[pleɪ̯t']	3	1
65	pram	/præm/	3	1	[p͡ɸwæ˜n]	1	1	[pɹæ˜m]	3	1
66	pyjamas	/pəˈʤɑməz/	4	3	[əˈʤɑ˜məz̩]	3	3	[pˇəˈʤɑ˜məz̩]	4	3
67	queen	/kwin/	3	1	[kwiə˜n]	3	0	[kwĭn]	3	1
68	rabbit	/ˈræbɪt/	3	2	[ˈwæbɪt']	2	2	[ˈɹæbɪt']	3	2
69	rain	/reɪn/	2	1	[ʋeɪ˜ːn]	1	1	N/A	N/A	N/A
70	ring	/rɪŋ/	2	1	[wɪ˜ŋ]	1	1	[wɪ˜ŋ]	1	1
71	roof	/ruf/	2	1	[wu̪fˑ]	1	1	[ɹufː]	2	1
72	roundabout	/ˈrəʊndəbaʊt/	5	3	[ˈɹəʊ˜ndəbaʊʔ]	5	3	N/A	N/A	N/A
73	sandwich	/ˈsæmwɪʤ/	4	2	[ˈs̪æ̃˜mɪʤˀ]	2	2	[ˈsæ˜mbɹɪʤˀ]	3	2
74	sausage	/ˈsɒsɪʤ/	3	2	[ˈʃɒʃɪʤ̩]	1	2	[ˈsɒsɪʤ]	3	2
75	school	/skul/	3	1	[s̪̃kuʊ]	2	1	[skuʊ]	3	1
76	scissors	/ˈsɪzəz/	3	2	ˈθ ɪ˜z̪əz̩	2	2	[ˈsɪzəz]	3	2
77	scooter	/ˈskutə/	3	2	ˈfŋdutə˜	1	1	[ˈskutʰʌ˜]	3	2
78	seesaw	/ˈsisɔ/	2	2	[ˈ(t̪̃ĭñ̪ɔ˜]	0	2	[ˈsĭʃɔˇ]	1	2
79	shark	/ʃɑk/	2	1	[ʃɑʔ]	1	1	N/A	N/A	N/A
80	sheep	/ʃip/	2	1	[ʃʰ iːpˑ]	2	1	[ʃip]	2	1
81	slipper(s)	/ˈslɪpəz/	4 (3)	2	[ˈθ lɪpə˜(C̲̄)]	2	2	[ˈslɪpə]	3	2
82	snake	/sneɪk/	3	1	[ñ̪eɪk]	1	1	[sneɪk]	3	1
83	sock	/sɒk/	2	1	[fŋɒ˜kˑ]	1	1	[sɒk]	2	1

84	spaghetti	/spəˈgɛti/	4	3	[ɪ˜ɦˈgɛtʰ i]	2	2	[spəˈgɛɾi]	3	3
85	spider	/ˈspaɪdə/	3	2	[ˈpˮ aɪdə]	2	2	[ˈspaɪdə]	3	2
86	splash	/splæʃ/	4	1	[blæʔʧ]	1	1	[splæʃː]	4	1
87	sponge	/spʌnʤ/	4	1	[mˮ.pʌ˜nʤˑ]	3	1	[spʌ˜nʤ]	4	1
88	square	/skwɛə/	3	1	[p͡fwɛə]	0	1	[skwɛə]	3	1
89	strawberry	/ˈstrɔbri/	5	2	[ˈɦ vwɔvwi]	0	2	[ˈʃtɔbi]	2	2
90	swing	/swɪŋ/	3	1	[fˮwɪ˜ŋ]	2	1	[swɪ˜ŋ]	3	1
91	teeth	/ti θ/	2	1	[tʰif]	1	1	[tʰ if]	1	1
92	telephone	/tʰ ɛləˈfəʊn/	4	3	[tʰɛlˌəˈf˜əʊ˜n]	4	3	[tʰɛləˈfəʊ˜n]	4	3
93	television	/tɛləˈvɪʒən/	5	4	[tʰɛləˈvɪðə˜n]	4	4	[tʰɛləˈvɪʒə˜n]	5	4
94	thankyou	/ˈ θ æŋkju/	4	2	[ˈfæ˜ŋxjʊ˘]	2	1	[ˈfæ˜ŋkju]	3	2
95	three	/ θ ri/	2	1	[fˌwiː]	0	1	[fwi]	0	1
96	thumb	/ θ ʌm/	2	1	[fʌ˜m]	1	1	[fʌ˜m]	1	1
97	tiger	/ˈtaɪgə/	2	2	[ˈtʰaɪg̊ə]	2	2	[ˈtʰ aɪgə]	2	2
98	toilet	/ˈtɔɪlət/	3	2	[tʰɔɪləfˮ]	2	2	[tʰ ɔɪlɪtʼ]	3	2
99	tomato	/təˈmɑtəʊ/	3	3	[tʰəˈmɑtʰəʊ..]	3	3	[tʰ əˈmɑtʰ əʊ]	3	3
10	tongue	/tʌŋ/	2	1	[tʰʌ˜ŋː]	2	1	N/A	N/A	N/A
10	toothbrush	/ˈtu θ brʌʃ/	5	2	[ˈtʰufbwʌ˜ç]	2	2	[ˈtʰ ufbʊʌʃ]	3	2
10	torch	/tɔʧ/	2	1	[tʰɔʧˮ]	2	1	[tʰ ɔʔʧ]	2	1
10	tractor	/ˈtræktə/	4	2	[ˈp͡ɸwæʔtˮ ə]	1	2	[ˈtʃɹækərə]	3	2
10	train	/treɪn/	3	1	[tɹeɪ˜n]	3	1	[tɹeɪ˜˘n]	3	1
10	umbrella	/ʌmˈbrɛlə/	4	3	[ʌ˜mˈbɹɛlɑ]	4	3	[ʌ˜mˈbɛlʌ]	3	3
10	vacuum cleaner	/ˈvækjum ˈklinə/	7	4	[ˈvæʔkjʊ̃m xĩnə]	5	4	N/A	N/A	N/A
10	van	/væn/	2	1	[væ˜n]	2	1	[væ˜n]	2	1
10	watch	/wɒʧ/	2	1	[wɒ˜ʔɦ]	1	1	[wɒʧ]	2	1

10	**web**	/wɛb/	2	1	[wɛb̥]	2	1	[wɛb̥]	2	1
11	**witch**	/wɪʧ/	2	1	[wɪʧː]	2	1	N/A	N/A	N/A
11	**yellow**	/ˈjɛləʊ/	2	2	[ˈjɛləʊ]	2	2	[ˈjɛləʊ]	2	2
11	**zebra**	/ˈzɛbrə/	3	2	[ˈdɛbwə]	1	2	[ˈzɛbɹə]	3	2
		T1	**325**	**193**						
		T2	**297**	**180**						

Appendix 4.5 Tallulah CS 1, T1, East Enders

J	OK. What did you do last week? Mum was about-saying something about 'East Enders'- what did you do?
Tallulah	Um I (.) was drawing a picture in (.) um Bobby's house
	[ʌ˜m (.) ˈʔæɛ͡ɪː wə˜m˳ˈbɔwɪ˜n ə ˈpʰ ɪʔʧə ˈɪ˜ːnə˜ (.) ɛ˜m (.) ˈbɒbɪ̆fŋ ˈhaʊ˜fŋ]
J	Right
Tallulah	And (.) um (.) we had to colour in because um-it was a play- is - Juliet and Romeo
	[ˈæ˜nt' (.) ʌ˜m (.) wi ˈhɛk͡ tʰ ə˜ ˈkʰʌləʷ ɪ˜n bɪˈkʌ˜z˳ʌ˜m ˈɪʔ wə˜fŋ ə ˈpleɪ ɪ˜fŋ (.) ˈʤulijːɛʔ əm ˈwəʊːmːiəʊ]
Tallulah	And-and-mum and dad had a fight (laugh)
	[ˈæ˜nd˳ (.) ænd (.) ˈmʌ˜m æ˜n ˈdæd˳ ˈhæd ə ˈfaɪ˜ʔ]
J	Right
Tallulah	And um then we got some (?pretending) (?pretend) calendars and – that's it really
	[æ˜nd˳ ə˜m ˈnɛ˜m wi ˈgɒʔ t˳ə˜m ˈbɛ˜nt˳ɛ˜nɪ˜ŋ (.) ˈbɛ˜n (.) ˈtʰɛ˜˳nʔ ˈkʰælə˜ndɜ˜ːfŋ ˈæ˜nt' (.) ðæʔfŋ ˈɪʔ (.) ˈwili]
J	That was it-right-where did you go?
Tallulah	Uh-to London-on the - car
	[ˈʌ˜ (.) tʰ ə ˈlʌ˜ndə˜˳n (.) ˈɒ˜n͡ə (.) ˈkʰ ɑ]
J	In the car? Did you drive all the way there?
Tallulah	No, not me!
	[ˈnə˜ʊ ˈnɒʔ ˈmiː]
J	Oh, not you?
Tallulah	Someone else
	[ˈsʌ˜mʌ˜n ˈɛ˜ʊfŋ]
J	Who was the person who drove?
Tallulah	I don't know
	[ˈʔaɪ˜ ˈdəʊ˜˳nʔ ˈnə˜˳ʊ]
J	Were there lots of children there?
Tallulah	About four
	[baʊʔ ˈfɔ]
J	About four?
Tallulah	Um-I mean - six
	[ə˜˳m ə ˈmɪ̆n (.) ˈsɪ̈ts˳]
J	And were they people from your school?
Tallulah	No, none of them
	[ˈnə˜ʊ ˈn˳ʌ˜n˳ əm̃˳ ðə˜m]
J	Where did they come from?
Tallulah	Well, one was in my drama and he's called Tom
	[ˈwɛʊ˜ ˈwʌ˜n wəz̃ˈɪ˜m͡ maɪ˜ ˈbwɑ˜˳mæ˜ æ˜n ˈhɪ̆fŋ ˈkʰ ɔːt' ˈtʰ˳ɒ˜˳ːm]

Appendix 4.6 Tallulah CS 2, T1, School

Tallulah	School-my school
	[ˈsˌ̃kuʊ (.) mãɪ ˈfŋ kuʊ]
J	Yeh-tell me about your school-do you like going to school?
Tallulah	No
	[ˈnːəˇʊ]
J	Oh, whoops (laugh) why not?
Tallulah	Um 'cos you have to work and and I want to be in reception again
	[əˇm̩ ˈkʰəˇv jũ ˈhæˇf̃ tʰũ ˈwɜˌˇːk' ʔæˇˌnɛˇˌ æˇˌn aɪ ˈwɒˇnə ˈbiʲ ɪˇn wəˈfŋ ˈsɛ̃pfŋ tˇ əˇˌm əˈgɛˇˌn̩]
J	You'd like to be in reception-why would you want to be in reception again?
Tallulah	'Cos they had no work –to do
	[ˈkʰəz ˆeɪ ˈhæd nəʊ ˈwɜːˌk' . {pp təˇ ˈdu pp}]
Tallulah	Not-like my cousin Ned-doesn't have to do any homework
	[nɒˌʔ (.) ˈlaˌɪʔ maˇˌɪ ˈkʰʌˇˌð̃əˇn ˈnɛˌtː' (.) {pp ˈdʌˌz̃.n, ˈæˌz.̃ təˌ duˌʷ ˈɛˌˇni ˈhəʊˌˇmɜˌk' pp}]
J	Is your cousin in reception?
Tallulah	Yes-he's called Ned-all my cousins are
	[ˈjːɛˌn.̃ hiz̃. ˈkʰ ɔʊd ˈnɛd (.) ˈʔɔ mãɪ ˈkʰ ʌðɪˇˌnn̄. ɑ.ˌˇ]
J	How old's your cousin?
Tallulah	Five
	[ˈfaɪˌf]

Appendix 4.7 Tallulah CS 3, T1, Spiders

Tallulah	Spider again
	[ˈbaɪdə əˈgɛ˜n]
J	Yeh-and there's a spider's .....
Tallulah	Web
	[ˈwɛb]
Tallulah	I'm scared of them-um spiders
	[ə˜ m̩ ˈɟgɛ˜ əd̩ ə ˈd̩ʌ˜m ə˜m ˈbaɪdəɱ̩]
J	Are you?
Tallulah	Real spiders-yeh
	[ˈwiʊ̯ ˈba˷ɪdəɟ̟ jɛ˷]
J	Why are you scared of them?
Tallulah	Um 'cos one (XXX) they crawled up and it was actually a big sp- money spider-on me
	[ʌ˜m kʰəz̟. ˈwʌ˜n (xxx̟) deɪ ˈkʰwɔʊd ʌp̩ æ˜n ɪʔ wəz̟. ˈæ˜ʔʃjiʲ ə˜ ˈbɪ˜ʔɱ̩ b̥ə˜ ˈmʌ˜ni ˈm̩.p̟aɪdə . ɒ˜m ˆmi]
Tallulah	And I got some money and it nearly took it
	[æ˜n ɔɪ ˈgɒʔ s̟ʌ˜m ˈmʌ˜nɪ̃ ˈæ˜n ɪʔ ˈnɪ̃li ˈt̪ʰ ʊk ɪʔ]
J	(laugh)
Tallulah	That's why I'm scared
	[ˈðæʔç ˆ aɪ˜m ˈɱ̩ kɛəd̩.]
J	They're supposed to be lucky
Tallulah	And –and daddy long legs- I'm scared of
	[ʔæ˜n (.) ˈʔæ˜ːnd̩. ˈd̩˷æd˷i ˈlɒ˜ŋ̩ ˈlɛg̩ɱ̩ (.) {$_{pp}$ m̩. ˈkʰɛ˷əd ə˷v̩.ː $_{pp}$}]
J	Mmm

Appendix 4.8 Tallulah CS 4, T1, Bratz

(Note: section in italics is off topic-referring to a problem with the microphone stand)

J	What do you like to watch?
Tallulah	I like Bratz
	[ˈa˛ɪ ˈla˛ɪt ˈbwæʔfŋ]
J	Ok-tell me about it-'cos I've never seen it
Tallulah	Ah-I don't know-I can't remember
	[ɑ (.) ˈaɪ d̥əʊ˜nʔ ˈnəʊ (.) æ̰ ˈkʰɑ˜n̥ əˈmɛ˜˛mbʌ]
J	But you like it
Tallulah	Well-well-there's some mean girls and - they're like-
	[wɛʊ wɛʊ ˈjeɪ θʌ˜m ˈmĭn ˈgɜ˛ʊz̰ æ˜nd. (.) ˈðɛə ˈlaɪx (.)]
Tallulah	and the Bratz who are really kind and they got (X) in a (XX)
	[æ˜nd. ðə ˈbwætfŋ huʷ ɑ ˈwili ˈkʰɑɪ˜˛nd̥ æ˜ndˆ ˈdeɪ gɒʔ (ˈbwæ˜fŋ) ɪ˜n ə (ˈpʰæ˜s̰ə˜˛n)]
Tallulah	and and it's like-the mean girls-they call them triplets because they're really (X)
	[æ˜n̰ æ˜nd. ˈɪʔð ˈlaɪk ə˜m də ˈmĭn ˈgɜʊz̰. (.) deɪ ˈkʰɔ də˜m ˈtwɪb. ʔətfŋ bə̥ˈkʰʌ deɪ ˈwili (ˈx˛)]
Tallulah	- and one of the Bratz accidentally worked for them-by accident-because they didn't know
	[(.) ɪ˜nd. ˈwʌ˜n ə dɪ ˈbæ˛t ˈækfŋ ɪdɛ˜nʔli ˈwɜ˛ʔt' fɔ ˈðə˜m {pp maɪʲ ˈæs̰ʌ˜ə˜n̥ʔ pp}) (.) bɪˈkʰəs̰ deɪ ˈdɪ˜˛nʔ nəʊ˛]
Tallulah	*Oh it's down - again*
	[ʔəʊ˛ʷ ɪʔç ˈdəʊ˜˛n̥ (.) ˈgɛ˜˛n]
J	*Oh it is a bit-oh dear*
Tallulah	*Broken I think*
	[ˈbwəʊkʰə˜n aɪ ˈθɪ˜˛ɒx]
J	*I think it's just going down slightly-there we are-I think it's fine*
Tallulah	*Is it still on?*
	[ˈɪz̰ ɪʔ ˈstɪlˆ ɒ˜n]
J	*Yes*
Tallulah	*Oh, so is it recording my voice?*
	[əʊ˛ ˈθ̰əʊ (.) ʔɪz ɪʔ əˈkʰɔdɪ˜ŋ maɪ ˈvɔ˛ɪs̰˛]
J	*It is*
Tallulah	*Cool!*
	[ˈkʰ uʊː]
Tallulah	(x) um and and um what else um-yeh-and um-they had a nice apartment
	[(dɛ˜˛) ə˜˛m æ˜˛nd. æ˜nd. ə˜m ˈwɒʔ ɛlfŋ ə˜mː (.) jɛ˛ ˈæ˜˛nd. ʌ˜˛m (.) ˈdeɪ hæ˜˛n̥ ə ˈnaɪs̰ iˈpʰ ɑ˛ʔnə˜˛nʔ]
Tallulah	And they actually work for a magazine-but it's their own
	[ˈæ˜˛nd deɪ ˈʔæʔçli˛ ˈwɜ˛˛k fɔ˛ ʔə ˈmægəz̰ĭn (.) ˈbʊʔ ɪʔs̰ ˈd˛ɛə ˈʔəʊ˜n̥]
Tallulah	'Cos the girl who accidentally work for the triplets
	[ˈkʰʌ˛s̰ də ˈgɜ˛ʊ hu˛ ˈʔæ˛ʔçədɛ˜˛n̥ʔli ˈwɜ˛ʔ fɔ də ˈtɹɪ˛blə˜˛ʔfŋ]

Tallulah	And they um-eh-and one of the Bratz quits
	[æ˜nd ˈlːðe̯ɪ ə˜m (ʊ˘ɛ˘) æ˘˷n ˈwʌ˜n əv də ˈbwætfŋ ˈkwɪːʔts]
Tallulah	Because (Bodeen) that was the mum of them-um was so mean
	[bəˈkʰʌ˜fŋ (bəˈdɪːn) ʔæʔ çə ðə ˈmʌ˜m əv ˈðɛ˘˷m (.) ˈə˘˷m wəs̃ ˆˈs̃əʊ ˈmiə˜n]
Tallulah	(?X X X shoe) and she (?actually/accidently) gone (XX) and she (?actually /accidently) (?took) forgot her high heeled shoes
	[(ˈæ˜ʔ ˈn̩ ˈdeɪ ˈs̃u) ʔæ˜n s̃i ˈæs̃ə̤li ˈgɒ˜n (XX) æ˜n ˈs̃i ˈæs̃li (gɛ˜n(n)i) (tʰ ʊʔ) fˀ̃ɔˈgɒʔ hɜ˘ ˈhaɪ ˈhiʊd ˈs̃˷ũːz̃˷]
Tallulah	And so she weared them because the triplets were actually talking about (Bodeen), their mum
	[æ˜n ˈfŋ ə˜ʊ s̃ɪ̈ ˈwɛəd d˷ə˜m ˈkʰ əz̤ də ˈpwɪblə?s̃ʷ wɜ˘ ˈʔæʔfŋ ə˜li ˈtʰ ɔkʰɪ˜n əˈbaʊʔ (wəˈdɪ̈n) ðɛ̆ɪ mʌ˜m]
Tallulah	And they were saying not nice stuff about her
	[ˈʔæ˜nd̤ də wə ˈs̃eɪ˜ŋ ˈnɒ˜ʔ ˈnaɪs̃ ˈs̃tʌ˷f əˈbəʊʔ hʌ]
J	Mmm
Tallulah	So-so-one of the Bratz weared the high heeled shoes and they thought it was (Bodeen)
	[d̤əʊ˷ (.) ˈs̃əʊ˷ (.) (də) ˈwʌ˜n ə ðə βəˈʔæ˷ʔfŋ ˈʊɛəd ˆ də ˈhaɪ ˈhiʊd ˈs̃ju˷z̃ ˈæ˘˷nd̤ ðeɪ ˈfɔʔ ɪʔ ˈwɒz̃ bəˈdɪ̈n]
Tallulah	And they actually told (Bodeen) and it was so funny because now they don't work for them (laughing)
	[æ˜n ðeɪ ˈʔæs̃ˈli ˈtəʊdˀˆ bəˈdɪ̈n æ˜n ˈɪʔ wəz̤ ˈsəʊ ˈfʌ˜ni bəˈkʰ əʔ ˈnɑʊ di ˈdəʊ˜nʔ ˈwɜʔ fɔ də˜m]
Tallulah	But they are still the daughters – (but) that's it!
	[ˈbʌʊʔ deɪʲ ɑ ˈs̃tɪʊ də ˈdɔtəz̤̃ (.) bə ˈðæʔs̃ ˈɪʔ]

Appendix 4.9 Tallulah CS 5, T1, Food

Tallulah	Jar
	[ˈʤ̪ːɑ]
J	A jar of...something you might put on bread or toast
Tallulah	Jam
	[ˈʤːæ˜m]
J	You might-do you like jam on bread?
Tallulah	A little bit 'cos I have it in school once
	[ə ˈlɪʔʊ ˈbɪˌʔ kʰəsˌ̃aɪ ˈhæv̩ ɪʔ ɪ˜n ˈfŋkuʊ ˈwʌ˜ˌn θˌ̃]
J	Did you? What's your favourite thing to have on – in a sandwich or on toast?
Tallulah	I don't have sandwiches
	[ˈʔaɪ jəʊ˜nʔ ˈhæ˜v ˈsˌ̃æmwɪʤə˜fŋ]
J	No?
Tallulah	I don't like bread
	[aɪ ˈdəʊ˜nʔ lãɪʔ ˈbʊɛd̩]
J	Do you not? What's your favourite food-what do you like best?
Tallulah	Burger King and McDonalds
	[ˈbɜˌdə ˈkʰɪ˜ŋ æ˜n mæk ˈgɒ˜nəʊˌzˌ̃]
J	Oh my goodness-is that your favourite thing? What about things that mum does-what's your favourite thing that mum does?
Tallulah	Oh her special chicken
	[ɛʊ hɛ ˈmˌ̩ˌ̃pɛfŋəʊ ˈʧɪkʰə˜ˌn]
J	Is that your favourite? Yeh? And what's special about the special chicken?
Tallulah	Um-because it's nice and spicy
	[ə˜ˌm bɪ ˈkʰənˌ̩̃ ɪʔsˌ̃ ͡ˈʤaɪsˌ̃ æ˜m ˈmˌ̩̃paɪsˌ̃i]
J	Is it?
Tallulah	It is mum-and- but I don't like it but little bit too spicy
	[ɪˌʔ ˈʔɪˌzˌ̃ ˈmʌ˜ˌm (.) æ˜ˌnd̩ (.) bəˌʔ ˈaɪ ʤəˌʊ˜nʔ ˈlaɪˌʔ ɪˌʔ bʌʔ ˈlɪˌʔʊ bɪˌʔ ˈtuˌ ˈmˌ̩̃paˌɪfŋ i]
J	OK

Appendix 4.10 Tallulah CS 6, T1, Dinosaur

Tallulah	Dinosaur (whisper)
	[{V.. ˈdaɪ˜nt̚ˌʰɔV..}]
J	Say it again
Tallulah	Dinosaur-I don't know which one that's called
	[ˈdaɪ˜nsɔ̃ . aɪ ˈdəʊ˜nʔ nəʊ ˈwʌʧ̃ wʌ˜nz̃. ˈdæʔs̃ ˈkˢ ɔtˀ]
J	I don't know either
Tallulah	There's a boy in my class what is um amazed with dinosaurs-he knows every single dinosaur (in the) whole wide world
	[ˈðɛ˜z̃. ə ˈbɔ˜ˌ˜ɪ ɪ˜n maɪ ˈkˢlɑ˜ˌs̃ wɒ˜ˌʔ ɪ˜nz̃. . ə˜ˌm əˈmeˌɪz̃. wɪv ˈdaɪ˜nːd.ɒ˜ˌn̰˜. ˈhi ˈnəʊz̃ ɛvi ˈs̃ɪŋgʊ ˈdaɪ˜nəˇdə˜ ŋə.. {*allegro* ˈhəʊ ˈwaɪʔ ˈwɜˌʊd *allegro*}]
J	Does he?
Tallulah	Yeh
J	I don't know what that sort is
Tallulah	Neither-it's a - tyrannosaurus-rex
	[{*pp* ˈnivə *pp*} (.) ɪ˜ʔdæ˜ (.) ˈpʰaɪ˜nˈfŋɔɹəsˌː ˈwɛks̃]
J	I'm not sure if it is-I think a tyrannosaurus has got big sharp teeth
Tallulah	And claws and that
	[æ˜n ˈklɔ˜z̃. ə˜n ˈðæʔ]
J	But-I think-I wonder if that's called a stegosaurus?
Tallulah	Yes 'cos stegosaurus (are) big-fat-lumpy-and they're sharp
	[ˈjɛ kʰəfŋ ˈkʰɛçkɔ˩ ə ˈbɪg ˈfæʔ ˈlʌ˜mpʰi (.) æ˜n ðɛə ˈʃɑpˌ]

Appendix 4.11 Tallulah T1 & T2 Examples of imitated sentences (CSP task)

Target and response	
	Mary's shoes are clean
T1	[ˈmɛəɹi (.) ˈʃud ə ˈxlĭn]
T2	[ˈmɛəɹiʒ ˈʃuz. ɑ ˈklĭn]
	She wrapped the parcel
T1	[s̃i ˈwæp˞͡ bə˘ ˈpʰɑs̃tŭ]
T2	[ʃi ˈɹæpt ðə ˈpʰɑsəʊ˷]
	Good girls are nice
T1	[gʊg˞ ˈgɛʊð̃ ɑ ˈnaɪs]
T2	[gʊg˞ ˈgɛʊz ɑ ˈnaɪsː]
	John played tennis
T1	[ˈʒɒ˜n (.) ˈpleɪd (.) ˈtʰɛ˜nɪʔːts̰]
T2	[ˈʤɒ˜nn ˈpleɪd ˈtʰɛ˜nɪs̰]
	She picked some flowers
T1	[ˈʃ̰i (.) ˈpʰɪkʼ (.) d̰ʌ˜m ˈplæ.wəfŋ̍]
T2	[ʃi ˈpʰɪkt sʌ˜m ˈflɑʊ˷wəz.]
	Sam ate an orange very slowly
T1	[ˈθ̃æ˜m ˈɛ˷ʔ ə ɒˈwɪ˷˜nʤ̰. fɛwi ˈləʊː.ˈli]
T2	[ˈsæ˜m ɛt eɪ ˈɒɹɪ˜nʤ̰ vɛʊi ˈsləʊli]
	He sneezed very loudly
T1	[hi ˈn̰.ʰhid fəlɛ˘ ˈvɛwi ˈlaʊd..li]
T2	[hi ˈsnizd vɛɹi ˈlaʊdli]
	We found presents under the tree
T1	[w̰i ˈfəʊ˜m˞͡ ˈpwɛ˜(d̰)ə˜nt ˈʌ˜nd.ə ʤə ˈʧɹi]
T2	[wi ˈfaʊnd̰ ˈpʊɛzə˜nʔs ˈʌ˜ndə də ˈʃɹi]
	Jane made some soup
T1	[ˈʤeɪ˜n ˈmeɪd ˈθ̃ʌ˜˷m (.) ʃupfŋ̍ ˈs̰jūpʼ tʼ]
T2	[ˈʤeɪ˜n ˈmeɪd̰ ˈsʌ˜m (.) ˈsupʼ]
	She gave the orange to Sam
T1	[ʃ̰ɪ ˈgeɪv. ðə ˈɒwənʤ̰ ʧə ˈθ̃ æ˜m]
T2	[ʃi (.) ˈgeɪv də ˈɒwənʤ̰ tʰə ˈsæ˜m]

Appendix 4.12 Tallulah T1 and T2 Intelligibility stimuli

Single words

Word	Adult target	**Tallulah 's realisation T1**	Number of words identified by individual listeners T1	**Tallulah 's realisation T2**	Number of words identified by individual listeners T2
BISCUITS	/ˈbɪskɪts/	[ˈbɪ θ̟ʰɱ̩ kⁿ ɪʔɱ̩]	98/132*	[ˈbˌʰ ɪskⁿ ɪts]	110/132*
BREAD	/bɹɛd/	[bwɛdˌ]	11/66	[bɹɛdˌ]	46/66
DUCK	/dʌk/	[dʌˌkˀ]	57/66	[dʌkˀ]	31/66
FROG	/fɹɒg/	[fˌwɒgˀ]	2/66	[fɒg]	49/66
GIRAFFE	/ʤəˈɹɑf/	[ʤəˈʊɑf]	65/66	[ʤəˇˈɹɑf]	51/66
MONKEY	/ˈmʌˀŋki/	[ˈmʌˀŋki]	60/66	[ˈmʌˀŋki]	42/66
QUEEN	/kwĩn/	[kwiəˀn]	19/66	[kwĩn]	39/66
SOCK	/sɒk/	[ɱ̩ɒˀkˀ]	14/66	[sɒk]	57/66
THUMB	/θ ʌˀm/	[fʌˀm]	21/66	[fʌˀm]	7/66
ZEBRA	/ˈzɛbɹə/	[ˈdɛbwə]	51/66	[ˈzɛbɹə]	49/66

*Score for BISCUITS calculated as 1 for the lexical item and 1 for the plural morpheme

Imitated sentences (CSP task)

Target sentence	**Tallulah 's realisation T1**	**Percentage of words recognised by individual listeners T1**	**Tallulah 's realisation T2**	**Percentage of words recognised by individual listeners T2**
I LIVE NEAR (A) BIG WOOD	[aɪ ˈlɪv nɛ (.) ˈnɛː ə ˈbɪg ˈwʊdˌ]	98.79%	[aɪˇ ˈlɪvˌ nɛ ə ˈbɪgˀ (.) ˈwʊdˌ]	76.06%
JOHN PLAYED TENNIS	[ˈʒɒˀn (.) ˈpleɪd (.) ˈtʰɛˀnɪʔːtsˌ]	95.45%	[ˈʤɒˀnn ˈpleɪd ˈtʰɛˀnɪsˌ]	42.05%
MY UNCLE IS (A) FARMER	[maɪˀ ˀˈʔʌˀŋk ͡əzˌ ə ˈfɑˀmə]	98.86%	[maɪˀ ˀˈʔʌˀŋklˌ ɪzˌ eɪ ˈfɑˀmə]	100%
THIS SHAPE IS (A) SQUARE	[ðɪʃ ˈʃeɪp ɪðˀ əˀ ˈ θ̟ʷɛə]	60.98%	[ðɪʃ ˈʃeɪp ɪzˌ ə ˈskwɛə]	87.88%
WE SAW (A) TENT BY (THE) RIVER	[wi ˈtɔ̟ˌʷ ə ˈtʰɛˀŋtⁿ ə baɪ ðə {ˌfˈwɪvəːˌf}]	50.30%	[wi ˈsɔˌ ʔɛɪ ˈtʰɛˀnʔ baɪ dəˇ ˈɹɪvæˇ]	65.45%

Conversational speech

Target sentence	**T1**	**Tallulah's realisation**	**Percentage of words**

	or T2		identified by individual listeners
BUT IT DIDN'T FALL OVER	T1	[bə ʔɪʔ ˈdɪ˜əɱ ˈfɔɬ əʊvə]	61.87%
I (EH) WAS DRAWING (A) PICTURE IN (UM) BOBBY'S HOUSE	T1	[ˈʔæɛ͡ɪː wə˜m̃. ˈbɔwɪ˜n ə ˈpʰ ɪʔʧə ˈɪ˜ːnə˜ (.) ˛ɛ˜m (.) ˈbɒbɪ̃ɱ ˈhaʊ˜ɱ]	72.54%
MAYBE IT'S JUST (A) PAPER	T1	[ˈm̃ɛbiʔ z̃. ˈd˛z̃əs˛t̃ ə ˈpʰeɪˈpʰɐ˛ː]	53.33%
WE USED SCISSORS LAST NIGHT	T1	[ˈwi ju ˈs̃˛ɪ˜z̃˛ət̃ ɪ̃ɑ˜s̃˛ ˈʔ͡naɪʔːʰ]	46.97%
WELL ONE WAS IN MY DRAMA AND HE'S CALLED TOM	T1	[ˈwɛʊ˛ ˈwʌ˜n wəz̃ˈɪ˜m͡ maɪ˜ ˈbwɑ˜˛mæ˛ æ˜n ˈhɪ̃ɱ ˈkʰ ɔːtˈ ˈtʰ˛ɒ˜˛ːm]	81.96%
(A) VERY NICE FISH	T2	[ə ˈvɛʊi ˈnaɪs ˈfɪ˛ʃː]	100%
ON MY BODY I HAVE FIVE LEGS	T2	[ˈʔɒ˜n maɪ ˈbɒdi ˈʔaɪ hæv (...) ˈfaɪv ˈlɛgz˛]	97.92%
ONE OF THOSE CAME TO OUR SCHOOL	T2	[ˈwʌ˜n ə ˈðəʊz ˈkʰeɪ˜m tʰəʷ ɑ ˈsku˛ʊ]	84.85%
THAT'S ONE OF THOSE BIG ONES WHAT SQUEEZE YOU	T2	[ðæts (.) ˈwʌ˜n ə ðəʊz˛ ˈbɪg ˈwʌ˜nz˛ wɒʔ ˈskwiʒ ju]	94.39%
THAT'S SIGN LANGUAGE	T2	[ˈðæts ˈsaɪ˜l͡ læ˜ŋwɪʤ̊]	88.26%

Appendix 4.13: Speech Processing Profile: Tallulah (7;3) T2

INPUT

OUTPUT

KEY
Standardised scores
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset
⇔Silent sorting CVC words by coda
(No change since T1)

E Are the child's phonological representations accurate
✓ Within typical range at T1
⇔Syllable/word/rhyme/identification
(No change since T1)

D Can the child discriminate between real words?
✓Within typical range at T1

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
✓Complex non-words- diff: z=-0.75

A Does the child have adequate auditory perception?
⇔No concerns

G Can the child access accurate motor programmes?
✓Naming 1 syllable words: z=0.833
XX Naming 2 syllable words: z=-3.47
✓Naming 3/4 syllable words: z=-0.40
✓Naming total: z=-1.32

H Can the child manipulate phonological units?
⇔Rhyme generation
⇔Segmentation of multisyllabic words into syllables
⇔Segmentation of CVC words
(No change since T1)

I Can the child articulate real words accurately?
⇔Blending of C-V-C into words

J Can the child articulate speech sounds without reference to lexical representations?
✓Within typical range at T1

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇔Oro-motor skills

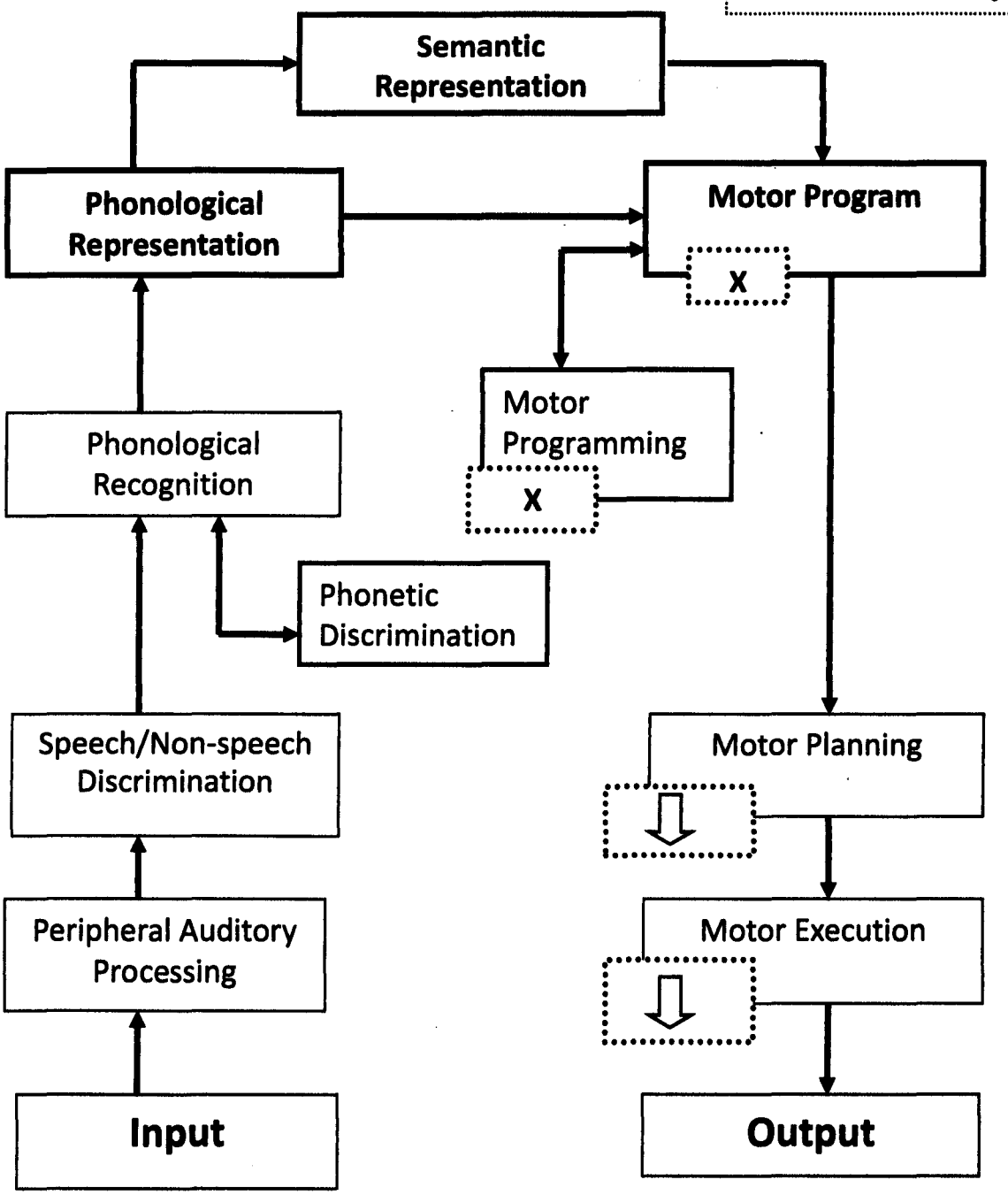
L Does the child reject his/her own erroneous forms? Yes

Appendix 4.14: Speech Processing Model: Tallulah T2

Speech Processing Model
(Stackhouse & Wells, 1997):
Tallulah suggested areas of difficulty, T2

KEY
Level of difficulty hypothesised from normed tasks
X or XX or XXX

Presence of difficulty hypothesised from weak/poor performance on informal tasks



Appendix 4.15 Tallulah CS 1, T2, Boa constrictor

J	And there's a
Tallulah	Snake snake-no-that's one of those big ones what squeeze you-viper
	[ˈsneɪk ˈsneɪkˌ (.) ˈnəʊ ðæts (.) ˈwʌ˜n ə ðəʊz. ˈbɪg ˈwʌ˜nz. wɒʔ ˈskwiʒ ju (.) ˈvaɪpə]
J	A boa constrictor
Tallulah	A boa constrictor-one of those came to our school
	[ə ˈbʊ˜stˈˈɹɪ˜ktˈˈə ˈwʌ˜n ə ˈðəʊz ˈkʰeɪ˜m tʰəʷ ɑ ˈsku˜ʊ]
J	Listen to that - boa constrictor
Tallulah	Boa constrictor
	[ˈbə˜ʊn ˈkʰɒ˜n.ˈtɹɪkdʌ]
J	Have you got that sound...
Tallulah	Oh it doesn't matter
	[əʊ ˈdʌ˜zn ˈmæ˜tˈ ə]
J	It does matter-let's have one more go- constrictor
Tallulah	Constrictor
	[ˈkʰɒ˜n(.)ˈstɹɪkdə]
J	Well-good-good-well done
Tallulah	Excuse me
	[ˈkʰ juz ˈmi]
J	OK-let's do it one more time- boa constrictor
Tallulah	Boa constrictor
	[ˈbəʊə ˈkʰɒ˜n(.)ˈstɹɪktə]
J	Well done
Tallulah	Can I tell you something?
	[ˈkʰaɪ ˈtɛ ju ˈsʌ˜mfɪ˜ŋ]
J	Yes
Tallulah	One of those came to our school
	[ˈwʌ˜n ə ˈdəʊz. ˈkʰeɪ˜m tʰ uʷ ɑ ˈskˈˈ uʊ]
J	Did it-what happened?
Tallulah	And a tarantula
	[ˈæ˜n ə ˈʧɹæ˜nʧəlʌ]
J	What happened with the boa constrictor?
Tallulah	Well it went on our legs-but don't cross your legs
	[ˈwɛʊ ʔɪʔ ˈwɛ˜nʔ ɒ˜n ʌ ˈlɛgzˌˌ (.) bʌʔ ˈdəʊ˜nʔ ˈkwɒʃ jə ˈlɛgz]
J	Right
Tallulah	It will (gesture)
	[ˈɪʔ wʊ]
J	Get around you?
Tallulah	And, and the tarantula got loose
	[ˈʔæ˜nd (.) ʔæ˜nd ðə ˈʧɹæ˜nʧələ gɒʔ ˈlus]
J	And then what happened?
Tallulah	Don't know
	[ˈdəʊ˜˛nʔ nəʊ˛]

Appendix 4.16 Tallulah CS 2, T2 Viper

J	What is it?
Tallulah	Um-it-what kind of snake? I know what kind of snake.
	[ə˜m ˈɪt' (.) wɒʔ ˈkʰaɪ˜n͡ ə ˈsneɪk (.) aɪ ˈnəʊ wɒʔ ˈkʰaɪ˜n͡ ə ˈsneɪk']
J	Do you-do you know that? I was expecting you to say 'snake'
Tallulah	A viper
	[ə ˈðaɪpʌ]
J	Could be-or a cobra?
Tallulah	Cobra-or viper
	[ˈkʰ əʊbɹə ɒ θ (.) ˈðaɪpə]
J	Could be-either
Tallulah	(click) No- viper. That other one what's big who squeeze you is viper.
	[ǀ ˈnəʊ ˈð̰̈əʊpə (.) ˈðæʔ ʌv͡ ˈwʌ˜n wɒm̰̈ ˈbɪg hʊ ˈskwiʒ ˈju ʔɪ θ ˈðaɪpə]
J	What's big-what's big *(note: implied meaning 'please repair')*
Tallulah	A viper um snake
	[ə ˈðaɪpə (.) ə˜m ˈsneɪk]
J	Viper *(note: implied meaning, giving model for imitation)*
Tallulah	Viper
	[ˈðaɪpə]
J	Viper
Tallulah	Viper
	[ˈvaɪpə]
J	Got it
Tallulah	Viper
	[ˈvaɪpə]

Appendix 4.17 Tallulah CS 3, T2, Pets

Tallulah	Another insect
	[əˈnʌvəˈʔɪ˜sɛktʼ]
J	What kind of insect?
Tallulah	A caterpillar
	[əˈkʰæ̠ɾ̪pʰ ɪlə]
J	Yeh
Tallulah	Oh-my my cousin had a pet caterpillar
	[ʊˈmaɪ maɪ ˈkʰʌzə˜n hæd əˈpɛʔ ˈkʰæt̠͡θ əpʰ ɪlə]
J	Really?
Tallulah	Yeh. And a dog.
	[jɛ̠ (.) ˈʔæ˜n əˈd̠ɒg]
J	I think the dog might be easier to look after than the caterpillar.
Tallulah	No, no. She keeps it in a box.
	[nəˈnəʊʃiˈkʰɪp̠s ɛ˜n əˈbɒʔs]
J	Oh what's this one?
Tallulah	But with holes in it. I had to do it by nails. She came over-from another land.
	[bə wɪv (.) ˈhəʊz ɪ˜̠n ˈɪ̠ʔ (.) ˈʔaɪʲ a̠z ˈd̪uʷ ɪʔ ba̠ɪ ˈneɪʊz (.) ʃi ˈkʰeɪ˜m ˈəʊvə̠ . fwə˜m əˈnʌvə ˈlæ˜̠ːnd]

Appendix 4.18 Tallulah CS 4 T2 Hospital

Tallulah	Hospital
	[ˈhɒm.ʔɒɪtʊ˷]
J	Oh tell me that word again
Tallulah	Hospital
	[ˈhɒm.ʔɒɪtʊ]
J	Is it a hospital (with nasalisation)
Tallulah	Hospital
	[ˈhɒspɪtʊ]
J	Oh, right
Tallulah	It's it-you know the big(f) building
	[ˈʔɪʔs (.) ɪʔ (.) jə ˈnəʊ ðə ˈbɪgf ˈbɪʊdɪ˜˷ŋ]
J	Yeh
T	Do you go there?
	[ʤu ˈgəʊ ðɛə˷]
J	I have been there, yeh
Tallulah	I have
	[ˈʔaɪ ˈhæ˷v]
J	Mmm
Tallulah	I have (?before) for mummy and she was having Vinci
	[aɪ ˈhæv (bəf) fɔ ˈmʌ˜miː æ˜n˷ ˈʃiz ˈhævɪ˜ŋ ˈvɪ˜nsi˷]
J	Ah-did you go and see him in hospital?
Tallulah	Yeh-and we stayed there for Burger King
	[ˈjɛ˷ (.) ˈʔæ˜n wi ˈseɪd˷ ðɛː fɔ ˈbɜ˷gə͡ˀ xɪ˜n]
J	Ah
Tallulah	And, and, and, can I tell you something?
	[ˈʔæ˜nd ˈæ˜nd ˈæ˜nd xə˜n ˈtʰɛ͡əː ˈsʌ˜mfɪ˜ŋk']
J	Mmm
Tallulah	(Click) on the way back we went to nanny's and Vincent was an, Vincent was a just a tiny little baby
	[l ˈɒ˜n ə ʊɛɪ ˈbæːk' wɪ ˈwɛ˜n tə ˈnæ˜niz. æ˜n ˈvɪ˜nz˷ə˜ wə˜ æ˜n ˈvɪ˜nz˷ə͡˜˜ wəzə͡ dəd͡ ə ˈt˷ʰaɪ˜ni ˈlɪtəʊ ˈbeɪbi]
J	Do you remember that then?
Tallulah	Yep, and look he's not in one of those pictures or those
	[ˈjɛp' (.) æ˜n ˈlʊk' xɪ̃n̰. ˈnɒ˜ʔ ɛ˜n ˈwʌ˜n ə ðəʊz ˈpʰ ɪkʧə ɔ ˈdəʊz]
Tallulah	But can I tell you what, I'm not in that picture
	[ˈbəʔ kə˜˜n aɪ ˈtʰɛʊ ju ˈwɒʔ ʔaɪ˜m ˈnɒʔ ɪ˜n ˈðæʔ̰ ˈpʰ ɪkʧə]
J	You're not?
Tallulah	No because I was I was a tiny little baby in mummy's-(?tummy button). I was-I didn't exist
	[ˈnəʊ bəˈkʰʌz. ˈaɪ wə ə wəʔ ə ˈtʰaɪ˜ni lɪə ˈbeɪbi ɪ˜n ˈmʌ˜miz. (ˈtʰəʊɪə˜nʔ) ˈaɪ wə (.) aɪ ˈdɪʔə˜˷n ˈɪ˷ʔsɪ˷ks]

Appendix 5.1 Harry: Results of standardised language assessment T1, CA 7;2 CELF-3 UK

Subtest	Scaled score	Percentile rank
Concepts & Directions	9	37
Word structure	12	75
Recalling Sentences	10	50
Formulated Sentences	14	91
Word Classes-Receptive	10	50
Sentence Structure	12	75
Word Associations	8	25

Composite Scores

Receptive Language	103	58
Expressive Language	111	77
Total Language Score	106	66

Appendix 5.2 Harry: Speech Processing Profile T1 (age 7;5)

KEY
Standardised scores
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

INPUT

OUTPUT

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset
⇓Silent sorting CVC words by coda

E Are the child's phonological representations accurate
✓ ALD (no picture), 93.33%
XXX ALD words in sentences, SIWI consonant clusters & SFWF fricatives
⇔Syllable/word/rhyme/identification

D Can the child discriminate between real words?
⇔Rhyme detection
✓ B&S real words: z=0.46

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
XXX B&S non-words: z=-0.5.2
X Complex non-words-same: z=-2.38
XX Complex non-words- diff: z=-2.74

A Does the child have adequate auditory perception?
⇔No concerns

G Can the child access accurate motor programmes?
XXX Naming 1 syllable words: z=-8.16
XXX Naming 2 syllable words: z=-8.16
XXX Naming 3/4 syllable words: z=-5.55
XXX Naming total: z=-8.44

H Can the child manipulate phonological units?
⇓Rhyme generation
⇔Segmentation of multisyllabic words into syllables
⇓Segmentation of CVC words

I Can the child articulate real words accurately?
⇔Blending of C-V-C into words
⇓Blending of C-C-V-C into words
⇓no evidence that imitation improved output

J Can the child articulate speech sounds without reference to lexical representations?
Non-word repetition:
XXX 1 syllable items z=-3.75
XXX 2 syllable items: z=-4.71
XX 3/4 syllable items: z=-3.34
XXX Total: z=-5.11

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇓ Oro-motor skills

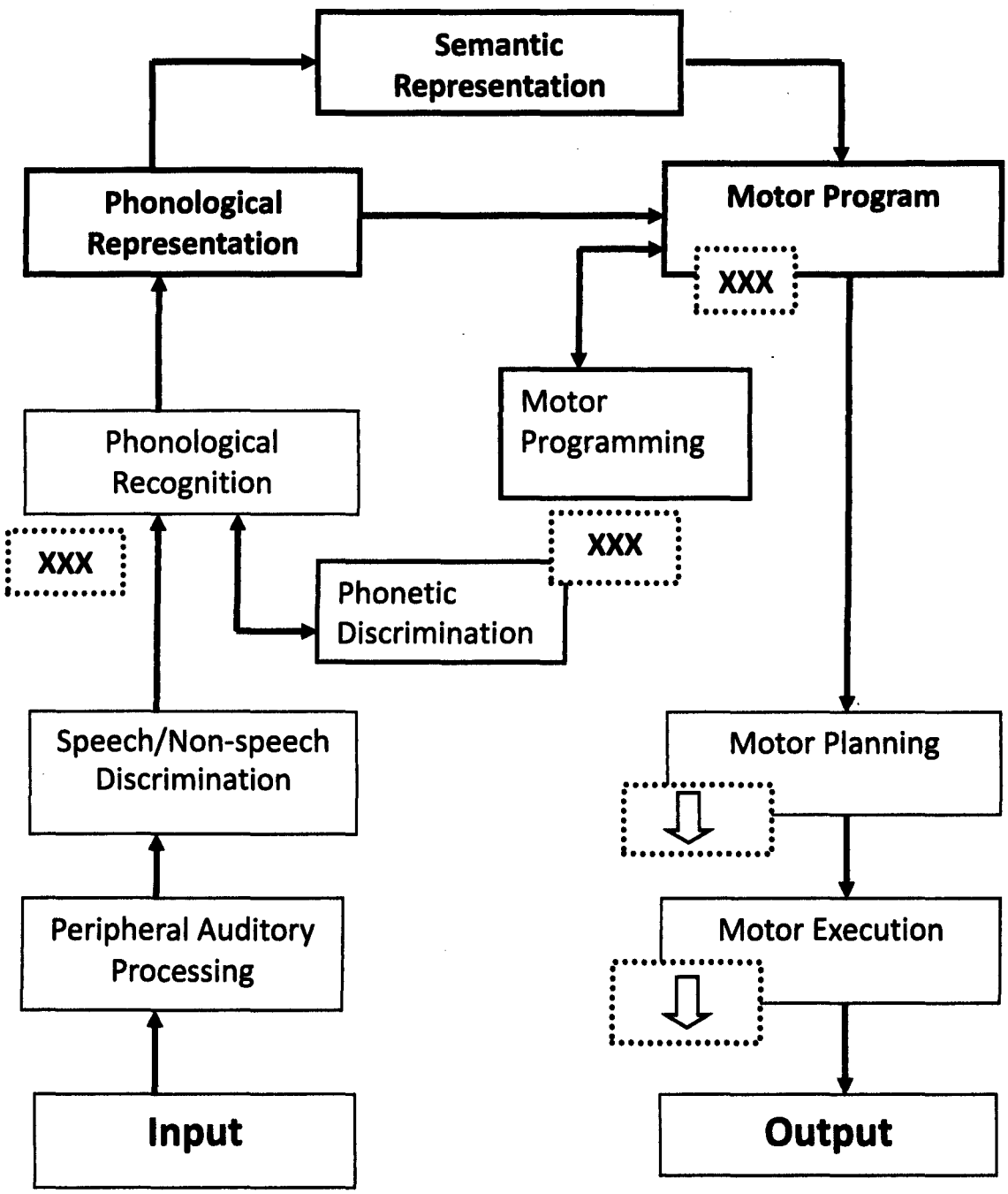
L Does the child reject his/her own erroneous forms? Rarely

Appendix 5.3 Harry: Speech Processing Model: T1

Speech Processing Model
(Stackhouse & Wells, 1997):
Harry suggested areas of difficulty, T1

KEY
Level of difficulty hypothesized from normed tasks
X or XX or XXX

Presence of difficulty hypothesised from weak/poor performance on informal tasks



Appendix 5.4 Harry: Single word naming, T1 (7;5) and T2 (8;5)
(taken from DEAP Phonology, DEAP Articulation and Stackhouse & Wells Naming Task)

	Word	Adult realisation	C score	V score	Harry's realisation (T1 7;5)	C score	V score	Harry's realisation (T2 8;5)	C score	V score
1.	aeroplane	/ˈɛərəpleɪn/	4	3	[ˈɛələpeɪ˜n]	2	3	[ˈɛələpe˜ɪn]	2	3
2.	apple	/ˈæpəl/	2	2	[ˈæbo]	0	1	[ˈæpʊɬ]	2	2
3.	bird	/bɜd/	2	1	[bʌ̠d]	2	0	[bɜd̰]	2	1
4.	biscuit	/ˈbɪskɪt/	4	2	[ˈbɪʔgɪt']	2	2	[ˈbɪʔkɪtsː]	3	2
5.	boat	/bəʊt/	2	1	[bəʊt]	2	1	[bə̰ʊt']	2	1
6.	book	/bʊk/	2	1	[bʊk']	2	1	[bʊk']	2	1
7.	boy	/bɔɪ/	1	1	[bɔɪ]	1	1	[bɔɪ]	1	1
8.	bread	/brɛd/	3	1	[ˈbwɛt']	1	1	[bwɛt̰]	1	1
9.	bridge	/brɪʤ/	3	1	[bwɪts]	1	1	[bwɪts]	1	1
10.	brush	/brʌʃ/	3	1	[bwʌs]	1	1	[bwʌs]	1	1
11.	butterfly	/ˈbʌtəflaɪ/	4	3	[ˈbʌtə˜faɪ]	3	3	[ˈbʌtəflaɪ]	4	3
12.	car	/kɑ/	1	1	[kʰ ɑ]	1	1	[kʰ ɑ]	1	1
13.	caravan	/ˈkærəvæn/	4	3	[ˈtʰæləbæ˜n]	1	3	[ˈkʰælivæ˜n̰]	3	2
14.	cat	/kæt/	2	1	[kʰ æt']	2	1	[kʰ æt]	2	1
15.	caterpillar	/ˈkætəpɪlə/	4	4	[ˈkʰ ætəpʰ ɪ lə]	4	4	[ˈkʰ ætipʰ ɪ lə]	4	3
16.	chair	/ʧɛə/	1	1	[tʰ ɛə]	0	1	[ʧɛə]	1	1

17.	chips	/ʧɪps/	3	1	[tɪps]	2	1	[ʧɪps]	3	1
18.	computer	/kəmˈpjutə/	5	3	[kʰɒ˜mˈpʰ ut ʌ]	4	3	[kʰɒ˜mˈpjutə]	5	3
19.	crab	/kræb/	3	1	[t̪wæp']	0	1	[kwæp']	1	1
20.	crocodile	/ˈkrɒkədaɪl /	5	3	[ˈt̪wɒkədaɪʊ]	3	3	[ˈkwɒʔə˘daɪʊ]	3	3
21.	dinosaur	/ˈdaɪnəsɔ/	3	3	[ˈdaɪ˜nə˘sɔ]	3	3	[ˈdaɪ˜nəsɔ]	3	3
22.	door	/dɔ/	1	1	[dɔ]	1	1	[dɔ]	1	1
23.	duck	/dʌk/	2	1	[dʌk]	2	1	[dʌk']	2	1
24.	dustbin	/ˈdʌsbɪn/	4	2	[ˈdʌsbɪ˜n]	4	2	[ˈdʌsbɪ˜n]	4	2
25.	ear	/ɪə/	0	1	[ɪə]	0	1	[ɪə]	0	1
26.	elephant	/ˈɛləfənt/	4	3	[ˈɛləfə˜nt']	4	3	[ˈɛləfə˜nt]	4	3
27.	feather	/ˈfɛðə/	2	2	[ˈfɛzə]	1	2	[ˈfɛvə]	1	2
28.	fish	/fɪʃ/	2	1	[fɪs]	1	1	[fɪʃ]	2	1
29.	fishing	/ˈfɪʃɪ˜ŋ/	3	2	[ˈfɪsɪ˜n]	1	2	[ˈfɪʃɪ˜ŋ]	3	2
30.	five	/faɪv/	2	1	[faɪz̩]	1	1	[faɪv̩]	2	1
31.	flower	/ˈflaʊwə/	3	2	[ˈflaʊwə]	3	2	[ˈflaʊwə]	3	2
32.	foot	/fʊt/	2	1	[fʊt']	2	1	[fʊt']	2	1
33.	frog	/frɒg/	3	1	[fɒk']	1	1	[fə˘wɒk']	1	1
34.	giraffe	/ʤəˈɹaf/	3	2	[gəwas]	0	1	[ʤəˈʊaf]	2	2
35.	girl	/gɜl/	2	1	[gɛʍ]	1	1	[gɜʊ]	2	1
36.	gloves	/glʌvz/	4	1	[gəlʌps]	2	1	[glʌv̩s]	3	1

37.	guitar	/gɪˈtɑ/	2	2	[bɪˈtɑ]	1	2	[dɪ˜ˈtɑ]	1	2
38.	hairdresser	/hɛəˈdrɛsə/	4	3	[hɛəˈdwɛsə]	3	3	[hɛəˈdrɛsə]	4	3
39.	hamburger	/hæmˈbɜgə/	4	3	[hæ˜mˈbɑgæ]	4	1	[hæ˜mˈbɜgə]	4	3
40.	helicopter	/ˈhɛləkɒptə/	5	4	[ˈheɪkʰ ɒkt ˗ ə]	3	2	[ˈhɛlikʰ ɒpt ə]	5	4
41.	hospital	/ˈhɒspɪtəl/	5	3	[ˈhɒsdəbəl]	3	3	[ˈhɒsəbəl]	3	3
42.	house	/haʊs/	2	1	[haʊs]	2	1	[hʌʊs]	2	1
43.	jam	/ʤæm/	2	1	[dæ˜m]	1	1	[ʤæ˜m]	2	1
44.	jelly	/ˈʤɛli/	2	2	[ˈd̥ɛli]	1	2	[ˈʤɛli]	2	2
45.	jump	/ʤʌmp/	3	1	[dʌ˜mp]	2	1	[ʤʌ˜mp]	3	1
46.	kangaroo	/ˈkæŋgəru/	4	3	[ˈtʰ æ˜ndəwu]	0	3	[ˈkʰ æ˜ŋgəwu]	3	3
47.	kitchen	/ˈkɪʧɪn/	3	2	[ˈkʰɪtsɪ˜n]	2	2	[ˈkʰɪtsɪ˜n]	2	2
48.	knife	/naɪf/	2	1	[nãɪf]	2	1	[nãɪf]	2	1
49.	ladder	/ˈlædə/	2	2	[ˈlædə]	2	2	[ˈlædə]	2	2
50.	ladybird	/ˈleɪdibɜd/	4	3	[ˈleɪdibɑːd]	4	2	[ˈleɪd̥ibɜd]	4	3
51.	leaf	/lif/	2	1	[lif]	2	1	[lif]	2	1
52.	legs	/lɛgz/	3	1	[lɛks]	1	1	[lɛks̪]	1	1
53.	lighthouse	/ˈlaɪthaʊs/	4	2	[ˈlaɪt̪haʊs]	3	2	[ˈlaɪʔhaʊs]	4	2
54.	money	/ˈmʌni/	2	2	[ˈmʌ˜ni]	2	2	[ˈmʌ˜ni]	2	2

55.	monkey	/ˈmʌŋki/	3	2	[ˈmʌ˜ŋg̊i]	2	2	[ˈmʌ˜ŋki]	3	2
56.	moon	/mun/	2	1	[mə˜ũn]	2	0	[mu˜˛n]	2	1
57.	mouse	/maʊs/	2	1	[ma˜ʊs]	2	1	[mə˜ʊs]	2	1
58.	orange	/ˈɒrɪnʤ/	3	2	[ˈɒwɪs]	0	2	[ˈɒwɪ˜nz˛]	1	2
59.	parachute	/ˈpærəʃut/	4	3	[ˈpʰ æləsut ʾ]	2	3	[ˈpʰ æwəʃut ʾ]	3	3
60.	parrot	/ˈpærət/	3	2	[pʰ ælət']	2	2	[pʰ æwət']	2	2
61.	pig	/pɪg/	2	1	[bɪk']	1	1	[pʰɪk̚]	1	1
62.	plate	/pleɪt/	3	1	[pleɪt]	3	1	[pleɪt']	3	1
63.	pram	/præm/	3	1	[pwæ˜mp']	2	1	[ɸʊæ˜m]	1	1
64.	pyjamas	/pəˈʤaməz/	4	3	[wiˈda˜məs]	1	3	[biˈʤa˜mis]	2	3
65.	queen	/kwin/	3	1	[ʍĩn]	1	1	[kwi˜˛n]	3	1
66.	rabbit	/ˈræbɪt/	3	2	[ˈwæb˛ɪt]	2	2	[ˈwæbɪʔ]	2	2
67.	rain	/reɪn/	2	1	[weɪ˜n]	1	1	[wɛ˛ɪ˜n]	1	1
68.	ring	/rɪ˜ŋ/	2	1	[wɪ˜ŋ]	1	1	[wɪ˜ŋ]	1	1
69.	roof	/ruf/	2	1	[wuf]	1	1	[wuf]	1	1
70.	roundabout	/ˈraʊndəbaʊt/	5	3	[ˈwaʊ˜nd̪əbaʊt']	4	3	[ˈwaʊ˜ndəbaʊt]	4	3
71.	sandwich	/ˈsæmwɪʧ/	4	2	[ˈsæ˜mwɪs]	3	2	[ˈsæ˜mwɪʦ]	3	2
72.	sausage	/ˈsɒsɪʤ/	3	2	[ˈsɒsɪs]	2	2	[ˈsɒsɪʔs]	2	2
73.	school	/skul/	3	1	[sɒ˜ʊ]	2	1	[skuʊ]	3	1
74.	scissors	/ˈsɪzəz/	3	2	[ˈsɪsəs]	1	2	[ˈsɪzəz]	3	2

75.	scooter	/ˈskutə/	3	2	[ˈsutə]	2	2	[ˈskutə]	3	2
76.	seesaw	/ˈsisɔ/	2	2	[ˈsisɔ]	2	2	[ˈsisɔ]	2	2
77.	shark	/ʃɑk/	2	1	[sɑk]	1	1	[ʃɑ̰k̰]	2	1
78.	sheep	/ʃip/	2	1	[sip̚]	1	1	[ʃip']	2	1
79.	slipper	/ˈslɪpə/	3	2	[ˈslɪp̚ ə]	3	2	[ˈslɪp̚ ə]	3	2
80.	snake	/sneɪk/	3	1	[sne˜ɪk']	3	1	[sne˜ɪk']	3	1
81.	sock	/sɒk/	2	1	[sɒ˘k']	2	1	[sɒ̰k']	2	1
82.	spaghetti	/spəˈgɛti/	4	3	[sʌˈbɛʔi]	2	3	[səˈgɛʔi]	3	3
83.	spider	/ˈspaɪdə/	3	2	[ˈspaɪdə]	3	2	[ˈspaɪdə]	3	2
84.	splash	/splæʃ/	4	1	[spæs]	2	1	[splæs]	3	1
85.	sponge	/spʌnʤ/	4	1	[spʌ˜ns]	3	1	[spʌ˜nz]	3	1
86.	square	/skwɛə/	3	1	[fɛə]	0	1	[skwɛə]	3	1
87.	strawberry	/ˈstrɔbri/	5	2	[ˈsɔbɛːɪ]	2	2	[ˈsɔbəwɪ]	2	2
88.	swing	/swɪŋ/	3	1	[sfɪ˜nh]	1	1	[swɪ˜ŋ]	3	1
89.	teeth	/ti θ /	2	1	[tʰ is]	1	1	[tʰ if]	1	1
90.	telephone	/tʰ ɛləˈfəʊ n/	4	3	[tʰɛlɪˈfəʊ˜n]	4	3	[tʰɛliˈfəʊ˜n]	4	3
91.	television	/tɛləˈvɪʒən /	5	4	[tʰɛəˈbɪzə˜n]	2	4	[ˈtɛləvɪzə˜n]	4	4
92.	thankyou	/ˈ θ æŋkju/	4	2	[ˈfæ˜ˌŋku]	2	2	[ˈfæ˜ŋkjuː]	3	2
93.	three	/ θ ri/	2	1	[fi]	0	1	[fwiʲ]	0	1
94.	thumb	/ θ ʌm/	2	1	[fʌ˜m]	1	1	[fʌ˜m]	1	1

95.	tiger	/ˈtaɪgə/	2	2	[ˈtʰ aɪɣə]	1	2	[ˈtʰ aɪgə]	2	2
96.	toilet	/ˈtɔɪlət/	3	2	[ˈtʰ ɔɪlət]	3	2	[ˈtʰ ɔɪləʔ]	3	2
97.	tomato	/təˈmɑtəʊ/	3	3	[tʰəˈmɑ˜tu]	3	2	[tʰ ʊˈmɑtəu]	3	3
98.	tongue	/tʌŋ/	2	1	[tʰʌ˜ŋ]	2	1	[tʰʌ˜ŋ]	2	1
99.	toothbrush	/ˈtu θ brʌʃ/	5	2	[ˈtʰuʔbʌ˷s]	2	2	[ˈt˷ufbwʌ˷s]	2	2
100.	torch	/tɔʧ/	2	1	[tʰ ɒts]	1	0	[tʰɔ˜ts]	1	1
101.	tractor	/ˈtræktə/	4	2	[ˈtɹæʔdə]	2	2	[ˈtɹæʔtə]	3	2
102.	train	/treɪn/	3	1	[tɹeɪ˜n]	3	1	[tɹeɪ˜n]	3	1
103.	umbrella	/ʌmˈbrɛlə/	4	3	[ʌ˜mbəˈwɛlə]	3	3	[ʌ˜mbəˈwɛlə]	3	3
104.	vacuum cleaner	/ˈvækjum ˈklinə/	7	4	[ˈbækwum] [ˈkwimə]	3	4	[ˈvækjũm]][ˈclĩmə]	5	4
105.	van	/væn/	2	1	[wæ˜n]	1	1	[v'æ˜n]	2	1
106.	watch	/wɒʧ/	2	1	[wɒts]	1	1	[wɒʔt̪sː]	1	1
107.	web	/wɛb/	2	1	[wɛp']	1	1	[wɛp']	1	1
108.	witch	/wɪʧ/	2	1	[wɪʦ]	1	1	[wɪʦ]	1	1
109.	yellow	/ˈjɛləʊ/	2	2	[ˈlɛləʊ]	1	2	[ˈjɛ˷ləʊ]	2	2
110.	zebra	/ˈzɛbrə/	3	2	[ˈzɛʔbə]	2	2	[ˈzɛʔbwə]	2	2
		T1 and T2	**322**	**192**	**T1**	**200**	**184**	**T2**	**256**	**190**
						62.11%	**95.83%**		**79.5%**	**98.95%**

Appendix 5.5 Harry CS 1, T1, Duck

Harry	Yeah, or it's just about to take off to fly into the water 'cos when they land in water yeah, they make a big splash and that's...
	[ˈjɛ ʔɔ˘͡ ɪʔ ˈdʌst əˈbɑʊʔ (n) ˈtʰeɪʔ ˈʔɒs (.) tʰu ˈfaɪʲ ɪ˜ntʷu (d̥)ɪ˘ ˈwɔ˘d̥ə tə ˈweˑ˜ɪʲ eɪ ˈleˑ˜ɪʲ ɪ˜n ˈwɔ˘ʔə jɛ˘ eɪ˜ ˈmeˑ˜ɪd ə ˈbɪg̊ ˈspæs əˑ˜n æts..]
J	Have you ever seen a duck trying to go on a frozen pond-when there's ice-what happens to them then?
Harry	They fall over - then they get up and they fall back over again, so if they fall over two times then they think 'I give up' and just lie there until it slowly starts to melt and as soon as they see it melts, they slide to it and go(ing) into it, and wait 'til more of it melts.
	[di ˈfəʊ ˈʔəʊzə ɪ˜ i ˈdɪʔ ˈʌp nɪ̃ ˈfɔ ˈbæʔ ˈəʊzə əˈdɛ˜n səʊ ɪs͡ eɪ˘ ˈfwaɪzə ˈtʰu [X X X X] ˈaɪ ˈgɪz ʌp˜ əˑ˜n͡ ʌs ˈlaɪ ðɛəˑ˜du ɪʔ ˈsəʊwi ˈsɑts tʰə ˈmɛʊ̰ʔ əˑ˜ ˈsuzeɪ ˈsi ɪʔ ˈmɛˑ˜ʊ˘ts (breath/laugh) eɪ ˈslaɪd͡ ˈtʰu ɪʔ æˑ˜n ˈdəʊɪ˜n ˈʔɪntʰu ɪʔ əˑ˜n weɪt˜ tʰu ˈmɔˑ˜z ɪʔ ˈmɛˑ˜ʊts]

Appendix 5.6 Harry CS 2, T1, Bread

Harry	I like the crust of the bread
	[ʔaɪ ˈlaɪʔ ðə ˈtʰ ʌ_st ɒz͡. ə ˈbwɛt]
J	Do you?
Harry	Yeh, I like to rip it open
	[ˈjɛ~~~~~~~~~ ʔaɪ ˈlaɪʔ də ˈwɪb ɪʔ ˈʔəʊʔp"ə~n]
J	You like the crusty bits?
Harry	Cos the crust is actually very hard to eat isn't it? (It's) so hard and tough.
	[tʰ əs ə ˈtwʌs ɪs ˈæsli vei ˈhɑd t"u ˈit ɪdn, ɪʔ͡ səʊ ˈhɑd ən ˈtʰʌ..s]
J	You like it?
Harry	Yes I (noise) And I like it with marmite on
	[ˈjɛs aɪ {CV} ə~n aɪ ˈlaɪʔ ɪʔ wɪz ˈmãɪmaɪt ɒ~n]

Appendix 5.7 Harry CS 3, T1, Funeral

Harry	Oh there's a funeral in the church isn't there?
	[əʊ ˈjɛs ə ˈfʉ̃nəbəl ɪ˜n ə ˈtʰ ɑts ɪ˜n, jɛ˜ə]
J	Yes
Harry	How do you think he died or...
	[ˈhɑʊ dʊ̃ jʊ̃ ˈfɪŋki ˈd_aɪd (.) ɒ˜ʔ]
J	Maybe he was old
Harry	Mm-that's-or maybe he had a heart attack
	[m dæʔs ɔɪ ˈme˜ɪbi (i) jæd ə ˈhɑʔ ˈtʰ æk]
J	Maybe, maybe
Harry	Or maybe got stabbed by a person
	[ɔ ˈme˜ɪbi dɒʔ ˈstæʔ baɪjə ˈpɑsə˜n]
J	Don't expect so
Harry	Or shot
	[ɔ ˈsɒtˈ]
J	It's most likely he was someone who was very old
Harry	Or had a heart attack 'cos they were too fat
	[ʔɔ ˈhæd ə ˈhɑʔ əˈtʰ æk səʊ ˈtʰ u ˈfætˈ]
J	Possibly

Appendix 5.8 Harry CS 4, T1, Goose feathers

Harry	Goose feather
	[ˈgus ˈfɛzə]
J	Could be a goose feather
Harry	And you know what?
	[æ˜n ju ˈnə˜ʊ͡ ˈwɒʔ]
J	What?
Harry	At the river we found-us found about eighty five goose feathers been washed up
	[ˈæʔ d̥ə ˈwɪz.ə wi faʊ˜ ʌs ˈfaʊ˜n (.) əʔbaʊʔ ˈɛɪti ˈfaɪz ˈgus ˈfɛzəz bĩn ˈwɒst ʌpʾ]
J	Did you? mmm
Harry	There was quite a lot
	[ʔɛəwəz̥ ˈtʰ aɪʔə ˈ↓ lɒ. ↑ɒtʾ]
Harry	Yeh. I saw one of them was cleaning his (bot)
	[jɛʔ aɪ ˈsɔ wɑzə˜m wəz ˈkʰ ĩnɪ hɪz ˈbɒt]
Harry	And a couple of goose feathers came up and then a big wave came and washed it up
	[æ˜nn̥̊ (.) ˈt̥ʌpəz ˈdus ˈfɛzəz ˈtʰeɪ˜m ʌp˞ ə˜nʊ˜ə ˈbɪʔ ˈweɪ ˈkʰɛ˜ːm ə˜n ˈwɒst ɪʔ ˈʌpʾ]
Harry	And (XX) I tell you how the wa(ve)-how the big wave comed?
	[ə˜n tʰ ɛʊz æz ˈtɛ jə ˈhɑʊ ə wɛ˘ ˈhɑʊʔ (.) ðə ˈbɪʔ ˈweɪz. ˈkʰʌ˜md.]'
Harry	It was a boat and the – and the um goose got hit and know what? She took off immediately and landed on sss
	[ɪʔ wɒz. ə ˈbəʊʔ ə˜n ðə ə˜n ðə ʌ˜m ə ˈgus dɒʔ ˈhɪtʾ ə˜n ˈnə˜ʊ wɒʔ ə ˈsi ˈtʰʊk̟ ɒs ɪ˜ˈmid̥əʔli æ˜n ˈlɑi ʔɒ˜nə˜sː]
J	She was alright was she?
Harry	Yeh and landed on the boat's top and decided to peck it and then they shooed it away
	[jɛ æ˜n ˈlæ˜ndɪʔ ɒ˜n (.) ðə ˈbəʊʔsː (.) tʰɒp˞ ən ʔisaɪʔ t̟ˈu ˈpɛk̟ ɪt̥ ə˜n i ˈsud ɪʔ əˈweɪ]

Appendix 5.9 Harry CS 5, T1, Halloween

Harry	I went out. We went all the way round the village um and then we actually went to..
	[aɪ ˈwɪ˜nt̬ ˈʔaʊt wɪ ˘͡ jɛ˜nʔ ɔlə˘ weɪ ˈwaʊ˜n ə ˈbɪlɪsː ʌ˜m æ˜n ˈnɛ˜n (.) wi ˈæʔsli ˈwɛ˜nʔ tʰ u..]
Harry	I live (*address*)
	[aɪ ˈlɪs] (*address*)
J	mmm
Harry	See but we didn't go to-well-we went to (*address*) first and then we went to (place name)
	[ˈsi bəʔ wi ˈdɪʔə˜ŋ ˈgəʊ tʰu wɛʊ wi ˈwɛ˜nt͡ tu (address) ˈfɑst æ˜n nɛ˜n wi ˈwɛ˜nt ˈɔːlə ˈwɛɪ tʰ u (place name)]
J	Hmm
Harry	And then we came all the way back
	[ə˜n ˈnɛ˜n wi ˈkʰeɪ˜m ˈɔlə ˈweɪ ˈbæk']
J	Right. So what did you do while you were in (place name)
Harry	Trick or treat
	[ˈtwɪʔ ɔ ˈtwit]
J	Ah so you and your sister-or was there a big group of you?
Harry	Big group
	[ˈbɪʔ ˈgwup']
J	And how do you know whose houses you can go to?
Harry	You just knock on doors that's got a big pumpkin. If you have a a decoration up then we knock on their door but if they don't we don't
	[du dʌ˘s ˈnɒʔ ɒ˜n ˈdɔs æs ˈgɒʔ ə ˈbɪʔ ˈpʰʌ˜nkɪ˜n ˈɪsu ˈhæs ə ə ˈdɛk▪ əweɪsə˜n ʌp ɛ˜m wi ˈnɒk ɒ˜n ɛə ˈdɔ bʌʔ ɪs eɪ ˈdəʊ˜nt̬ wi ˈdəʊ˜nt̬]
Harry	Apart from people who we know
	[ɪ˜mˈpɑʔ fɒ˜m ˈpʰipʊl hu ˈɯi ˈnə˜ʊ]
J	Ah right OK-so it's a kind of code
Harry	Yeh
J	A pumpkin means you can knock on the door
Harry	Yeh
J	And did you come back with a bag of treats?
Harry	A bo-no-a humongously big box of it all full up. Cos know those little pumpkin boxes?
	[ə ˈbɒʔ ˈnə˜ʊ ə ˈhũmʌ˜ːsli ˈbɪ˜ʔ (.) ˈbɒks əz ˈɪt ˈɔʊ fuwʌp' tʰəs ˈnə˜ʊ ləʊs ˈlɪʔəl ˈpʰʌ˜nkɪ˜n ˈbɒksɪz]
J	Mmm
Harry	Well that's what we had
	[wɛʃ wɒʔ ˈwi ˈhæt']
J	Mmm
Harry	And (shall I tell you) what? I filled my one-well I have-Mummy nearly-mummy bought a box in case I run out of room but I filled up that box
	[æ˜n dæde˜ɪ ˈwɒʔ ˈaɪ fɪld ˈmãɪ wʌ˜ʔ wɛl ˈaɪ haɪ ˈmʌ˜mi ˈnɪʔi ˈmʌ˜mi ˈbɔʔ ə ˈbɒks ɪ˜n tʰeɪs aɪ wɑ˜ʊs͡ ˈwʊ˜m bʌʔ aɪ ˈfɪld ˈʌp dæʔ ˈbɒks̬]
J	Oh my goodness. And what was your favourite that was in it?

Harry	A thousand chocolates put into one-that's-there was a chocolate (we tasted just one chocolate) then there's one-then there's one and then it goes back to normal and then there's another one and another one and then it goes back to normal like that
	[ə ˈfɑʊsə˜n ˈtʰɒkləts puʔ ˈɪ˜nd ˈwʌ˜n ðæʔs n̩ ne˜ɪ wɒzə ˈtʰɒkləʔ ɪ˜ tʰeɪsi ʌs̩ wʌ˜n ˈtʰɒkləʔ ˈd̪ɛd̪ɛz. ˈwʌ˜n ə˜ˈnɛz. ˈwʌ˜n ɛ˜jəʊz̩ bæʔ tʰə nɔ˜mə˜ʊ ə˜nɛ˜ d̪əʊz. (breath) əˈnʌ˜və̩ ˈwʌ˜n əˈnʌz̩ə ˈwʌ˜n (XˈXX) tʰə ˈmɔ˜mʊ˜ laɪʔ ðæt']
J	So it was a good evening's work?
Harry	Yep. And at at home I didn't even eat any
	[ˈjɛp' æʔjə ˈʔæʔ ˈæt ˈhəʊ˜m aɪ ˈjɪ˜jɪ˜n ˈit ɛ˜ni]
J	Didn't you?
Harry	No, until now
	[ˈnə˜ʊ ə˜ntʊ ˈnɑʊ]
J	Oh, right
Harry	And this morning I ate sweeties for breakfast. I ate nearly all of them
	[ə˜ntʊ æ˜n zɪs ˈmɔ˜nɪ˜ aɪ eɪʔ ˈsfiʔis fɔ ˈbɛʔkəs aɪ niː ˈeɪʔ ɔˈzɛ˜m]
J	Do I believe you? Mmm not sure if I believe that story about having all your sweeties for breakfast
Harry	Why?
	[ˈwaiː]
J	I think you might be teasing]
Harry	Good one!
	[ˈgʊʔ wʌ˜n]

Appendix 5.10 Harry CS 6, T1, Spiders

Harry	Mummy's frightened of spiders
	[ˈmʌ˜mɪs ˈfaɪʔn ə˜ ˈspaɪdəs]
J	Are you?
Harry	No mummy is
	[nə˜ʊ ˈmʌ˜mɪ ˈɪs]
J	Oh mummy is. What does she do?
Harry	She steps on them and kill them
	[si ˈsɛps̩ɒ˜n ɛ˜m ən ˈkʰ ɪʊ ð̩ɛ˜m]
J	Oh poor spiders
Harry	I know. Once there was a humungous one and daddy took it out of the house (.....) and it came back into (the) house and mummy stepped on it
	[ʌ ˈnə˜ʊ wə˜səs huˈmʌ˜ŋgəs ˈwʌ˜n ə˜n ˈd̩æd̩i ˈtʰʊ˘ ɪʔ ɑʊzə ˈhaʊs (xxxxxx) ɪʔ ˈkʰeɪ˜m ˈbæ˘ ɪ˜ntu ˈhaʊs ə˜n ˈmʌ˜mɪ˜ ˈstɛpt ɒ˜n ɪt]
J	Oh dear. Poor spider.
Harry	Yeh.
J	They can be quite helpful to us I think 'cos they eat flies.
Harry	Yes (...) he eats flies-they will take over the planet but (?so as) spiders as uh-eventually spiders will eventually take over the planet
	[ˈjɛ (XXX) ɪ ˈʔits ˈfaɪs ðeɪ wə˘ ˈtʰɛəzəʊʔ də ˈpʰæ˜nɪ˜t' bəʔ səʊ˘ʷ æ ˈspaɪdəs ə əˈbɛ˜ntəli ˈspaɪ˘d̩əs wu əˈbɛ˜ntəli ˈtʰeɪʔ əʊvə ə ˈpʰænɪ˜t]
J	Will they?
Harry	Yeh
J	And why do you think that?
Harry	'Cos- I- know one spider yeah (...) well but (...) lay two million eggs in one egg sac and if they're really lucky they might (make) a make two egg suc-sacs- and that's a lot of spiders
	[tʰəs ɪ˘ʔ ˈnə˜ʊ wʌ˜n ˈspaɪdə jɛ (XX. XXX. X˷) ˈleɪ (.) ˈtʰu ˈmɪ˜jə˜n ˈæxs ɪ˜ ˈwʌ˜n ˈɛk ˈsæʔ æ˜n ɪs ə wiː ˈlʌʔi ɛɪ mãɪ me˜ɪ (ə) me˜ɪʔ ˈtʰu ɛʔ ˈsʌkː' ˈsæks n ˈæts ə ˈlɒʔ ə ˈsp˘aɪdəs]

Appendix 5.11 Harry, T1, Examples of imitated sentences (CSP task)

Target and response	
	I gave the elephant a ˈ banana
	[aɪ ˈgeɪ ˘s ə˜n bə. ˈnɛ˜ləbə˜n?jə? ə (.) bə˜ˈnɑ˜nə]
	John collects ˈ stamps
	[ˈgɒ˜n təˈlɛts ˈsæ˜?nts]
	Sam loved to ˈ dance
	1. [ˈsæ˜m lʌ˜ lɑ˜?n lɑ˜ns ˈlʌns tə ˈdɑ˜ns] 2. [ˈsæ˜m lʌf ˈdʌ˜ns]

Appendix 5.12 Harry, T1 and T2 Intelligibility stimuli

Single words

Word	Adult target	**Harry's realisation T1**	Number of words identified by individual listeners T1	**Harry's realisation T2**	Number of words identified by individual listeners T2
BOOK	/bʊk/	[bʊk']	66/66	[bʊk']	53/66
CHAIR	/ʧɛə/	[tɛə]	30/66	[ʧɛə]	66/66
CRAB	/kræb/	[t̪wæp']	17/66	[kwæp']	21/66
GLOVE	/glʌv/	[gəlʌp]	0/66	[glʌv̩.s]	61/66
LEGS	/lɛgz/	[lɛks]	83/132*	[lɛks̪]	44/132*
LIGHTHOUSE	/ˈlaɪthaʊs/	[ˈlaɪt̪haʊs]	61/66	[ˈlaɪʔhaʊs]	52/66
ORANGE	/ˈɒrɪ˜nʤ/	[ˈɒwɪs]	63/66	[ˈɒwɪ˜nz̩.]	34/66
SPLASH	/splæʃ/	[sp˘æs]	28/66	[splæs]	66/66
THANKYOU	/ˈθæ˜ŋkju/	[ˈfæ˜˷ŋku]	66/66	[ˈfæ˜ŋkju:]	23/66
WATCH	/wɒʧ/	[wɒts]	20/66	[wɒʔt̪s:]	28/66

*Score 1 for lexical item and 1 for plural morpheme

Imitated sentences (from CSP task)

Target sentence	**Harry's realisation T1**	Percentage of words recognised by individual listeners T1	**Harry's realisation T2**	Percentage of words recognised by individual listeners T2
GOOD GIRLS ARE NICE	[ˈgʊʔ dɛ˘ʊz̩. ə ˈnaɪs]	50.61%	[ˈgʊʔ gʊz ɑ ˈnaɪs:]	66.36%
(THE) BROWN BEAR EATS FISH	[ðə ˈbaʊ˜n bɛ ˈʔits ə ˈfɪs:]	61.42%	[ˈbɑʊ˜m ˈbwɑʊ˜: ˈwɛə ʔits ˈfɪs]	30.30%
CLAIRE ATE ALL HER LUNCH	[ˈklɛ:əʔ ɛʔ ˈɔ hə ˈlʌ˜nts]	94.19%	[ˈklɛə: ɔʊ hə ˈlʌ˜nts:]	74.24%
SHE GAVE (THE) ORANGE TO SAM	[si ˈdeɪz̩. ə ˈʔɒwɪ˜ns d̩.ə ˈsæ˜m]	32.83%	[si ˈgeɪv ˈnɒwɪ˜n ˈtʰ u ˈsæ˜m]	40.66%
MARY'S SHOES ARE CLEAN	[ˈmɛwiz̩. ˆˈsuz ɑ ˈklĭn]	79.29%	[ˈmɛwiʃ ˆˈʃuz ə ˈklĭn]	94.95%

Conversational speech

Target sentence	T1 or T2	Harry's realisation	Percentage of words identified by individual listeners
'COS THEY'RE SHARP	T1	[ˈtʰ ɒs ɛə ˈsɑpʾ]	15.15%
GOT TO BE CAREFUL OF SCISSORS DON'T YOU	T1	[dədə̩ bi ˈtʰɛəfʊː ˈsɪz.əz. ˈdəʊ˜ nju]	67.42%
HOW DO YOU THINK HE DIED?	T1	[ˈhɑʊ d̪ʊ̆ jʊ̆ ˈfɪŋki ˈd_aɪd]	82.58%
OR MAYBE HE HAD (A) HEART ATTACK	T1	[ɔɪ ˈme˜ɪbi (i) jæd ə ˈhɑʔ ˈtæk]	66.16%
OH THERE'S (A) FUNERAL IN (THE) CHURCH ISN'T THERE?	T1	[əʊ ˈjɛs ə ˈfʉ̃nəbəl ɪ˜n ə ˈtɑts ɪ˜n. jɛ˜ə]	29.92%
SO ALL TOGETHER IN (THE) WHOLE FAMILY THERE'LL BE 5 CHILDREN	T2	[səʊ ˈɔʊ təˈgɛvəʷ ɪ˜n ə ˈhəʊl ˈfæ˜mli əɬ bi ˈfaɪv. ˈʧɪʊdɹə˜n]	98.76%
WELL IT WAS LIKE-ALWAYS MIDNIGHT	T2	[ˈwɛʊ ɪʔ wəɻ ˈlaɪʔ ɔˈweɪ˜ ˈmɪʔnɑ̃ɪʔ]	41.16%
WELL THEY BASICALLY HAD (A) SPARE ONE THAT THEY BROUGHT FROM THEIR BOAT	T2	[ˈwɛʊ ðeɪ ˈbeɪsɪʔi hætʾ ə ˈspɛə wʌ˜n ðæʔ ðeɪ ˈbɹɔʔ fwə˜˘m ðɛə ˈbəʊtʾ]	86.49%
WELL, (A)BOUT 3 HOURS JOURNEY TO IT	T2	[wəʊ (.) ˈbaʊʔ ˈfwiʲ ɑʊz. ˈʤɜni tuʷ ˈɪʔ]	79.65%
YEAH AND THEY GOT TWO-THREE CHILDREN	T2	[ˈjɛ æ˜n eɪ ˈgɒʔ ˈt̪u ˈfʊi ˈʧɪʊdɹə˜n]	98.27%

KEY
Standardised scores (*norms at age 7;0)
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

Appendix 5.13 Harry: Speech Processing Profile T2 (age 8;5)

INPUT

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset
⇔Silent sorting CVC words by coda

E Are the child's phonological representations accurate
⇓ALD words in sentences, SIWI consonant clusters
⇔Syllable/word/rhyme/identification

D Can the child discriminate between real words?
⇔Rhyme detection
✓ *B&S real words: z=-0.86

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
✓ *B&S non-words: z=-0.8
✓ Complex non-words: z=-0.42

A Does the child have adequate auditory perception?
⇔No concerns

OUTPUT

G Can the child access accurate motor programmes?
XXX*Naming 1 syllable words: z=-5.66
XXX*Naming 2 syllable words: z=-5.03
XXX*Naming 3/4 syllable words: z=-3.84
XXX*Naming total: z=-5.64

H Can the child manipulate phonological units?
⇓Rhyme generation
⇔Segmentation of multisyllabic words into syllables
⇓Segmentation of CVC words

I Can the child articulate real words accurately?
⇔Blending of C-V-C into words
⇔Blending of C-C-V-C into words

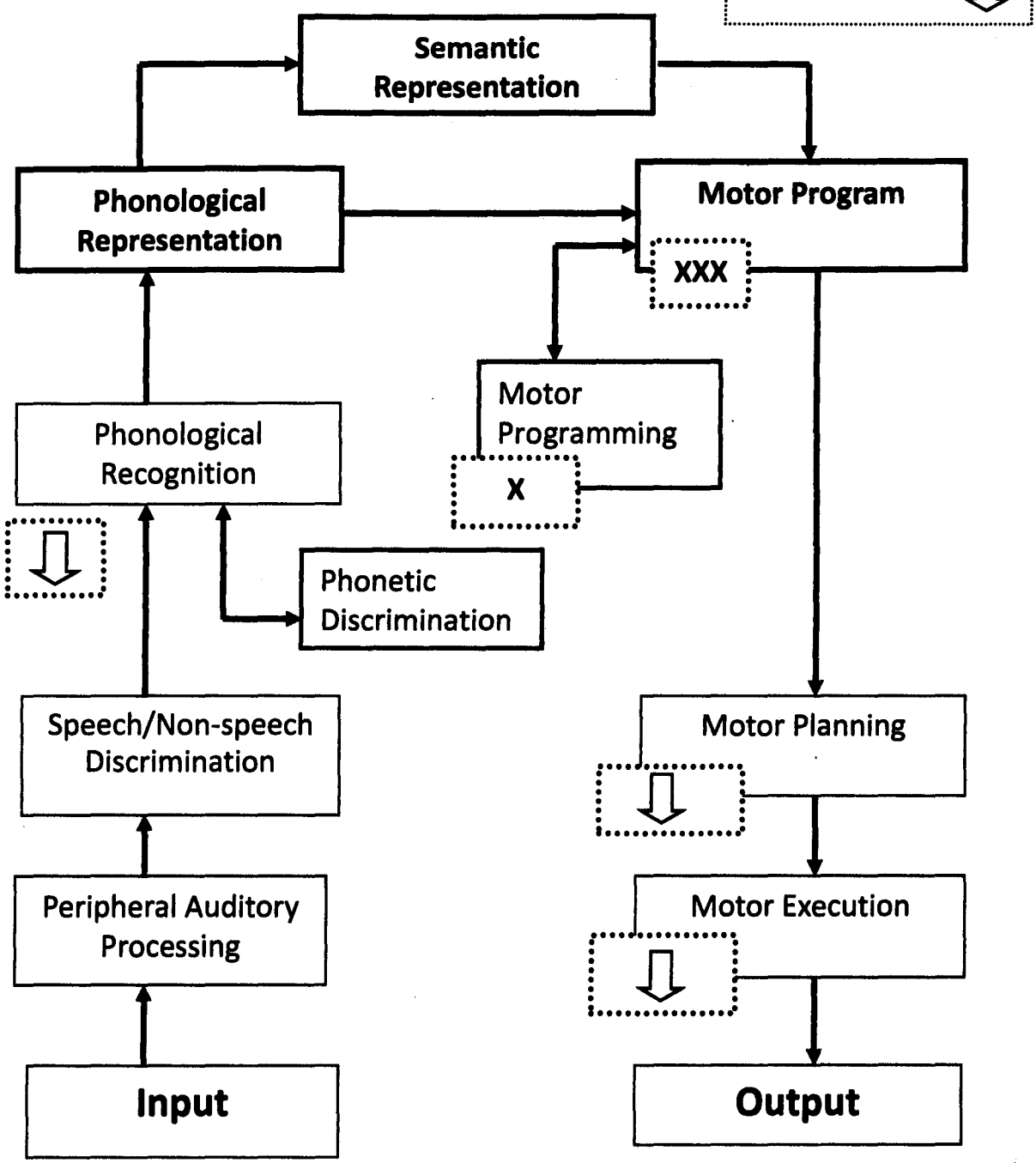
J Can the child articulate speech sounds without reference to lexical representations?
Non-word repetition:
✓ *1 syllable items z=-0.02
✓ *2 syllable items: z=-1.02
X*3/4 syllable items: z=-2.06
✓ *Total: z=-1.46

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇓ Oro-motor skills

L Does the child reject his/her own erroneous forms? Yes with occasional prompts

Appendix 5.14 Harry: Speech Processing Model T2

(Stackhouse & Wells, 1997):
Harry suggested areas of difficulty, T2



Appendix 5.15 Harry CS, T2, Sweden

J	Tell me about Sweden
Harry	(Noise) well it was a bit ho- ho- hot
	[(ɑːə) wʌʊ çi jɔ çəʔs ə ˈbɪʔ ˈhɒ ˈhɒ ˈhɒʔ]
J	Hot? I always think Sweden would be cold
H	Well it isn't-it's midsummer when we get there
	[ˈwɛʔh jɪʔ ˈɪz̩.n̩.ʔ ɪts ˈmɪ˜ʔsʌ˜mə ˈwɛ˜m wi ˈgɒʔ ðæ]
J	Was it
Harry	Yeh-I was sweating buckets
	[ˈjɛ ʔɒs͡ sfɪ˜ŋ ˈbʌgɪt̪s]
J	You were sweating buckets?
Harry	Yeh
J	Really
Harry	Yeh
J	Yeh-OK-so tell me about it-were-was –were the days long-much longer days than here-the sunlight-more sunlight
Harry	No-yeh
J	So it was light right the way into the evening was it?
Harry	Well it was like always midnight
	[ˈwɛʊ ɪʔ wəɻ ˈlaɪʔ ɔˈweɪ ˈmɪʔnãɪʔ]
J	Was it?
Harry	Yeh-(laugh) and I always stayed up all the way to midnight
	[ˈjɛ̰ (laugh) ɑˈwəs͡ ˈseɪd ʌp˞ ˈɔʊ ə ˈweɪ t̪ ˈmɪʔnãɪʔ]
J	Really?
Harry	Yes
J	Gosh-ok-and you went to see-is it you mum's brother?
Harry	Yeh-and they got two-three children so all together in the whole family there'll be five children
	[ˈjɛ æ˜n eɪ ˈgɒʔ ˈt̪u ˈfʊi ˈʧɪʊdɪə˜n səʊ ˈɔʊ təˈgɛvəʷ ɪ˜n ə ˈhəʊl ˈfæ˜mli əɬ bi ˈfaɪv̩. ˈʧɪʊdɪə˜n]
J	Right
Harry	S and D, C and R, and the most handsomest boy (Harry)
	[(S, D, C, R) æ˜n ðə ˈmə˜ʊs ˈhæ˜msəd̪ɪv ˈbɔɪ (H)]
J	OK. So did they live in Stockholm?
Harry	Stockholm?
	[ˈstɒkhəʊ˜m]
J	That's the capital city of Sweden. Did they live there?
Harry	Um-yeh-well-half in it, half not
	[m͡ ˈjɛ̰ wɛʊ ˈhɑf ɪ˜n ɪʔ n̩ ˈhɑf ˈnɒ˜ʔ]
J	Right
Harry	It was-well- about three hours journey to it
	[ɪ ͡ˈwəz (.) wəʊ (.) ˈbaʊʔ ˈfwiʲ ɑʊz̩. ˈʤɜni tuʷ ˈɪʔ]
J	Was it-from the airport?
Harry	No-to Stockholm
	[ˈnəʊ tə ˈstɒkhəʊ˜m]
J	To Stockholm-OK, OK. So what sort of house do they live in? Is it like your house-an English house?
Harry	Nope-it's a caravan

	[ˈnəʊpʼ ɪt̪s ə ˈkʰæːˆəbæ˜̪n]
J	Is it-OK-how did you all fit it?
Harry	Yeh-it sort of XXXXx - they have one humungous one and one little one for S & D
	[ˈjɛ ɪʔ ˈsɔʔ əv̪ (XX X X X) d̪ɪ˜ʲ ɛ̪fː ˈwʌ˜n huˈmʌ˜ŋgəs ˈwʌ˜n n̪ wʌ˜n ˈlɪʔtəʊ̪ ˈwʌ˜n fʰɔ˜ (S) n̪ (D)]
J	Right
Harry	And that's rather messy so (xxx) sort (xxxxx) it very well
	[{V̪ æ˜n ˈðæts wɑvə ˈmɛsi (X XX) wi (X XX X X) ɪʔ ˈwɛwi ˈwɛʊ V̪}]
J	OK
Harry	And then we have a big one for mum-well-they basically had a spare one that they brought from their boat
	[æ˜n ˈðɛ˜n wiʲ æv ə ˈbɪg̊ ˈwʌ˜n fə˜ ˈmʌ˜m̪ (.) ˈwɛʊ ðeɪ ˈbeɪsɪʔi hæt' ə ˈspɛə wʌ˜n ðæʔ ðeɪ ˈbɹɔʔ fwə˜˜m ðɛ̪ə ˈbəʊt']
J	Right
Harry	Yeh - they got a big motor boat that's-no- this is me-driving (driving noise)
	[jɛʲ eɪ ˈgɒʔ ə ˈbɪg̊ ˈmə˜ʊtə ˈbəʊk æts . nəʊ ðɪs ɪz̪ ˈmi (.) ˈdɹaɪvə˜n (noise)]
J	So did you go on the boat?
Harry	Yeh
J	Yeh
Harry	Yeh-I -how I've made a tidal wave behind me – (xx) like this-that's how-from the floor to here that's how high the waves were behind me
	[jɛ (.) aɪ˜n (.) ˈhaʊʷ aɪ(v̪.) ˈmeɪʔ ə ˈtaɪʔt̪ə ˈweɪ baɪ˜mˆ ˈmɪ̃ (XXX) (ð)ɪs ðæts ˈhaʊ (.) fɒ˜m ə ˈfɔ tə ˈhɪə ðæts ˈhɑʊ ˈhaɪ ðə ˈweɪz̪ wə bə˜˜ˈhaɪ˜m mi]

Appendix 6.1 Lily: Results of standardised language assessment T1, CA 7;4 CELF-4 UK

Subtest	Scaled score	Percentile rank
Receptive language		
Concepts & Following Directions	10	50
Word Classes-Receptive	13	84
Sentence Structure	12	75
Understanding Spoken Paragraphs	11	63
Expressive language		
Word structure	2	0.4
Recalling Sentences	4	2
Formulated Sentences	6	9
Word Classes- Expressive	15	95
Expressive Vocabulary	7	16
Working memory		
Number Repetition- Forwards	4	2
Number Repetition-Backwards	7	16
Number Repetition-Total	4	2
Composite scores		
Core Language	73	4
Receptive Language	110	75
Expressive Language	63	1
Language Content	102	55
Language Structure	76	5

Appendix 6.2 Speech Processing Profile: Lily (7;2) T1

KEY
Standardised scores
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

INPUT

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset

E Are the child's phonological representations accurate
✓ ALD (no picture), real words: z=0.31
✓ 1 syllable items: z=2.93
✓ 2 syllable items: z=-0.71
X 3/4 syllable items: z=-1.74

D Can the child discriminate between real words?
X B&S real words: z=-2.2

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
XXX B&S non-words: z=-7.72
XXX Complex non-words-same: z=-9.98
✓ Complex non-words- diff: z=0.073

A Does the child have adequate auditory perception?
✓ No concerns

OUTPUT

G Can the child access accurate motor programmes?
XXX Naming 1 syllable words: z=-12.33
XXX Naming 2 syllable words: z=-12.07
XXX Naming 3/4 syllable words: z=-7.27
XXX Naming total: z=-12.01

H Can the child manipulate phonological units?
⇓Rhyme generation
⇔Segmentation of multisyllabic words into syllables
⇓Segmentation of CVC, CCVC words
⇓phoneme, deletion, transposition

I Can the child articulate real words accurately?
Real word repetition
XXX 1 syllable items z=-14.12
XXX 2 syllable items: z=-9.62
XXX 3/4 syllable items: z=-15.12
XXX Total: z=-14.05

J Can the child articulate speech sounds without reference to lexical representations?
Non-word repetition:
XXX 1 syllable items z=-5.87
XXX 2 syllable items: z=-7.34
XXX 3/4 syllable items: z=-6.35
XXX Total: z=-8.33

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇓Oro-motor skills

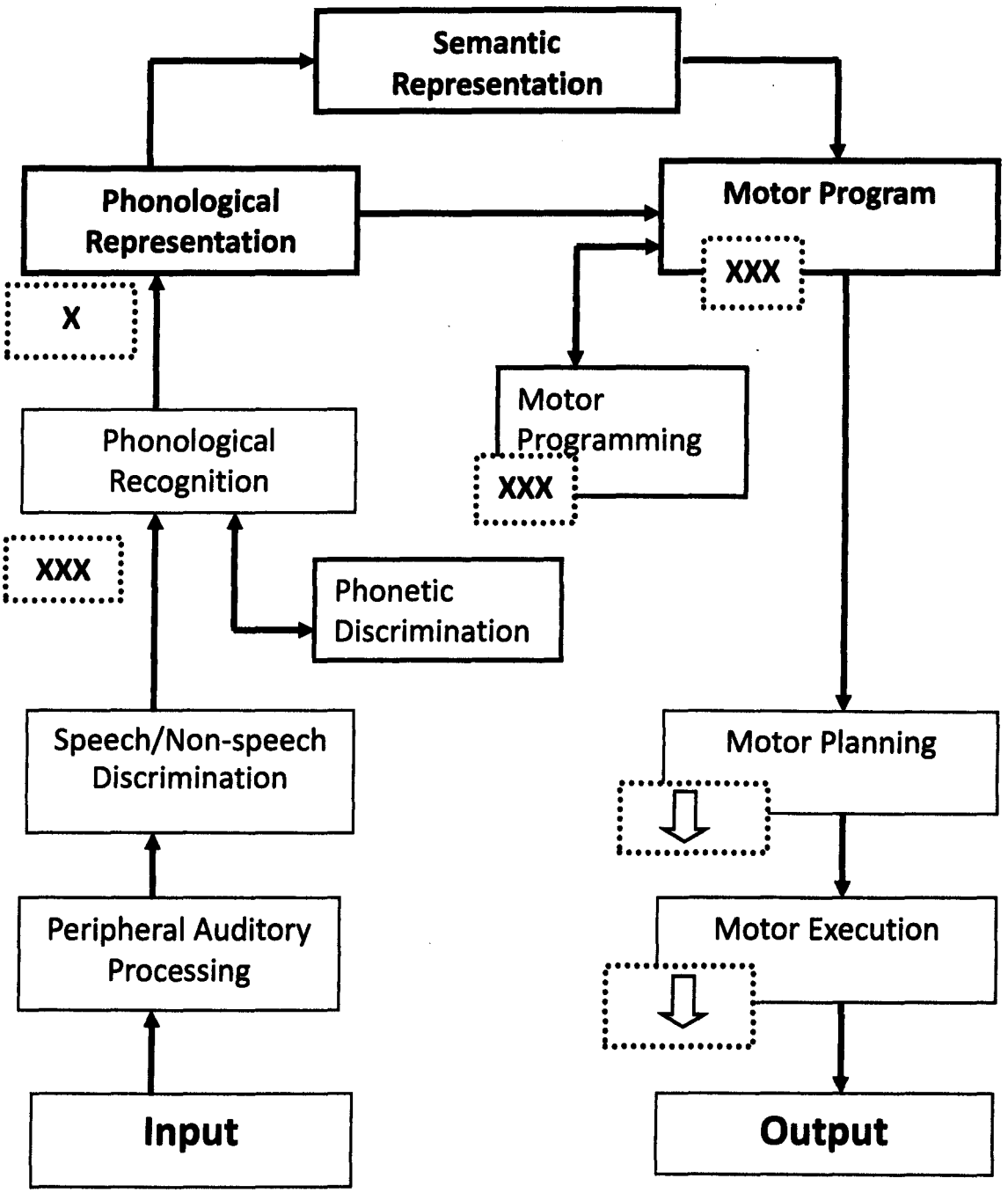
L Does the child reject his/her own erroneous forms? Occasionally

Appendix 6.3 Lily: Speech Processing Model T1

Speech Processing Model
(Stackhouse & Wells, 1997):
Lily suggested areas of difficulty, T1

KEY
Level of difficulty hypothesized from normed tasks
X or XX or XXX

Presence of difficulty hypothesised from weak/poor performance on informal tasks



Appendix 6.4 Lily: Single word naming T1 (7;2) and T2 (8;11)

(taken from DEAP Phonology, DEAP Articulation and Stackhouse & Wells Naming Task)

	Word	Adult realisation	C score	V score	Lily's realisation (T1 7;2)	C score	V score	Lily's realisation (T2 8;11)	C score	V score
1	aeroplane	/ˈɛərəpleɪn/	4	3	[ˈʔɛəwəp̼ eɪ˜n]	2	3	[ˈʔɛəɹəp˘leɪ˜n]	4	3
2	apple	/ˈæpəl/	2	2	[ˈʔæpəʊ]	2	2	[ˈʔæpʊw]	2	2
3	bird	/bɜd/	2	1	[bɜːd̩]	2	1	[bɜ̠d̩ː]	2	1
4	biscuits	/ˈbɪskɪts/	5	2	[ˈbɪʔkɪ̠ʔ]	2	2	[ˈbɪʔsgːɪtːs]	5	2
5	book	/bʊk/	2	1	[bʊkː']	2	1	[bʊkː']	2	1
6	boy	/bɔɪ/	1	1	[bɔɪ]	1	1	[bɔɪ]	1	1
7	bread	/brɛd/	3	1	[pʰɛ̠ɬ]	0	1	[bːɹɛd̩']	3	1
8	butterfly	/ˈbʌtəflaɪ/	4	3	[ˈbʌʔəvaɪ̠]	2	3	[ˈbʌtəflaɪ̠]	4	3
9	car	/kɑ/	1	1	[kʰɑ̠]ː	1	1	[kʰ ɑ]	1	1
10	caravan	/ˈkærəvæn/	4	3	[ˈtʰ æwəwæ̠˜nt]	1	3	[ˈkʰæɹəˈvæ˜n]	4	3
11	cat	/kæt/	2	1	[kʰæt]	2	1	[kʰ æt]	2	1
12	caterpillar	/ˈkætəpɪlə/	4	4	[ˈdæʔəp̼ ɪlə̠]	3	4	[ˈkʰætəpʰɪlə̠]	4	4
13	chair	/ʧɛə/	1	1	[tʰ ɛə̠ː]	0	1	[ʧɛə̠]	1	1
14	computer	/kəmˈpjutə/	5	3	[ˈbuʔə̠]	1	2	[ˈkʰɒ˜mp(.)ˈbutə̠̠]	4	2
15	crab	/kræb/	3	1	[dæb̩]	1	1	[kːɹæb̩']	3	1
16	crocodile	/ˈkrɒkədaɪl/	5	3	[ˈdʌʔədaɪjəʊ̩h]	1	2	[kʰʊkʰədaʊ̠]	3	2
17	dinosaur	/ˈdaɪnəsɔ/	3	3	[ˈdaɪ˜nəʔɔ̠ː]	2	3	[ˈdaɪ˜nəsɔ]	3	3
18	door	/dɔ/	1	1	[d̩ɔ̠]	1	1	[dɔ̠]	1	1
19	duck	/dʌk/	2	1	[d̩ʌ̩k̩']	2	1	[dʌkː']	2	1
20	dustbin	/ˈdʌsbɪn/	4	2	[ˈdʌʔ̩bɪ˜n]	3	2	[ˈdʌsb̩ɪ˜n]	4	2
21	ear	/ɪə/	0	1	[ʔɪə]	0	1	[ʔɪːə̠]	0	1
22	egg	/ɛg/	1	1	[ɛ̠g̼]	1	1	[ʔɛg̼]	1	1
23	elephant	/ˈɛləfənt/	4	3	[ˈʔɛləfːə̠˜nʔ]	4	3	[ˈʔɛləfːə˜nt']	4	3
24	feather	/ˈfɛðə/	2	2	[ˈf˘æbɑː]	1	0	[ˈfːɛvɑ˘]	1	1
25	fish	/fɪʃ/	2	1	[fɪ]	1	1	[fɪʔʃ]	2	1

26	fishing	/ˈfɪʃɪŋ/	3	2	[ˈfɪhʔhɪ˜n]	1	2	[ˈfːɪʔʃɪ˜ŋkʼ]	2	2
27	five	/faɪv/	2	1	[faɪ̯ːpˀ]	1	1	[fʼa̯ɪv]	2	1
28	flower	/ˈflaʊwə/	3	2	[ˈfːaʊ̯wə̯]	2	2	[ˈfːlaʊ̯wə̯]	3	2
29	foot	/fut/	2	1	[fːuʔ]	2	1	[fːʊʔtʼ]	2	1
30	frog	/frɒg/	3	1	[fːɒgˀ]	2	1	[fːɹɒgˀ]	3	1
31	giraffe	/ʤəˈrɑf/	3	2	[dɑːf]	1	1	[ʤəˈɹɑ̯f]	3	2
32	girl	/gɜl/	2	1	[dɛʊ]	1	1	[gɛɱ]	2	1
33	glove	/glʌv/	3	1	[dˌʌbˌːˉtʰ]	0	1	[gəlʌv]	3	1
34	gloves	/glʌvz/	4	1	[dʌbːth]	0	1	[gːlʌʔvzˌ]	4	1
35	guitar	/gəˈtɑ/	2	2	[dɑ̯]	0	1	[tʰɑ̯]	1	1
36	hairbrush (T2: brush)	/ˈhɛəbrʌʃ/ /brʌʃ/	4 (3)	2 (1)	[ˈʔɛəbːʌʔ]	1	2	[bːɹʌʔʃ]	3	1
37	hairdresser	/ˈhɛədrɛsə/	4	3	[ˈʔɛədˌɛʔʌ̯ːˈ]	1	3	[ˈhɛə̯drɛsə̯]	4	3
38	hamburger	/ˈhæmbɜgə/	4	3	[ˈʔæˌ˜mbɜdˌə]	2	3	[ˈhæ˜mbɜgə]	4	3
39	helicopter	/hɛləˈkɒptə/	5	4	[ʔɛləˈdɒʔdɑːˈ]	2	3	[hɛlɪˈkɒp̚tə̯̈]	5	4
40	hospital	/ˈhɒspɪtəl/	5	3	[ˈʔɒʔəʔbˌʊʊ]	1	3	[ˈhɒʔpɪtəʊ]	4	3
41	house	/haʊs/	2	1	[haʊːptʰ]	1	1	[haʊʔsʼ]	2	1
42	jam	/ʤæm/	2	1	[dæːm]	1	1	[ʤæ˜mh]	2	1
43	jelly	/ˈʤɛli/	2	2	[ˈdɛli]	1	2	[ˈʤɛli]	2	2
44	kangaroo	/ˈkæŋgəru/	4	3	[ˈbɛ˜nəwul]	0	2	[kʰæ˜ŋgəɹu]	4	3
45	kitchen	/ˈkɪʧɪn/	3	2	[ˈkʰɪˌdɪ˜n]	2	2	[ˈkɪʔʧɪ˜n]	3	2
46	kitchen	/ˈkɪʧɪn/	3	2	[ˈtʰɪʔtʼɪ˜n]	1	2	[ˈkʰ ɪʔʧɪ˜n]	3	2
47	knife	/naɪf/	2	1	[nːãɪfʰ ːˈ]	2	1	[nãɪ̯fːˈ]	2	1
48	ladder	/ˈlædə/	2	2	[ˈlæˌdə̯]	2	2	[ˈlædə̯̈]	2	2
49	leaf	/lif/	2	1	[liʔfˉ]	2	1	[lʼif]	2	1
50	legs	/lɛgz/	3	1	[lɛg̊tsˌ]	2	1	[lɛg̊sːˈ]	3	1
51	lighthouse	/ˈlaɪthaʊs/	4	2	[ˈlaɪʔhaʊ̯ᴍ]	3	2	[ˈlaɪthaʊs]	4	2
52	money	/ˈmʌni/	2	2	[ˈmʌ˜ni]	2	2	[ˈmʌ˜niˌ̯]	2	2
53	monkey	/ˈmʌŋki/	3	2	[ˈmʌ˜ŋːkʼ i]	3	2	[ˈmʌ˜ŋki]	3	2
54	moon	/mun/	2	1	[muˌ˜iəːn]	2	0	[mûǂ]	1	1

55	mouse	/maʊs/	2	1	[maʊ̯ˑʔ]	1	1	[maʊʔʃ]	1	1
56	orange	/ɒˈrɪnʤ/	4	2	[ˈʔɒwɪ˜nː]	1	2	[ʔɒˈɹɪ˜nʤ]	4	2
57	parachute	/ˈpʰ ærəʃut/	4	3	[ˈpʷ æwəʔuˑʔ]	2	3	[ˈpʰæˑrəʃut']	4	3
58	parrot	/ˈpærət/	3	2	[ˈɸ̆æwəˑʔ]	1	2	[pʰ æɹət]	3	2
59	pig	/pɪg/	2	1	[bikˀ]	0	0	[pʰɪgˑ̆ː]	2	1
60	pig	/pɪg/	2	1	[bɪgʷ]	0	1	[pʰɪgʷ]	2	1
61	plate	/pleɪt/	3	1	[bẹɪˑʔ]	1	1	[pleɪt']	3	1
62	pram	/præm/	3	1	[pʷ æˑ˜n]	1	1	[pʰɹæ˜ːm]	3	1
63	pyjamas	/pəˈʤɑməz/	4	3	[ˈʔədɑ˜məˀ˜ʔsˌ]	1	3	[pəˈʤɑ˜ˑmə˜z˳]	4	3
64	queen	/kwin/	3	1	[dĭn]	1	1	[kːwĭn]	3	1
65	rabbit	/ˈræbɪt/	3	2	[ˈwæbɪtˌ]	2	2	[ˈɹːæbɪʔˀ]	3	2
66	ring	/rɪŋ/	2	1	[wɪ˜ŋː]	1	1	[ɹːɪŋk]	1	1
67	roof	/ruf/	2	1	[ʊu]	0	1	[ɹuf]	2	1
68	roundabout	/ˈrəʊndəbaʊt/	5	3	[ˈwəʊ˜ndə˜baʊ˜ˑʔ]	4	3	[ˈɹəʊ˜ndəbaʊtˀ]	5	3
69	sandwich	/ˈsæmwɪʤ/	4	2	[ˈʔæ˜mwɪd˳]	2	2	[ˈsːæ˜mwɪʤ]	4	2
70	sausage	/ˈsɒsɪʤ/	3	2	[ˈʔɒʔhɪdzˑ˳]	0	2	[ˈsːɒsɪʤ]	3	2
71	school	/skul/	3	1	[d˳əɯ]	0	0	[sˌkˑul]	3	1
72	scissors	/ˈsɪzəz/	3	2	[ˈʔɪʔd˳əd˳]	0	2	[ˈsɪdəd˳s]	1	2
73	scooter	/ˈskutə/	3	2	[ˈduʔhʌˑˑː]	0	2	[ˈsːkutəˑ˳]	3	2
74	seesaw	/ˈsisɔ/	2	2	[ˈʔiʔɔ]	0	2	[ˈsiʃɔ]	1	2
75	sheep	/ʃip/	2	1	[ʔipˀ]	1	1	[ʃipːˀ]	2	1
76	slipper	/ˈslɪpə/	3	2	[ˈʔɪʔpʰɑˑˑː]	1	1	[ˈsːlɪp̆əˑ˳]	3	2
77	snake	/sneɪk/	3	1	[sne˜ɪkˀ]	3	1	[sne˜ɪkːˀ]	3	1
78	sock	/sɒk/	2	1	[sʲ ɒp]	1	1	[sːjɒʔ]	1	1
79	sock	/sɒk/	2	1	[sɒʔ]	1	1	[sˑˑɒʔʘ]	1	1
80	spaghetti	/spəˈgɛti/	4	3	[ˈtʰɛʔiˑ˳]	1	2	[skɛtˌi]	2	2
81	spider	/ˈspaɪdə/	3	2	[ˈbaɪd˳ə]	1	2	[ˈspaɪdəˑ˳]	3	2
82	splash	/splæʃ/	4	1	[bæç]	0	1	[sp̆læʃ]	4	1
83	sponge	/spʌnʤ/	4	1	[bʌ˜nːt]	1	1	[spʰʌ˜ntˌˀ]	3	1
84	square	/skwɛə/	3	1	[dɛəˑ˳]	0	1	[skwɛəˑ˳]	3	1

85	strawberry	/ˈstrɔbri/	5	2	[ˈtɔːbi]	2	2	[ˈstːɹɔ̟ˌbɹi]	5	2
86	swing	/swɪŋ/	3	1	[fːɪ˜ŋ]	1	1	[sˈwɪ˜ŋkʼ]	2	1
87	teeth	/ti θ /	2	1	[dif]	0	1	[tʰ ifː]	1	1
88	telephone	/ˈtɛləfəʊn/	4	3	[ˈtɛləfˇəʊ˜n]	4	3	[ˈtɛləfəˌʊ˜n]	4	3
89	television	/ˈtɛləˈvɪʒən/	5	4	[ˈdɛləˈvɪdə˜n]	3	4	[ˈtɛləvˌːɪʤə˜n]	4	4
90	thank you	/ˈ θ æŋkju/	4	2	[ˈmːɛnʔjuˌ]	1	2	[ˈfæ˜ŋːçju]	2	2
91	this (T2: that)	/ðɪs/	2	1	[dɪʔ]	0	1	[væʔ]	1	1
92	three	/ θ ri/	2	1	[fːwi]	0	1	[fːɹɪ̈]	1	1
93	thumb	/ θ ʌm/	2	1	[fʌ˜mp]	1	1	[fʌ˜mh]	1	1
94	thumb	/ θ ʌm/	2	1	[fwʌ˜nt]	0	1	[fʌ˜m]	1	1
95	tiger	/ˈtaɪgə/	2	2	[ˈtʰ ːaɪvə]	1	2	[ˈtʰaˌɪgə]	2	2
96	tiger	/ˈtaɪgə/	2	2	[ˈt‧ aɪdə]	1	2	[tʰaˌɪgə]	2	2
97	toilet	/ˈtɔɪlət/	3	2	[ˈtʰ ɔɪləʔ]	3	2	[tʰ ɔlətːʼ]	3	2
98	tomato	/təˈmɑtəʊz/	4	3	[ˈmɑ˜ʔəʊˌ]	2	2	[tʰəˈmɑ˜təʊ(dzˌ)]	3	3
99	toothbrush	/tu θ ˈbrʌs/	5	2	[ˈduˌ fːbʌˌt̪ː]	1	2	[ˈtuʔfːbɹʌʔʃ]	4	2
100	torch	/tɔʧ/	2	1	[dɔʔ]	0	1	[tʰ ɔʔʧ]	2	1
101	tractor	/ˈtræktə/	4	2	[ˈdæʔt‧ əˌ]	1	2	[ˈtɹæʔt‧ əˌ]	3	2
102	train	/treɪn/	3	1	[t̪ˌeɪ˜n]	2	1	[t̪ˌeɪ˜n]	3	1
103	umbrella	/ʌmˈbrɛlə/	4	3	[ʌ˜mˈbɛləˌ]	3	3	[ʔʌ˜mˈbɹɛləˌ]	4	3
104	van	/væn/	2	1	[fːæˌ˜n]	1	1	[vˌːæ˜n]	1	1
105	watch	/wɒʧ/	2	1	[wɒtːs̪]	1	1	[wɒʔʧ]	2	1
106	watch	/wɒʧ/	2	1	[wɒtːʼ]	1	1	[wɒʧː]	2	1
107	web	/wɛb/	2	1	[wɛbˌ]	2	1	[wɛbˌʼ]	2	1
108	yellow	/ˈjɛləʊ/	2	2	[ˈlɛləʊ]	1	2	[jːɛləʊˌ]	2	2
109	zebra	/ˈzɛbrə/	3	2	[ˈɛb̪vɑˌː]	1	2	[ˈzɛʔbɹɑˌ]	3	1
		T1 **T2**	**314** **(313)**	**189** **(188)**	**T1**	**141**	**174**	**T2**	**283**	**182**
						PCC	**PVC**			
						44.90%	**92.06%**		**90.41%**	**96.80%**

Appendix 6.5 Lily CS 1, T1, Puppy

Lily	And I got a new dog
	[æ˜n aɪ dɒʔ ə ˈnũ ˈdɒgˀ]
J	Have you? OK-so what's your new-tell me about your new dog
Lily	It keep on nipping people
	[ɪʔ ˈbiʔ ɒ˜nˀ ˈnɪ˷ʔˈbɪ˜n ˈbiˈbə˷˷ʊ]
J	Right-does it? Is it a puppy?
Lily	Yeh
	[ˈjɛ˷˷ʔ]
J	Oh-puppies get a bit nippy don't they?
Lily	And we can't take it for a walk yet
	[æ˜n ˈwi ˈdɑ˜nʔ ˈdeɪʔ ɪʔ vɔ˜ʷ ə ˈwɔkʔ ˈjɛ˷˷ʔ]
J	Oh, has it got to have some injections first? Oh then- maybe after Christmas-yeh-and what's your puppy's name?
Lily	Tiny and Tilly
	[ˈdaɪ˜niʲ æ˜n ˈdɪli˷˷]
J	Oh-how many –have you got one or two?
Lily	One
	[ˈwʌ˷˷˜n]
J	One-OK-and who...
Lily	Sometimes we call it Tilly, sometimes we call it Tiny
	[ˈʔʌ˜˷ndaɪ˜m wi ˈdɔl ɪʔ ˈdɪl̥i ˈʌ˷˜ndaɪ˜m wi˷ ˈdɔl ɪʔ ˈda˷ɪ˜ni˷˷]
J	Oh, so you call it different names-I didn't understand that-so you got two different names-that's funny-does it know its name?
Lily	Both of them names
	[ˈbəʊʔ wə dɛ˜m ˈnɛ˜ɪ˷˷md˷ː]

Appendix 6.6 Lily CS 2, T1, MP3 player

Lily	A guitar
	[ə ˈdɑ..ː]
J	Can you say it one more time?
Lily	A guitar
	[ə ˈdɑ..ː]
J	Yeh-did anybody play a guitar when you did your Christmas music last week? Anyone play the piano? What kind of music did they have?
Lily	p-p-on-music on the- p- computer
	[pʼ (.) pʼ (.) ɒ̃n (.) ˈmʊ̃dɪʔ ɒ̃n də (.) pʼ (.) ˈbuˈʔɑ..]
J	Really? On the computer? Ah
Lily	(Or)-for my birthday I got a MP3 player
	[ɔ̃ ˈvɔ.. mãɪ ˈbɜʔbeɪʲ aɪ ˈdɒʔ əʔ ˈɛmˈbiˈfˇi ˈbeɪjə..]
J	Did you really?
Lily	And a camera and – a-a-a- high school musical (?)pillow
	[ɛ̃n ə ˈdæ̃mwə n, æ (.). ɛ̃n (.) ʌ (...) ən ə ˈʔaɪʔ dʊ̃ʊ ˈmʊ̃dəʔʊ ˈbɪləʊ..]
J	Ah I know somebody else who likes High School Musical. You got a pillow? Is that for your bed?
Lily	It-got- (gl) –it like a diary and it got it-you got –got a lock for it-and- if you want to look (through it) you (must) zip it open
	[ɪʔ (.) ˈdɒʔ g͡ˆlʌˇ ɪʔ ˈlaɪʔ ə ˈdaɪˈwiʲ əˇnl ɪʔ dɒʔ ɪʔ (..) ˈju.. dɒʔ ə ˈlɒʔ wɔ ɪʔ æˇn (.) ˈɪʔ juʔ wɑˇn ʔə ˈlʊʔ wʊ̃ wɪʔ ˈju wəʔ ˈʔɪp ɪʔ ˈəʊpʰə..ˇn]
J	Oh
Lily	And you can write in it and you need to put some pictures in there
	[æˇn ju dəʔ ˈwaɪ.ʔ ɪˇnɪʔ æˇn ju ˈnid ə ˈbɪʔ ʌˇm ˈbɪʔd̥əd̥ ɪn ˈdɛə..]
J	Oh I see, like a sort of album
Lily	And and there a plug for the MP3 player but it don't work then you (X X ?up ?and ?plays) it but mine don't work
	[ɛˇn əˇn ˈɛəʷ ə ˈbʌg vɔʷə ˈɛˇmˈbiˈvi ˈbeɪjə bʌʔ ɪʔ ˈdəʊˇn wɜ..ʔ nɛˇn ju (wʌʔ ʌʔ) ˈʌp ɛˇn ˈleɪdː ɪʔ bʌʔ ˈmaɪn ˈdəʊn ˈwɜ..k̥]
J	OK

Appendix 6.7 Lily CS 3, T1, Bratz

J	And this one?
Lily	watch
	[v. ͡ wɒʔk']
J	Have you got a watch? Uh hu. What does your watch look like?
Lily	It Bratz
	[ˈɪʔ ˈb̪æʔts]
J	Right-is the-the- the strap that's black?
Lily	Purple
	[ˈb̪ɜʔpʰə̟ʊ]
J	Purple? Oh, it's a Bratz one, I've just remembered what you said now, worked out what you said. A Bratz watch? Well, I've never seen one of those, what does it look like?
Lily	It's purple with Bratz people on
	[ɪt ˈpʰɜpʰʊ̯ wɪdˀ ˈb̪æʔ ˈp̪ʰip̯ʊʷ ɒ̃n]
J	Really? It's got the Bratz people on it. I don't know anything about Bratz but somebody else was telling me a bit about them. What happens in those Bratz stories, who's in it?
Lily	There a girl called Chloe in it and I like Chloe.
	[ˈɛəʷ ə ˈdɛʊ tʰ u ˈk̪ʰəʊ̟i ɪ̃n ɪʔæ̃n ˈaɪ laɪ ˈ͡gəʊ̟i]
J	And so this girl Chloe, is she a goodie or a baddie in Bratz?
Lily	Goodie
	[ˈdʊʔ. di]
J	Oh that's good and what sort of things does she do?
Lily	Her help people
	[ɛ ˈɛlpˀ ˈpʰ ipʰ əɬ]
J	Oh, so what happens in Bratz, are there some people who help people? (lily nods) Oh, I see. And are there some baddies in there too? Who are the baddies?
Lily	I don't know them names
	[ˈaɪ dəʊʔ ˈnəʊ̃ dɛ̃nˀ ˈne̞ɪ̟̃m̩]
J	OK, what sort of things do they do that means they're bad?
Lily	Them nick pictures
	[ɛmː ˈn̪ɪʔ ˈbɪʔ. ˈdʌ̟]
J	Right
Lily	? and (they) them get (XXX) there is a girl who's a (reporter) there and the princess and her always like pink
	[ɛ̃nːɪ ɛ̃n ˈdɛʔ (ɛɪ i jə) æʷ ɪd ə ˈdɛʊʷ u də (ˈbɔʔɛ) dɛə ʔɛ də ˈbɪ̃ndɛ̃ʔ ɛ̃n̪̊ ɜ ˈɔweɪ laɪʔ ˈbɪ̃ŋ̊ːk']
J	They like pink?
Lily	And them like to nick the Bratz (star(s))
	[æ̃n nɛ̃m ˈlaɪʔ ə ˈnɪ̃ʔ də ˈpʰæ̟ʔ (ˈdɑ̟)]
J	Right, have you got a favourite colour?
Lily	Red and pink
	[ˈwɛd͡ ɛ̃n ˈbɪ̃ŋ̊kˀ]
J	Red and pink, not just pink? And do you like purple? (Lily nods) You do as well
Lily	And yellow and orange

	[æ˜n ˈlɛləʊ̤̤ (.) æ˜n ˈɒwɪ˜nːt]
Lily	And white and blue
	[æ˜n ˈwaɪ̤̤ʔ æn ˈb̤ṳ̤]
J	And what about silver?
Lily	And gold
	[ɛ˜nʔ ˈdəʊd˜]

Appendix 6.8 Lily CS 4, T1, Birthday

Lily	And it nearly Bobby birthday
	[æ˜n ɪʔ ˈnɪ˜li ˈbɒbiʔ ˈbɜ(.)ˈdeɪ]
J	I think he's going to be two? Mmm-I wonder what he would like for his birthday
Lily	Iggle piggle and Bob the builder and Thomas the tank
	[ˈɪʔəʊ ˈbɪʔəːʊ ə˜n ˈbɒb də ˈbɪʊdə ɛ˜n ˈdɒ..˜mə.. ə.. dæ˛˜ŋk']
J	Oh right-those are the things that he likes
Lily	Yeah-and him like - and him like sheep
	[jɛ æ˜n ɪ˜m ˈlaɪk (.) æ˜n ɪ˜m ˈlaɪʔ (.) ˈʔi..pʰ]
J	He likes sheep?
Lily	But when we see sheep him say baba baba
	[bʌʔ ˈwɛ˜n wi ˈʔi ˈʔip ɪ˜m ʔɛɪ ˈbæˈbæ ˈbæˈbæ]
	(laugh)
Lily	But sometimes him point at horses and say baba baba
	[bʌʔ ˈʌ˜ndaɪ˜n ɪ˜m ˈbɔɪ˜nʔ æʔ ˈʔɔʔi ə˜n ɛɪ ˈbæbæ n˛ ˈbæbæ˛]
J	(Laugh) Oh does he?
Lily	And (?under ?sometimes) and him like tractors as well
	[æ˜n (ʌ˜ndə) (.) æ˜n ɪ˜m ˈlaɪʔ ˈdæʔdəd ə ˈwɛ..ʊ]

Appendix 6.9 Lily CS 5, T1, Hospital

Lily	When I went –{click} {ee}-yesterday I went (for a lunch)
	[ˈwɛ˜n aɪ ˈwɛ˜nʔ ǂ iʔ (.) ˈjɛʔdədeɪ aɪ ˈwɛ˜nʔ (f ɔ ə ˈlʌ˜nt')]
Lily	then my stepsister come round then my brother hided un-around a bush
	[dɛ˜n maɪ˜ ˈdɛʔɪʔdə ˈɬʌ˜m ˆwaʊ˜ nɛ˜n m mãɪ ˈbʌdə ˈʔaɪdɪd ʌ˜n ʔəˈwəʊ˜nd ə ˈbʊ˜ʔ]
Lily	and then (?but) mummy said where is Adam but then him not jumped up and then him start running
	[ə˜n ɛ˜n (bə˜) ˈmʌ˜mi ɛd (.) ˈwɛə ɪd ˈʔædə˜m (.) buʔ nɛ˜ˈnɪ˜nɒ˜ʔ ˈdʌ˜mpt ʌp ə˜ˈnɛ˜nɪ˜n (.) ˈdɑʔ wʌ˜nɪ˜n]
Lily	and then him tripped over –over –a light cos it was-it was- –it used to be pirate den
	[ə˜ˈnɛ˜nɪ˜n ˈdɪʔt ˆəʊdə (.) ˈəʊvə ə ˈlaɪ ʔ dɪdɪʔ wəd˜ (..) ɪʔ wəd˜(.) ɪʔ ˈjuʔ də bi ˈbaɪwəʔ ˈd ɛ˜n]
J	Ah
Lily	He went there and him tripped over one of the lights and him him cutted him leg
	[ˈi wɛ˜nʔ ˈdɛə (.) ɛ˜n hɪ˜n ˈdiʔdɪd ˈʔəʊdə wʌ˜n ə də ˈlaɪʔ æ˜n ɪ˜n (.) ˈɪ˜m ˈdʌʔdɪd ɪ˜m ˈlɛg̊]
J	Oh dear, did he cry
Lily	And we needed to take him to the hospital
	[æ˜n ˈwi ˈnidɪd˜ də tˢɛɪʔ ɪ˜m du də ˈʔɒʔdəʔbəʊ]
J	That yesterday? Goodness me-and did you have to wait ages at the hospital?
Lily	(?well) it was yesterday night
	[(də) ˈɪʔ wədə ˈjɛʔdədeɪ ˈnãɪ ʔ]
J	Oh dear, did he have to have stitches in his leg?
Lily	Butterfly ones
	[ˈbʌʔə β aɪ ˈwʌ˜nd.']
J	Ah, that's what made you think of it-butterflies -that's' right
Lily	And doctors
	[æ˜n ˈdɒʔdəd s]
J	And the doctors at the hospital-yes

Appendix 6.10 Lily CS 6, T1, Ladybirds

Lily	A ladybird
	[ə ˈlɛɪdibɜ̟d]
J	Yeh, do you get them in your garden ever?
Lily	[ˈnə˜ʊ]
J	No?
Lily	But I did get two and I kept them
	[ˈbʌʔ ai ˈdɪʔ ˈdɛ̟ʔ ˈdu ə˜n ˈaɪ ˈdɛʔ ˈdɛ˜̟n]
J	What happened?
Lily	Um-uh-anum ff-um-well (XX) didn't get out 'cos I put it in a tin in the garden with holes in
	[mː (.) ʌ̟ (.) nə˜m (.) fː nə (ə ˈdaɪn) ˈdɪdə dɛ̟ʔ ˈʔəʊ̟ʔ dəd aɪ ˈbʊʔ ɪʔ ɪ˜n ə ˈdɪ˜n ɪ˜n ə ˈdɑdə˜n wɪd̟ ˈʔaʊl dɪ˜n]
J	Right-and did you let them go or did you keep them?
Lily	Keep them. Then my brother said him going to let them go and I said no and then we both start fighting but him-when we went outside and start fighting outside him-him falled over and kicked the tin and all the ladybirds got out
	[ˈdip˺ ˈdɛ˜n (.) nɛ˜n ˈmãɪ ˈbʌ(.)ˈdʌ ɛ̟ʰ ˈɪ˜n dʌ˜nə ˈlɛʔ ɛ˜n ˈdəʊ ə˜n ˈnɛ˜n ə aɪ ˈʔɛd˺ nə˜ʊʷ ə˜nɛ˜nə˜ wi bəʊʔ ˈdɑʔ ˈfaɪʔɪn bəʔ ɪ˜n (.) ˈwɛ˜n wi (.) ˈwɛ˜nʔ ˈʔəʊ(.)ˈʔaɪd ə˜n ˈdɑʔ ˈv̥aɪʔɪ˜n əʊʔaɪd˺ ˈɪ˜m ɪ˜m ˈfɔdɪd əʊ̟dəʷ æ˜n ˈdɪʔˈdɪd də ˈdɪ˜n æ˜n ˈɔl də ˈlɛɪdibɜd˺ dɒʔ ˈəʊ̟ʔ]

Appendix 6.11 Lily, T1 and T2, Examples of imitated sentences (CSP task)

Target and response	
	We saw the elephant at the zoo
T1	[wi ˈɔd˞ də ˈɛləfˇə˜nʔ hɛ..ˇ də ˈʔ u]
T2	(1) [wi ˈsɔɾ ʌʔ ˈɛləfˇə˜nʔ æʔ dəˇ ˈʃu] (2) [wi ˈsɔd əʔ ˈɛləfə˜nʔ æ..ʔ ðə ˈsːu]
	He gave me a banana (him gave me a banana)
T1	[ˈɪ˜m deɪ ˈmiʲə ˈnɑ˜ˈnɑ..˜]
T2	[hiˇ.. ˈgeɪb˞ mɪ̃ʲ ʌ bəˈnɑ˜nɑ˜..]ː
	John collects stamps
T1	[ˈdɒ˜n dəˈdɛʔ ˈdæ..˜nt]
T2	[ˈʤɒ˜n dəˈklɛʔ. s ˈstæ˜mps]
	Sam loved to dance
T1	[ˈæ˜m lʌb təˈdɑ˜n. ts̻ː]
T2	[ˈslæ˜ (.) ʃæm (.) lʌv t̻ ə dɑ˜ns]
	Alice put gloves on her hand
T1	[ɛˈlɪs̻ bɪʔ ˈdʌb ˆɒ˜n ə ˈæ˜nːd.˞]
T2	[æˈlɪʔs̻ pʰʌʔ ˈglʌbd. ɒ˜n ə ˈhæ˜..nd.˞]
	Good girls are nice
T1	[ˈd̻ʊʔ ˈd̻ɛldˆɑ ˈnaɪ..ːt']
T2	[ˈgʊg˞ ˈgɛʊd ɑ ˈnaɪs]
	She wrapped the parcel
T1	[ɜʔ ˈwɛʔ dəˇ ˈbɑ..ːhə..ʊ]
T2	[si ˈɹæp̻ də ˈbɑʃəʊ]
	My mum hugged me when I was sad
T1	[ˈmɑ̃ɪ ˈmʌ˜m˞ ˈɛʔm̃ɪ̃ wɛ˜n aɪˇ wʊˇt' ˈɑə..t']
T2	[ˈmɑ̃ɪ ˈmʌ˜m ˈh̻ʌg˞d. mɪ̃ wɛ˜n aɪ wəsˆ ˈsæd.]
	I wore a jumper
T1	[aɪ ˈvɔʷ ɪ ˈdɛ˜nʔbʌ..]
T2	[aɪ ˈwɔˈ ə ˈʤʌ˜mpə..]
	My left leg hurts
T1	[mɑ̃ɪ ˈlɛf ˈɬɛd' ˈɝʔ]
T2	[mɑ̃ɪ ˈlɛf lɛg˞ ˈtɜts]
	(The) brown bear eats fish
T1	[də ˈbaʊ˜m ˈbɛə iʔ ˈfˇɪʔt']
T2	[ˈbɹaʊ˜m ˈbɛə iʔ ˈfɪʔʃ]
	You can read my book
T1	[ˈju dəv ˈʊib˞ ˈmɑ̃ɪ ˈbʊkːˈ]
T2	[ˈju kʰʌ˜n ˈɹɪb˞ ˈmɑ̃ɪ ˈbʊx]

Appendix 6.12 Lily T1 and T2 Intelligibility stimuli

Single words

Word	Adult target	**Lily's realisation T1**	Number of listeners identifying word T1	**Lily's realisation T2**	Number of listeners identifying word T2
CAR	/kɑ/	[kʰɑ..ː]	51/66	[kʰ ɑ]	51/66
FISH	/fɪʃ/	[fɪ]	11/66	[fɪʔʃ]	66/66
GIRL	/gɜl/	[dɛʊ]	28/66	[gɛɱ]	66/66
PRAM	/præ˜m/	[pˇæ..˜n]	0/66	[pʰɹæ˜ːm]	66/66
SAUSAGE	/ˈsɒsɪʤ/	[ˈʔɒʔhɪdz.]	2/66	[ˈsːɒsɪ]	50/66
SCHOOL	/skul/	[d.əuɱ]	5/66	[sˌkˌ.ˈul]	48/66
TIGER	/ˈtaɪgə/	[ˈtʰ ːaɪvə]	17/66	[ˈtʰa..ɪgə]	59/66
TOMATOES	/təˈmɑtəʊz/	[ˈmɑ˜ʔəʊ..]	22/66	[tʰəˈmɑ˜təʊ(dz.)]	66/66
TRAIN	/tɹeɪ˜n/	[tˌeɪ˜n]	32/66	[tˌɹeɪ˜n]	63/66
VAN	/væ˜n/	[fːæ..˜n]	2/66	[v.ːæ˜n]	66/66

Imitated sentences

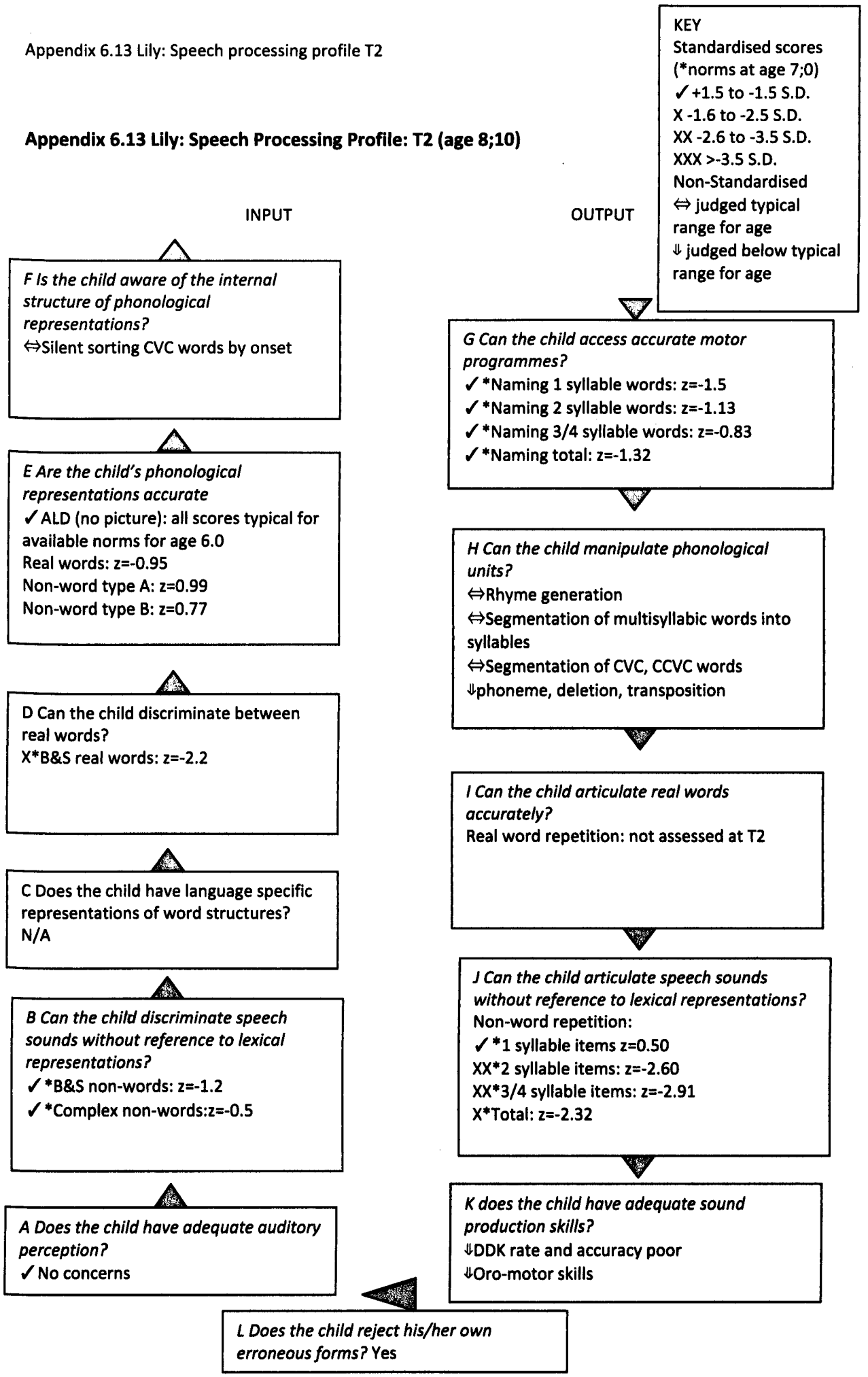
Target sentence	**Lily's realisation T1**	Percentage of words recognised by individual listeners T1	**Lily's realisation T2**	Percentage of words recognised by individual listeners T2
HE (HIM) JUDGED THE COMPETITION	[ɪ˜n ˈd̈ʌʔ də ˈdɒ˜mˇʔəˈdɪʔə˜..n]	0.76%	[hi ˈʤʌʔ d.ə ˈkɒ˜ntəˈtɪʃə˜n]	33.71%
HE SNEEZED VERY LOUDLY	[ɪ˜n ˈni..t'.. wɛwi ˈlaʊd̥li..]	54.24%	[hi ˈsnid.ʰ vɛɹi ˈlaʊ..dlɪ..ː]	88.48%
JOHN COLLECTS STAMPS	[ˈdɒ˜n dəˈdɛʔ ˈdæ..˜nt]	0.30%	[ˈʤɒ˜n dəˈklɛʔ.s ˈst.æ˜mps]	74.55%
MY LEFT LEG HURTS	[mãɪ ˈlɛf ˈɨɛt' ˈɜʔ]	87.27%	[mãɪ ˈlɛf lɛg˜ ˈtɜts]	99.70%
YOU MUST STIR IN THE SUGAR	[ˈjʊˇ mʌ..ʔ ˈdɜʷ ɪ˜n də ˈʔʊdə..]	32.42%	[ˈju mʌs ˈstɜˈ ɪ˜n və ˈsʊ..gə..]	85.71%

Conversational speech

Target sentence	**T1 or T2**	**Lily's realisation**	**Percentage of**

			words identified by individual listeners
I ACTED AND SINGED	T1	[ʔaɪ‥ ˈʔæ‥ʔdɪd æ˜n ˈʔɪ˜nɪʔt]	17.42%
IN THE OFFICE AND IN THE HALL	T1	[ɪ˜n də ˈʔɒ‥f˜ːɪʔ ɛ˜n ˈɪ˜n də ˈʔɔ‥ʊ]	48.79%
ON BOXING DAY I WILL GO TO MY DAD'S	T1	[ʔɒ˜n ˈbɒʔdɪ˜n̰ ˈdeɪʲ aɪ wʊfŋ̰ ˈdəʊ dufŋ̰ maɪ ˈdæʔ]	31.31%
ON THE CHRISTMAS TREE	T1	[ˈʔɒ˜n də ˈdɪʔmə ˈdi]	53.54%
WE MAKED DECORATIONS	T1	[wi‥ ˈmeɪ‥ʔɪd˞ ˈdɛ‥ʔəweɪʔə˜n̰]	66.36%
BECAUSE WE DIDN'T HAVE A TRAILER	T2	[ˈbikə‥d. wi ˈdɪdn̩ ˈhæv̩ə ˈtɹe˷ɪlə‥]	85.45%
BOBBY WOULD SAY, STOP DAD, STOP DAD, TAKE ON HOME	T2	[ˈbɒbi wʊd͡ ˈde‥ɪ ˈstɒp̩ dæd. ˈstɒp dæd ˈtʰeɪx wʌ˜n͡ ˈəʊ˜ːm]	69.09%
BUT WE DIDN'T STAY THAT LONG BECAUSE IT WAS GETTING COLD	T2	[ˈb.ʌʔ ˈwi dɪdə˜nt ˈsteɪ væʔ ˈlɒ˜ŋ bɪˈkʰ əd ɪʔ wəd˞ ˈgɛ˜ːŋ ˈk̰əʊd.]	98.76%
WE COUNT HOW MANY PEOPLE WAS IN ONE PLACE	T2	[wi ˈkʰ aʊ˜ʔɪ ʔaʊ ˈmɪ˜ni ˈpʰipʰʊ wɒd ɪ˜n wʌ˜n ˈple˷ɪs]	82.42%
WELL WE WENT TO NEW FOREST	T2	[ˈwɛʊ wi ˈwɛ˜nt˞ t̰su ˈnu ˈfɒ‥ɹɪs]	97.92%

Appendix 6.13 Lily: Speech Processing Profile: T2 (age 8;10)



KEY
Level of difficulty hypothesized from normed tasks
X or XX or XXX

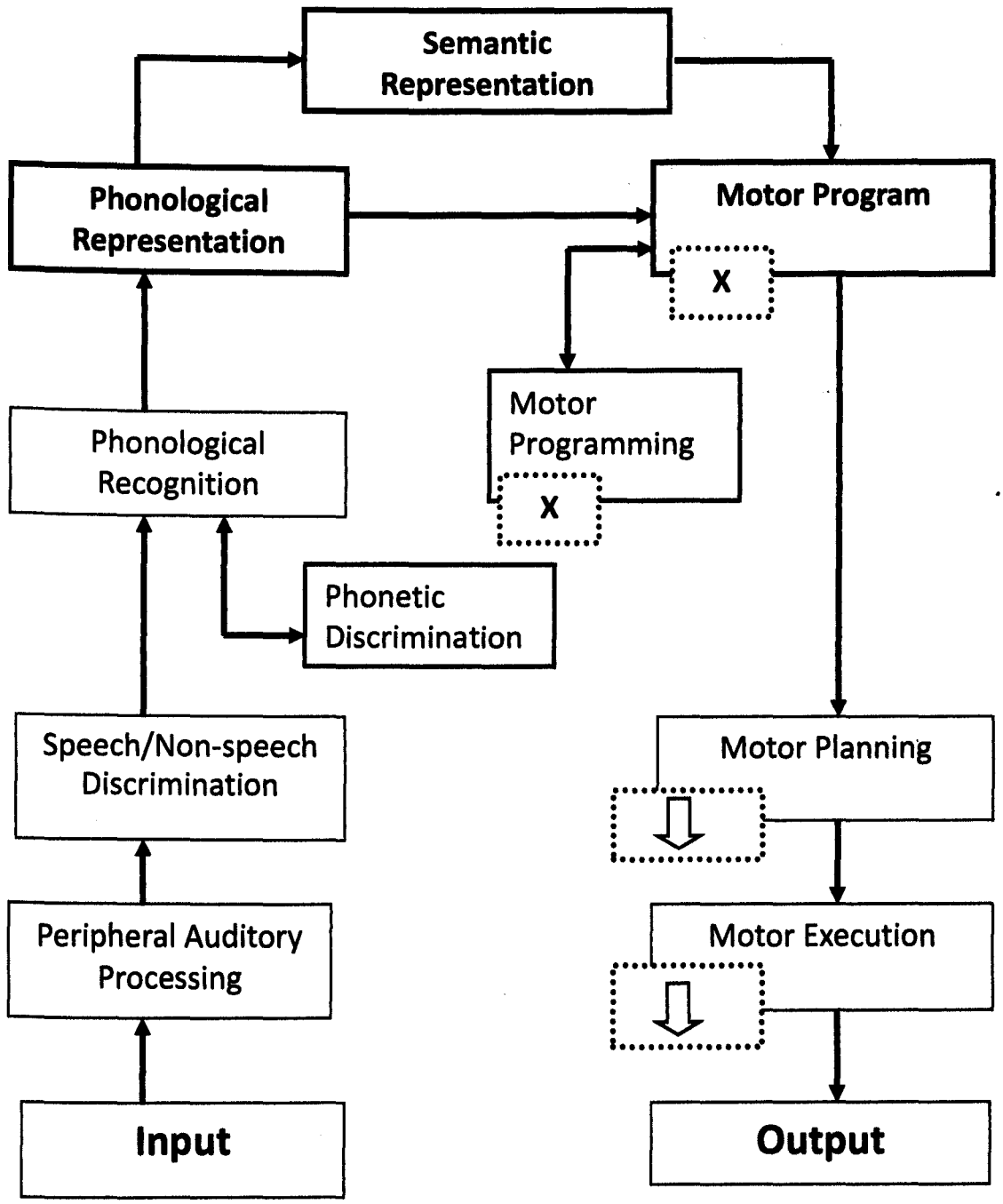
Presence of difficulty hypothesised from weak/poor performance on informal tasks

⇩

Appendix 6.14 Lily: Speech Processing Model T2

(Stackhouse & Wells, 1997)

Lily suggested areas of difficulty, T2



Appendix 6.15 Lily CS 1, T2, New Forest

Lily	And everywhere we went there was horses walking around with nobody there -was just walking away- around on their own
	[ə˜ˇn ˈɛvɹiwɛə wi ˈwɛ˜nʔ də wəd ˈhɔsi„ ˈwɔk'ɪn əˈɹɑʊ˜m wɪd ˈnə˜ʊbɒdi vɛˇ wə ˈdʌʔ ˈwɔkɪ˜n əˈweɪ˜n ˈɹəʊ˜ŋg ɒ˜ŋ vɛˈ ˈəʊ˜n]
J	Ah yeh, cos they're free aren't they to walk around-they're called New Forest ponies aren't they? Yeh. But the ones that you rode were kept in a stable?
Lily	Yeh
J	OK, so was that was your favourite thing?
Lily	Yeh
J	OK what else?
Lily	And every time we came to um New Forest-when we sawed horses Bobby would say 'stop dad, stop dad, take one home'
	[ə˜nˈɛvɹiˈt‾aɪ˜mwiˈkʰeɪ˜m tʰu ʌ˜m ˈnʊ̃ ˈfɒɹɪʔ wɛ˜n wi sɔ„d„ ˈhɔsɪd. ˈbɒbi wʊdˆ ˈde„ɪ ˈstɒp̰ dæd. ˈstɒp dæd ˈtʰeɪx wʌ˜nˆ ˈəʊ˜ːm]
J	laughs
Lily	And N said um we would never be able to catch one but the next day there was um foals
	[ə˜nˈnãɪd̪əʊ ˈsɛd. ʌ˜m ʍʊd.' ˈnɛ˜vəˆ ˈbiʲ ɛb̰ʊ dəʔ ˈkʰætɬ ˈwʌ˜n pʰʌʔ ðə ˈnɛ˜ʔ ˈdeɪ vɛ wəd ə˜m ˈfəʊld.z.]
Lily	And there was a foal laying on the fl-um- (?just) walking about- everyone stroked it and it didn't do nothing
	[ə˜n ˈvɛə wʊd̰ ə ˈfəʊ„ʊ ˈleɪ˜n ɒ˜n ə fl ʌ˜m .s. ˈwɔkɪ˜n əˈbəʊːʔ nɛ˜vn. ˈθ „ɹəʊʔ ɪʔ æ˜nɪ˜ʔ ˈdɪdn. d.u ˈnʌ˜fɪ˜ŋ]
Lily	And then it lay down and stroked it and kissed it and everything
	[ə˜nˆ nɛn ɪʔ ˈleɪ ˈdaʊ˜n æ˜n ˈstɹəʊʔ.ˈdɪʔ æ˜n ˈkʰɪ„ʔ dɪʔ æ˜n ˈɛvəˈfɪ˜ŋk']
Lily	And N said we would never be able to get one and that day N thought we could would be able to catch one
	[æ˜nt' ˈnãɪdəʊ ˈsɛd. wi wʊd. ˈnɛvə biʲ ˈɛ̈ɪbl. də ˈgɛʔ ˈwʌ„˜n æ˜n ˈðæʔ ˈdeɪ ˈnaɪd̪əʊ ˈfɔʔ (.) wi kʰʊ„ʔˆ wʊd.˜ biʲ ˈɛbl. də ˈkʰæʧ wʌ˜n]
J	Mm but you didn't
Lily	Because we didn't have a trailer (laugh)
	[ˈbikə„d. wi ˈdɪdn. ˈhæv̰ə ˈtɹe˜ɪlə„]

Appendix 6.16 Lily CS 2, T2, Holiday

Lily	Yeh-and um-there was-um-we needed a dress-there was a competition-and it was-in all the whole wide world
	[jɛ æ˜nd (.) ʌ˜m (.) vɛə wɒd (.) ʌ˜m (.) wi ˈnidɪd ə ˈdɹɛʔːsː (.) v.ɛə wɒd ə ˈkʰɒ˜nɪtɪʃə˜n (.) æ˜n ɪʔ wəd (.) ɪ˜n ɔʊ ðə ˈhəʊʊ ˈwæʔ ˈwəʊd˞]
	We count(ed) how many people was in one place
	[wi ˈkʰ aʊ˜ʔɪ ʔaʊ ˈmɪ˜ni ˈpʰipʰʊ wɒd ɪ˜n wʌ˜n ˈple˳ɪs]
	But we didn't stay that long because it was getting cold
	[ˈb.ʌʔ ˈwi dɪdə˜nt ˈsteɪ væʔ ˈlɒ˜ŋ bɪˈkʰ əd ɪʔ wəd˞ ˈgɛ˜ːŋ ˈkʷəʊd.]
J	mm
Lily	And um-well-um-my cousin went to get some money to get something to eat so me and my mate was um on our own
	[æ˜nd ʌ˜m (.) wu˳ (.) ʌ˜m͡ ˈmaɪ ˈkʰʌdə˜m wɛ˜nʔ əʔ gɛʔ ˈsʊ˜m͡ ˈmʌ˜ni d.ə ˈgɛʔ ˈsʌ˜ŋɪ˜ dəʷ ˈiʔ səʊ˳ ˈmijʌ˜m͡ maɪ ˈmeɪʔ wɒd ʌ˜m ˈʔɒ˜n ɑʲ ˈəʊ˜n]
J	mm
Lily	And waiting for them to come back in the field that we was um in with-dressing up as a pirate
	[æ˜m ˈweɪʔn. fə vɛ˜n də ˈkʌ˜m ˈbækˈɪ˜n͡ də ˈfiʊd˳ væ˳ʔ wə˜ wɒd ə˜m ˈɪ˜n ˈwɪv (.) ˈdɹɛsɪ˜n ʌp æz. ə ˈpʰ aɪɹəʔ]
	And then-we –it was that cold we- me and my mate hided uh-uh- behind the ice-cream van and it was really warm and then it start moving so we was like 'come back here' cos it-because it was nice and warm
	[ə˜n ˈnɛ˜n (.) wi (.) ɪʔ wʊ˜d ˈvæʔ ˈkʰəʊ˳d wi˳ (.) ˈmi æ˜m maɪ ˈmeɪʔ ˈhaɪd˳d˳ ʌʔʌʔ ˈʔaɪ˜nʔ də (.) ˈaɪʔ ˈkɹiŋ(.)fə˜(.)ˈv˳æ˜n æ˜˜n ɪt wəʔ ˈɹili ˈwɔ˜m æ˜nɛ˜n ɪʔ ˈstɑ˳ʔ ˈmuvɪ˜n səʊ wi wəd laɪk ˈkʰ ʌ˜m ˈbækˈ ˈi˳əː ʌd˳ ɪʔ biˈkʷ ʊd ɪʔ wʊd ˈnaɪs æ˜m ˈwɔ˜mː]
J	Right, OK
Lily	And my pirate hat was keep on flying away
	[æ˜m͡ maɪ ˈpʰaɪɹəʔ ˈhæ˳ʔ wɒʔ ˈpʰiʔ ɒ˜ŋ ˈfːla˳ɪɪ˜n əˈweɪ˳]
J	So was your friend someone you met on holiday?
Lily	Um-well-it my cousin friend and um I met her and she my friend too now
	[ʌ˳˜m (.) wɛʊ (.) ɪʔ mãɪ ˈkʰʌz.ə˜n ˈfɹɛ˜nd æ˜n ə˜m aɪ ˈmɛʔ ɛ˳ ə˜nː si ˈmãɪ ˈfˇɛ˜n͡ ˈtu nãʊ˳]
J	OK

Appendix 6.17 Lily CS 3, T2, JLS

J	Tell me about JLS
Lily	Well-um-it (?was) good and um I was on N's shoulders the whole way through
	[wɛʊ ʌ˜m ɪt dɔ˘d. ˈgʊd. æ˜nd. ʌ˜m ˈaɪ wə˘d ɒ˜n ˈnãɪʤəs ˈsəʊldəd. də˘͡ əʊ͡ ˈweɪ ˈfɹu..]
J	Were you?
Lily	And N said um when we was trying to go N said 'I don't want to go to this JLS'
	[ə˜n ˈnãɪdəʊ ˈsɛd ə˜m ˈwɛ˜n wi wəd̥ ˈtɹaɪɪ˜n də˘ ˈgəʊ ˈnãɪdəʊ ˈsɛd. ɔɪ ˈdəʊ˜nʔ wɒ˜nə ˈgəʊ tə vɪs ˈʤeɪlɛs]
	And then when we was there N like'I can't see, I can't see'
	[ə˜n ðɛ˜n ˈwɛ˜n wi wə ˈv..ɛə ˈnãɪdəʊ læk' ʌ ˈkʰɑ˜ŋʔ ˈsi aɪ ˈkʰɑ˜nʔ ˈsi]
	Then mum said um-'you said you didn't want to come so why are you that bothered?'
	[vɛn ˈmʌ˜m ˈsɛd. ʌ˜m (.) ju ˈsɛd. ju ˈdɪdə˜ wɒ˜nə˜ ˈkʰ:ʌ˜m s˘əʊ ˈwaɪ□ ɑ□ ju ˈvæʔ ˈbɒ□ β ɜ..d'.]
J	(Laugh) what did he have to say to that?
Lily	He said 'well I did want to come really'
	[hi ˈsɛ˘d. wɛʊʷ aɪ ˈdɪd̥ wɒ˜nə ˈkʰʌ˜m ˈɹɪli]

Appendix 6.18 Lily CS 4, T2, New bike

Lily	And also we went down to the chalet at the weekend and Courtney came down for the first time
	[æ˜nd ˈɔʊsˈəʊ wi ˈwɛ˜nʔ ˈdaʊ˜n ˈdə ˈʃælɛ ʔæʔ də ˈwikʰɛ˜nd„ n, ˈkʰɔ˜ʔni ˈkʰeɪ˜m ˈdaʊ˜n fɔ də ˈfəʔ ˈt‧aɪ˜m]
	And we went to the car boot sale and he got a new bike
	[ə˜n wi wɛ˜nʔ t‧ u də kʰ ɑbu^ seɪʊ æ˜n i ˈgɒʔ ə ˈnu ˈbaɪ„ːk']
J	Who got a new bike? Bobby? OK
Lily	Bobby
	Right, OK
	And I took my bike in the back
	[ə˜n aɪ ˈtʰ ʊk ˈmaɪ ˈbaɪk ɪ˜n də ˈbæk']
J	Can you fit it into the car, going down?
Lily	Um well we-duh-it-we did shut the back on it
	[ə˜m ˈwɛʊ wi ˈdʊ ɪʔ (.) ˈwi ˈdɪd ˈʃʌʔ də ˈbækˣ ɒ˜n ˈɪ„ʔ]
J	mm
Lily	Because we got a four by four
	[biˈkʰ ɒʔwi ˈgɒʔ ə ˈfɔ„ baɪ ˈfɔ„ː]
J	Oh right, course you have, yes
Lily	So it-um-the back bit-we could fit it in because we got a back bit on it
	[ˈsəʊ„ ɪʔ ʌ˜m (.) ðə ˈbæk bɪʔ wi kʰʊd ˈfɪʔ ɪʔ ɪ˜n biˈkɒʔ wi ˈgɒʔ ə ˈbæk'ː ˈbɪt ɒ˜nɪʔ]
J	OK

Appendix 6.19 Lily CS 5, T2, Seeing the sea

J	Can you see the sea from the chalet? Is it right on the beach?
Lily	We just look out the window and all you can see is the sea.
	[wi ˈʧʌʔ ˈlʊk ɑʊʔ ðə ˈwɪ˜ndəʊʷ ə˜n͡ nɛ˜n ˈɔʊ ju çə˜n ˈsiʲ ɪd̥͡ də˘ ˈsi]
J	That's nice
Lily	And my grandad got a pub near the sea and we go there and all we can see is the sea and the beach
	[æ˜m͡ maɪ ˈgɹændæd˞͡ gɒʔ ə ˈpʰʌb.ʰ nɪ˜ə də ˈsiʲ ə˜m ˈwi ˈgəʊ ˈvɛː ɛ˜n ɔ wi kʰʌ˜n ˈsi ɪd.͡ də ˈsi . ə˜n də ˈbitsː]
J	What do you like doing on the beach?
Lily	Going on the jet skis
	[ˈgəʊɪ˜n ɒ˜n ə ˈsgɛʔ ˈdid.s]
J	On the?
Lily	Jet skis
	[ˈsgɛʔ ˈsdid]
J	Oh, the jet skis-is that another word we might want to have a little look at in a minute-that is a tricky word-I'll jot that one down for in a minute-jet skis
Lily	Jet skis
	[ˈʧɛʔ ˈstid.s]
J	Oh that was better but we'll have another look at it again in a minute-here we go-what have we got here?
Lily	And I like riding the horses
	[æ˜n əʊ ˈlaɪʔ ˈɹa..ɪdɪ˜n ə ˈhɔsɪ..d.z.ː]
J	Mm-real ones? Are they at the pub?
Lily	Mm-every day we go to Leah's (XX) my cousin and she got-get horses-they bring horses and Leah always ask if I can go on the one
	[m (.) ˈɛvɹi ˈdɛɪ ʍi ˈgəʊ du ˈliə (ˈnəʊd.s) mãɪ ˈkʰʌd.ə˜n ʌ˜m ʃi ˈgɒʔ ˈgɛʔ ˈʔɔsɪʔ ə˘m (.) vɛɪ ˈbɪ˜ŋ ˈhɔsɪd. ə˜n ʌ˜m ˈliəʔ ɔˈweɪd. ˈɑs ɪʔ ˈaɪ kʰə˜ŋ ˈgəʊ ɒ˜m ˈwʌ˜n]
J	That's good
Lily	she said yes so I like trotting and jumping over the um sea locks
	[{ₚsi sɛd jɛ..ₚ} səʊʷ ˈaɪ la..ɪʔ ˈtʰɹɒtʰɪ˜n æ˜n ˈʧʌ˜mpɪ˜n ə..ʊvə də ʌ˜m ˈsi ˈlɒ..ks]
J	That sounds really good

Appendix 7.1 Hamish: Results of standardised language assessment T1, CA 7; CELF-4 UK

Subtest	Scaled score (average range 7-13 subtests; 85-115 composite scores)	Percentile rank (average range 16-84)
Receptive subtests		
Concepts & Following Directions	10	50
Word Classes: Receptive	13	84
Sentence Structure	12	75
Understanding Spoken Paragraphs	11	63
Expressive subtests		
Word structure	4	2
Recalling Sentences	6	9
Formulated Sentences	3	1
Word Classes: Expressive	7	16
Expressive Vocabulary	7	16
Working memory		
Number Repetition: Forwards	4	2
Number Repetition: Backwards	7	16
Number Repetition: Total	4	2
Composite scores		
Core Language	75	5
Receptive Language	108	70
Expressive Language	65	1
Language Content	94	34
Language Structure	77	6

KEY
Standardised scores
✓ +1.5 to -1.5 S.D.
X -1.6 to -2.5 S.D.
XX -2.6 to -3.5 S.D.
XXX >-3.5 S.D.
Non-Standardised
⇔ judged typical range for age
⇓ judged below typical range for age

Appendix 7.2 Hamish: Speech Processing Profile T1 (age 6;7)

INPUT

F Is the child aware of the internal structure of phonological representations?
⇔Silent sorting CVC words by onset
⇓Silent sorting CVC words by coda

E Are the child's phonological representations accurate
⇔Identification of CVC items from segmented phonemes, e.g. p-i-g

D Can the child discriminate between real words?
✓ B&S real words: z=1.25
⇔S/D judgements real words

C Does the child have language specific representations of word structures?
N/A

B Can the child discriminate speech sounds without reference to lexical representations?
XX B&S non-words: z=-2.27
XXX B&S non-word coda clusters: z=-3.51

A Does the child have adequate auditory perception?
⇔No concerns

OUTPUT

G Can the child access accurate motor programmes?
XXX Naming 1 syllable words: z=-14.00
XXX Naming 2 syllable words: z=-11.00
XXX Naming 3/4 syllable words: z=-5.04
XXX Naming total: z=-11.93

H Can the child manipulate phonological units?
⇓Rhyme generation
⇓Segmentation of multisyllabic words into syllables

I Can the child articulate real words accurately?
Real word repetition
XXX 1 syllable items z=-13.81
XXX 2 syllable items: z=-9.97
XXX 3/4 syllable items: z=-8.81
XXX Total: z=-13.27

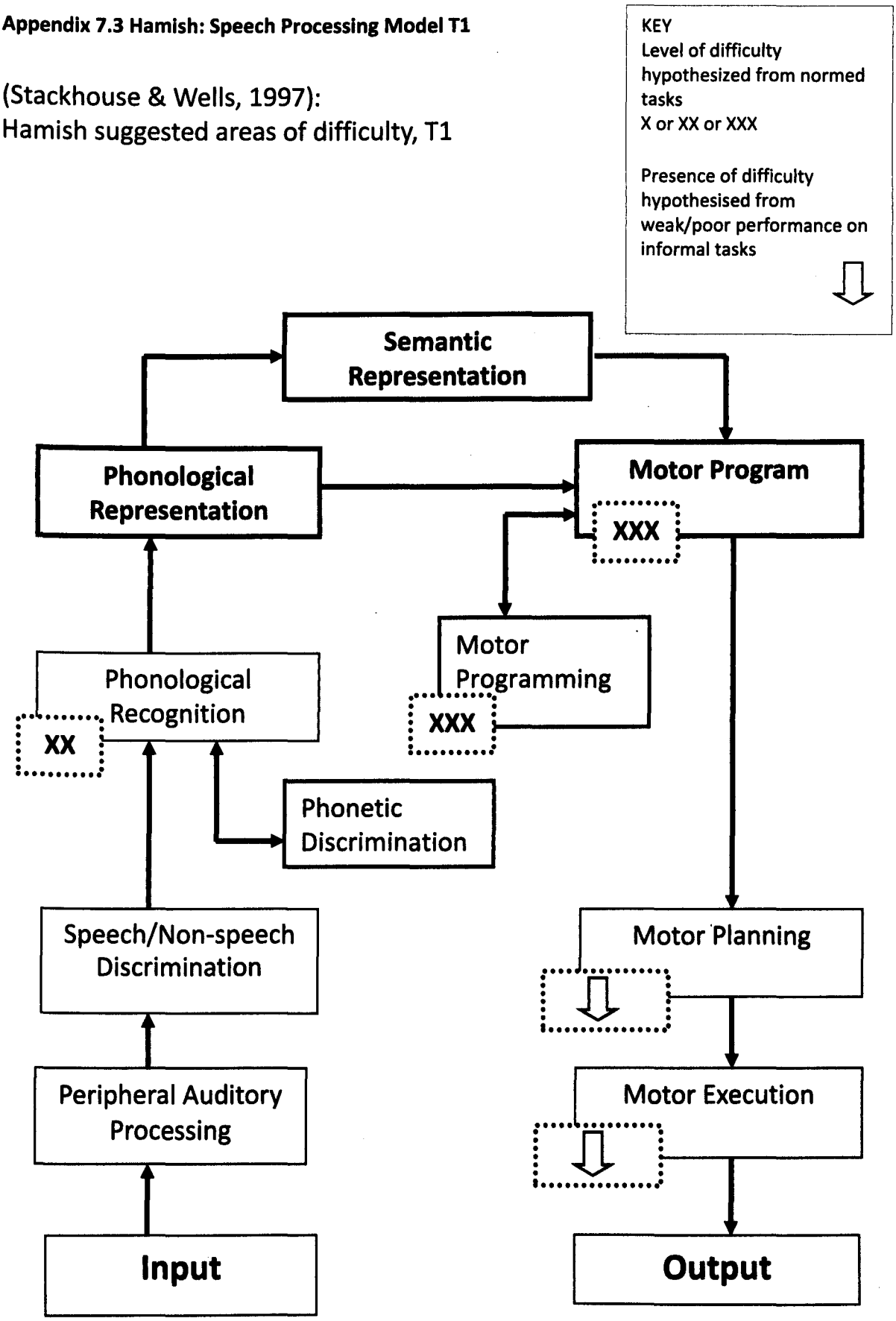
J Can the child articulate speech sounds without reference to lexical representations?
Non-word repetition:
XXX 1 syllable items z=-13.91
XXX 2 syllable items: z=-11.42
XXX 3/4 syllable items: z=-5.55
XXX Total: z=-10.84

K does the child have adequate sound production skills?
⇓DDK rate and accuracy poor
⇔Oro-motor skills

L Does the child reject his/her own erroneous forms? Occasionally

Appendix 7.3 Hamish: Speech Processing Model T1

(Stackhouse & Wells, 1997):
Hamish suggested areas of difficulty, T1



Appendix 7.4 Hamish: Single word naming, T1 and T2
(taken from DEAP Phonology, DEAP Articulation and Stackhouse & Wells Naming Task)

	Word	Adult realisation	C score	V score	Hamish's realisation (T1 7;5)	C score	V score	Hamish's realisation (T2 8;5)	C score	V score
1.	aeroplane	/ɛərəˈpleɪn/	4	3	[ʔæˈweɪ˜]	0	1	[ʔɛəwəˈleɪ˜n]	2	3
2.	apple	/ˈæpəl/	2	2	[ˈʔæ̠p̚ʊ]	2	2	[ˈʔæpʰ ʊ]	2	2
3.	bird	/bɜd/	2	1	[bɜd̠h]	1	1	[bɜ̠ɾ]	1	1
4.	birthday cake	/ˈbɜ θ deɪˈk eɪk/	5	3	[ˈbɜʔteɪʔteɪʔ]	1	3	N/A	N/A	N/A
5.	biscuits	/ˈbɪskɪts/	4	2	[ˈbɪʔnɜ˜(ʔ)ə˜n]	1	1	[ˈbɪʔːdəʔ]	1	1
6.	boat	/bəʊt/	2	1	[bəʊʔ]	2	1	N/A	N/A	N/A
7.	book	/bʊk/	2	1	[bʌ˜ʔ]	1	0	[bʊʔ]	1	1
8.	boy	/bɔɪ/	1	1	[bɔɪ]	1	1	[bɔɪ]	1	1
9.	bread	/brɛd/	3	1	[fæʔfŋ]	0	0	[fæ˜ʔ]	0	0
10.	bridge	/brɪʤ/	3	1	[fɪʔfŋ̈]	0	1	N/A	N/A	N/A
11.	hairbrush	/ˈhɛəbɹʌʃ/	(4)	(2)	[ˈʔæʔfʌʔ(fŋ˘)]	0	1			
	brush	/brʌʃ/	3	1				[fʌʔfŋ]	0	1
12.	butterfly	/ˈbʌtəflaɪ/	4	3	[ˈbʌ̠ʔə̠laɪ]	3	3	[ˈbʌʔə˘l̠aɪ]	3	3
13.	car	/kɑ/	1	1	[dɑ]	0	1	[tʰ ɑ]	0	1
14.	caravan	/ˈkærəvæn/	4	3	[ˈtʰ æwəvʌ˜˘]	1	2	[ˈtʰæwəvæ˜n]	2	3
15.	cat	/kæt/	2	1	[dæʔ]	1	1	[tʰ æʔ]	1	1

16.	caterpillar	/ˈkætəpɪlə/	4	4	[ˈtʰ æ..ʔəfɪ..lə]	2	4	[ˈtʰ æʔəpʰ ɪ lə]	3	4
17.	chair	/ʧɛə/	1	1	[dæ˜..]	0	0	[tʰãə]	0	0
18.	chips	/ʧɪps/	3	1	[ˈfɪʔpˇɪʔ]	1	1	N/A	N/A	N/A
19.	computer	/kəmˈpjutə/	5	3	[ˈfuʔʌʔʌʔ]	0	1	[ˈfuʔʌʔʌʔ]	0	1
20.	crab	/kræb/	3	1	[fæp']	0	1	[fæp']	0	1
21.	crocodile	/ˈkrɒkədaɪl/	5	3	[ˈfɒʔətʰa..ɪjə..ʊː]	2	3	[ˈfɒ..ʔədaɪʊ]	2	3
22.	dinosaur	/ˈdaɪnəsɔ/	3	3	[ˈdaɪ˜nətʰɑˇ]	2	2	[ˈdaɪ˜nətsɔ]	2	3
23.	door	/dɔ/	1	1	[dɔ]	1	1	[dɔ]	1	1
24.	duck	/dʌk/	2	1	[dʌʔ]	1	1	[dˬˇʔ]	1	1
25.	dustbin	/ˈdʌsbɪn/	4	2	[ˈdʌʔbɪ˜n˜]	3	2	[ˈdʌʔbɪ˜n˜]	3	2
26.	ear	/ɪə/	0	1	[ʔɪː]	0	0	[ɪə]	0	1
27.	egg	/ɛg/	1	1	[ʔæʔ]	0	0	[ʔæʔ]	0	0
28.	elephant	/ˈɛləfənt/	4	3	[ˈʔæ..lə..ʔhə..˜nʔ fŋ]	3	2	[ˈʔɛləʔə˜nʔ fŋ]	3	3
29.	feather	/ˈfɛðə/	2	2	[ˈbæ˜ʔɑˇ..]	0	0	[ˈpʰæ˜ʔə˜nʔ]	0	1
30.	fish	/fɪʃ/	2	1	[fɪʔfŋ]	1	1	[sːpɪʔfŋ]	0	1
31.	fishing	/ˈfɪʃɪŋ/	3	2	[ˈbɛʔɪ˜n]	0	1	[ˈfɪʔɪ˜n]	1	2
32.	five	/fɑɪv/	2	1	[faɪʔ]	1	1	[faɪʔ]	1	1
33.	flower	/ˈflɑʊwə/	3	2	[ˈflɑʊwə]	3	2	[ˈlɑʊwə]	2	2
34.	foot	/fʊt/	2	1	[bʊʔ]	1	1	[fʊʔ]	2	1
35.	frog	/frɒg/	3	1	[fɒʔ]	1	1	[fɒʔ]	1	1

36.	giraffe	/ʤəˈrɑf/	3	2	[fɑ˜:ʔ]	0	1	[fɑ˜:ʔ]	0	1
37.	girl	/gɜl/	2	1	[dæʊ̯]	1	0	[d̪æl]	1	0
38.	glove	/glʌv/	3	1	[lʌːp˜]	1	1	[k. lʌp']	1	1
39.	gloves	/glʌvz/	4	1	[ˈglʌʔb̥.ɪʔ]	2	1	[ˈlʌʔbɪʔ]	1	1
40.	guitar	/gɪˈtɑ/	2	2	[dəˈtsɑ̤̆:]	0	2	[ˈtsɪʔtɑ]	1	2
41.	hairdresser	/hɛəˈdrɛsə/	4	3	[ʔæˈfæʔə]	0	1	[ʔɛəˈfɛ̥ʔʌ]	0	3
42.	hamburger	/hæmˈbɜgə/	4	3	[ʔæ˜mˈbɜwə]	2	3	[æ˜nɾˈbɜ̥ɾʌ]	1	2
43.	helicopter	/ˈhɛləkɒptə/	5	4	[ʔæləˈdɒʔʌ̤̆]	1	2	[ʔɛ̥liˈtʰ ɒʔə]	1	4
44.	hospital	/ˈhɒspɪtəl/	5	3	[ˈʔɒʔəbɒʔə̤̆ʊ]	0	2	[ˈʔɒʔəpʰ ɒʔʊ]	2	2
45.	house	/haʊs/	2	1	[ʔɑʊʔ]	0	1	[ʔɑʊʔɱ]	0	1
46.	jam	/ʤæm/	2	1	[ˈfæwə˜̤̆n̥]	0	1	[tɬæ˜m]	1	1
47.	jelly	/ˈʤɛli/	2	2	[ˈfæli:]	1	1	[ˈfɛ̤̆li]	1	2
48.	jump	/ʤʌmp/	3	1	[fʌ˜̤̆mp']	2	1	N/A	N/A	N/A
49.	kangaroo	/ˈkæŋgəru/	4	3	[ˈd̥æ˜ndəʊəu]	0	2	[ˈtʰæ˜ndəʊu]	0	3
50.	kitchen	/ˈkɪʧɪ˜n/	3	2	[ˈdɪʔɪ˜n]	1	2	[ˈtʰɪʔə˜nɱ]	1	2
51.	knife	/naɪf/	2	1	[naɪʔ]	1	1	[naɪʔ]	1	1
52.	ladder	/ˈlædə/	2	2	[ˈlæʔːʌ]	1	1	[ˈlæʔɒ˜]	1	1
53.	leaf	/lif/	2	1	[liʔːɸː]	1	1	[liʔ]	1	1
54.	legs	/lɛgz/	3	1	[ˈɬæːʔt̥̆ɛ]	1	0	[ˈlæʔɪt̥]	1	0

55.	lighthouse	/ˈlaɪthaʊs/	4	2	[ˈlaɪʔaʊ˜ʔ]	2	2	[ˈlaɪʔaʊ˜ʔ]	2	2
56.	money	/ˈmʌni/	2	2	[ˈmʌ˜ ̤ni]	2	2	[ˈmʌ˜ni]	2	2
57.	monkey	/ˈmʌŋki/	3	2	[ˈmʌ˜nʔi]	1	2	[ˈmʌ˜nʔɪjɪʔ]	1	2
58.	moon	/mun/	2	1	[mɜ˜n]	2	0	[mũwə˜n̰]	2	0
59.	mouse	/mɑʊs/	2	1	[ˈmæ˜ʔʊ̰ʔ]	1	0	[mãʊʔ]	1	1
60.	orange	/ˈɒrɪnʤ/	3	2	[ɔˈjɪ˜n]	1	2	[ɔˈjɪ˜n]	1	2
61.	parachute	/ˈpærəʃut/	4	3	[ˈp͡fæwəfəʊʔ]	1	2	[ˈpæwəfuʔ]	2	3
62.	parrot	/ˈpærət/	3	2	[ˈbæwɪʔ]	1	1	[ˈpʰ æʊəʔ]	2	2
63.	pig	/pɪg/	2	1	[bɪʔ]	0	1	[pʰ ɪʔ]	1	1
64.	plate	/pleɪt/	3	1	[b̰eɪʔ]	1	1	[p̰ leɪʔ]	3	1
65.	pram	/præm/	3	1	[fæ˜m]	1	1	[p̰ æ˜m̰]	2	1
66.	pyjamas	/pəˈʤɑməz/	4	3	[ˈlɑ˜mijə]	1	1	[ˈlɑ˜mijə]	1	1
67.	queen	/kwin/	3	1	[fɪ̈ːn]	1	1	[fɪ̈n]	1	1
68.	rabbit (bunny rabbit)	/ˈræbɪt/	3	2	[ˈw̰æbəʔ]	2	1			
		/ˈbʌ˜niˈræbɪt/	(5)	(4)				[ˈbʌ˜nɪ̈næbɪʔ]	4	4
69.	rain	/rɛɪ˜n/	2	1	[weɪ˜n]	1	1	N/A	N/A	N/A
70.	ring	/rɪ˜ŋ/	2	1	[ʊɪ˜n]	0	1	[wɪ˜n]	0	1
71.	roof	/ruf/	2	1	[wəʊʔ]	0	0	[wuʔ]	0	1
72.	sandwich	/ˈsæmwɪʤ/	4	2	[ˈt͡sæ˜mbwʊʔ]	2	1	[ˈt͡sæ˜m͡mʌ˜]	1	1

73.	sausage	/ˈsɒsɪʤ/	3	2	[ˈt‿ ɒʔəʔ]	0	1	[ˈtʰ ɒʔɛʔ]	0	1
74.	school	/skul/	3	1	[ləʊ̯]	0	0	[lɔ̯ʊ]	1	0
75.	scissors	/ˈsɪzəz/	3	2	[ˈtʰ ɪʔəwəʔ]	0	2	[ˈtʰ ɪʔəwəʔ]	0	2
76.	scooter	/ˈskutə/	3	2	[ˈfuʔɑ̤h]	1	1	[ˈt̤͡sṳʔʌ]	1	1
77.	seesaw	/ˈsisɔ/	2	2	[ˈt͡sitɔ]	0	2	[ˈt̤ʰ itʰ ʊ]	0	1
78.	shark	/ʃɑk/	2	1	[fɑ̯ːʔ]	0	1	N/A	N/A	N/A
79.	sheep	/ʃip/	2	1	[fip']	1	1	[fip]	1	1
80.	slipper	/ˈslɪpə/	3	2	[ˈnɪʔp͡fɑ˜]	1	1	[l̤ɪʔpˇə]	2	2
81.	snake	/sneɪk/	3	1	[neɪʔt'̤]	1	1	[neɪʔ]	1	1
82.	sock	/sɒk/	2	1	[dɒʔfŋ]	0	1	[tʰ ɒʔfŋ]	0	1
83.	spaghetti	/spəˈgɛti/	4	3	[ˈt͡s̤ɛ̤ʔi]	1	2	[ˈtʰ æʔi]	1	1
84.	spider	/ˈspaɪdə/	3	2	[ˈbaɪdə̤]	1	2	[ˈʦa̤ɪdə]	1	2
85.	splash	/splæʃ/	4	1	[læʔ]	1	1	[læʔ(ŋ)]	1	1
86.	sponge	/spʌnʤ/	4	1	[fʌ˜nt']	1	1	[pʰʌ˜nd̤']	2	1
87.	square	/skwɛə/	3	1	[fæ˜]	0	0	[p͡fæ˜]	0	0
88.	strawberry	/ˈstrɔbri/	5	2	[ˈfɔbi]	1	2	[ˈfɔbi]	1	2
89.	swing	/swɪ˜ŋ/	3	1	[fɪ˜ŋ]	1	1	[fˈɪn]	0	1
90.	teeth	/ti θ/	2	1	[diʔ]	0	1	[tʰ iʔ]	1	1
91.	telephone	/ˈtʰ ɛləˈfə ʊn/	4	3	[ˈtʰɛləvə˜m̩]	2	2	[ˈtʰæːfɜ˜̤n]	2	0
92.	television	/tɛləˈvɪʒə˜	5	4	[t‿æ̤ləˈbɪʔə˜n]	3	3	[tʰɛlibɪʔə˜n	3	4

		n/						]		
93.	thankyou	/ˈθ æŋkju/	4	2	[ˈt͡sæ˜nʔdəu]	0	1	[ˈʔæ˜nʔt̪u̪..]	0	2
94.	this	/ðɪs/	2	1	[dɪʔ]	0	1	[ðɪʔ]	1	1
95.	three	/θ ri/	2	1	[f̪ːi]	0	1	[fɪ]	0	1
96.	thumb	/θ ʌm/	2	1	[fʌ˜m]	1	1	[pʰʌ˜m]	1	1
97.	tiger	/ˈtaɪgə/	2	2	[ˈdaɪjə]	0	2	[ˈtaɪdə]	1	2
98.	toilet	/ˈtɔɪlət/	3	2	[ˈlɔɪləʔ]	2	2	[ˈtʰ ɔɪləʔ]	3	2
99.	tomato	/təˈmɑtəʊ/	3	3	[ʔəˈmɑ˜ʔəʊ]	2	3	[cəˈmɑ˜ʔəʊ]	2	3
100.	tongue	/tʌŋ/	2	1	[dʌ˜n]	0	1	N/A	N/A	N/A
101.	toothbrush	/ˈtu θ brʌʃ/	5	2	[ˈduʔfˇʌʔ]	0	2	[ˈt̪ʰu̪..ʔfʌ˜ʔ]	1	2
102.	torch	/tɔʧ/	2	1	[t͡sːɔʔ]	0	1	[tʰ ɔʔɱ]	1	1
103.	tractor	/ˈtræktə/	4	2	[ˈfæʔɑ˜]	0	1	[ˈfæʔə]	0	2
104.	train	/treɪn/	3	1	[feɪ˜n˜]	1	1	[feɪ˜n]	1	1
105.	umbrella	/ʌmˈbrɛlə/	4	3	[ʔʌ˜nˈfælə]	1	2	[ʔʌ˜nˈfɛ̪lə]	1	3
106.	vacuum cleaner	/ˈvækjum ˈklinə/	7	4	[ˈb̪æʔɬũm ˈlimə˜]	2	4	N/A	N/A	N/A
107.	van	/væn/	2	1	[ˈfæwə˜n]	1	1	[bæːɾ]	0	1
108.	watch	/wɒʧ/	2	1	[f̪ɒʔ]	0	1	[wːɔʔ]	1	0
109.	web	/wɛb/	2	1	[wæ˜b̪]	2	0	[wæb˜]	2	0
110.	witch	/wɪʧ/	2	1	[wɪʔɱ]	1	1	N/A	N/A	N/A
111.	yellow	/ˈjɛləʊ/	2	2	[ˈʔəɬəʊ]	1	1	[ˈlɛləʊ]	1	2
112.	zebra	/ˈzɛbrə/	3	2	[ˈv̪æʔbʌ]	1	1	[ˈvɛʔbʌ]	1	2
		T1	**325**	**193**	**T1**	**101**	**142**	**T2**	**112**	**150**
		T2	**297**	**180**		**31.07%**	**73.57%**		**37.71%**	**83.33%**

Appendix 7.5 Hamish CS 1, T1, Monkey T1

Hamish	Monkey
	[ˈmʌ˜nʔi]
	I got one
	[ˈaɪ dɒʔ ˈwʌ˜n]
J	I don't believe you!
Hamish	I do
	[ai ˈdu:]
J	A live one
Hamish	No
J	(laugh)
Hamish	You know them ones what them move (?them legs)
	[u ˈnũ ðɛ˜m ˈwʌ˜nɪʔ wɒʔ ðɛ˜m mũ ˈvæ˜m ˈlæːə̯]
J	Right-OK
Hamish	I got one of them ones
	[aɪ ˈnɒ˜ʔ wʌ˜n ə ˈlɛ˜m ˈwʌ˜nə]
J	Have you? Oh
Hamish	And it in this school
	[ʔæ˜n ɪʔ ˈɪ˜n dɪʔ ˈləʊɬ]
J	Is it?
Hamish	Learning
	[ˈlɜnɛ˜n]
J	Is it?
Hamish	In that class
	[ʔɪ˜n͡ ˈnæ˜̯ʔ ˈlɑ]
J	Did it come to school?
Hamish	Yeh
J	With Edward?
Hamish	Yeh-and that it name-Edward
	[jɛ ə˜n͡ ˈnæ˜ʔ ɪʔ ˈneɪ˜m ˈʔæʔwəʔ]
J	Edward the monkey came with Edward the boy?
Hamish	And it mine
	[æ˜n ɪʔ mãɪ]
J	Oh-did he borrow it from you?
Hamish	No-it in that class (X X) Katie
	[ˈnə˜ʊ ɪʔ ˈɪ˜n næ˜ʔ ˈlɑ (ʔɒ˜m ɪʔ) ˈne˜ɪʔʊ͡i]
J	Does it live there or does it go home?
Hamish	(?going) to my home-cos it mine-and it Edward
	[ˈfəʊ˜nu ˈmãɪʲ ˈəʊ˜n̩-ˈnə˜ʔ ɪʔ ˈmãɪn-n̩ ɪʔ͡ æʔwəʔ]
J	And Edward's- do you share it?
Hamish	No it-a name-is Edward
	[nə˜ʊ (.) ɪʔ (.) ə ˈne˜ɪm ɪʔ ˈʔæʔwəʔ]
J	Is Edward-oh-I see it is yours and it's called Edward but it's at school with your brother Edward
Hamish	No
J	No?
Hamish	It a (x) Katie
	[ɪʔ ə (wɪ) (.) ˈg̈e̯ɪʔi]

J	It stays here?
Hamish	X X X no. You know Katie
	[ˈhɪə-nə˜ʊ-u nû ˈne˜ɪʔi]
J	Mm
Hamish	Katie
	[ˈɢeɪʔi]
J	yeh
Hamish	Katie in that class
	[ˈɢeɪʔi ɪ˜n ˈnæʔ lɑ]
J	Yes
Hamish	She is looking after it
	[ˈiʲ əʔ ˈlʊʔɪ˜n ˈɑʔəʷ ɛ̤ʔ]
J	Oh-Katie's looking after it
Hamish	And it not Edward
	[æ˜n ɪʔ ˈnɒ˜ʔ ˈæʔwə̰]
J	Oh right
Hamish	And it mine
	[æ˜n ɪʔ mãɪː]
J	Oh it's yours-I see

Appendix 7.6 Hamish CS 2, T1, Fish and chips

Hamish	A fish
	[ə ˈbɪʔfŋ]
	And- do you know what?
	[ˈæ˜n (..) dɒ˜ nũ ˈwɒʔ]
	I – had-sugar with it-I had some sugar with it.. my chips
	[ˈaɪ (...) ˈʔæ (...) ˈfˑːʊ. ʔə.. wɪ.ʔə..(..) ɔɪʲ æʔ ˈd̪ə˜ɱ ˈfʊʔə wɪb̪ɪʔ (..) mãɪ ˈfɪʔpɪʔ]
J	Really
Hamish	Yeh
	[jɛ˜]

Appendix 7.7 Hamish CS 3, T1, House

Hamish	House
	[ˈʔaʊʔ]
J	Does it look like your house?
Hamish	Um-no
	[əˇm (.) ˈnəˇʊ]
J	No? What does your house look like?
Hamish	My house look like-it look like- that (gesture) (?that's straight?) and it in a line-it not like (gesture to draw square)-m-m-m (sound with gesture)
	[ˈmaɪˇn ˈaʊˇʔ lʊʔ ˈlaɪ (.) ɪʔ ˈlʊʔ laɪʔ wæʔ (.) ˈvæ ˈdeɪʔ n̩ ɪˇn ə ˈlaɪˇn (.) ɪʔ nɒˇʔ ˈlaɪ m̩ m̩ m̩]
J	OK- -so it's a sort of a long house is it?
Hamish	Yeh. Here is the kitchen –and then it (was) out of kitchen- there a (?big hall)
	[ˈjiɑˇː (.) ˈiəʷ ɪʔ ə ˈdɪʔɪˇn (.) n̩ ˈnɛˇn̩ ɪʔ wə ˈʔəʊʔ ɒʔ ˈdɪʔn̩ (.) dɛʷ ə ˈbɪʔ ˈð]
Hamish	And that (?through) a kitchen on that other side- Rayburn
	[əˇn ˈnæˇʔ nuʷ ə ˈtʰɪʔɪˇn ɒˇn͡ næˇ ˈæʔə taɪ (.) ˈʊːeɪbə̤ˇn̩]
Hamish	and then it (?was) down the hall- through that way- the spare room- Edward's room
	[ˈnɛˇn ɪʔ wə ˈdæˇn ə ˈʔəʊ (.) nũ ˈðæʔ ˈweɪ (.) ə ˈbæ ʊˇm (.) ˈʔæʔwəʔ ˈwʊˇm]
Hamish	Then through that way mummy and daddy room
	[ˈʔnɛˇn̩ʔ bṳ ˈðæʔ ˈweɪ ˈmʌˇmiʲ æˇn ˈdædi ˈʊˇm]
Hamish	And through this way- bathroom
	[əˇn vu ˈðɪʔ weɪ (.) ˈfɑʔʊˇm]
Hamish	(It was this room in here)- Mummy room. There a bathroom in there
	[ˈɪʔ wə ˈnɪ ˈʊəʊˇ̃m̩ əˇn ˈʔɪː (.) ˈmʌˇmi ˈʊˇm (.) ˈðɛəʷ ə ˈbɑʔwʊˇm ɪˇˈnæˇ]
Hamish	(X X X) out - past other bathroom
	[ˈnu ɪʔ wə ˈʔəʊʔ (.) ˈpʰɑʔ ˈæʔə ˈbɑʔwʊˇm]
Hamish	And then my room
	[ˈn̩ˇ͡ nɛˇn mãɪ ˈʊɜˇmʰ]
Hamish	And Katie's room
	[æˇn (.) ˈneɪʔi ˈmɜˇm]
J	OK-is it a bungalow? Has it got stairs?
Hamish	Yeh – it a bungalow
	[ˈjɛ ɪʔ ə ˈbʌˇnd̤ələʊ]

Appendix 7.8 Hamish CS 4, T1, Numbers

J	Number?
Hamish	Five – number six
	[ˈpˆfaɪʔ (...) ˈmʌ˜nə˜ ˈdɪʔ]
J	Pardon?
Hamish	Number six
	[ˈmʌ˜nə˜ ˈdɪ̰ʔ]

Appendix 7.9 Hamish CS 5, T1, Saw and knife

Hamish	Saw
	[t͡sɔ]
J	Not a saw- something else you cut with
Hamish	But my dad got a saw
	[bə maɪ ˈd̥æd˞͡ dɒʔ ə ˈtɔd]
J	Has he?
Hamish	A real one
	[ə ˈwiʊ ˈwʌ̃˞n]
J	A real one?
Hamish	Mm
J	It isn't a saw tho'- it's a bit smaller than that
Hamish	I got that knife
	[ˈaɪ ˈnɒʔ ðæʔ ˈnãɪʔ]
J	Yeh - that's right
Hamish	I got that knife
	[ˈaɪ ˈnɒʔ ðæʔ ˈnãɪʔ]
J	You've got one like it?
Hamish	No- I got exactly the same
	[ˈnəʊ̯˘ (.) aɪ nɒʔ ˈtæ̃ʔli ə ˈt͡seɪ̃n̩]
J	Exactly the same?
Hamish	Yeh
	[jɛ̃˞]

Appendix 7.10 Hamish CS 6, T1, Holiday

Hamish	(click) I went on holiday
	[l ʌ ˈwɛ˜nʔ ɒ˜n ˈɒwədeɪ]
J	Oh-good-you went on holiday-where did you go?
Hamish	Two times to France
	[ˈdu ˈtʰaɪ˜mɪʔ du ˈf ̌ɑ˜nʔfŋ]
J	Twice to France-two times to France?
Hamish	On a p-on Friday
	[ˈɒ˜n ə pː ɒ˜n ˈf ̌aɪdeɪ]
J	Mm
Hamish	It was on Friday at the beginning of the summer holiday and everybody else was here
	[ˈɪʔ wə ˈɒ˜n ˈvaɪdeɪ ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈd̥ʌ˜mə ˈʔɔwə ̌deɪ n̥ ˈʔæ̥ʔibɒʔi ˈʔɛ̥ʊʔ wɒʔ ˈɪːʔ]
J	Oh-so you missed the end of term did you?
Hamish	Yeh
	[jʌ̥h]
J	Yeh
Hamish	No-it was beginning of the term
	[ˈnə˜ʊ ˈɪʔ wɒʔ ˈeɪʔ ˈdɪ˜nɪ˜n ɒʔ ə ˈt ̽ɜ˜m]
J	It was at the beginning?
Hamish	Yeh
	[jɛ]
J	OK
Hamish	And in the morning we went on an aeroplane
	[æ˜n (.) ˈɪ˜n ə ˈmɔ˜nɪ˜mː (.) i ˈwɛ˜nʔ ɒ˜n ə ˈʔɛ̥wəˈleɪ˜n̥]
J	Mm-so you went on an aeroplane
Hamish	And then after that – when we landed and then we went again and we went on a train
	[ə˜n nɛ˜n ˈɑʔə ˈðæʔ (.) və˜n i ˈlæ˜ndɪʔ n̥ n̥ wi ˈwɛ̥˜nʔ əˈdɛ̥˜n ə˜m̂ mɪ̆ ˈvɛ˜nʔ ɒ˜n ə ˈf ̌e̥ɪ˜n̥]
J	Oh
Hamish	And it was under water
	[ə˜n ɪʔ wʊ̆ʔ ˈʌ˜ndə ˈwɔʔə]
J	Oh-is it um-was it called Eurostar?
Hamish	Yeh
	[jɛ]
J	Ah-so you went on Eurostar - so you went to France twice-once by plane and once by Eurostar- is that right?
Hamish	Yeh
	[jʌ]
J	Where did you stay? Was it a caravan or a hotel?
Hamish	It near the mountains
	[ɪʔ ˈmɪʷ ə ˈmæ˜nʔɪ˜nɛ ̌ə]
J	Was it?
Hamish	And it-it a house and one of my friends lived in it but not anymore 'cos them went to a different country-(XX)-them live in LA
	[ə˜n ˈɪʔ ɪʔ ə ˈʔɑ˜ʊʔ (.) æ˜n ˈwʌ˜n ə mə˜ ˈvæ˜nd̥ɪʔ ˈlɪʔ ɪ˜nɪʔ

	bə ˈnɒ˜ʔ ɛ˜ni ˈmɔ˜ nə˜ ðəm ˈwɛ˛˜nʔ du ə ˈdɪʔn˛ʔ ˈdʌ˜mpi (d̪ɪ˜d̪ə mː) ɛ˜m lɪʔ ɪ˜n ˈæleɪ]

Appendix 7.11 Hamish: T1 & T2 Examples of imitated sentences (CSP task)

Target and response	
	Alice put gloves on her hands
T1	[ˈʔælɪʔ bʊʔ ˈlʌʔɪʔ ɒ˜n ə˜ ˈæ˜nfŋ]
T2	[ˈælɪʔ ˈfʊʔ ˈlʌʔbɪʔ ɒ˜n ɪʔ ˈæ˜nfŋ]
	Claire ate all her lunch
T1	[ˈlɑ ˈʔæʔi ˈɔ ə ˈlʌ˜n]
T2	[ˈlɛəʷ ɛʔiʔ ˈɔ i ˈlʌ˜n . ts]
	Good girls are nice
T1	1. [ˈwʊʔ ˈnɜ næ˜ʔ ˈnaɪʔ] 2. [ˈnʊ˜ʔ ˈnɛ˜ʊʷ ɔ ˈnãɪʔ]
T2	[ˈwʊʔ ˈdɛʊd ɑ ˈnãɪʔfŋ]
	Jane made some soup
T1	[ˈweɪ˜n (.) ˈme˜ɪʔ nʌ˜m ˈduː]
T2	[ˈfeɪ˜n ˈme˜ɪ ˈtʌ˜m ˈtuʔ]
	John played tennis
T1	[ˈwɒ˜n (..) ˈpəleɪ ˈtʰæ˜nɪ˜h]
T2	[ˈfɒ˜n (.) ˈleɪ ˈtʰæ˜nɪʔ]
	John collects stamps
T1	[ˈwɒ˜ːn əˈlæʔ ˈdæ˜nʔfŋ]
T2	[ˈfɔ˜n dəˈlæʔ ˈtæ˜m(b)ɪʔfŋ]
	Mary's shoes are clean
T1	[ˈmɛ˜wi ˈluʔɪʔ ɑ ˈvĭːn]
T2	[ˈmɛ˜wi ˈlũn (.) (ə) ˈfũʔ ˈmɛwi (.) ˈfũː aɪˈlĭn]
	My left leg hurts
T1	[ˈmãɪ˜ ˈlæ˜ʔ ˈlæ˜ʔ ˈəː]
T2	[ˈmãɪ ˈlæ˜ʔ læʔ ˈʌː]
	Sam ate an orange very slowly
T1	[ˈd̥æ˜m ˈnɛ˜ʔ əʔ ɔˈjɪ˜n wɛwi ˈlɜli]
T2	[ˈtæ˜m ˈæʔ ɒʔ ˈɒjɪ˜n ˈʊɛwi ˈləʊli]
	Sam loved to dance
T1	[ˈdæ˜n ˈlʌʔ ə ˈdɑ˜n]
T2	[ˈtæ˜m ˈlʌʔ tə ˈdɑ˜n]
	She cut my hair
T1	[i ˈdʌʔ mʌ˜ ˈʔæːʔ]
T2	[i ˈtʌʔ mãɪ ˈʔæ˜ː]
	The brown bear eats fish
T1	[ə ˈf˜æ˜n (.) ˈbæ iʔ ˈbɪ˜]
T2	[ə ˈfaʊ˜n ˈbæ˜ iʔ ˈfɪː]
	This shape is a square
T1	[vɪʔ ˈfeɪp ɪʔ ə ˈfæ˜ː]
T2	[vɪʔ ˈfeɪp ɪʔ ə ˈfæ˜ː]
	You can read my book
T1	[ˈʔəʊ˜n ə ˈmĭ mãɪ ˈbʌʔ]
T2	[nə˜m̂ mĭd mãɪ ˈbʊəʔ]
	You eat pudding with a spoon
T1	[əʊ˜ʔ iʔ ˈbʊʔɪ˜n wɪ˜ ə ˈp̥ʒ˜nʰ]

T2	[ɔ ˈiʔ ˈpʊʔɪ˜n wɪʔ ə ˈfʉ̃n]
	We watched television all day
T1	[wɻɪ ˈwɒʔ (.) ˈtʰɛˌləbɪʔə˜n ɔ ˈdeɪ]
T2	[i ˈwɒʔ (.) ˈtʰɛˌləbɪʔə˜n ɔ ˈdeɪ]

Appendix 7.12 Hamish, Intelligibility stimuli

Single words

Word	Adult target	**Hamish's realisation T1**	Number of listeners identifying word T1	**Hamish's realisation T2**	Number of listeners identifying word T2
feather	/ˈfɛðə/	[ˈbæ˜ʔɑ˜..]	0/66	[ˈpʰæ˜ʔə˜nʔ]	0/66
fishing	/ˈfɪʃɪ˜ŋ/	[ˈbɛʔɪ˜n]	0/66	[ˈfˈɪʔɪ˜n]	9/66
pig	/pɪg/	[bɪʔ]	2/66	[pʰ ɪʔ]	14/66
snake	/sneɪk/	[neɪʔːtˈ]	26/66	[neɪʔ]	56/66
spider	/ˈspaɪdə/	[ˈbaɪdə.]	40/66	[ˈʦa..ɪdə]	47/66
square	/skwɛə/	[fæ˜]	1/66	[pˆfæ˜]	0/66
strawberry	/ˈstrɔbri/	[ˈfɔbi]	17/66	[ˈfɔbi]	7/66
swing	/swɪ˜ŋ/	[fɪ˜ŋ]	0/66	[fˈɪn]	2/66
teeth	/ti θ/	[diʔ]	2/66	[tʰ iʔ]	12/66
toothbrush	/ˈtu θ brʌʃ/	[ˈduʔfˇʌʔ]	0/66	[ˈtʰu..ʔfʌ˜ʔ]	14/66

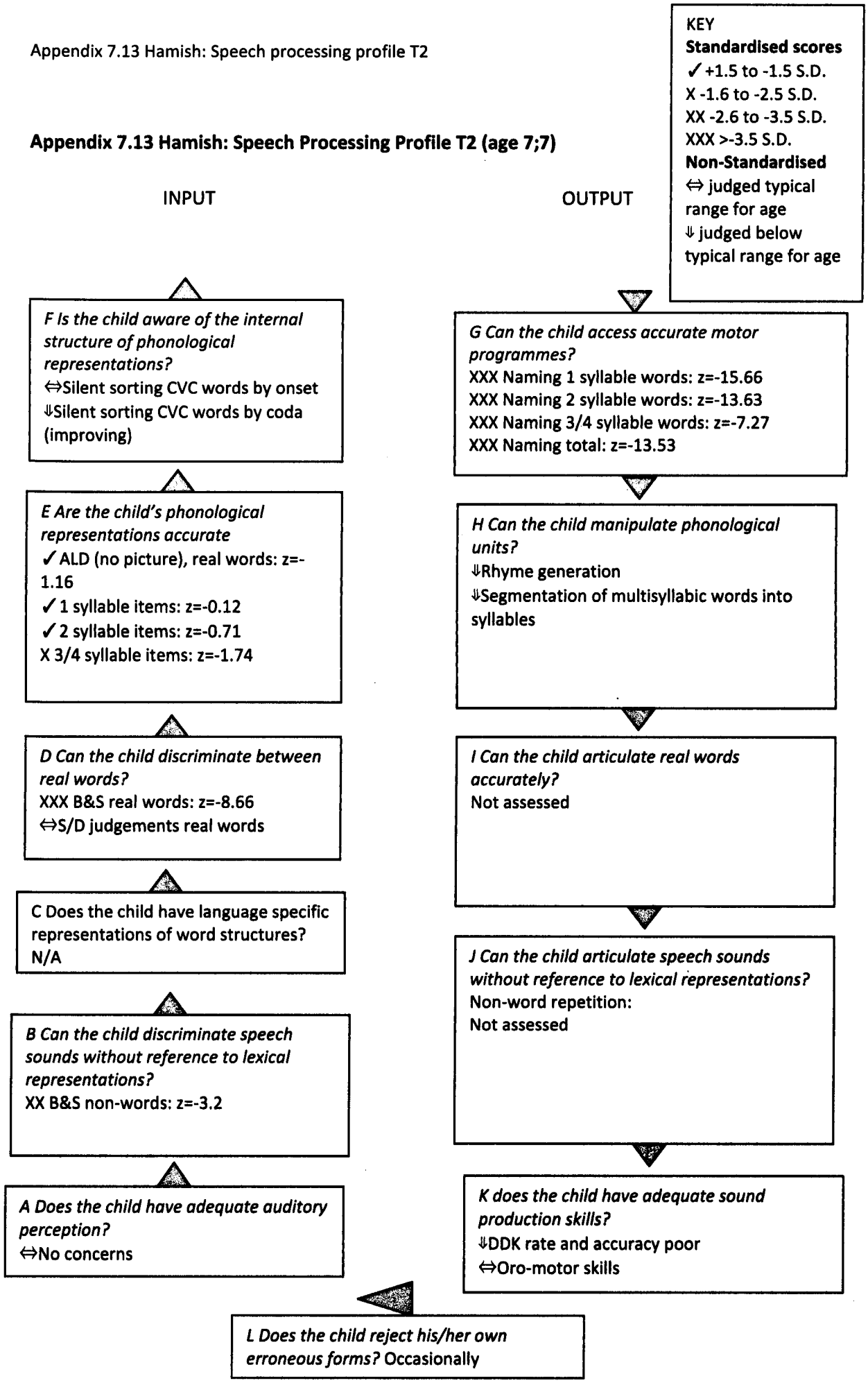
Imitated sentences (CSP task)

Target sentence	**Hamish's realisation T1**	**Percentage of words recognised by individual listeners T1**	**Hamish's realisation T2**	**Percentage of words recognised by individual listeners T2**
He gave me a banana	[i ˈdeɪ ˆɱɪ̈jə ˈnɑ˜nə..]	60.81%	[i ˈdeɪʔ ˈmi ə ˈnɑ˜nə..]	85.45%
She wrapped the parcel	[i ˈʊæ˜ʔ ə ˈbɑ˜ʔəʊ]	9.09%	[i ˈʊæʔ bə.. ˈpʰ ɑʔəʊ]	23.11%
They argued all day	[ðə˜m ˈʔɑdʊʊɪ ˈʔɔ deɪ]	42.42%	[ðeɪ ˈʔɑtʰ ʊwɪ ˈɔʊ deɪ]	62.42%
We saw an elephant at the zoo	[wi ˈdɔʷ ə ˈʔæləʔɪ˜nʔ ˈæʔ ə ˈdu]	14.65%	[wi (.) ˈtʰ ɔʷ ə ˈʔæləʔɪ˜nʔ ˈæʔ n, ˈtʰ u]	28.03%
You must clean your teeth	[ð ˈmæʔ ˈlɪ̈nˆ nɔ ˈdi]	0.30%	[ð ˈmʌ˜ʔ ˈlɪ̈ʔ ˈɔ ˈtʰ i]	6.06%

Conversational speech

Target sentence	T1 or T2	Hamish's realisation	Percentage of words identified by individual listeners
AT (THE) BEGINNING OF (THE) SUMMER HOLIDAY	T1	[ˈʔæʔ ə ˈdɪ˜nɪ˜n ɒʔ ə ˈd̪ʌ˜mə ˈʔɔwə˜deɪ]	19.70%
I WENT ON HOLIDAY	T1	[ʌ ˈwɛ˜nʔ ɒ˜n ˈɒwədeɪ]	71.21%
IN THE MORNING WE WENT ON (A) AEROPLANE	T1	[ˈɪ˜n ə ˈmɔ˜nɪ˜m: (.) i ˈwɛ˜nʔ ɒ˜n ə ˈʔɛ̪wəˈleɪ˜n̪]	59.09%
ONE OF MY FRIENDS LIVES IN LONDON	T1	[ˈwʌ˜n əʔ maɪ˜n ˈvæ˜nːɪʔ ˈlɪʔ ɪ˜n ˈlʌ˜ndə˜n]	50.84%
TWO TIMES TO FRANCE	T1	[ˈdu ˈtʰaɪ˜mɪʔ du ˈf˜ɑ˜nʔfŋ]	8.33%
AND I WAS AT (THE) FRONT SO (THE) WATER (WENT) AT ME FIRST	T2	[n̩ ˈʔaɪ wə ʔæʔ ə ˈfʌ˜n təʊ ˈwəʊʔəʊ ˈwɛ̪˜nt̪ ʔæʔ ˈmi fɑʔ]	23.94%
AND THAT'S WHY THEY DO IT WITH MARSHMALLOWS	T2	[ə˜ læ ˈwæ li ˈduʷ ɪʔ wɪ ˈmɑʔmæˈləʊwɪ]	13.94%
IT WENT ON (THE) BOAT	T2	[ˈʔɪʔ wɛ̪˜nʔ ˈɒ˜n də ˈb̪əʊʔn̩ ʔ]	53.64%
QUITE (A) LOT WE FED ON (THE) BOAT	T2	[ˈwaɪʔ ə ˈlɒʔ wi ˈfæʔ ɒ˜n ə ˈbəʊʔfŋ]	61.69%
WE WENT TO NEW YORK FIRST	T2	[wi ˈwɛ̪˜nʔ tʰu ˈnū ˈjɔʔ ˈfɑ˜̪ːʔ]	89.39%

Appendix 7.13 Hamish: Speech Processing Profile T2 (age 7;7)

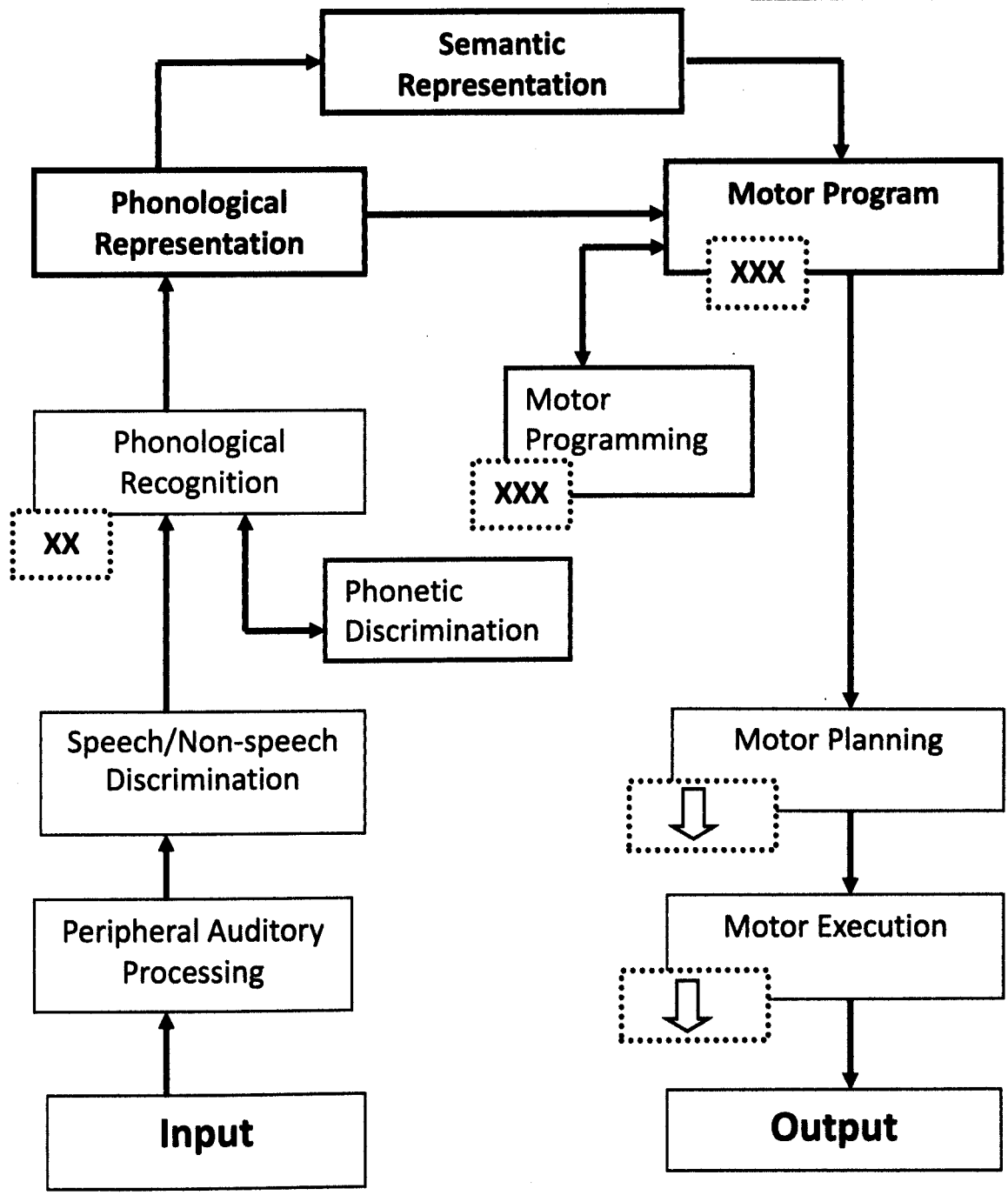


Appendix 7.14 Hamish: Speech Processing Model T2

(Stackhouse & Wells, 1997):
Hamish suggested areas of difficulty, T2

KEY
Level of difficulty hypothesized from normed tasks
X or XX or XXX

Presence of difficulty hypothesised from weak/poor performance on informal tasks



Appendix 7.15 Hamish CS 1, T2, Alligators

J	So tell me about your summer-tell me what you've been doing
Hamish	Went to Disney
	[ˈwɛ˜ˌnt˜ tʰ u ˈdɪʔnɪ̃]
Hamish	I went-I went to America
	[ʔaɪ ˈwɛˌnʔ (.) aɪ ˈ wɛˌntˆ tʰu ˈmæwˌɪʔə]
J	Mm
Hamish	New York and then I went-landed in Newami (i.e. Miami)
	[ˈnũ ˈjɔʔ n, nɛ˜n aɪ ˈwɛˌ˜nʔ (.) ˈlæ˜ndɪ ɪ˜nˆ ˈnuʔæ˜mi]
Hamish	[X X (?five years) X at in Florida-where there near - there is lot of alligator and (XX)]
	[ˈfaɪ jɪə ˈtʰʌ˜mæʔ ɪ˜n ˈlɒwɪʔʌ„ (.) ˈwæʔ lʊʔ ˈnɪːə (.) ˈðɛəʷ ɪʔ ˈlɒʔ ɒʔ ˈælɪdeɪʔə ə˜n ˈwʊʔɪt']
Hamish	And then we went-we went to New York first
	[æ˜n ˈðæ˜n (.) ˈwi (.) ˈwæ˜nʔ (.) wi ˈwɛˌ˜nʔ tʰu ˈnũ ˈjɔʔ ˈfɑ˜ˌːʔ]
Hamish	And then we - and attack marshma-alligators with marshmallows
	[ə˜ nɛ˜n wɪ̃ (.) ə˜n əˈtæʔ ˈmɑ˜ʔmæ˜ (.) ˈælɪdeɪʔə wɪ ˈmɑmæləʊfŋ]
J	You fed alligators with marshmallows?
Hamish	Yeh
J	How did you do that?
Hamish	(?Like that)
	[(mə˜ dæʔ)]
J	But how did you do it...
Hamish	An airboat-we do it on a airboat
	[n, ˈɛˌəbəʊʔ (.) ˈwi duʷ ˈɪʔ ɒ˜n ə ˈɛˌəbəʊʔ]
Hamish	And hit them in the water
	[ə˜n ˈɪʔ ðə˜m ˈɪ˜n ə ˈwɔːʔʌ]
Hamish	(X X) do (?to) them - but a lot of times it will sink in the water
	[nɒʔ ˈfæ˜mp, du ðə˜m (.) ˈbɪʔ ə ˈlɒʔ ə ˈbaɪ˜m ɪʔ wʊ ˈɬɪŋʔ ɪ˜n ə ˈwɔːʔʌ]
Hamish	And that why they do it with marshmallows
	[ə˜ læ ˈwæ li ˈduʷ ɪʔ wɪ ˈmɑʔmæˈləʊwɪ]
Hamish	(Don't) know why
	[ɛ˜nə˜ʊ ˈwaɪ]
J	Oh so how many alligators?
Hamish	Quite a lot we fed on the boat
	[ˈwaɪʔ ə ˈlɒʔ wi ˈfæʔ ɒ˜n ə ˈbəʊʔfŋ]
Hamish	On the air boat what had a big (pro)peller on the back
	[ˈɒ˜n ə ˈʔɛˌəbəʊʔ wɒʔ ˈæʔ ə bɪʔ ˈpɛləʷ ɒ˜n ə ˈbæʔ]
Hamish	They go extremely fast
	[ðeɪ ˈwəʊ (.) ˈfɪ̃məli ˈfɑʔ]
J	OK. So was that you favourite thing on the whole holiday?
Hamish	Yeh
J	They like marshmallows do they?
Hamish	Um-not a lot!
	[ə˜m (.) ˈnɒʔ ə ˈlɒʔ]

Appendix 8.1 Speech output summary: Tallulah, Harry, Lily, Hamish: T1 & T2

(Note: this table indicates the presence of phonological processes but not the frequency of their occurrence; shaded cells indicate that the process did not occur in the data at T1 or T2)

Phonological process analysis (PPA)								
Structural processes	**Tallulah T1**	**Tallulah T2**	**Harry T1**	**Harry T2**	**Lily T1**	**Lily T2**	**Hamish T1**	**Hamish T2**
Weak syllable deletion	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Final C deletion			Yes	No	Yes	No	Yes	Yes
Initial C deletion	Yes	No			Yes	No		
Vowel insertion (epenthesis)			Yes	Yes				
Cluster reduction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diphthong reduction							Yes	Yes
Diphthongisation							Yes	No
Coalescence of features	Yes	No	Yes	Yes			Yes	Yes
Segmental processes								
Pre-vocalic voicing					Yes	Yes	Yes	Yes
Final obstruent (post-vocalic) devoicing	Yes	Yes	Yes	Yes				
Velar fronting	Yes	No	Yes	No	Yes	No	Yes	Yes
Stopping	Yes	No			Yes	Yes	Yes	Yes
Alveolar realisation of labiodental fricatives			Yes	No				
Deaffrication			Yes	Yes	Yes	Yes	Yes	Yes
Gliding of approximants	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Glottal replacement			Yes	Yes	Yes	Yes	Yes	Yes
Vowel lowering							Yes	Yes
Vowel fronting							Yes	Yes
Word level errors								
Consonant harmony	Yes	No			Yes	No	Yes	Yes
Features not captured through PPA								
Atypical nasal realisations	Yes	Yes					Yes	Yes
Lexical idiosyncrasies			Yes	Yes	Yes	No		
Atypical duration/CV transitions					Yes	Yes		

Appendix 8.2 Tallulah, Harry, Lily, Hamish: Connected speech processes T1 and T2

Process	Tallulah		Harry		Lily		Hamish	
	T1	T2	T1	T2	T1	T2	T1	T2
PCC	70.82	91.47	62.11	79.50	44.90	90.41	31.07	37.71
Assimilation (A)								
t#	2/4*	2/4*	0/4*	3/4*	1/4*	3/4*	0/4*	0/4*
n#	2/4*	2/4*	0/4*	3/4*	3/4*	2/4*	0/4*	0/4*
d#	4/4	4/4	0/4*	1/4*	2/4	3/4	0/4*	0/4*
#ʃ	1/2*	2/2	0/2*	2/2	0/2*	1/2*	0/2*	0/2*
Elision (E)								
Ct#C	2/4*	1/4*	2/4*	3/4*	1/4*	3/4*	0/4*	0/4*
Cd#C	7/10	3/10*	10/10	7/10*	5/10*	5/10*	2/10*	2/10*
Liaison (L)								
j-	1/4*	2/4*	1/4*	4/4	1/4*	4/4	2/4*	0/4*
w-	0/2*	1/2*	1/2*	1/2*	0/2*	2/2	1/2*	1/2*
r-	0/4*	1/4*	0/4*	1/4*	4/4	4/4	3/4*	2/4*
Articles								
Indefinite	0/2	0/2	0/2	1/2	0/2	0/2	0/2	0/2
Definite	0/2	0/2	0/2	1/2	0/2	0/2	0/2	0/2
*scores from CSP task below range expected for age								
CSP in conversational speech	A E L	A E L	L	A L	L	A E L	L	L

Appendix 8.3 Summary of intelligibility results Tallulah, Harry, Lily, Hamish, T1 and T2

	Tallulah		**Harry**		**Lily**		**Hamish**	
	T1	T2	T1	T2	T1	T2	T1	T2
PCC	70.82%	91.47	62.11	79.50	44.90	90.41	31.07	37.71
PVC	95.41%	99.43	95.83	98.94	92.06	96.80	73.57	83.33
Single words								
Mean %	54.82	66.25	59.78	64.14	23.41	85.12	13.33	24.39
SD%	6.03	18.54	15.71	13.63	15.79	9.10	10.86	13.02
% Range	27.27-81.82	18.18-100	27.27-90.91	33.33-91.67	0-63.64	54.55-100	0-40.00	0-60.00
Imitated sentences								
Mean %	80.30	74.79	64.23	62.22	36.42	78.21	25.69	41.21
SD%	17.67	14.35	14.09	12.71	11.23	10.06	12.57	13.10
% Range	50-100	36.36-95.45	28.57-100	35.71-82.14	12.50-62.50	50.00-95.83	8.00-56.00	16.00-76.00
Conversational speech								
Mean %	66.71	92.70	54.12	82.17	40.09	86.07	45.30	46.14
SD%	13.30	8.12	15.68	9.61	17.84	6.66	13.52	12.62
% Range	33.33-91.67	54.55-100	21.88-87.50	48.84-95.35	3.57-75.00	69.05-97.62	10.00-73.33	20.00-82.86