

New Zealand Articulation Test Manual

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Chapter 1

The origins of the NZAT

Rationale for developing and norming the test:

The development and norming of the NZAT was driven out of a clinical need for locally normed assessments which are appropriate for the New Zealand context.

Articulation assessments commonly used in New Zealand (NZ) are developed in Britain or America, have a cultural bias with some test items and are expensive to purchase. NZ clinicians also use normative data from British and American populations, which have significant differences from the NZ community in ethnic makeup, educational practises and linguistic dialects. The main studies previously used for normative data in NZ are from Templin (1957), Pool, (1931) and Sanders (1972). Often the norms used are presented in oversimplified charts outlining the age ranges in which children master sounds, without adequate accompanying information to allow clinicians to interpret the charts correctly. For example Sander's (1972) chart as presented in *Much More Than Words*, (Specialist Education Services, 2000) does not show the percentages that the end and beginning of the bars on the chart represent, or the criteria for mastery of each consonant sound by position. This leads to misinterpretation of the chart by clinicians.

There were two NZ normative studies published in the 1980s, by the Otago Speech Therapy Association. The first study (Justin, Gibson and Silva, 1980) normed the Dunedin Articulation Test (DAT) on children aged 2-6 years. The DAT assessed sounds using a mixture of single words and sentences with a mixture of picture and object stimuli. The DAT is not currently used, as it is outdated in vocabulary e.g. "the cowboy has a gun".

Justin, Lawn and Silva (1983) normed the Dunedin Articulation Check (DAC) on children aged 7-8 years. The DAC assessed a later developing group of consonant sounds using picture stimuli. It was a very brief screening tool, targeted towards a less disordered population, than the Group Special Education (GSE) School Focus Service now provides a service for. This test is no therefore longer used in GSE.

It is important to have local norms for assessment tools, so that children are compared on a "like to like" basis. It is difficult to use norms gained from one test to interpret another, because of:

- differences of percentage of acceptable productions in comparison to use-opportunities
- criteria for acquisition of sounds differing between researchers
- differing methods of presenting results
- different phonemic contexts of the word which the sounds are assessed in
- different conditions sounds were tested under e.g. single words versus sentences and spontaneous versus imitated production (Dodd, Holm, Hua and Crosbie, 2003; Porter and Hodson, 2001).

Smit, Hand, Freilinger, Bernthal and Bird, (1990) found that children are acquiring some speech sounds earlier than reported in the first speech sound acquisition studies such as Templin's research (1957). Continued use of normative data from studies in different populations, using different methods, from several decades ago, is therefore contraindicated.

In addition, it is useful clinically to know whether certain types of errors are more or less likely to spontaneously resolve and which types of error are a concern or considered typical, at different ages. Normative studies tend to limit reports of their findings to whether a phoneme was correct or incorrect. This information is available in their raw data, but seldom disseminated to clinicians.

For these reasons, a commonly used articulation test in New Zealand was updated and a normative study was undertaken to provide this information for clinicians in New Zealand.

The Tauranga Articulation Test

The Tauranga Test of Articulation was developed by Ros De Candole in 1986. Originally intended for her own clinical use, it gained popularity with other therapists and became widely used around New Zealand.

The test was a systematic means of assessing an individual's articulation of the consonant sounds of New Zealand English. It was designed as a screening assessment to provide a quick method of checking school aged children's articulation. It was recommended to be used in conjunction with a spontaneous speech sample, and language screening assessments. Children identified as having articulation difficulties would require further assessment of their articulation and / or phonological processes.

The test was designed to be produced at low cost by GSE offices for distribution among GSE clinicians.

The test was updated and revised in 2003. The best features of the original were retained. Changes were made in consultation with the original author and clinicians via surveys and pilot studies of the test

(as described in Chapter 2). Here is a summary of the new features and those which were retained from the original:

- Pictures were updated for all items.
- Word choices were changed as outlined in Table 1.1.
- Phonetic symbol labels above test items were removed, as older children were able to read some of these and gain a cue for how to say the word correctly.
- Cues for therapists to elicit the target word were added for items which more than 10% of children did not name spontaneously in the trials of the test.
- Vocabulary items which were often incorrectly identified were removed from the test.
- A multisyllabic section and discussion picture were added to allow assessment of children's articulation in more complex phonetic contexts and in connected speech.
- The score form was updated to include space to record stimulability, multisyllabic subtest and discussion picture results.
- The test was reviewed by a Maori cultural panel for cultural bias, and was trialled on children of a variety of ethnicities in the trial study.
- The test was first trialled on children both from a low socioeconomic school, but who had normal developing communication skills and the final version was trialled on children from clinicians' caseloads with speech and / or language disorders. This was to ensure its suitability for both the normally developing and disordered population.
- The test was renamed the New Zealand Articulation Test as clinicians from all over the country contributed to its development.

Sound	TAT	NZAT	Reason for change
Final /p/	Sheep	Cup	Vocabulary
Initial /t/	Tent	Tap	Vocabulary
Medial /g/	Dragon	Burger	Vocabulary / consonant harmony
Medial /f/	Elephant	Dolphin	Multisyllabic word
Final /l/	Ball		Clinically insignificant sound
Medial /v/	Diver	T.V.	Vocabulary
Medial /n/	Banana	Money	Vocabulary
Medial /l/	Elephant	Toilet	Multisyllabic word
Medial /s/	Castle	Whistle	Vocabulary
Final /z/	Bees	Cheese	Morphemic s
Medial /tʃ/	Matches	Watching	Vocabulary
Final /tʃ/	Torch	Watch	Vocabulary
Initial /z/	Zebra	Zip	Vocabulary
Medial /z/	Scissors	Puzzle	Consonant harmony
Medial /ʃ/	Washing	Fishing	Difficult to picture
Medial /dʒ/	Engine	Magic	Vocabulary / difficult to picture / consonant harmony
Final /dʒ/	Orange	Fridge	Consonant harmony
Initial /j/	Yacht	Yoghurt	Vocabulary
Medial /j/	Onion		Clinically insignificant sound
Medial /w/	Flower		Clinically insignificant sound
Medial /ʒ/	Television		Clinically insignificant sound
Medial /θ/		Nothing	Clinically significant sound
Initial /pr/	Pram	Present	Vocabulary
Initial /gr/	Grapes	Green	Vocabulary
Initial /bl/	Blocks	Blue	Vocabulary
Initial /kw/	Queen		Uncommon blend
Initial /str/	Stripes	Straw	Vocabulary
Initial /skr/	Screw	Scratch	Vocabulary
Initial /spr/	Spring	Spray	Vocabulary

Table 1.1 Word Changes from the TAT to the NZAT

Chapter 2

Development and description of the NZAT

Development of the NZAT through pilot and trial studies

Pilot Study 1

The first version of the NZAT was trialled with sixteen five year olds (representing a variety of ethnicities) from a low socio-economic school. It was assumed that if the pictures were successful in eliciting the target word from the youngest children at school, with a likelihood of limited experiences and vocabulary, then they would be appropriate for all school children. Words, which required semantic cues or imitation by 33% of children or more, were investigated and where possible, were changed to simpler vocabulary.

Pilot Study 2

The purpose of this study was to improve the NZAT picture and word choice, and administration guidelines from feedback from clinicians. This study ran from July to August 2003. Ten clinicians administered the pilot version of the NZAT to three children from their Communication Initiative caseloads, who had a range of mild to severe speech disorders. Clinicians filled in feedback forms about the picture and word choice and layout of the NZAT, which were analysed for common trends. The score forms from the children were analysed in terms of how different clinicians transcribed responses, to guide improvements of the administration guidelines.

Trial Study:

The trial study ran from August until November 2003 and involved fourteen clinicians, who each administered the test to a maximum of five children on their Communication Initiative caseloads. The testing of each child was taped and the transcription of the responses sent back to the research coordinator for analysis.

A different method of transcribing responses was trialled from the way used in the Pilot Studies - transcribing the whole word instead of just the target sound for each word. These two methods were compared and the single sound transcription method for the normative sample was decided on. Clinicians would typically administer the test first in this way, with single sound transcription, and if further investigation of phonological processes was needed, would proceed onto more in depth testing. It is important to norm the test in the way it would typically be used, so that the testing conditions are the same between the normative sample and clinical practise. Single sound transcription is faster and possibly a more accurate method of recording responses than whole word transcription. (See Chapter 4 for a brief comparison of test retest and inter-rater reliability between the Goldman-Fristoe Test of Articulation (whole word transcription) and the NZAT (single word transcription)).

Assessment of more than one sound per test item was also considered at this point. Although clinicians are able to assess multiple sounds per word, when testing children with severe speech disorders, it can often be difficult to accurately transcribe more than one unusual error per word. Therefore, some therapists prefer to assess one sound per word. While this method takes longer than assessing several sounds per word, many therapists working with children with severely disordered speech prefer this method of assessment. For the purposes of normative sampling, it also allowed clinicians to just listen to the one sound per stimulus item, possibly increasing accuracy. It also allowed choosing the word which had

the best phonemic context to assess each sound, instead of having to compromise the context in order to accommodate more sounds per word.

Variations in the way clinicians administered the test and filled in score forms were analysed. Adjustments were then made to the administration guidelines to clarify the standard administration procedures, in preparation for the normative sample.

The number and type of prompts the children required to name each word was analysed. It was recorded whether the child could name the picture spontaneously, with a semantic cue, or if they needed to imitate the word after the clinicians. 69/87 words were named by more than 90% of the children without the need for imitation. The children in this sample were from clinicians' caseloads and on average, would be less able to name pictures, than the normative sample will be. Some therapists also skipped the semantic cue prompt and went straight to imitation on some items, which meant the number of children who could name the pictures spontaneously could have been higher.

Of the eighteen words which needed to be imitated by 10% or more of children, five of these have since been dropped from the test, as the sounds they assessed were assessed elsewhere or deemed clinically insignificant (initial /kw/, medial /w/, medial /j/, medial / ʒ / and final /l/.) Of the remaining thirteen words, the average percentage of children needing to imitate the word was 16.3%. One of these words was able to be improved on ("fly" changed to "flower" for initial /fl/). However, generally speaking, the words which the children required a model for, were sounds which are less commonly occurring and therefore have a smaller pool of test words to select from. The words selected, even though some children were unfamiliar with the words, were judged to be the best words possible

for these sounds. For example, there are no nouns starting with /ð/, so this sound is always going to be difficult to assess in a picture based articulation assessment.

Several final improvements to the pictures in the NZAT were also made at this point.

Cultural Review Panel

The word and picture choice of the NZAT was reviewed by a panel of Maori Special Education staff. None of the words were found to have a cultural bias for Maori children.

Description of the NZAT

Subtests of the NZAT:

The NZAT contains 5 subtests: Singleton consonants, blended consonants, vowels, multi-syllabic words and the discussion picture.

Singleton consonant and blend subtests

The singleton and blend subtests were used for the normative sample. They are made up of 82 pictured items. The child is asked to either name the picture or answer a question about it. The clinician does not model the responses, unless the child is unable to say the target word with semantic cues. A delayed imitation technique is then used. Anthony, Bogle, Ingram and McIsaac (1971, as cited in Kilminster and Laird, 1978) found no significant differences in test results gained by spontaneous rather than imitative responses on 2 administrations of the same test. While no statistically significant differences were found in this study, in clinical practice, some individual children are often noted to say words differently when producing words spontaneously versus in imitation. There may not be enough variation to be statistically significant, but still spontaneous productions are preferred in assessments where possible.

Vowel subtest

The vowel subtest was not normed, as vowels are much less likely to be in error compared to consonants at five years old (Templin, 1957). They are less likely to affect intelligibility if they are in error. Interlistener reliability is likely to be lower for vowels as opposed to consonants due to clinician's own differing vowel systems from dialectal differences.

The vowel section need not be administered, unless vowel errors are noted as the child names pictures in the earlier sections. All the

vowels and diphthongs are included in the consonant and blend section. The vowel section is to be used to specifically test vowel production, if further investigation is required.

The discussion picture

The discussion picture is administered by simply showing the child the picture and making non-directive, non-specific comments about the picture to the child e.g. "look at that!" If the child does not spontaneously talk about what they see in the picture, s/he is encouraged to talk about the picture by prompts such as "tell me about this part (point)". Minimal encouragers are used to encourage the child speak for as long as deemed necessary by the clinician.

The discussion picture was not included in the normative sample, as it is impossible to elicit a standard sample of spontaneous language from children, as both content and volume of language can vary greatly. In order to gain a connected speech sample in a standardised format, delayed sentence imitation would have had to have been used. However, Bankson and Bernthall (1982) compared delayed word imitation and delayed sentence imitation on children with multiple articulation errors. They found both methods produced the same results. Delayed sentence imitation was therefore not seen to be a valuable addition to the test.

A spontaneous connected speech sample is however, an important part of the assessment of a child's speech. McLeod, Hand, Rosenthal and Hayes (1994), found that for the majority of children with speech disorders, children's production of consonant clusters was the same in connected speech samples as in single words. However, there were significant differences in some phonological processes studied, especially for some individuals. A connected speech sample can be used to estimate intelligibility, which is an important factor in clinical decisions.

The multisyllabic subtest

The multisyllabic subtest provides extra information about a child's ability to coordinate multiple syllables. This subtest was not included in the normative data, as the multisyllabic section is an optional addition to the test. It is especially recommended for children with motor speech disorders such as dyspraxia. If a child has difficulty in the multisyllabic section, more in depth testing with an assessment specifically designed for motor speech disorders is recommended.

Stimulability testing

Stimulability testing assesses the child's ability to produce a previously misarticulated phoneme correctly, when given maximum prompting, both visual and aural. The stimulability information suggests to the clinician which sounds will respond most readily to therapy and those that will require a more prolonged effort. (Milisen, 1954).

Stimulability is determined by asking the examinee to watch and listen carefully as the clinician correctly produces sounds or words previously misarticulated. The examinee then tries to imitate the sounds / words as modelled. Stimulability in the NZAT is assessed with the sound in isolation, and in the positions the sound was misarticulated in, both in syllables and in words. Stimulability was not assessed in the normative sample, but is essential to administer to guide clinical decisions.

Chapter 3

Normative sampling

The NZAT normative sample was completed between February and June 2004, with a sample of 1014 children aged 5 years to 8 years, tested at 53 schools nationwide.

Examiners

Examiners were recruited from every region in New Zealand. (See Appendix B for a complete list of examiners.) All but two examiners were employed by Special Education. These two were final year speech language therapy students, who administered the test under supervision. All examiners were familiar with articulation testing and proficient in transcribing responses using the International Phonetic Alphabet (IPA). To ensure the quality of the data collection, Administration Guidelines and an example response form were provided to each therapist. Specific training of administration of the test and transcription using IPA was not deemed necessary. Phonetics and transcription using IPA is part of every clinician's qualification. The administration guidelines alone should be sufficient to enable clinicians to administer the test in a standardised manner. Conditions for norming should be the same as clinicians using the test in their clinical practise and therefore specific training was contraindicated.

Contact was maintained between the research coordinator and examiners by newsletter, email and telephone.

Site and Sample Selection

Each examiner was given a sample assignment which described the demographics of a sample of children to test. Examiners approached local schools for permission to test the children. Schools could then choose whether they wanted signed and returned

permission forms, or informed consent only. Therapists obtained the school roll for the ages concerned and selected the children matching the sample assignment, using a randomised procedure. Every fifth child on the roll was selected, starting from the tenth name on the list. The therapist tested the children at school during school hours. In small rural schools, it was not possible to use a randomised procedure to select the children, as there were not enough children with the target demographics. In these cases, all the potential subjects were used, provided they met other subject criteria.

The normative sampling procedure was simple. The consonant and blend sections of the test were administered to all children according to the Administration Guidelines. If the child articulated the sound correctly, a dot was marked on the response form. If the child used another sound, this was transcribed using IPA symbols. Diacritics were not recorded except for nasalisation. This was because only differences from typical production which cause a loss of phonological contrast, distraction for the listener or a loss of intelligibility are clinically significant.

Response forms were then sent back to the research coordinator for analysis. Statistical analysis was undertaken by statisticians from the New Zealand Council for Educational Research.

Characteristics of the sample:

Geographic region

The population of geographical regions was proportionally represented in the sample. Table 3.1 shows the population of each region compared to the percentage of normative sample. Care was

taken to represent each region of the country as closely as possible to the proportion of the total population. Each region was represented within 3% of the proportion of the population of New Zealand, except for Waikato, which was under represented by 6.1%. Proportions of rural versus urban children also reflected recent census information. 25% of the sample was from communities with a population of 1000 or fewer, with the remaining 75% from urban areas.

Gender and age

The standardisation testing plan is summarised in Table 3.2. The sample was divided primarily by gender and age, and aimed at 100 children in each group. This was done because of the established gender and age differences in developmental growth of articulation. Due to the relatively rapid changes in articulation development at age five years, a 6 month interval was used for this younger sample. Intervals of one year were used for the 6-8 year olds. Subjects were any age within their band e.g. 6 year olds could be aged from 6 years, 0 months to 6 years 11 months. In some smaller schools, target gender numbers in certain age groups were unavailable, leading to some gender groups by age being less than target. However, total sample targets were met for all age groups.

Socio economic status

An estimate of socio-economic status was controlled for by splitting the schools into decile bands of low (1-3), mid (4-7) and high deciles (8-10). Decile ranking is based on the extent to which a school draws its students from low socio-economic communities. Decile 1 schools are the 10% of schools with the highest proportion of students from low socio-economic communities, whereas decile 10 schools are the 10% of schools with the lowest proportion of these students. There are six factors which determine the socio-

Region	N sample population	% total sample	% NZ population*
Northland	38	3.8	3.7
Auckland	325	32.1	32
Bay of Plenty	64	6.3	6.2
Waikato	38	3.8	9.9
Manuwatu-Wanganui	82	8.1	6.2
Taranaki	16	1.6	1.2
Hawkes Bay	68	6.7	3.7
Wellington	124	12.2	11.2
Marlborough	14	1.4	1.2
Nelson	17	1.7	1.2
Tasman	7	0.7	1.2
Canterbury	138	13.6	12.5
West Coast	7	0.7	0.7
Otago	51	5.0	4.9
Southland	25	2.5	2.5

Table 3.1 Representation of total normative sample by geographic region.

*NZ population data from Statistics New Zealand census information, 2003.

Age	Female sample		Male sample		Total sample	
	Target N	Actual N	Target N	Actual N	Target N	Actual N
5:0-5:5	100	100	100	101	200	201
5:6-5:11	100	109	100	90	200	199
6	100	93	100	108	200	201
7	100	112	100	94	200	206
8	100	89	100	118	200	207
Totals	500	503	500	511	1000	1014

Table 3.2: NZAT Norming Testing Plan, by gender and age.

economic ranking: Household income, occupation, household crowding, educational qualifications, income support, and ethnicity. The latest decile information available (2003) from the Ministry of Education was used. Table 3.3 shows the target percentage for each decile band compared to the normative sample. The percentage of the normative sample differed from target percentage by up to 9%, with each band being well represented.

Decile Bands	N	Target %	% of sample
1-2	300	20	29
3-7	432	50	43
8-10	282	30	28

Table 3.3: Percentage of sample drawn from low mid and high decile bands.

Ethnicity

Examinees were classified into the following groups: European / Pakeha, Maori, Pacific Island, Asian or other. For many children, more than one ethnicity was recorded. For the purposes of this analysis, ethnicity was prioritised as follows:

If one of the ethnicities stated was Maori, that child was classified as 'Maori', otherwise if one of the ethnicities stated was Pacific, that child was classified 'Pacific', otherwise if one of the ethnicities stated was Asian, that child was classified 'Asian', otherwise if one of the ethnicities stated was European / Pakeha, that child was classified 'European / Pakeha', otherwise if one of the ethnicities stated was 'other', that child was classified 'Other'.

Table 3.4 shows the proportion of the sample from each ethnicity, compared with the population of New Zealand. Minority ethnicities were well represented in the normative sample.

Ethnicity	% of NZ population*	% of sample population
European	77	63
Maori	14	24
Pacific Island	6	10
Asian	6	3
Other	1	7

Table 3.4: Representation of ethnic groups in the sample compared with the NZ population. *Data from Statistics New Zealand census information 2001.

Special education status

Children who had Ongoing and Reviewable Resourcing Scheme (ORRS) Funding; permanent hearing loss; cleft palate and diagnosed syndromes which adversely affect learning were excluded from the normative data. This was because of the link between articulation ability and these conditions. Children with hearing loss, cleft palate and certain syndromes display a pattern of errors caused by physiological or sensory differences which are not applicable to the typically developing child.

Children who were already receiving speech therapy services for language and or speech difficulties, but did not fit in the above categories, were included in the sample. This is because the full range of articulatory ability needed to be represented in the sample.

Children with inadequate English to express themselves fluently were excluded. This was because their scores would have been affected by a lack of vocabulary knowledge and or an incomplete knowledge of English phonology as compared to their other language(s).

Chapter 4

Reliability and validity

Reliability

Reliability of tests is measured to ensure that the test results are consistent across time and different examiners. This section addresses internal reliability, test retest reliability and inter-rater reliability.

Internal reliability

Internal reliabilities were computed using co-efficient alpha. This is based on the intercorrelation among all comparable parts of the same test. The alpha reliabilities represent a measure of homogeneity of items throughout the test and are calculated using the variance of the dichotomously scored items (correct or incorrect production).

Table 4.1 lists the alpha reliabilities for the five age groups by gender. The alpha reliabilities range from 0.84 to 0.95 for males and 0.86 to 0.95 for females. The median reliability for males was 0.93, and 0.92 for females. This represents an acceptable level of internal reliability.

Test retest reliability

Test-retest reliability measures how much the individual's score might possibly change on retesting, if a period of time has elapsed between testings. Change could be due to an individual's maturation, or fluctuation in the ability being measured, or random difference in performance. In the case of the NZAT, score

Age	Male		Female	
	N	Alpha	N	Alpha
5:0 – 5:5	101	0.96	100	0.95
5:6 – 5:11	90	0.93	109	0.92
6	108	0.91	93	0.94
7	94	0.93	112	0.86
8	118	0.84	89	0.87
Median	0.93		0.92	

Table 4.1 Alpha reliabilities for NZAT normative sample by age and gender.

difference could also be due to differences in the examiners perception and transcription of errors.

The NZAT was administered twice to 47 subjects. The interval between testings, ranged from 2 to 3 weeks. All retesting was done by the same examiner who administered the NZAT the first time. Subjects were not informed that they would be retested at the initial administration. Table 4.2 lists the percent agreement for presence of error between the first testing and second testing for each sound tested. Most agreements were 100%. Least agreement was with initial /θ/ at 81%, final /θ/ at 85% and medial /ð/ at 85%. However, median percentage agreements were all 100% for initial, medial final and blended sounds. This demonstrates that for half the judgments for the 47 subjects, the dichotomous (correct or incorrect) retest result for each item was the same as in the first testing.

Table 4.2: Test-retest reliability as measured by percent of agreement for presence of errors. $n = 47$

Sound	Initial	Medial	Final
p	100	100	100
b	100	100	100
t	100	100	100
d	100	96	100
k	100	100	100
g	100	100	100
f	100	100	100
v	100	100	100
m	100	100	100
n	100	100	100
l	98	100	
h	100		
r	94	94	
w	100		
j	100		
ɲ		100	100
s	96	98	98
z	96	98	98
ʃ	100	100	100
tʃ	98	100	100
dʒ	100	100	100
θ	81	96	85
ð	98	85	

Blend	%	Blend	%
pr	96	sl	100
br	98	sw	100
fr	96	sm	100
tr	98	sn	100
dr	100	sp	100
kr	100	sk	98
gr	100	st	100
bl	98	spr	94
pl	100	str	96
kl	100	skr	100
gl	98	skw	100
fl	98		

Inter-rater reliability

The scoring of the NZAT is highly dependent on the ability of the examiner to judge each sound as correct or incorrect. Therefore inter-rater reliability was examined. Two pairs of different examiners tested the same sample twice. The interval between testings was 2-3 weeks. The inter-rater reliability sample included 51 subjects in total.

Table 4.3 lists the percentage of agreement for presence of error between the two testings by the different examiners for each item tested. Agreements ranged from 75% (final /θ/) to 100%. The median percentage agreements were all high at 98% for initial, medial and final sounds and 92% for blends. This demonstrates that for half the judgments for the 51 subjects, the pairs of examiners were in 98% agreement or greater for single consonants and 92% or greater for consonant blends.

These results were higher than Goldman and Fristoe (2000) reported medians of 93 for initial sounds (including blends), and 90 each for

medial and final sounds. The higher rater reliability in the NZAT study could be due to testing only one sound per word using single phoneme transcription, compared to testing up to two sounds per word using whole word transcription.

Table 4.3: Inter-rater reliability as measured by percent of agreement for presence of errors. $n = 51$

Sound	Initial	Medial	Final
p	98	96	84
b	100	100	96
t	98	100	86
d	100	94	94
k	98	96	98
g	98	98	96
f	100	100	98
v	94	98	98
m	100	100	100
n	100	100	100
l	100	100	
h	100		
r	92	98	
w	100		
j	98		
ɲ		94	100
s	94	94	96
z	86	94	92
ʃ	98	98	98
tʃ	98	100	100
dʒ	100	96	100
θ	84	90	75
ð	94	86	

Blend	%	Blend	%
pr	92	sl	82
br	98	sw	90
fr	96	sm	90
tr	98	sn	88
dr	92	sp	88
kr	96	sk	88
gr	98	st	86
bl	100	spr	88
pl	100	str	82
kl	100	skr	86
gl	98	skw	86
fl	100		

Validity

The validity of a test determines how well the test is measuring what it purports to measure. Evidence of test validity must demonstrate that the test adequately samples the domain it purports to measure (content validity) and that it measures the trait or underlying construct it claims to measure (construct validity).

Content Validity

Content validity addresses the question of whether the items in the test adequately sample the domain that the test purports to measure – in the case of the NZAT, the articulation of consonant sounds. All but one of the consonant sounds of Standard NZ English are measured in the NZAT. The sound /ʒ/ was not measured due to its relative infrequency in English words, particularly in words in young children's vocabularies. Three other singleton sounds, /j/, /ð/ and /w/, were not assessed in all consonant positions in which they occur in English. This is because medial /j/ and /h/ are seldom in

error, and final /ð/ is a low priority for therapy. While the NZAT includes a vowel section, this was not included in the normative testing sample, as vowels are seldom in error over age 5 years. Clinicians can use the vowel section for supplemental testing of children as needed.

James (2001) studied how well items in articulation tests discriminated between children with and without speech impairments. She found that the words with the highest discrimination were monosyllabic words containing word initial or word final blends and polysyllabic words. Disyllabic and polysyllabic words beginning with a weak syllable were also highly discriminating. She found that monosyllabic words with a CV or CVC shape, especially containing early developing sounds, had unacceptable levels of item discrimination. She recommended that use of tests which contain a preponderance of monosyllabic words with a CVC shape and the normative data derived from them be critically reviewed, especially for children aged four years and older.

The NZAT contains 32 CV and CVC words from a total of 82 test items, which is a high percentage of the total test. It tests initial and final sounds in single syllable words and medial consonants in disyllabic words. These words were carefully chosen to avoid difficult phonemic contexts, where surrounding consonants may have an effect on the tested consonant. This was to test the production of sounds in the easiest context possible. From clinical practise, for most children, if they can produce a sound in the easiest context possible, they are likely to generalise it to more difficult contexts over time without direct intervention. Therefore, it makes sense to assess a sound in its easiest context to reduce over identifying children as requiring therapy. (An exception to this is children with developmental verbal dyspraxia, where generalisation is much slower. If dyspraxia is suspected from NZAT results,

further in depth testing with a test specifically designed for dyspraxia is recommended.) The multisyllabic word subtest was included in the NZAT for supplemental testing of sounds in more difficult phonemic contexts.

In terms of obtaining normative data for over four year olds using CV and CVC words, James (2001) correctly notes that only a smaller percentage of children are still developing these sounds in these simple word structures at these ages. However, for the purposes of clinical practise in GSE, it is only that small percentage of children who are aimed to be identified through GSE screening assessment procedures.

Blended consonant sounds were only assessed in initial position in the NZAT, despite the fact that many English words contain word medial and final blends. Word initial blends are considered to be more important for intelligibility. As well as this, from clinical practise, children who can produce a blend in word initial position, usually generalise this ability to other positions in words without direct intervention. Again, an exception would be children with developmental verbal dyspraxia.

While the NZAT records a single attempt at each tested sound at the single word level, some children's productions of sounds vary from one attempt to the next. In such cases, whole word transcription of each test item can be used at the clinician's discretion.

The NZAT includes a phonological process analysis form for clinicians to use, if further analysis of processes is indicated. The NZAT however, was not designed to specifically assess phonological processes. While the analysis will provide information on the child's use of phonological processes, it is not equivalent to using a test specifically designed to analyse rule based behaviour,

and use of these tests is recommended if time permits (Garn-Nunn, 1986).

Further description of the NZAT's development and content, is detailed in Chapter 2 and provides further evidence of content validity.

Construct validity

Construct validity data establish the degree to which the underlying construct or trait the test purports to test is actually measured. The NZAT purports to measure the articulation of consonant and blended sounds in the most clinically significant positions in single words. As children increase in articulatory ability as they mature, evidence that the NZAT is measuring articulation is confirmed by the increasing total score for subjects as they get older. (See Appendix A; Table A-2). This table also closely correspond with the results of other normative studies of articulation tests, such as Goldman and Fristoe (2000). Similar ages of acquisition can be seen for the items tested.

Chapter 5

Determining and Interpreting Scores

Examiner qualifications:

Only people specifically trained in phonetics and the nature of articulation disorders should administer the NZAT. Only persons with specific training in speech language therapy should make decisions from this information, regarding the severity and type of disorder, the need for further in depth testing and targets for intervention.

Interpreting scores

The NZAT should be administered according to the Administration Guidelines in the front of the test. Deviations from the testing guidelines, may mean it is invalid to compare the results gained with the normative data.

Use of norms tables for individual sounds

A child's articulation of individual sounds can be compared to their age and gender matched peers using the norms tables (Appendix A, Table A-2). For example, if a six year old female is not articulating /tʃ/ correctly in initial position, by looking up the female norms, under 6-6:11 year olds, initial /tʃ/, we can see that 97.85 of her peers in the normative sample did articulate that sound correctly in the NZAT.

Comparison of error type using error tables

A child's manner of producing a particular sound can be compared to their age matched peers using the error tables. For example, if the above child was using /g/ for /tʃ/ in initial position, from looking at the transcribed responses of the total sample of six year olds, we see

that no other child in the sample substituted /g/ for /tʃ/ at age 6, or in fact, any other age. Unusual error patterns can indicate a higher need for intervention than typical developmental errors.

Typical developmental errors can be traced using these tables, so that clinicians can determine which errors are likely to resolve with age and which errors are less affected by age. For example, 7.46% of 5:0-5:5 year olds tested were using /θ/ for /s/ in initial position. At 5:6-5:11 years, the percentage increased, with 9.55% of children are using /θ/ for /s/. A steady decrease in this error pattern can then be seen, until by 8 years, 1.93% of children tested had an interdental lisp. However, the frequency of children using a /ɹ/ for /s/ does not substantially decrease between the ages of 5-8, with 0.5% of the sample using this substitution at age 5:0-5:5, and 0.48% at age 8 years. This may indicate that lateral sounds tend not to spontaneously resolve and require intervention to correct. Lateral lisps may therefore be seen as a higher priority for intervention than interdental lisps.

Percentile ranks and standard scores

Once the consonant and blends subtests have been administered to the child, the score is determined by adding up the total number of errors. Therefore if a child had twenty sounds in error, their score is twenty. Calculate the child's age in years and months and locate Table A-1: Standard scores and percentiles in Appendix A. For example, if the above child was a 5:0-5:5 year old male, their standard score would be 88 and the percentile rank 18. This means that 81% of their age and gender matched peers tested, had fewer errors than this child on this test.

A standard score indicates the distance of an individual's score from the mean, taking into account the variability of scores among

examinees. A standard score of 100 is average for the individual's age. The standard deviation is 15. However, this standard deviation cannot be interpreted in the same way as standard scores from tests of intelligence or vocabulary knowledge or many other abilities. This is because articulation ability does not follow a normal curve development, but is heavily skewed. Most children made very few or no errors, with a small percentage of children with multiple errors. With abilities that are normally distributed, the range of scores within one standard deviation of the mean includes approximately 68% of the population, two standard deviations includes about 95% and three standard deviations includes over 99% of the population. As the distribution of scores across ages in the NZAT is heavily skewed, comparisons between the standard scores and percent of population cannot be made. The actual percentile rank is reported for each standard score by age and gender to allow clinicians to make these comparisons accurately.

Standard scores are not recommended for clinical use. They were included in the NZAT for use in research projects, where researchers need to report on average scores across a group of subjects. Percentiles cannot be averaged, added or subtracted, as they are an ordinal or rank scale, whereas standard scores are an interval scale of measurement and therefore can be arithmetically manipulated in this way.

Diagnostic Interpretation

Raw error scores are useful as supplemental information in diagnostic decisions. A range of factors goes into decision making about diagnosis and whether a child is taken on for therapy including: Intelligibility, age, attention skills, language skills, cognition, family or school concerns, support for speech programme, type of errors, number of errors, other coexisting disorders e.g. sensory or motor disorders. Examiners can administer

all or some of the subtests of the NZAT using their clinical judgement. They can then see on the score form the range and pattern of errors the child presents with. A suggested procedure for analysis of this information is outlined, which was adapted from the test manual for the Goldman-Fristoe Test of Articulation 2 (Goldman and Fristoe, 2000).

- Note which sounds are misarticulated and under what conditions e.g. single words versus connected speech, different phonemic contexts.
- Determine the consistency of an examinee's errors of articulation. Whole word transcription is recommended when inconsistency is suspected.
- Determine in what position the examinee's articulation occurs most frequently (initial, medial, final).
- Determine what type of errors are observed most frequently e.g. omissions, substitutions or distortions.
- Note if the examinee is making errors on more frequently occurring sounds e.g. /t/, /s/, /r/, or on less common sounds e.g. /ʃ/, /j/, /tʃ/.
- See if the examinee's articulation errors can be categorised by placement, manner or voicing.
- Determine if the examinee's sounds are only on sounds likely to develop later or if they are on sounds at many different developmental levels.
- Stimulability testing provides an estimate of how an individual is likely to respond to therapy and which errors sounds are likely to be corrected with the least difficulty.

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Standard Scores and Percentiles Corresponding to Raw Total Scores

Age 5 years 0 months to 5 years 5 months

Male Sample

Raw score	Standard score	Percentile rank
0	114	>94
1	113	87
2	111	81
3	110	74
4	109	65
5	107	55
6	106	47
7	105	42
8	103	39
9	102	36
10	101	34
11	99	33
12	98	31
13	97	29
14	95	27
15	94	26
16	93	25
17	92	22
18	90	20
19	89	19
20	88	18
21	86	16
22	85	15
23	84	14
24	82	13
25	81	12
26	80	11
27	78	10
28	77	10
29	76	9
30	75	8
31	73	7
32	72	7
33	71	6
34	69	6
35	68	5
36	67	5
37	65	5
38	64	4
39	63	4
40	61	4
41	60	3
42	59	3
43	57	2
44	56	1
45	55	<1
46	54	<1

Female Sample

Raw score	Standard score	Percentile rank
0	112	95
1	111	86
2	109	79
3	107	70
4	106	59
5	104	49
6	103	38
7	101	31
8	99	27
9	98	22
10	96	20
11	95	18
12	93	16
13	91	15
14	90	14
15	88	13
16	87	12
17	85	11
18	83	10
19	82	9
20	80	8
21	79	7
22	77	7
23	75	6
24	74	6
25	72	5
26	71	4
27	69	3
28	67	2
29	66	2
30	64	1
31	63	<1
32	61	<1

Standard Scores and Percentiles Corresponding to Raw Total Scores

Age 5 years 5 months to 5 years 11 months

Male Sample

Raw score	Standard score	Percentile rank
0	115	95
1	113	87
2	111	81
3	109	73
4	107	60
5	105	49
6	104	42
7	102	36
8	100	32
9	98	28
10	96	25
11	94	23
12	92	21
13	90	20
14	88	19
15	87	18
16	85	15
17	83	13
18	81	12
19	79	10
20	77	9
21	75	8
22	73	7
23	71	6
24	70	5
25	68	4
26	66	4
27	64	3
28	62	2
29	60	1
30	58	<1
31	56	<1
32	54	<1

Female Sample

Raw score	Standard score	Percentile rank
0	115	>94
1	113	85
2	111	77
3	109	70
4	107	60
5	104	50
6	102	38
7	100	30
8	98	26
9	96	23
10	94	21
11	92	20
12	90	19
13	88	18
14	85	17
15	83	16
16	81	15
17	79	13
18	77	12
19	75	11
20	73	9
21	71	7
22	69	5
23	67	4
24	64	3
25	62	3
26	60	2
27	58	2
28	56	1
29	54	<1
30	52	<1

Standard Scores and Percentiles Corresponding to Raw Total Scores

Age 6 years 0 months to 6 years 11 months

Male Sample

Raw score	Standard score	Percentile rank
0	114	93
1	112	81
2	109	71
3	107	62
4	104	50
5	102	38
6	100	29
7	97	24
8	95	22
9	92	20
10	90	17
11	87	15
12	85	14
13	83	13
14	80	12
15	78	11
16	75	10
17	73	9
18	71	8
19	68	7
20	66	6
21	63	5
22	61	4
23	58	3
24	56	2
25	54	1

Female Sample

Raw score	Standard score	Percentile rank
0	109	>85
1	106	64
2	104	51
3	102	38
4	99	28
5	97	20
6	95	14
7	93	11
8	90	10
9	88	9
10	86	8
11	83	8
12	81	7
13	79	7
14	76	5
15	74	5
16	72	4
17	69	4
18	67	4
19	65	3
20	63	3
21	60	2
22	58	2
23	56	1
24	53	<1
25	51	<1

Appendix A: Table 1

Standard Scores and Percentiles Corresponding to Raw Total Scores

Age 7 years 0 months to 7 years 11 months

Male Sample

Raw score	Standard score	Percentile rank
0	110	83
1	107	61
2	105	50
3	103	41
4	101	30
5	98	21
6	96	19
7	94	18
8	91	17
9	89	16
10	87	15
11	85	14
12	82	13
13	80	12
14	78	11
15	76	10
16	73	9
17	71	8
18	69	7
19	67	6
20	64	5
21	62	4
22	60	3
23	58	3
24	55	2
25	53	2
26	51	1
27	49	1
28	46	<1
29	44	<1

Female Sample

Raw score	Standard score	Percentile rank
0	110	77
1	106	48
2	102	35
3	98	28
4	94	21
5	89	15
6	85	13
7	81	11
8	77	9
9	73	7
10	69	6
11	65	5
12	61	3
13	57	2
14	53	1
15	49	<1
16	45	<1
17	41	<1

Standard Scores and Percentiles Corresponding to Raw Total Scores

Age 8 years 0 months to 8 years 11 months

Male Sample

Raw score	Standard score	Percentile rank
0	111	79
1	106	52
2	102	41
3	97	32
4	93	21
5	89	13
6	84	10
7	80	8
8	76	7
9	71	6
10	67	5
11	63	4
12	58	4
13	54	3
14	49	2
15	45	1
16	41	<1
17	36	<1
18	32	<1
19	28	<1

Female Sample

Raw score	Standard score	Percentile rank
0	108	73
1	104	40
2	100	30
3	96	24
4	91	16
5	87	10
6	83	9
7	79	8
8	74	7
9	70	6
10	66	5
11	62	4
12	57	3
13	53	2
14	49	1
15	45	<1
16	40	<1
17	36	<1

APPENDIX A: Table 2

P Values of Items by Age, for Male Sample

Singleton Consonants

Sound	Position	5:0-5:5	5:6-5:11	6:0-6:11	7:0-7:11	8:0-8:11
p	i	98.02	98.89	100.00	100.00	100.00
	m	98.02	98.89	100.00	100.00	100.00
	f	97.03	98.89	100.00	100.00	98.31
b	i	100.00	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	97.03	97.78	99.07	100.00	98.31
t	i	97.03	97.78	100.00	100.00	100.00
	m	100.00	98.89	100.00	98.94	100.00
	f	89.11	94.44	94.44	95.74	95.76
d	i	100.00	98.89	100.00	100.00	100.00
	m	95.05	96.67	94.44	97.87	98.31
	f	95.05	97.78	100.00	100.00	99.15
k	i	94.06	97.78	100.00	98.94	100.00
	m	96.04	96.67	100.00	98.94	100.00
	f	97.03	97.78	99.07	98.94	99.15
g	i	95.05	97.78	100.00	98.94	100.00
	m	96.04	96.67	100.00	98.94	100.00
	f	97.03	97.78	100.00	98.94	100.00
f	i	99.01	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	99.01	94.44	98.15	97.87	99.15
v	i	95.05	98.89	97.22	98.94	100.00
	m	97.03	97.78	99.07	100.00	100.00
	f	77.23	83.33	92.59	96.81	94.92
m	i	100.00	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	97.03	100.00	100.00	100.00	100.00

n	i	99.01	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	99.01	100.00	100.00	100.00	100.00
l	i	94.06	94.44	100.00	98.94	100.00
	m	95.05	95.56	100.00	98.94	100.00
h	i	100.00	100.00	100.00	100.00	100.00
r	i	94.16	87.78	91.67	94.68	99.15
	m	82.18	87.78	92.59	94.68	98.31
w	i	100.00	98.89	100.00	100.00	100.00
j	i	97.03	96.67	100.00	100.00	100.00
ŋ	m	93.07	92.22	95.37	97.87	97.46
	f	95.05	97.78	95.37	97.87	100.00
s	i	85.15	90.00	94.44	93.62	96.61
	m	86.14	91.11	92.59	93.62	97.46
	f	87.13	90.00	91.67	93.62	97.46
z	i	74.26	87.78	92.59	93.62	94.07
	m	86.14	91.11	92.59	94.68	98.31
	f	86.14	91.11	87.04	93.62	93.22
ʃ	i	93.07	95.56	95.37	95.74	100.00
	m	89.12	95.56	95.37	95.74	99.15
	f	86.14	95.56	94.44	94.68	100.00
tʃ	i	91.09	95.56	96.30	97.87	100.00
	m	92.08	93.33	97.22	96.81	100.00
	f	90.10	95.56	97.22	96.81	100.00
dʒ	i	93.07	96.67	96.30	98.94	99.15
	m	92.08	95.56	97.22	96.81	99.15
	f	92.08	97.78	96.30	97.87	99.15
θ	i	20.79	22.22	25.93	48.94	62.71
	m	32.67	31.11	36.11	62.77	70.34
	f	33.66	25.56	38.89	54.26	63.56
ð	i	67.33	81.11	79.63	85.11	93.22
	m	33.66	38.89	47.22	71.28	74.58

Consonant Blends (male sample)

Sound	Position	5:0-5:11	5:6-5:11	6:0-6:11	7:0-7:11	8:0-8:11
pr	i	79.21	86.67	87.96	93.62	95.76
br	i	81.19	85.56	92.59	94.68	96.61
fr	i	77.23	85.56	87.96	91.49	97.46
tr	i	87.13	88.89	92.59	93.62	97.46
dr	i	81.19	86.67	93.52	92.55	98.31
kr	i	79.21	88.89	91.67	93.62	97.46
gr	i	80.20	88.89	92.59	93.62	96.61
bl	i	93.07	94.44	100.00	98.94	100.00
pl	i	94.06	95.56	99.07	98.94	100.00
kl	i	91.09	93.33	99.07	98.94	100.00
gl	i	90.10	93.33	100.00	97.87	100.00
fl	i	92.08	94.44	100.00	98.94	100.00
sl	i	79.21	85.56	93.52	91.49	97.46
sw	i	82.18	90.00	93.52	91.49	97.46
sm	i	83.17	91.11	92.59	93.62	97.46
sn	i	84.16	91.11	93.52	93.62	97.46
sp	i	85.15	88.89	92.59	94.68	97.46
sk	i	81.19	86.67	91.67	92.55	97.46
st	i	83.17	88.89	92.59	92.55	97.46
spr	i	68.62	77.78	83.33	88.30	94.92
str	i	69.31	76.67	81.48	90.43	94.07
skr	i	69.31	76.67	81.48	88.30	94.07
skw	i	78.22	86.67	90.74	94.68	97.46

P Values of Items by Age, for Female Sample

Singleton Consonants

Sound	Position	5:0-5:11	5:6-5:11	6:0-6:11	7:0-7:11	8:0-8:11
p	i	99.00	99.08	100.00	100.00	100.00
	m	100.00	99.08	100.00	100.00	100.00
	f	96.00	98.17	98.92	100.00	100.00
b	i	100.00	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	97.00	98.17	98.92	99.11	100.00
t	i	98.00	100.00	100.00	100.00	100.00
	m	81.00	83.49	91.40	86.61	92.13
	f	98.00	97.25	98.92	98.21	96.51
d	i	98.00	100.00	100.00	100.00	100.00
	m	93.00	94.50	84.95	96.43	94.38
	f	98.00	100.00	100.00	99.11	100.00
k	i	96.00	99.08	97.85	100.00	100.00
	m	99.00	100.00	97.85	100.00	100.00
	f	100.00	100.00	97.85	100.00	98.88
g	i	99.00	99.08	97.85	100.00	100.00
	m	98.00	100.00	97.85	100.00	100.00
	f	99.00	100.00	97.85	100.00	100.00
f	i	99.00	99.08	100.00	100.00	100.00
	m	100.00	99.08	100.00	100.00	100.00
	f	93.00	96.33	97.85	98.21	100.00
v	i	93.00	97.25	96.77	99.11	100.00
	m	96.00	97.25	98.92	99.11	100.00
	f	89.00	87.16	94.62	94.64	97.75
m	i	100.00	100.00	100.00	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	100.00	100.00	100.00	99.11	100.00

n	i	100.00	100.00	98.92	100.00	100.00
	m	100.00	100.00	100.00	100.00	100.00
	f	100.00	100.00	100.00	100.00	100.00
l	i	98.00	99.08	100.00	100.00	100.00
	m	96.00	99.08	100.00	100.00	100.00
h	i	99.00	100.00	100.00	100.00	100.00
r	i	85.00	88.07	93.55	94.64	94.38
	m	86.00	89.91	95.70	95.54	96.63
w	i	100.00	99.08	100.00	100.00	100.00
j	i	96.00	99.08	98.92	100.00	100.00
ŋ	m	94.00	99.08	98.92	95.54	100.00
	f	98.00	98.17	97.85	96.43	100.00
s	i	96.00	87.16	97.85	98.21	96.63
	m	95.00	87.16	97.85	89.21	98.88
	f	96.00	88.99	96.77	96.43	96.43
z	i	88.00	84.40	96.77	98.21	95.51
	m	93.00	86.24	97.85	99.11	96.63
	f	92.00	86.24	93.55	93.75	94.38
ʃ	i	97.00	99.08	96.77	100.00	100.00
	m	95.00	98.17	96.77	100.00	98.88
	f	96.00	97.25	95.70	99.11	100.00
tʃ	i	95.00	99.08	97.85	100.00	98.88
	m	97.00	98.17	97.85	98.21	98.88
	f	96.00	99.08	97.85	100.00	98.88
dʒ	i	95.00	98.17	97.85	100.00	98.88
	m	96.00	98.17	96.77	98.21	98.88
	f	96.00	97.25	96.77	98.21	98.88
θ	i	19.00	22.02	51.61	62.50	70.79
	m	34.00	33.94	64.52	83.04	79.78
	f	31.00	24.77	61.29	75.89	76.40
ð	i	68.00	76.15	93.55	95.54	96.63
	m	44.00	45.87	66.67	83.04	87.64

Consonant Blends (female sample)

Sound	Position	5:0-5:11	5:6-5:11	6:0-6:11	7:0-7:11	8:0-8:11
pr	i	87.00	82.57	93.55	92.86	95.51
br	i	84.00	87.16	93.55	95.54	97.75
fr	i	84.00	88.99	92.47	94.64	97.75
tr	i	85.00	90.83	97.85	97.32	97.75
dr	i	84.00	86.24	97.85	94.64	98.88
kr	i	87.00	88.99	94.62	94.64	98.88
gr	i	87.00	87.16	92.47	98.21	97.75
bl	i	93.00	98.17	97.85	100.00	100.00
pl	i	92.00	98.17	96.77	100.00	100.00
kl	i	93.00	98.17	97.85	100.00	100.00
gl	i	91.44	98.17	97.85	100.00	100.00
fl	i	94.00	97.25	96.77	99.11	100.00
sl	i	90.00	88.99	95.70	97.32	96.63
sw	i	90.00	88.99	96.77	97.32	97.75
sm	i	92.00	88.99	96.77	97.32	96.63
sn	i	89.00	89.91	96.77	97.32	97.75
sp	i	92.00	88.99	96.77	97.32	97.75
sk	i	90.00	88.99	95.70	96.43	97.75
st	i	89.00	89.91	96.77	97.32	96.63
spr	i	85.00	80.73	90.32	91.07	95.51
str	i	80.00	72.48	88.17	91.07	93.26
skr	i	82.00	82.57	90.32	91.07	96.63
skw	i	87.00	87.16	95.70	97.32	96.63

Appendix A: Table 3

Percentage of Transcribed Responses by Sound and Age

Number of subjects in each age grouping:

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	Total	
n	201	199	201	206	207	1014

Singleton Consonants

p initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
p	98.51	98.99	100.00	100.00
b	1.49	0.50	0.00	0.00
f	0.00	0.50	0.00	0.00

p medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
p	99.00	98.99	100.00	100.00
b	1.00	0.50	0.00	0.00
f	0.00	0.50	0.00	0.00

p final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
p	96.52	98.49	99.50	100.00	99.03
σ	3.48	1.51	0.50	0.00	0.97

b initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
b	100.00	100.00	100.00	100.00

b medial

	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
b	100.00	100.00	100.00	100.00

b final

b Final	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
b	97.01	97.99	99.00	99.51	99.03
ø	1.49	0.50	0.00	0.00	0.97
bs	0.50	0.00	0.00	0.00	0.00
d	0.50	1.01	0.50	0.00	0.00

f	0.00	0.00	0.50	0.00	0.00
p	0.50	0.00	0.00	0.00	0.00
r	0.00	0.50	0.00	0.00	0.00
v	0.00	0.00	0.00	0.49	0.00

t initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
t	97.51	98.99	100.00	100.00
ø	0.50	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00
k	0.50	1.01	0.00	0.00
s	1.00	0.00	0.00	0.00

t medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
t	79.60	79.90	86.07	83.50	86.47
?	0.50	1.01	0.00	0.97	0.48
d	19.90	19.10	13.93	15.53	13.04

t final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
t	93.53	95.98	96.52	97.09	95.65
ø	5.47	3.52	3.48	2.91	3.86
?	1.00	0.00	0.00	0.00	0.48
k	0.00	0.50	0.00	0.00	0.00

d initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
d	99.00	99.50	100.00	100.00
g	1.00	0.50	0.00	0.00

d medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
d	94.53	95.98	90.05	97.09	96.62
t	5.47	4.02	9.95	2.91	3.38

d final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
d	96.52	98.99	100.00	99.51	99.52
ø	2.49	1.01	0.00	0.49	0.48
t	1.00	0.00	0.00	0.00	0.00

k initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
k	95.02	98.49	99.00	99.51	100.00
d	0.50	0.00	0.00	0.00	0.00
t	4.48	1.51	1.00	0.49	0.00

k medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
k	97.51	98.49	99.00	99.51	100.00
ø	1.00	0.00	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
t	1.00	1.51	1.00	0.49	0.00

k final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
k	98.51	98.99	98.51	99.51	99.03
σ	0.50	0.50	1.00	0.00	0.97
t	1.00	0.50	0.50	0.49	0.00

g initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
g	97.01	98.49	99.00	99.51	100.00
d	2.99	1.51	1.00	0.49	0.00

g medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
g	97.01	98.49	99.00	99.51	100.00
d	2.49	1.51	1.00	0.49	0.00
k	0.50	0.00	0.00	0.00	0.00

g final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
g	98.01	98.99	99.00	99.51	100.00
pk	0.00	0.50	0.00	0.00	0.00
d	1.99	0.50	1.00	0.49	0.00

f initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
f	99.00	99.50	100.00	100.00
b	1.00	0.50	0.00	0.00

f medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
f	100.00	99.50	100.00	100.00
b	0.00	0.50	0.00	0.00

f final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
f	96.02	95.48	98.01	98.06	99.52
ø	0.00	0.00	0.00	0.49	0.00
ø	1.00	0.00	0.00	0.00	0.00
b	0.00	0.50	0.00	0.00	0.00
v	2.99	4.02	1.99	1.46	0.48

v initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
v	94.03	97.99	97.01	99.03	100.00
b	2.99	2.01	0.00	0.00	0.00
f	2.49	0.00	0.50	0.00	0.00
r	0.00	0.00	0.50	0.00	0.00
w	0.50	0.00	1.99	0.97	0.00

v medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
v	96.52	97.49	99.00	99.51	100.00
ø	0.50	0.00	0.00	0.00	0.00
b	1.99	2.51	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
f	0.00	0.00	0.50	0.00	0.00
w	0.50	0.00	0.50	0.49	0.00

v final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
v	83.08	85.43	93.53	95.63	96.14
ø	0.50	0.50	0.00	0.97	0.00
b	15.42	13.57	6.47	2.91	3.86
bz	0.00	0.50	0.00	0.00	0.00
f	0.50	0.00	0.00	0.00	0.00
vø	0.00	0.00	0.00	0.49	0.00
z	0.50	0.00	0.00	0.00	0.00

m initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
m	100.00	100.00	100.00	100.00

m medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
m	100.00	100.00	100.00	100.00

m final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
m	98.51	100.00	100.00	99.51	100.00
ms	0.50	0.00	0.00	0.00	0.00
s	0.50	0.00	0.00	0.00	0.00
sp	0.00	0.00	0.00	0.49	0.00
mp	0.50	0.00	0.00	0.00	0.00

n initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
n	99.50	100.00	99.50	100.00	100.00
s	0.00	0.00	0.50	0.00	0.00
w	0.50	0.00	0.00	0.00	0.00

n medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
n	100.00	100.00	100.00	100.00

n final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
n	99.50	100.00	100.00	100.00
ø	0.50	0.00	0.00	0.00

l initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
l	96.02	96.98	100.00	99.51	100.00
j	1.00	1.51	0.00	0.49	0.00
v	0.00	0.50	0.00	0.00	0.00
w	2.99	1.01	0.00	0.00	0.00

l medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
l	95.52	97.49	100.00	99.51	100.00
ø	0.00	0.50	0.00	0.00	0.00
j	1.99	1.01	0.00	0.49	0.00
w	2.49	1.01	0.00	0.00	0.00

h initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
h	99.50	100.00	100.00	100.00
ø	0.50	0.00	0.00	0.00

r initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
r	84.58	87.94	92.54	94.66	97.10
u	1.49	0.50	0.50	0.49	0.97
f	0.50	0.00	0.00	0.00	0.00
w	13.43	11.56	6.97	4.85	1.93

r medial

	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
r	84.08	88.94	94.03	95.15	97.58
u	1.00	1.00	0.50	0.97	0.97
l	0.50	0.00	0.00	0.00	0.00
w	14.43	10.05	5.47	3.88	1.45

w initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs
w	100.00	98.99	100.00	100.00
v	0.00	1.01	0.00	0.00

j initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
j	96.52	97.99	99.50	100.00	100.00
ø	1.49	0.50	0.00	0.00	0.00
fr	0.00	0.50	0.00	0.00	0.00
l	1.00	1.01	0.50	0.00	0.00
t	0.50	0.00	0.00	0.00	0.00
w	0.50	0.00	0.00	0.00	0.00

n initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
n	93.53	95.98	97.01	96.60	98.55
ng	0.00	0.50	1.49	2.43	0.00
d	0.50	0.00	0.00	0.00	0.00
g	0.50	0.50	0.50	0.00	0.48
n	5.47	3.02	1.00	0.97	0.97

n final

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
n	96.52	97.99	96.52	97.09	100.00
ng	0.00	0.00	0.50	1.46	0.00
nk	0.50	0.00	0.00	0.97	0.00
n	2.99	2.01	2.99	0.49	0.00

s initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
s	90.55	88.44	96.02	96.12	96.62
ʃ	0.00	1.01	0.00	0.49	0.00
ð	0.50	0.00	0.00	0.00	0.00
ç	0.00	0.50	0.00	0.00	0.00
ʒ	0.50	0.50	0.00	0.49	0.97
θ	7.46	9.55	3.98	2.43	1.93
d	0.50	0.00	0.00	0.00	0.00
š	0.50	0.00	0.00	0.49	0.48

s medial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
s	90.55	88.94	95.02	96.12	98.07
ʃ	0.00	0.50	0.00	0.49	0.00
ð	0.50	0.00	0.00	0.00	0.00
ç	0.00	0.50	0.00	0.00	0.00
ʒ	0.50	0.50	0.00	0.97	0.48
θ	7.46	9.55	4.48	2.43	1.45
š	0.50	0.00	0.00	0.00	0.00
z	0.50	0.00	0.50	0.00	0.00

s final

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
s	91.54	89.45	94.03	95.15	97.10
ʃ	0.00	0.50	0.00	0.49	0.00
ð	0.50	0.00	0.00	0.00	0.00
ø	0.50	0.50	0.00	0.00	0.00
ç	0.00	0.50	0.00	0.00	0.00
ʒ	0.50	0.50	0.00	0.97	0.48
θ	6.47	8.54	5.97	3.40	1.93
f	0.50	0.00	0.00	0.00	0.00
š	0.00	0.00	0.00	0.00	0.48

z initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
z	81.09	85.93	94.53	96.12	94.69
ð	7.46	8.04	3.98	0.49	1.45
ðt	0.50	0.00	0.00	0.00	0.00
ʒ	1.00	0.50	0.00	0.49	0.00
θ	1.00	1.01	1.00	1.46	0.48
dʒ	0.00	0.50	0.00	0.00	0.97
j	0.00	0.50	0.00	0.00	0.00
k	0.50	0.00	0.00	0.00	0.00
s	8.46	3.52	0.00	0.97	1.93
š	0.00	0.00	0.00	0.00	0.48
tð	0.00	0.00	0.50	0.00	0.00
z	0.00	0.00	0.00	0.49	0.00

z medial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
z	89.55	88.44	95.02	97.09	97.58
ð	7.46	8.04	3.98	0.49	0.48
ʒ	0.00	0.00	0.00	0.49	0.00
ʒ	0.50	0.50	0.00	0.49	0.00
θ	0.00	1.51	1.00	1.46	0.48
d	0.50	1.01	0.00	0.00	0.00
dʒ	0.00	0.50	0.00	0.00	0.48
s	1.49	0.00	0.00	0.00	0.48
š	0.00	0.00	0.00	0.00	0.48
z	0.50	0.00	0.00	0.00	0.00

z final

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
z	89.05	88.44	90.05	93.69	93.72
ʃ	0.00	0.00	0.00	0.00	0.97
ð	5.97	6.03	4.48	0.49	0.97
ðz	0.00	0.00	0.50	0.00	0.00
ʒ	0.00	0.00	0.50	0.00	0.00
ʒ	0.00	0.00	0.50	0.00	0.00
ø	1.00	0.00	0.00	0.00	0.00
ʒ	0.50	0.50	0.00	0.49	0.48
θ	0.50	2.01	1.49	2.43	0.48
dʒ	0.00	0.50	0.00	0.00	0.48
s	2.99	2.51	2.49	2.91	2.42
š	0.00	0.00	0.00	0.00	0.48

j initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
j	95.02	97.49	96.02	98.06	100.00
j nasalised	0.00	0.00	0.00	0.49	0.00
ø	0.50	0.00	0.00	0.00	0.00
ç	0.00	0.50	0.00	0.00	0.00
ɹ	0.00	0.50	1.49	1.46	0.00
θ	0.50	0.00	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
g	0.50	0.00	0.00	0.00	0.00
s	1.99	1.51	2.49	0.00	0.00
t	0.50	0.00	0.00	0.00	0.00
ʈ	0.50	0.00	0.00	0.00	0.00

j medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
j	91.54	96.98	96.02	98.06	99.03
j nasalised	0.00	0.00	0.00	0.49	0.00
ɹ	0.00	0.50	1.49	0.97	0.48
θ	1.49	0.00	0.00	0.00	0.00
g	0.50	0.00	0.00	0.00	0.00
s	5.97	2.51	2.49	0.49	0.48
t	0.50	0.00	0.00	0.00	0.00

j final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
j	91.04	96.48	95.02	97.09	100.00
j nasalised	0.00	0.00	0.00	0.49	0.00
ø	0.50	0.00	0.00	0.00	0.00
ç	0.00	0.50	0.00	0.00	0.00
ɹ	0.00	0.50	1.49	1.46	0.00
θ	1.49	0.00	0.00	0.49	0.00
g	0.50	0.00	0.00	0.00	0.00
s	5.97	2.51	3.48	0.49	0.00
tʂ	0.50	0.00	0.00	0.00	0.00

tj initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
tʃ	93.03	97.49	97.01	99.03	99.52
ʃ	1.49	0.50	0.50	0.00	0.48
ɹ	0.00	0.50	0.00	0.49	0.00
d	0.50	0.00	0.00	0.00	0.00
k	0.00	0.50	0.00	0.00	0.00
s	0.50	0.00	0.00	0.00	0.00
t	2.49	0.50	1.49	0.00	0.00
ʈ	0.50	0.00	0.00	0.49	0.00
tɹ	0.00	0.00	1.00	0.00	0.00
tθ	1.00	0.00	0.00	0.00	0.00
ts	0.50	0.50	0.00	0.00	0.00

tj medial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
tʃ	94.53	95.98	97.51	97.57	99.52
ʃ	0.50	0.50	0.00	0.49	0.00
ɹ	0.00	0.50	0.00	0.49	0.00
ʂ	0.00	0.00	0.00	0.49	0.00
d	0.50	0.00	0.00	0.00	0.00
dʒ	0.00	0.00	0.50	0.00	0.00
s	0.00	0.50	0.00	0.00	0.00
t	1.00	0.50	0.00	0.00	0.00
ʈ	0.50	0.00	0.00	0.49	0.00
tɹ	0.00	0.00	1.00	0.00	0.48
tθ	1.00	0.00	0.00	0.00	0.00
ts	1.99	2.01	1.00	0.49	0.00

tj final

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
tj	93.03	97.49	97.51	98.54	99.52
j	1.00	1.01	0.00	0.00	0.00
ø	0.50	0.00	0.00	0.00	0.00
ɹ	0.00	0.50	0.00	0.97	0.00
s	0.50	0.00	0.00	0.00	0.00

t	0.50	0.00	0.00	0.00	0.00
ʈ	0.00	0.00	0.00	0.49	0.00
tɹ	0.00	0.00	1.00	0.00	0.48
tθ	1.00	0.00	0.00	0.00	0.00
ts	2.99	1.01	1.49	0.00	0.00
z	0.50	0.00	0.00	0.00	0.00

dʒ initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
dʒ	94.03	97.49	97.01	99.51	99.03
ʒ	0.00	0.50	0.50	0.00	0.00
d	2.49	0.50	0.50	0.00	0.00
ɖ	0.50	0.00	0.00	0.49	0.00
dʒ	0.00	0.00	0.50	0.00	0.00
dʝ	0.00	0.00	1.00	0.00	0.00
dr	0.50	0.00	0.00	0.00	0.00
dw	0.50	0.00	0.00	0.00	0.00
dz	0.50	0.50	0.00	0.00	0.00
g	0.00	0.50	0.00	0.00	0.00
s	1.00	0.00	0.50	0.00	0.00
ʈʂ	0.00	0.50	0.00	0.00	0.97
ʈθ	0.50	0.00	0.00	0.00	0.00

d3 medial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
d3	94.03	96.98	97.01	97.57	99.03
j	0.00	0.00	0.50	0.00	0.00
z	0.50	1.51	0.00	0.00	0.00
k	0.00	0.50	0.50	0.00	0.00
i	0.00	0.00	0.00	0.49	0.00
d	1.99	0.50	0.50	0.49	0.00
dg	0.00	0.00	0.50	0.00	0.00
θ	0.50	0.00	0.00	0.00	0.00
dj	0.00	0.00	0.00	0.49	0.00
ds	0.50	0.00	0.50	0.00	0.00
dz	1.00	0.00	0.00	0.97	0.00
g	0.50	0.00	0.00	0.00	0.00
gj	0.00	0.50	0.00	0.00	0.00
tj	0.00	0.00	0.00	0.00	0.97
z	1.00	0.00	0.50	0.00	0.00

d3 final

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
d3	94.03	97.49	96.52	98.06	99.03
k	0.00	0.50	0.50	0.00	0.00
θ	0.50	0.00	0.00	0.00	0.00
i	0.00	0.00	0.00	0.49	0.00
d	1.00	0.00	0.00	0.00	0.00
dθ	0.00	0.00	0.00	0.49	0.00
dg	0.00	0.00	0.50	0.00	0.00
dθ	0.50	0.50	0.00	0.00	0.00
ds	1.00	0.50	0.50	0.00	0.00
dz	1.00	0.00	1.00	0.00	0.00
s	0.50	0.00	0.00	0.00	0.00
tj	1.00	1.01	1.00	0.49	0.97
z	0.50	0.00	0.00	0.49	0.00

θ initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
θ	19.90	22.11	37.81	56.31	66.18
j	0.00	0.50	0.00	0.00	0.00
i	0.00	0.50	0.00	0.00	0.00
b	1.00	0.00	0.00	0.00	0.00
f	76.62	74.37	61.19	41.75	33.82
fj	0.00	0.50	0.00	0.00	0.00
fl	0.50	0.00	0.00	0.00	0.00
p	0.50	0.00	0.00	0.00	0.00
s	0.50	0.50	0.00	0.49	0.00
t	1.00	1.51	1.00	1.46	0.00

θ medial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
θ	33.33	32.66	49.25	73.79	74.40
i	0.00	0.50	0.00	0.00	0.00
b	0.50	0.00	0.00	0.00	0.00
d	0.50	0.50	0.00	0.00	0.00
f	63.18	65.83	49.25	25.24	25.60
s	1.49	0.00	0.50	0.97	0.00
t	1.00	0.50	1.00	0.00	0.00

θ final

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
θ	32.34	25.13	49.25	66.02	69.08
θ	1.00	0.00	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
f	65.17	72.86	50.25	33.01	30.92
k	0.00	0.50	0.00	0.00	0.00
s	0.00	1.01	0.00	0.00	0.00
t	1.00	0.50	0.50	0.97	0.00

θ initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
θ	67.66	78.39	86.07	90.78	94.69
b	0.50	0.00	0.00	0.00	0.00
d	23.38	19.60	10.95	7.28	4.83
g	0.50	0.00	0.00	0.00	0.00
h	0.50	0.00	0.00	0.00	0.00
l	0.50	0.00	0.00	0.00	0.00
n	0.50	0.00	0.00	0.00	0.00
v	6.47	2.01	2.99	1.94	0.48

θ medial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
θ	38.81	42.71	56.22	77.67	80.19
θ	0.50	0.50	0.00	0.00	0.00
b	2.99	0.00	0.00	0.00	0.00
d	21.39	19.10	11.44	6.31	2.90
f	1.99	2.01	4.98	0.98	0.48
l	0.50	0.00	0.00	0.00	0.00
s	0.00	0.50	0.50	0.00	0.00
v	33.83	35.18	26.87	15.05	16.43

/r/ blends

pr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
pr	83.08	84.42	90.55	93.20	95.65
b	0.50	0.00	0.00	0.00	0.00
br	0.00	0.00	0.00	0.49	0.00
f	0.50	0.00	0.00	0.00	0.00
fr	0.00	0.50	0.00	0.00	0.00
fw	0.00	0.50	0.00	0.00	0.00
p	1.99	1.51	1.49	0.49	0.00
pu	1.49	1.00	1.00	1.46	1.93
pj	0.00	0.00	0.00	0.49	0.00
pw	11.44	11.56	5.97	3.88	2.41
qr	0.50	0.00	0.00	0.00	0.00
r	0.00	0.00	0.50	0.00	0.00
sw	0.50	0.00	0.50	0.00	0.00
t	0.00	0.50	0.00	0.00	0.00

br initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
br	82.59	86.43	93.03	95.15	97.10
b	3.48	0.50	1.49	0.49	0.00
bu	0.50	1.01	0.00	0.49	1.45
bl	0.50	0.00	0.00	0.00	0.00
bw	11.94	10.55	5.47	3.88	1.45
f	0.50	0.00	0.00	0.00	0.00
pr	0.00	0.50	0.00	0.00	0.00
pw	0.00	0.50	0.00	0.00	0.00
sw	0.50	0.00	0.00	0.00	0.00
w	0.00	0.50	0.00	0.00	0.00

tr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
pr	0.50	0.00	0.00	0.00	0.00
sr	0.50	0.00	0.00	0.00	0.00
sw	0.50	0.00	0.50	0.00	0.00
t	0.50	0.50	1.00	0.49	0.00
tu	0.00	0.50	0.50	0.97	0.48
tj	1.99	1.51	0.00	0.00	0.48
tjj	0.00	0.00	0.00	0.49	0.00
tjr	0.00	0.50	0.00	0.00	0.00
tjw	0.50	0.50	0.00	0.00	0.00
tw	6.97	5.03	1.99	1.94	0.97

dr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
dr	82.59	86.43	95.52	93.69	98.55
z	0.00	0.00	0.00	0.49	0.00
b	0.00	0.00	0.00	0.49	0.00
br	1.00	0.00	0.00	0.00	0.00
d	0.50	0.00	0.50	0.00	0.00
du	0.00	0.50	0.50	0.97	0.97
d3	3.48	5.53	1.00	0.49	0.00
d3j	0.00	0.00	0.00	0.49	0.00
d3w	0.50	1.51	0.00	0.00	0.00
dj	0.50	0.00	0.00	0.00	0.00
djw	0.00	0.50	0.00	0.00	0.00
dw	8.46	4.52	1.99	3.40	0.48
fr	0.50	0.00	0.00	0.00	0.00

gl	0.50	0.00	0.00	0.00	0.00
gw	0.50	0.00	0.00	0.00	0.00
t	0.50	0.00	0.00	0.00	0.00
t0w	0.50	0.00	0.00	0.00	0.00
tr	0.50	0.50	0.50	0.00	0.00
w	0.00	0.50	0.00	0.00	0.00

kr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
kr	83.08	88.94	93.03	94.17	98.07
d	0.50	0.00	0.00	0.00	0.00
dr	0.00	0.50	0.00	0.00	0.00
fw	0.00	0.50	0.00	0.00	0.00
gl	0.50	0.00	0.00	0.00	0.00
gr	0.50	0.00	0.00	0.49	0.00
k	1.49	0.00	0.00	0.00	0.00
ku	0.50	1.01	0.50	0.49	0.48
kl	0.50	0.00	0.00	0.00	0.00
kw	8.46	8.04	4.48	3.88	1.45
kwj	0.00	0.00	0.00	0.49	0.00
pr	1.49	0.00	0.00	0.00	0.00
pw	0.00	0.50	0.00	0.00	0.00
R	0.00	0.00	0.50	0.00	0.00
sw	0.00	0.50	0.00	0.00	0.00
t	0.00	0.00	0.50	0.49	0.00
tr	1.49	0.00	1.00	0.00	0.00
tw	1.00	0.00	0.00	0.00	0.00
w	0.50	0.00	0.00	0.00	0.00

gr initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
gr	83.58	87.94	92.54	96.12	97.10
br	1.99	0.00	0.50	0.00	0.00
bw	0.00	1.01	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
d3	0.00	0.00	0.00	0.49	0.00
dr	1.49	0.50	0.50	0.00	0.00
dw	0.50	0.00	0.00	0.49	0.00
g	1.00	0.50	0.50	0.00	0.00
gu	0.50	1.01	1.00	0.49	1.45
gl	0.50	0.00	0.00	0.00	0.00
gw	8.96	9.04	3.98	2.43	1.45
r	0.00	0.00	0.50	0.00	0.00
sw	0.00	0.00	0.50	0.00	0.00
tw	0.50	0.00	0.00	0.00	0.00
w	0.50	0.00	0.00	0.00	0.00

// blends

bl initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
bl	93.03	96.48	99.00	99.51	100.00
b	1.00	0.50	1.00	0.49	0.00
bj	1.00	0.50	0.00	0.00	0.00
br	0.50	0.50	0.00	0.00	0.00
bw	3.98	1.51	0.00	0.00	0.00
pl	0.50	0.50	0.00	0.00	0.00

pl initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
pl	93.03	96.98	98.01	99.51	100.00
il	0.00	0.50	0.00	0.00	0.00
b	0.50	0.00	0.00	0.00	0.00
p	1.49	0.50	1.00	0.49	0.00
pu	0.00	0.00	0.50	0.00	0.00
pj	1.00	0.50	0.00	0.00	0.00
pr	1.00	0.50	0.00	0.00	0.00
pw	2.99	1.01	0.50	0.00	0.00

kl initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs'	
kl	92.04	95.98	98.51	99.51	100.00
il	0.00	0.50	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
k	0.50	0.50	0.50	0.00	0.00
kj	1.00	0.50	0.00	0.00	0.00
kr	1.49	1.01	0.00	0.00	0.00
kw	1.99	0.50	0.00	0.00	0.00
pl	1.00	0.50	0.00	0.00	0.00

pw	0.00	0.50	0.00	0.00	0.00
t	0.50	0.00	1.00	0.49	0.00
tw	1.00	0.00	0.00	0.00	0.00

gl initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
gl	92.04	95.98	99.00	99.03	100.00
bl	1.00	0.50	0.00	0.00	0.00
bw	0.00	0.50	0.00	0.00	0.00
d	0.50	0.00	0.50	0.49	0.00
dw	0.50	0.00	0.00	0.00	0.00
g	1.49	0.50	0.00	0.00	0.00
gj	1.00	0.50	0.00	0.00	0.00
gr	0.50	1.51	0.00	0.00	0.00
gw	2.49	0.50	0.00	0.49	0.00
kl	0.50	0.00	0.00	0.00	0.00
l	0.00	0.00	0.50	0.00	0.00

fl initial

Age	5yrs-5y 5m	5y 6m - 6 yrs 5y 11m	7 yrs	8 yrs	
fl	93.03	95.98	98.51	99.03	100.00
il	0.00	0.50	0.00	0.00	0.00
b	0.50	0.00	0.00	0.00	0.00
f	1.99	0.50	0.50	0.49	0.00
fj	0.50	0.50	0.00	0.00	0.00
fr	1.00	1.01	0.00	0.00	0.00
fw	2.49	1.51	1.00	0.49	0.00
l	0.50	0.00	0.00	0.00	0.00

/s/ blends

sl initial

Col	Pct	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sl		84.58	87.44	94.53	94.66	97.10
ʃ		0.50	0.00	0.00	0.00	0.00
ʃl		0.00	0.00	0.00	0.49	0.00
ðl		0.50	0.00	0.00	0.00	0.00
çl		0.00	0.50	0.00	0.00	0.00
ɪ		0.00	0.00	0.00	0.49	0.00
ɪl		0.50	1.01	0.00	0.97	0.00
ɪw		0.00	0.50	0.00	0.00	0.00
θ nasalised		0.50	0.00	0.00	0.00	0.00
θl		6.47	7.54	4.98	2.43	2.42
θw		0.50	0.00	0.00	0.00	0.00
d		0.50	0.00	0.00	0.00	0.00
fl		0.50	0.00	0.00	0.00	0.00
l		0.50	0.50	0.00	0.00	0.00
s		1.00	0.50	0.50	0.00	0.00
sl		0.00	0.50	0.00	0.49	0.48
sʃ		1.00	0.50	0.00	0.00	0.00
sw		1.99	1.01	0.00	0.00	0.00
t		1.00	0.00	0.00	0.00	0.00
tʃ		0.00	0.00	0.00	0.49	0.00

sw initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sw	86.07	89.45	95.02	94.66	97.58
ʃw	1.49	0.00	0.00	0.49	0.00
ðw	0.50	0.00	0.00	0.00	0.00

çw	0.00	0.50	0.00	0.00	0.00
ɪw	0.00	0.50	0.00	1.46	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θw	6.47	7.54	4.48	1.94	1.93
f	0.50	0.00	0.00	0.49	0.00
fw	0.50	1.01	0.50	0.49	0.00
hw	0.50	0.00	0.00	0.00	0.00
p	0.50	0.00	0.00	0.00	0.00
s	0.50	0.00	0.00	0.00	0.00
sw	0.00	0.50	0.00	0.49	0.48
skw	0.50	0.00	0.00	0.00	0.00
t	0.50	0.00	0.00	0.00	0.00
w	1.00	0.50	0.00	0.00	0.00
z	0.50	0.00	0.00	0.00	0.00

sm initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sm	87.56	89.95	94.53	95.63	97.10
ʃm	0.00	0.00	0.00	0.49	0.00
ðm	0.50	0.00	0.00	0.00	0.00
çm	0.00	0.50	0.00	0.00	0.00
ɪm	0.00	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θm	6.97	6.53	4.98	2.43	2.42
f	0.00	0.00	0.50	0.00	0.00
hm	0.50	0.00	0.00	0.00	0.00
m	2.99	1.01	0.00	0.00	0.00
p	0.50	0.00	0.00	0.00	0.00
sm	0.00	1.51	0.00	0.49	0.48
sw	0.50	0.00	0.00	0.00	0.00

sn initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sn	86.57	90.45	95.02	95.63	97.58
ʃn	0.00	0.00	0.00	0.49	0.00
ðn	0.50	0.00	0.00	0.00	0.00
çn	0.00	0.50	0.00	0.00	0.00
ɪn	0.50	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θm	0.50	0.00	0.00	0.00	0.00
θn	6.97	6.03	4.48	2.43	1.93
k	0.50	0.00	0.00	0.00	0.00
n	2.49	1.01	0.00	0.00	0.00
s	0.50	0.00	0.50	0.00	0.00
sʃ	0.50	0.00	0.00	0.00	0.00
šn	0.00	1.51	0.00	0.49	0.48
sw	0.50	0.00	0.00	0.00	0.00

sp initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sp	88.56	88.94	94.53	96.12	97.58
ʃp	0.00	0.00	0.00	0.49	0.00
ðp	0.50	0.00	0.00	0.00	0.00
çp	0.00	0.50	0.00	0.00	0.00
ɪp	0.00	0.50	0.00	0.97	0.00
θ	0.00	0.50	0.00	0.00	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θp	6.47	8.04	4.98	1.94	1.93
θr	0.50	0.00	0.00	0.00	0.00

b	0.50	0.50	0.00	0.00	0.00
f	0.50	0.50	0.50	0.49	0.00
p	1.99	0.00	0.00	0.00	0.00
sp	0.00	0.50	0.00	0.00	0.48
sb	0.50	0.00	0.00	0.00	0.00

sk initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
sk	85.57	87.94	93.53	94.66	97.58
ʃ	0.00	0.50	0.00	0.00	0.00
ʃk	0.00	0.00	0.00	0.49	0.00
θt	0.50	0.00	0.00	0.00	0.00
çk	0.00	0.50	0.00	0.00	0.00
ɪk	0.00	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θk	7.46	7.04	4.98	2.43	1.93
θt	0.50	0.00	0.00	0.00	0.00
g	0.50	0.00	0.00	0.00	0.00
k	1.99	0.50	0.00	0.00	0.00
s	0.50	0.00	0.50	0.49	0.00
sk	0.00	0.50	0.00	0.00	0.48
sd	0.50	0.00	0.50	0.00	0.00
sg	0.00	0.00	0.00	0.49	0.00
st	1.99	2.01	0.50	0.49	0.00
t	0.00	0.50	0.00	0.00	0.00

st initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
st	86.07	89.45	94.53	95.15	97.10
ʃ	0.00	0.50	0.00	0.00	0.00
ʃt	0.50	0.00	0.00	0.49	0.00
θd nasalised	0.50	0.00	0.00	0.00	0.00
θt	0.50	0.00	0.00	0.00	0.00
çt	0.00	0.50	0.00	0.00	0.00
ɪt	0.00	0.50	0.00	1.46	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θk	0.00	0.00	0.00	0.00	0.48
θt	7.96	7.54	4.98	2.43	1.93
d	1.00	0.50	0.00	0.00	0.00
k	0.50	0.00	0.00	0.00	0.00
s	1.00	0.00	0.50	0.49	0.00
st	0.00	0.50	0.00	0.00	0.48
sk	0.50	0.50	0.00	0.00	0.00
t	1.00	0.00	0.00	0.00	0.00

CCC blends

spr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
spr	76.62	79.40	86.57	89.81	95.17
ʃpr	0.50	0.00	0.00	0.49	0.00
ɔpr	0.00	0.50	0.00	0.00	0.00
ɪpr	0.00	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θp	0.00	0.00	0.50	0.00	0.00
θpu	0.50	0.00	0.00	0.49	0.48
θpl	1.00	0.00	0.00	0.00	0.00
θpr	3.48	5.53	3.98	2.43	1.93
θpw	1.99	2.01	0.50	0.00	0.00
b	1.00	0.00	0.00	0.49	0.00
br	0.50	0.00	0.00	0.00	0.00
fpw	0.00	0.50	0.00	0.00	0.00
fr	0.00	1.01	0.00	0.00	0.00
fw	0.00	0.00	0.50	0.00	0.00
p	0.50	0.00	0.00	0.00	0.00
pu	0.00	0.00	0.00	0.49	0.00
pr	0.50	0.00	0.00	0.00	0.00
Pw	0.50	0.00	0.00	0.00	0.00
spr	0.00	0.50	0.00	0.00	0.48
sb	0.50	0.00	0.00	0.00	0.00
sp	4.48	1.51	1.49	0.00	0.00
spu	0.50	0.00	0.50	0.49	0.97
spj	0.00	0.00	0.00	0.49	0.00
spl	1.00	0.00	0.00	0.00	0.00
spw	5.97	8.04	5.97	3.88	0.97
str	0.00	0.50	0.00	0.00	0.00

str initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
str	74.63	75.38	84.58	90.78	93.72
ʃd	0.00	0.00	0.50	0.00	0.00
ʃr	1.00	0.00	0.00	0.49	0.00
ʃt	1.00	0.00	0.00	0.00	0.00
ʃtʃw	0.00	0.50	0.00	0.00	0.00
ʃtr	1.49	2.51	2.99	0.97	0.97
ʃtw	0.00	1.01	0.00	0.00	0.00
ɪr	0.00	0.00	0.50	0.00	0.00
itr	0.00	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θt	0.00	0.50	0.50	0.00	0.00
θtu	0.50	0.00	0.00	0.00	0.00
θtr	4.48	5.53	3.48	2.43	1.93
θtw	1.49	1.01	0.50	0.49	0.00
d	0.50	0.00	0.00	0.00	0.00
dʒw	0.00	0.50	0.00	0.00	0.00
dr	1.00	0.50	0.00	0.49	0.00
f	0.50	0.00	0.00	0.00	0.00
fr	0.00	0.50	0.00	0.00	0.00
fw	0.00	0.50	0.00	0.00	0.00
pw	0.00	0.50	0.00	0.00	0.00
s	1.00	0.00	1.00	0.00	0.00
str	0.00	0.50	0.00	0.00	0.48
sd	0.50	0.00	0.00	0.00	0.00
sdʒ	0.50	0.50	0.00	0.00	0.00
sk	0.50	0.00	0.00	0.00	0.00

skr	0.00	0.50	0.00	0.00	0.00
sr	1.00	0.00	0.00	0.00	0.00
st	0.50	0.50	0.50	0.97	0.00
stu	0.00	1.00	0.50	0.49	1.45
stʃ	0.00	1.01	0.50	0.00	0.48
stw	6.97	5.53	4.48	1.46	0.97
sw	0.50	0.00	0.00	0.49	0.00
t	0.50	0.00	0.00	0.00	0.00
tr	1.00	0.00	0.00	0.00	0.00
tw	0.00	1.01	0.00	0.00	0.00

skr initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
skr	75.62	79.90	85.57	89.81	95.17
ʃkr	0.00	0.00	0.00	0.97	0.48
ʃpr	0.50	0.00	0.00	0.00	0.00
ʃr	0.00	0.00	0.00	0.49	0.00
θpl	0.50	0.00	0.00	0.00	0.00
ɪkr	0.00	0.50	0.00	0.97	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θk	0.00	0.00	0.50	0.00	0.00
θku	0.50	0.00	0.00	0.00	0.48
θkn	0.50	0.00	0.00	0.00	0.00
θkr	2.99	5.03	3.98	1.46	1.93
θkw	2.49	1.01	0.50	0.00	0.00
θr	0.00	0.00	0.00	0.49	0.00
θtr	0.00	0.00	0.00	0.49	0.00
θw	0.50	0.00	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00

fw	0.00	0.50	0.00	0.00	0.00
gr	1.00	0.00	0.00	0.00	0.00
gw	0.00	0.50	0.00	0.00	0.00
k	0.50	0.00	0.00	0.00	0.00
kr	0.50	0.00	0.00	0.00	0.00
r	0.00	0.00	0.50	0.00	0.00
s	0.50	0.00	0.50	0.00	0.00
skr	0.00	0.50	0.00	0.00	0.00
skw	0.00	0.00	0.00	0.00	0.48
sbw	0.00	0.50	0.00	0.00	0.00
sk	0.50	1.51	0.00	0.00	0.00
sku	0.00	0.00	0.50	0.00	0.48
skw	7.96	7.54	6.97	4.37	0.97
spr	0.50	0.00	0.50	0.00	0.00
str	2.49	1.01	0.50	0.49	0.00
stw	1.00	1.01	0.00	0.00	0.00
sw	0.00	0.00	0.00	0.49	0.00
t	0.50	0.00	0.00	0.00	0.00
w	0.00	0.50	0.00	0.00	0.00

skw initial

Age	5yrs-5y 5m	5y 6m - 5y 11m	6 yrs	7 yrs	8 yrs
skw	82.59	86.93	93.03	96.12	97.10
skw	0.00	0.50	0.00	0.00	0.00
spr	0.50	0.00	0.00	0.00	0.00
stw	0.50	0.00	0.00	0.00	0.00
skw	0.00	0.50	0.00	0.00	0.00
ikw	0.00	0.50	0.00	0.49	0.00
θ	0.50	0.50	0.00	0.00	0.00
θ nasalised	0.50	0.00	0.00	0.00	0.00
θgw	0.00	0.50	0.00	0.00	0.00

θk	0.00	0.00	0.50	0.00	0.00
θku	0.00	0.00	0.00	0.00	0.48
θkw	5.97	6.03	4.48	1.94	1.93
θw	0.50	0.00	0.00	0.00	0.00
d	0.50	0.00	0.00	0.00	0.00
fw	0.00	0.50	0.00	0.49	0.00
gw	1.49	0.00	0.00	0.00	0.00
hkw	0.00	0.50	0.00	0.00	0.00
kw	0.50	0.00	0.00	0.00	0.00
s	0.50	0.00	0.50	0.00	0.00
skw	0.00	0.50	0.00	0.00	0.48
sk	0.50	0.50	0.00	0.00	0.00
skr	0.00	0.00	0.50	0.00	0.00
spr	0.50	0.00	0.00	0.00	0.00
spw	0.00	0.50	0.50	0.00	0.00
str	0.50	0.00	0.00	0.00	0.00
stw	2.49	1.51	0.00	0.00	0.00
sw	1.49	0.50	0.50	0.97	0.00
t	0.50	0.00	0.00	0.00	0.00

APPENDIX B

Examiners participating in the normative study of the NZAT 2004:

Claire Bannan
Claire Darlow
Julie Miller
Dianne Thompson
Sally Steven
Trish Reid
Vicki Renwick
Nicole Plummer
Claire Gibling
Jennifer Rourke
Dianne Walker
Gay Easterbrook
Sharon Collier
Kellie Vautier
Kate Goodrich
Ann Marie Gray
Clare Shepherd
Fiona Klemm
Jayne Moyle

Sarah Courtnage
Ros de Candole
Amy Robertson
Helena Walsh
Sarah Martin
Jo Donnelly
Christian Wright
Susan Lee
Ross Harland
Melanie Gliddon
Jackie MacLennan
Liz Sides
Lynn Barnes
Nicola Kelsey
Thelmarie Couprie
Denise Hill
Ruth Baumberger
Faye Holmes
Margaret Bourke

Angela Hickling
Lyn Kerr
Samantha Jerard
Jane Carroll
Julia Cantrell
Debbie Brewers
Christine Curnow
Linda Taylor
Lynn Keen
Marie Hammond
Mary Connor
Julie Marchant
Nadine Prescott
Jane Musgrave
Jan Hills
Sarah Fraser
Kate Morgan
June Laverty