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VARIABILITY IN THE PRODUCTION OF WORDS CONTAINING CONSONANT CLUSTERS BY TYPICAL TWO- AND THREE-YEAR-OLD CHILDREN

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ABSTRACT

Objective: Variability describes speech differences within individual children, as well as differences between children. Variability within children has been used as an indicator of speech impairment so knowledge of typical children's variability enhances clinicians' diagnostic and prognostic decisions. This study aimed to describe the extent of variability within children in the production of consonant clusters by typically developing children.
Patients and Methods: Sixteen typically developing children aged between two- and three-years were studied monthly for six months. Spontaneous speech samples were used to construct variability profiles for repeated productions of words containing consonant clusters.
Results: Variability between and within individuals featured prominently. Half (53.7%, range = 42.4 - 77.6%) of all the words that were repeated were produced variably. As the children became older, they increased the accuracy of their productions overall; however, variability between and within individuals continued to occur.
Conclusion: If the speech of typically developing children is highly variable, then the extent and nature of variability must be defined when it is used as a diagnostic marker of speech impairment.

Appreciating the existence and nature of variability in speech development is important for differentiating between typical speech acquisition and impaired speech. The term 'variability' is generally applied in two ways. Firstly, variability is used to describe differences **between individuals** in their rates and sequences of development. This has also been referred to as 'individual differences'[1, 2]. Speech variability between individuals also occurs when different children of the same age or stage of development have different realisations for particular phonemes or words. Alternatively, variability is used to describe inconsistencies **within individuals'** patterns of behaviour [3-8]. In speech development, variability within individuals occurs in two different forms. Firstly, variability occurs when a child has different realisations of a particular phoneme or consonant cluster, for *different lexical items*. For example, /k/ may be realised as [k] in *car* [ka], but [t] in *cat* [tæt]. Secondly, variability occurs when a child has different realisations for *multiple productions of the same lexical item*. For example, a child with variable repeated productions of *truck* may realise /tr/ as [trʌ:], [twʌk], and [dʌk]. The present study focused on this last aspect of speech variability; that is variability within individuals' multiple productions of the same lexical items.

Many studies on speech variability within individuals have involved very young children, in the prelinguistic and the first-fifty word periods of language development [1, 7, 8-13]. Progress beyond the first fifty words has been understood as a period of significant transition for children developing language. In one of the earliest and most famous examples of speech variability Leopold [14] demonstrated that his daughter, Hildegard, showed decreases rather than advances in the maturity of her productions of *pretty* over time, as well as producing varied multiple productions at particular ages. At age 0;10 she produced *pretty* as [prəti], at 1;4 [pwɪti], [pəti] and [pyɪti], then by 1; 10 *pretty* was produced as [bɪdi]. In contrast, French[7] analysed the speech of her son, Andrew, from 1;8 to 1;11 and described phonetic variability as 'an infrequent phenomenon' (p. 77). Smith[15] recorded the phonology of his son, Amahl from 2;2 to 4;0 years of age. He provided extensive longitudinal information on speech variability through describing Amahl's variable productions of the same target words. Intra-word phonological variability was examined by Leonard et al.[8] in eight typically developing children ranging from 1;10 to 2;2 years of age. These researchers concluded that inconsistency in repeated productions of words was most likely to occur when one or more aspect of the word was unstable; that is phonological elements (e.g., consonants, word shapes) were present in a child's speech, but not yet mastered. Dyson and Paden [16] conducted a seven month longitudinal study on phonological acquisition strategies used by two-year-olds. Although multiple productions of target words within speech samples were not recorded for analysis, comparing each participant's productions of target words across time led to them to describe variability within individuals by commenting 'this period of roughly two to three-and-one-half years of age seems to be one of extreme variability with participants 'trying out' a variety of strategies to approximate the adult model' (p.16). Vogel Sosa and Stoel-Gammon[45] conducted a longitudinal study and found that children aged between 1;0 and 2;0 had high overall rates of variability with a peak at the onset of combinatorial speech. Overall, most studies of young children agree that early words are 'extremely variable in pronunciation' [17] (pp. 340-341).

Variability (also called inconsistency) is often associated with children who are exhibiting impaired speech development [3, 18-23]. Firstly, variability has been identified as a diagnostic indicator in the speech of children with childhood apraxia of speech [22, 24]. For example, Marquardt et al. [22] measured token-to-token variability in repeated word productions from connected speech samples and indicated that childhood apraxia of speech

was characterised by high levels of total token and error token variability and low levels of word target stability. Secondly, variability is also used to diagnose inconsistent deviant disorder which is characterised by a high percentage of variable repeated productions of words which cannot be explained by phonological processes or changes in linguistic load[18]. Thirdly, according to Grunwell[21] the existence of speech variability without evidence of improved accuracy where most words were produced inconsistently incorrectly potentially indicated a phonological impairment. Fourthly, in children with speech impairment of unknown origin, Tyler, Lewis and Welch [25] found that error consistency was the only variable strongly associated with phonological change in two groups of twenty children with speech impairment.

Despite the view that variability can be indicative of speech impairment, Ingram [26] indicates that investigation of phonological acquisition and individual variation has been based on "the false assumption that normal acquisition is homogeneous while delayed acquisition is not... the range of variation of phonological deviance for children with phonological disorders is no greater than that for normal children" (pp. 94-95). Other researchers support this perspective; for example, Dinnsen and Chin[27] comment that "the results of our research program reveal disordered systems to be highly varied. The variation, however, is not unlimited. In fact, it appears to be quite principled. Moreover, the principles governing disordered systems do not appear to differ from those governing developing or established systems" (p. 150). Therefore, at the present time it seems important to continue to investigate similarities and differences between factors of phonological variability that are indicative of typical and impaired speech development.

Thus, the aim for the present research was to describe the occurrence of variability in the speech of typical two- to three-year old children. Due to the paucity of information on children's development in areas other than singleton consonants, the production of consonant clusters was selected as the area of focus. The acquisition of consonant clusters marks a significant milestone in the development of young children's speech and language skills. Although consonant clusters occur in many of the words used by young children[28], almost all children experience difficulties correctly producing them[5, 29-33].

METHOD

Participants

Sixteen typically developing children were the participants for the present longitudinal research. The participants' ages ranged from 2;0 to 2;11 (mean 2;6) at the beginning of the study and from 2;5 to 3;4 (mean 2;11) at the end of the study. There were 5 males and 11 females, who were from monolingual homes, where their parents spoken Australian English.

Participants demonstrated typical development on measurements of: cognition[34], hearing, oromusculature[35], expressive and receptive language [36, 37]. Additionally, all participants exhibited typical phonological skills for their age based on the following measures undertaken on 100 spontaneous utterances: percentages of consonants produced correctly (PCC), phonetic and phonemic inventories, cluster production and word shapes were analysed for each child's language sample[32] (see Appendix A).

Procedure

A qualified speech pathologist conducted six visits at monthly intervals for each participant. All visits occurred in the participant's home and were approximately one to one and one-half hours in duration. Participants were provided with six bags of toys whose names and attributes contained consonant clusters (see Appendix B)[37]. They were encouraged to talk about the toys in each bag as they played with them for as long as they wanted in order to increase the naturalness of the sample as well as the opportunity for repeated production of the same words. The speech pathologist used self talk, parallel talk and prompting to elicit speech. No attempt was made to limit the number of productions of each word. Participants

wore a vest containing a Shure TP ETP non-diversity radio lapel microphone, using a Marantz CP 430 audio cassette recorder which recorded onto Maxell MX metal cassette tapes. Lip to microphone distance was maintained at 15 centimetres.

The transcribed speech sample was restricted to words whose targets contained consonant clusters in the word-initial and/or word-final position. Imitated words were excluded from the analysis. Imitated words were defined as those which were reproduced by the participant within 5 seconds of the researcher producing the utterance. Further, words containing clusters which were created morphophonemically (i.e., produced through use of past tense, third person singular, possessives or plurals; e.g., *ha<u>ts</u>* /-ts/) were excluded from analysis so that variability was not influenced by morphological skill. Every production of a word containing a consonant cluster was transcribed on-line by the qualified speech pathologist, using narrow transcription. The entire speech sample was audio-taped to enable checking of on-line data recording. The audio recordings were listened to in a quiet environment as often as necessary, to maximise the accuracy of transcriptions. Three analyses of variability were undertaken: type-token ratio, variability index[38] and variability profiles[21].

Reliability

Reliability analyses were performed on ten percent of the data. A qualified, experienced speech pathologist transcribed every consonant cluster word spoken by the participants on-line. A second qualified, experienced speech pathologist was present online as a reliability judge for 10 of the 96 samples (10%) and later checked transcriptions using the tape recorder. Inter-judge percent agreement calculations for 2865 data points resulted in agreement of 0.91 for broad transcription and 0.85 for narrow transcription. Agreement from individual participants ranged from 82.8-95.9% for broad transcription and 75.4-88.2% for narrow transcription. When discrepancies arose, the first speech pathologists' judgement was used.

RESULTS

Six speech samples from each of the sixteen participants were analysed. The samples contained between 19 (Participant 2 (P2), sample 1 (S1)) and 139 words containing consonant clusters (P12/S5), with an average of 76.1 words. Younger participants tended to have smaller numbers of words containing consonant clusters; however, a direct relationship between age and sample size was not apparent (see Appendix C). On average, participants had repeated productions for 16.9 words in each sample (see Appendix C). The minimum number of target words with repeated productions was 5 (P2/S1 &5) and the maximum was 32 (P8/S2 and P14/S6). Older participants tended to have more words for which there was more than one production in their sample than younger participants; however, there were several exceptions (e.g., P11). Some participants exhibited a substantial difference in the number of repeated words in the speech samples over time; for example, P1 repeated 10 or fewer words for the first 5 samples, but 26 words in the final sample. P8 more than doubled the number of repeated words from sample 1 (14) to sample 2 (32) and P11 almost halved the number of repeated words from sample 1 (16) to samples 2, 3 and 4 (9).

Variation occurred in the length of each participant's speech samples and the number of repeated productions of words. Sample sizes ranged from 19-139 (mean 76.1) words containing consonant clusters and between 5 and 32 (mean 16.9) words were repeated at least once (see Appendix C). Despite these differences, the target words were similar in each sample, because of the consistent organisation of the stimuli toys with which the spontaneous speech samples were obtained.

Type-token ratios. Type-token ratios were computed for each sample (see Appendix C). The type-token ratio was calculated by dividing the number of types by the number of

tokens. The smaller the type-token ratio, the greater the number of repeated productions; 1.0 indicates a sample where no words were repeated. Type-token ratios ranged from 0.32 (P14/S2) to 0.74 (P11/S4). An overall type-token ratio of 0.51 was calculated by adding the total number of types for all samples and dividing this figure by the total number of tokens (also added from all samples). This indicated that overall, approximately half of the words were repeated productions.

Variability index. The variability index[38] indicates the degree to which repeated productions of target words are produced inconsistently incorrectly. The following formula is used to calculate a score for the variability index:

$$\frac{\text{Number of repeated words showing different errors}}{\text{Total number of repeated words - Number of repeated words, one or more produced correctly}}$$

The variability index was calculated automatically using Computerized Profiling[38] and was based on whole word variability and narrow transcription. Therefore allophonic differences and differences in vowels or singletons are included, as well as different realisations of consonant clusters. Appendix C demonstrates that the participants' variability index ranged from 0.00 (all repeated words were consistently incorrect, inconsistently correct or consistently correct) to 1.00 (every repeated word had at least two different productions, none of which matched the adult target form, i.e., words equivalent to Grunwell's[21] inconsistently incorrect).

Variability profiles. Data based on Grunwell's[21]) 4 categories of consistency and accuracy of word production was obtained to construct variability profiles. Words were categorised as **consistently incorrect** if repeated productions were identical but did not match the adult target phonological form; **inconsistently incorrect** for repeated target words with at least one different production; **inconsistently correct** for words with at least one different production and at least one realisation that matched the adult form; and **consistently correct** for words that consistently matched the adult target. The categories were based on whole word variability, therefore repeated productions of a target word were determined to be inconsistent if differences were present in vowels, consonant singletons and / or consonant clusters contained in the word. For example, *green* realised as [gri:] and [grin] was inconsistently correct.

No participant showed a clear progression in the proportions of different categories of repeated words across their six speech samples, however cross-sectional and longitudinal examination of the data revealed overall progressive trends (see Figure 1). Between the ages of 2;0 and 3;4, these children increased the percentage of words they produced correctly, either inconsistently or consistently. Younger participants (e.g., P2) typically had profiles consisting almost entirely of repeated words that were **inconsistently** or **consistently incorrect**. Older participants (e.g., participants 13, 14, 15 and 16) typically had profiles which included all four categories of repeated words for each of their six speech samples. Participants first began to produce words that were **inconsistently correct** between the ages of 2;2 and 2;5, although this category was not necessarily established in subsequent samples (e.g., P2, samples 3 and 4). Participants 1 and 3 had profiles where **consistently correct** repeated words appeared before **inconsistently correct**.

Variability within participants was evident in speech samples which deviated from the overall progressive trends (see Figure 1). Participant 13 progressively decreased the proportion of consistently correct repeated words in samples 1-3, and then reversed this pattern, to increase the proportion of consistently correct repeated words in samples 4-6. Participant 9 steadily increased the proportion of consistently correct repeated words over the six months; however, the proportions of consistently incorrect repeated words fluctuated.

Variability between participants was particularly evident through comparing P12 with other participants. Although one of the older participants in the study, P12's graph contained very small proportions of words produced either **inconsistently** or **consistently correctly**. This was more characteristic of younger participants (e.g., participants 1-5) than of her peers (e.g., participants 9-11, 13-15).

Insert Figure 1 here

Next, the variability profiles (see Figure 1) were used to study the extent to which **variable realisations** occurred for repeated productions of target words in each speech sample, regardless of the accuracy of production. Percentages of **inconsistently incorrect** and **inconsistently correct** repeated words were added together, to display the percentage of variable repeated words in each sample. Overall participant results (i.e., data compiled from six samples) are contained in Table 1. Differences in the percentage of variable words in each sample were evident between participants and within individual participants. Cross-sectional and longitudinal examination revealed no clear aged based relationship to determine the proportion of variable repeated words in a speech sample. Overall, there were at least two *different* productions for 53.7% of repeated words in the speech samples. The minimum percentage of repeated words with variable productions in a sample was 18.2% (P13, sample 6) and the maximum percentage of variable word productions was 100.0% (P2, samples 2 and 5; P11, sample 2).

Insert Table 1 about here

DISCUSSION

Speech variability between individuals and within individuals is an important issue which continues to influence our understanding of typical and impaired phonological development. The two- to three-year-olds in the present study exhibited extensive variability within production of repeated words that contained consonant clusters. The proportion of words that were produced as either inconsistently correct or inconsistently incorrect ranged from 42.4% (P13) to 77.6% (P2). This finding is in support of Leonard et al. (1982) who indicated that "variable words are most often those which have more advanced canonical forms or sounds" and "word shape as well as consonant composition may play a role in intra-word variability" (p. 56). The present investigation specifically targeted consonant clusters, an advanced canonical form. Further, the data was elicited from spontaneous speech, a sampling method which increases the opportunities for variability. Differences can occur between speech produced spontaneously versus imitated speech[39] and between words produced in isolation versus words produced in connected speech[2, 40,], particularly for consonant clusters [41, 42]. The results also illustrated that typical development is not linear. For the majority of phonological measures used, few individual participants showed a clear progression over the six month period. Future analyses could consider the impact of word length as well as developmentally correct and developmentally incorrect cluster production on children's variability.

The results from this study provide a relevant contribution to discussions concerning variability as a potential indicator of speech impairment. According to the procedures used to obtain Dodd's variability index[18], a score of more than 40% of repeated words produced with variable realisations on a 25-word consistency test indicates that children should receive the classification of inconsistent disorder. Although the present study used different sampling techniques from Dodd, the present study also included a calculation for the percentage of variable repeated words in each speech sample. Simply applying Dodd's criteria of greater than 40% variability leads to the identification of 89.6 % (86/96) of speech samples from

these typically developing children as potentially warranting classification of an inconsistent disorder.

However, there are a number of definitional features of "variability" that differentiate the data from the present investigation from data used to identify children with speech impairment. Predominantly, variability as a diagnostic indicator has been applied to children who are older than the participants in the present study, which is important to consider since variability is considered to decrease with increasing age[43, 44]. Additionally, variability as a diagnostic indicator is typically applied to variability in single word productions. For example, Dodd's variability index[18] is based on three repetitions of a set of 25 single (usually polysyllabic) words, which are elicited in a specific, structured naming procedure. The percentage of variable repeated words for the present study was calculated from words (usually monosyllabic) elicited in spontaneous speech in a relatively unstructured play setting. Further, a proportion of the words in the present study were repeated more than three times, thus increasing the probability of variation occurring. Additionally, in the present study the number words repeated per child per session were highly variable; this could influenced the results. Finally, variability as a diagnostic indicator has been applied to broad transcription of speech data [18]. In contrast, the present investigation applied narrow transcription, thus phonetic distortions of fricatives, affricates and /r/ *were* judged to be inconsistent in the percentage of variable repeated words in the present investigation.

Conclusion

Variability between and within individuals featured prominently in speech samples elicited in spontaneous speech, from this group of typically developing two- to three-year-olds. As the children became older, they increased the accuracy of their productions overall; however, variability between and within individuals continued to occur. If typically developing children are highly variable, then one must take care not to interpret group trends (averages) as rigid criteria for identification of speech impairment. Variability, per se, may not be an accurate diagnostic marker for different types of speech impairment (e.g., childhood apraxia of speech) if it is a shared characteristic of children with typically developing speech. Definitions of the type and nature of variability should be described to differentiate between variability in typically developing children and those with speech impairment. Additionally, the effect of accuracy and developmental vs. nondevelopmental mismatches on the extent of variability may also assist in differentiation between these two groups.

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Appendix A.

Participant	Sex	Age: Screening	PCC	Inventory of consonants* (any syllable position)	Inventory of consonant clusters* (word-initial and -final)	MLU	Reynell standard score	Griffiths general quotient (z score)
P1	F	1;10	63.5	p, b, t, d, k, g, m, n, f, θ, s, z, ʃ, h, w, j, l	pl, dw, -gs, -ks, -nz, -ts, -ʃt	2.33	0.5	119 (.37)
P2	M	1;11	29.3	p, b, t, d, k, g, n, ŋ, s, h	none	1.10*	1.4	112 (-.12)
P3	F	1;11	77.9	p, b, t, d, k, g, m, m, n, f, s, z, h, w, l	none	1.87*	0.9	120 (.43)
P4	F	2;0	47.4	p, b, t, d, k, g, m, n, f, θ, s, z, h, tʃ, dʒ, w, j, l	st, kw, bw, -nt, -ms, -ŋk	1.70	0.7	109 (-.32)
P5	F	2;2	63.4	p, b, t, d, k, g, m, n, ŋ, f, v, ð, θ, s, z, ʃ, h, w, j, l	dr, td, -nt, -pθ	2.69	2.7	124 (.71)
P6	F	2;5	64.5	p, b, t, d, k, g, m, n, ŋ, f, ð, s, z, ʃ, ʒ, h, tʃ, w, j, l	kl, fl, st, sn, sw, tw, bw, dw, kl, ts, tw, -dz, -mp, -nd, -ntʃ, -nʒ, -ts	2.50	0.4	114 (.02)
P7	F	2;6	77.7	p, b, t, d, k, g, ʔ, m, n, ŋ, f, v, θ, ð, s, z, ʃ, h, tʃ, w, j, l	pl, bl, fl̥, sp, dw, tw, gw, bw, θp, θt, -st, -lf, -nd, -nt, -ts, -ŋk, -ŋk	3.24	2.2	124 (.71)
P8	M	2;6	62.7	p, b, t, d, k, g, m, n, ŋ, f, v, θ, ð, s, z, ʃ, h, tʃ, w, j, l, r	pl, bl, kl, kw, gw, bw, -kθ, -nd, -nz, -nθ, -pθ, -tθ	2.54	0.9	112 (-.11)

P9	M	2;6	69.7	p, b, t, d, k, g, f, v, θ, ð, s, z, h, w, j, l	pl, bl, fl, tw, bw, fw, pw, pr, θp, θt, -dð, -ks, -kt, -nt, -nz, -nð, -ts, -tθ	3.25	0.7	129 (1.06)
P10	M	2;6	74.3	p, b, t, d, k, g, m, n, ŋ, f, v, ð, s, z, h, t ʃ, w, l	bl, st, tw, tw, ts, -nd, -ks, -pt, -ts	2.52	-0.3	103 (-.74)
P11	F	2;7	77.1	p, b, t, d, k, g, m, n, ŋ, f, s, h, tʃ, dʒ, w, j, l, r	br, pl, bl, kl, fl, sp, tw, tʃw, -ks, -nd, -ts	2.61	1.3	123 (.64)
P12	F	2;7	63.7	p, b, t, d, k, g, m, n, f, v, θ, ð, ʃ, h, w, j, l	dw, -kθ, -mp, -ntɾ, -nð, -tθ, -ŋk	3.25*	1.3	131 (1.19)
P13	F	2;9	80.1	p, b, t, d, k, g, m, n, ŋ, f, v, s, z, h, tʃ, dʒ, w, j, l	bl, kl, st, tw, dw, fw, -nd, -nt, -ts, -ŋk	2.65	1.0	120 (.43)
P14	M	2;9	80.1	p, b, t, d, k, g, m, n, ŋ, f, v, θ, ð, s, z, ʃ, h, tʃ, w, j, l	bl, sp, st, sm, dw, tw, skw, bw, wv, ps, -st, -lz, -mz, -nd, -nz, -nʃ, -ts	3.28	1.3	132 (1.26)
15	F	2;10	77.0	p, b, t, d, k, g, m, n, ŋ, f, v, θ, ð, s, h, tʃ, dʒ, w, j, l	pl, bl, θt, -kθ, -nd, -nt	2.53	0.5	125 (.78)
16	F	2;10	83.3	p, b, t, d, k, g, m, n, ŋ, f, v, θ, ð, s, z, ʃ, h, tʃ, w, j, l	br, pl, sp, st, sn, -gz, -gθ, -ld, -mz, -nd, -nt, -nz, -ts	3.12	1.6	133 (1.33)
Mean		2;5	**68.2**			**2.57**	**1.1**	**120.6 (0.47)**

Key
PCC = Percentage of consonants correct
MLU = Mean length of utterance
* = Sample length <100 words

Appendix B. Toys used to elicit consonant clusters in the spontaneous speech task [37]

Toys organised according to theme	Additional words containing consonant clusters	
• **Blocks** - magnetic blocks of different shapes and colours	• green • blue • orange	• triangle • square • three
• **Kitchen toys** - stove, tray, plates, spoons, glasses, cups, teapot, saucepans, doll, brush	• drink • stir • dress • green • blue	• black • stripes • sleep • close
• **Transport toys I** - train, track, bridge, plane	• black • green	• crash • fly
• **Transport toys II** - truck, tractor, traffic lights	• stop • green	• crash • drive
• **Drawing** -crayons and paper	• draw • green • blue • black • brown	• orange • pink • grey • flower • tree
• **Animals** - frog, snail, snake puppet, glasses, clock	• green • stripes • spots	

Appendix C. Speech sample characteristics.

Participant (age)	Types*	Tokens*	Type-Token Ratio	Number of repeated words*	Variability index
P1 (2;0)	20	32	0.62	10	0.50
P1 (2;1)	24	36	0.67	7	0.57
P1 (2;2)	28	43	0.65	9	0.89
P1 (2;3)	23	47	0.49	9	0.56
P1 (2;4)	27	42	0.64	9	0.57
P1 (2;5)	44	97	0.45	26	0.54
P1 Average	**27.7**	**49.5**	**0.56**	**11.7**	**-**
P2 (2;0)	10	19	0.53	5	0.60
P2 (2;1)	16	43	0.37	11	1.00
P2 (2;2)	26	54	0.48	13	0.67
P2 (2;3)	19	35	0.54	8	0.75
P2 (2;4)	20	38	0.53	5	1.00
P2 (2;5)	23	41	0.56	7	0.57
P2 Average	**19.0**	**38.3**	**0.50**	**8.2**	**-**
P3 (2;0)	19	38	0.50	9	0.67
P3 (2;1)	20	33	0.61	8	0.50
P3 (2;2)	19	27	0.70	7	0.29
P3 (2;3)	31	56	0.55	16	0.20
P3 (2;4)	21	33	0.64	6	0.67
P3 (2;5)	39	83	0.47	19	0.76
P3 Average	**24.8**	**45.0**	**0.55**	**10.8**	**-**
P4 (2;2)	22	39	0.56	10	0.60
P4 (2;3)	24	35	0.69	9	0.78
P4 (2;4)	25	66	0.38	14	0.92
P4 (2;5)	25	65	0.38	16	0.60
P4 (2;6)	31	73	0.42	15	0.50
P4 (2;7)	28	57	0.49	13	0.55
P4 Average	**25.8**	**55.8**	**0.46**	**12.8**	**-**
P5 (2;3)	24	38	0.63	8	0.62
P5 (2;4)	42	74	0.57	17	0.71
P5 (2;5)	45	94	0.48	24	0.55
P5 (2;6)	39	99	0.39	21	0.61
P5 (2;7)	50	95	0.53	20	0.71
P5 (2;8)	49	89	0.55	20	0.55
P5 Average	**41.5**	**81.5**	**0.51**	**18.3**	**-**
P6 (2;6)	33	61	0.54	12	0.62
P6 (2;7)	34	51	0.67	9	0.71
P6 (2;8)	35	58	0.60	16	0.25
P6 (2;9)	39	63	0.62	14	0.38
P6 (2;10)	42	69	0.61	14	0.33
P6 (2;11)	52	86	0.60	17	0.38
P6 Average	**39.2**	**64.7**	**0.61**	**13.7**	**-**
P7 (2;7)	35	80	0.44	20	0.44
P7 (2;8)	48	88	0.55	19	0.44
P7 (2;9)	49	131	0.37	27	0.45
P7 (2;10)	42	96	0.44	18	0.71
P7 (2;11)	44	73	0.60	18	0.27
P7 (3;0)	48	87	0.55	19	0.09
P7 Average	**44.3**	**92.5**	**0.48**	**20.2**	**-**
P8 (2;7)	43	76	0.57	14	0.85
P8 (2;8)	61	125	0.49	32	0.47
P8 (2;9)	51	103	0.50	25	0.33

P8	(2;10)	57	95	0.60	22	0.52
P8	(2;11)	67	125	0.54	26	0.50
P8	(3;0)	57	116	0.49	23	0.45
P8 Average		**56.0**	**106.7**	**0.53**	**23.7**	**-**
P9	(2;7)	36	71	0.51	14	0.40
P9	(2;8)	39	71	0.55	17	0.55
P9	(2;9)	49	104	0.47	24	0.35
P9	(2;10)	51	117	0.44	23	0.47
P9	(2;11)	60	113	0.53	25	0.26
P9	(3;0)	71	131	0.54	25	0.24
P9 Average		**51.0**	**101.2**	**0.50**	**21.3**	**-**
P10	(2;8)	28	69	0.41	15	0.36
P10	(2;9)	32	88	0.36	22	0.11
P10	(2;10)	43	119	0.36	23	0.43
P10	(2;11)	39	95	0.41	23	0.21
P10	(3;0)	33	61	0.54	15	0.31
P10	(3;1)	45	79	0.57	19	0.62
P10 Average		**36.7**	**85.2**	**0.43**	**19.5**	**-**
P11	(2;8)	36	63	0.57	16	0.36
P11	(2;9)	34	47	0.72	9	1.00
P11	(2;10)	28	41	0.68	9	0.33
P11	(2;11)	32	43	0.74	9	0.50
P11	(3;0)	31	50	0.62	11	0.83
P11	(3;1)	37	51	0.73	12	0.17
P11 Average		**33.0**	**49.2**	**0.67**	**11.0**	**-**
P12	(2;9)	35	84	0.42	20	0.45
P12	(2;10)	52	100	0.52	25	0.17
P12	(2;11)	53	107	0.50	26	0.84
P12	(3;0)	58	105	0.55	26	0.48
P12	(3;1)	50	139	0.36	29	0.62
P12	(3;2)	56	107	0.52	27	0.52
P12 Average		**50.7**	**107.0**	**0.47**	**25.5**	**-**
P13	(2;10)	32	61	0.52	16	0.31
P13	(2;11)	31	51	0.61	12	0.43
P13	(3;0)	43	66	0.65	12	0.30
P13	(3;1)	41	66	0.62	14	0.42
P13	(3;2)	45	78	0.58	16	0.27
P13	(3;3)	65	104	0.62	22	0.10
P13 Average		**42.8**	**71.0**	**0.60**	**15.3**	**-**
P14	(2;10)	49	102	0.48	20	0.32
P14	(2;11)	44	137	0.32	19	0.65
P14	(3;0)	49	83	0.59	17	0.29
P14	(3;1)	48	110	0.44	22	0.11
P14	(3;2)	62	134	0.46	32	0.39
P14	(3;3)	50	110	0.45	25	0.46
P14 Average		**50.3**	**112.7**	**0.45**	**22.5**	**-**
P15	(2;10)	34	83	0.41	18	0.44
P15	(2;11)	31	57	0.54	15	0.29
P15	(3;0)	39	76	0.51	18	0.43
P15	(3;1)	41	80	0.51	19	0.44
P15	(3;2)	44	87	0.51	17	0.47
P15	(3;3)	62	123	0.50	24	0.38
P15 Average		**41.8**	**84.3**	**0.50**	**18.5**	**-**
P16	(2;11)	38	69	0.55	17	0.57
P16	(3;0)	40	73	0.55	16	0.30

P16 (3;1)	38	73	0.52	18	0.31
P16 (3;2)	44	84	0.52	21	0.27
P16 (3;3)	33	54	0.61	12	0.37
P16 (3;4)	53	86	0.62	20	0.00
P16 Average	**41.0**	**73.2**	**0.56**	**17.3**	**-**
Overall Average	**39.1**	**76.1**	**0.51**	**16.9**	**-**

Note.

* Individual words may have been repeated once only, or several times. Thus, the number of repeated words does not necessarily equate to the number of tokens minus the number of types.

Table 1
Percentage of repeated words with variable realisations.

Participant (age)	% V	Participant (age)	% V	Participant (age)	% V	Participant (age)	% V
1. (2;0-2;5)	61.4	5. (2;3-2;8)	64.5	9. (2;7-3;0)	55.5	13. (2;10-3;3)	42.4
2. (2;0-2;5)	77.6	6. (2;6-2;11)	53.7	10. (2;8-3;1)	42.7	14. (2;10-3;3)	43.7
3. (2;1-2;6)	53.8	7. (2;7-3;0)	54.5	11. (2;8-3;1)	69.7	15. (2;10-3;3)	47.7
4. (2;2-2;7)	68.8	8. (2;7-3;0)	51.4	12. (2;9-3;2)	53.6	16. (2;11-3;4)	55.8
Total (all participants): 53.7% variable							

Note. Percentage variability (% V) figures were calculated for each participant through raw data from the six speech samples for the number of **inconsistently incorrect** and **inconsistently correct** repeated words, then dividing by the total number of repeated words for the six speech samples and multiplying by 100. The percentage of repeated words that were realised consistently is equal to 100% - the percentage of variable word productions (% V).

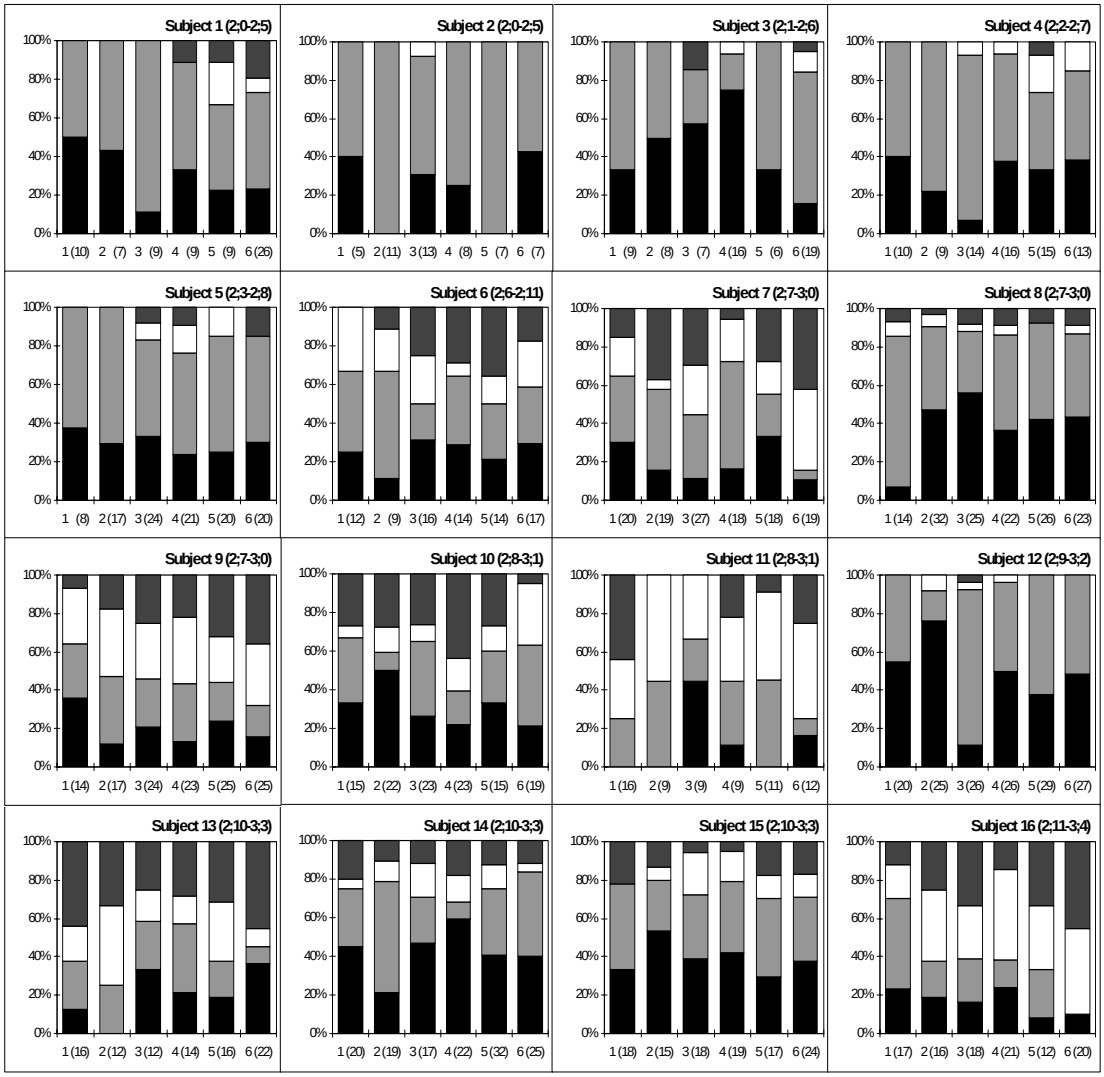

Figure 1

Participant profiles for consistency and accuracy of repeated words.

Classification of repeated words based on Grunwell (1992):

- consistently correct
- inconsistently correct
- inconsistently incorrect
- consistently incorrect

Note. The number of repeated words in each sample is enclosed in parentheses, adjacent to the sample number (x axis). Participants' ages during the data collection period are enclosed in parentheses following the participant numbers (i.e., age at first sample - age at last sample). The y axis indicates the percentage of each repeated word classification contained in the sample.