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# Between-word junctures in early multi-word speech*

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ABSTRACT

Most children aged 1;6 to 2;0 begin to use utterances of two words or more. It is therefore important for child phonologists to consider the development of phonetic and phonological phenomena that characterize connected speech. The longitudinal case study reported here investigated three juncture types – assimilation, elision and liaison – in the speech of a typically-developing child between the ages of 2;4 and 3;4. Attempts at production of these adult juncture types occurred from the onset of two-word utterances. However, for some juncture types, the child still had to perfect the intergestural relationships and gestural articulations that the adult between-word junctures demand. This process of phonetic development was largely accomplished by the age of 3;4. With one exception, between-word junctures appear not to be the result of learned phonological rules or processes. The exception is liaison involving /r/, which did not occur until the child was three years old.

## INTRODUCTION

The production by adults of a range of between-word juncture types in connected speech has been well documented. Comprehensive accounts and classification of the phenomena which occur have been discussed by various researchers (for example, Barry, 1984; Lodge, 1984; Gimson, 1989) and are generally referred to as PROCESSES. While we retain this term in reporting previous research, for our own study we have adopted the more theoretically neutral term JUNCTURE TYPES, for reasons that will become apparent in the

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course of this report. We describe occurrences of the connected speech phenomena as instances of CLOSE JUNCTURE and its absence (in a relevant context) as OPEN JUNCTURE (cf. Gimson, 1989; Wells, 1994).

Using electropalatography (a computer-based technique which records patterns of lingual–palatal contact), Wright & Kerswill (1989) demonstrate that between-word processes can be articulatorily gradual. Kerswill (1985, 1987) suggests that processes which are sociolinguistically salient tend to be articulatorily discrete, whereas those which are not sociolinguistically salient are applied more gradually according to speech rate. The occurrence of connected speech processes has also been explained in terms of syntactic structure (Rotenberg, 1978; Kaisse, 1985). Papers by Selkirk (1984) and Panagos & Prelock (1994) discuss how processes might be described within a phonological framework. In addition, Browman & Goldstein (1987) have shown how some connected speech phenomena can be described within the framework of ARTICULATORY PHONOLOGY, based on the observation that in connected speech, gestures decrease in magnitude and overlap by a greater amount.

Despite this there has been little description of these juncture types in the speech of children. Until recently most research on phonological development has focused on isolated words. This is understandable given the large number of phenomena which occur at the single word level. What investigation there has been of children's connected speech has concentrated on the production of idiosyncratic phonological processes with a domain larger than the single word (Stemberger, 1988). These processes do not correspond to ones produced by English-speaking adults. The child Gwendolyn whose speech is reported in Stemberger (1988) does produce between-word processes which are similar to processes produced by adults, but not by adults speaking English. Data which record the stages of development in children's connected speech of English adult-like juncture types, such as final consonant cluster reduction and anticipatory assimilation, have not previously been reported. Whether or not there is a developmental trend for children's production of between-word junctures and whether or not some juncture types develop differently from others remain open questions.

Newton & Wells (1999) aimed to fill this gap in our knowledge. The study reported there examined the production of three between-word juncture types in the speech of children aged between 3;0 and 7;0. Junctures investigated were the following:

1. Assimilation (anticipatory) – where word-final alveolar /t, d and n/ assimilate in place of articulation to following word-initial bilabial or velar oral and nasal stop consonants. For example, 'white cloud': [waɪkklaʊd]; 'red balloon': [rɛbbəlun]; 'one missing': [wʌmmɪsɪŋ].

2. Elision (or final consonant cluster reduction) – where /t/ and /d/ elide in the environment /C_#C/. For example, 'lost Bertie': [lɒsbɜti]; 'find Jack': [faɪndʒæk].
3. Liaison – where, in certain accents of English, glides /j, w and r/, rather than a glottal stop, are inserted over the word boundary, between two vowels. For example, 'tidy up': [taɪdi$^{j}$ʌp]; 'go up': [gəʊ$^{w}$ʌp]; 'saw a': [sɔ$^{r}$ə].

The results of the study reported in Newton & Wells (1999) indicated that there was no obvious developmental trend evident for these three between-word juncture types and no gross changes in their occurrence were found between 3;0 and 7;0. Moreover, the children were found to use the junctures in similar proportions and with the same variation as would be expected from adult speakers (about 75–80% of possible instances).

These results raise interesting questions concerning when and how between-word juncture types develop from the time children start to produce two-word utterances. The absence of developmental change in the production of these junctures suggests that they may not be 'acquired' as phonological rules, but instead happen more or less automatically. Alternatively, the between-word junctures may be learnt, with the learning largely complete before the age of around 3;6, the age of the youngest children in that study.

A logical next step, in order to decide between these two hypotheses, would therefore be to examine the speech of children younger than those recorded in the first study. The study reported here involves the analysis of two- and multi-word utterances from a younger child, who has recently started to produce them. The aim of this investigation was to discover whether any changes in the realizations at the sites for these between-word junctures occur at a younger age, and whether the children at this age use the between-word junctures in the same proportion as older children. Developmental changes in the production of between-word junctures may occur, but it may be that they are not quantitative shifts as analysed in Newton & Wells (1999). More qualitative analysis of this child's speech would therefore be needed.

## METHOD

The single case study has traditionally been the preferred methodology for addressing issues related to phonological development, at least in speech production: examples considering connected speech phonology include Donahue (1986), Stemberger (1988) and Matthei (1989). The data presented here were collected as part of a longitudinal single case study of one boy (CW) from the age of 2;4 to 3;4. CW was resident in North London, had normal speech and language abilities and English as his first and only language. The varieties of English to which he was primarily exposed are non-rhotic: father

close to RP (Wells, 1982), mother with a few West Midlands features. Information on CW's segmental phonetic inventory and its distribution and, more specifically, on his realizations of individual target consonants at three points during the course of this study is given in the Appendix.

Recordings of CW's spontaneous speech were made approximately fortnightly, with each recording session lasting about one hour. CW was recorded while involved in play activities with adults or other children. No specific tasks were carried out, though some games or activities (for example, a 'shape' game, or talking about a collection of 'Thomas the Tank Engine' trains) were carried out on several occasions during the many sessions. Speech was recorded using Digital Audio Tape (DAT), for best quality recording, with the microphone positioned on the floor of the room. One of the results of the informality of the recording sessions was that the recording conditions were sometimes less than ideal. A lapel microphone, for example, rather than a stationary one may have resulted in better quality recordings. However, the fact that CW was recorded at home, in familiar surroundings, meant that he was always comfortable with the recording environment. This was crucial, since the linguistic phenomena that this study aimed to investigate were much less likely to be elicited from a two-year-old child under more formal conditions.

All audible utterances were orthographically transcribed. Some utterances were inaudible, as speech was occasionally obscured by loud noises (such as dropping bricks onto a wooden floor). Potential sites for the juncture types under investigation were identified in CW's recorded speech. These were defined as ones where it appeared that the two relevant segments were potentially adjacent in the child's output form (e.g. V#V for liaison) – rather than in the putative target adult form. Thus, for example, the two strings transcribed orthographically as 'Daddy is' and 'he alright' were both regarded as potential liaison environments, even though the latter is not a possible adult form.

All such instances were transcribed phonetically by the first author, a trained phonetician with experience of transcribing child speech. It became apparent during the course of the study that CW's realizations of the potential juncture sites could be characterized in three different ways: occurrence of the adult phenomenon in question (e.g. assimilation); occurrence of open juncture; occurrence of a realization not observed in adult connected speech. Therefore, on the basis of the phonetic transcriptions the juncture sites were assigned to categories (see below for fuller descriptions). 10% of these were given to the second author, a trained phonetician with extensive experience of transcribing child speech, for transcription and assignment to categories. Interrater reliability was calculated for the latter and revealed an agreement of 90·6%. In cases of disagreement in categorization discussion between the authors led to an agreed interpretation.

TABLE 1. *Examples of CW's realization of target /d/ and /n/ in non-assimilation and assimilation environments*

| Realization/age | Utterance | Gloss |
|---|---|---|
| Realization of /d/ | | |
| Non-assimilation environments | | |
| 2;6 | [hɛd] | head |
| 2;7 | [bʊɛd] | bread |
| 3;0 | [kʌbəd] | cupboard |
| 3;1 | [ɪnsaɪd] | inside |
| Assimilation environments | | |
| 2;4 | [tɛgglɛn] | Ted Glenn |
| 2;7 | [niʔkʊeɪn] | need crane |
| | [ʊaɪʔpipʊ] | ride people |
| 2;8 | [dæʔkʊæç] | had crash |
| 2;9 | [meɪdəmaɪ] | made my |
| 2;11 | [ʊɛbbəlun] | red balloon |
| 3;0 | [nibmaɪ] | need my |
| 3;2 | [dɪgkʌm] | did come |
| 3;3 | [niggɛt] | need get |
| | [nibblu] | need blue |
| 3;4 | [hædmɪstə] | had Mr |
| Realization of /n/ | | |
| Non-assimilation environments | | |
| 2;4 | [dɒn] | gone |
| 2;7 | [dɔdən] | Gordon |
| 2;9 | [dʒægɪn] | dragon |
| 3;1 | [gɑdən] | garden |
| Assimilation environments | | |
| 2;4 | [wʌmpleɪdeɪ] | one playday |
| | [wʌmmɪsɪŋ] | one missing |
| 2;6 | [ʊəmaɪ] | in my |
| | [tʃɪkɪmpɒts] | chicken pox |
| 2;7 | [ɪmmɪnɪʔ] | in minute |
| 2;8 | [ɪmpʌdʊ] | in puddle |
| | [kæbi] | can be |
| 2;9 | [kæmpleɪ] | can play |
| | [dʌnmun] | done moon |
| | [daõbɑbʊə] | down Barbara |
| 2;10 | [ɪnmaɪ] | in my |
| 2;11 | [pɑdəmmi] | pardon me |
| | [wʌŋkɔd] | one called |
| | [ɒnpɪʔtʃə] | on picture |
| 3;0 | [ɒmmaɪ] | on my |
| | [kænkʊæs] | can crash |
| 3;1 | [bʊaʊmbɒts] | brown box |
| 3;2 | [wʌnpis] | one piece |
| 3;3 | [kæŋgɛʔ] | can get |
| | [gʊinpɛn] | green pen |
| 3;4 | [gʊimbɔ] | green ball |

## RESULTS

### *Assimilation*

By the start of the period under study, CW was routinely using [n] and [d] as his only realizations respectively of target word-final (coda) /n/ and /d/, in pre-pausal and prevocalic positions (see Appendix). Examples are included in Table 1.

In environments in CW's speech for assimilation of word-final /n/ and /d/ (though many fewer target environments for the latter were elicited: 25 over the 12 months of the study, as opposed to 166 target environments for assimilation of /n/), instances of assimilation occur from the onset of the study, when CW is 2;4, for example, 'one missing': [wʌmmɪsɪŋ] and 'Ted Glen': [tɛgglɛn]. While over the early sessions utterances which include the items 'in …', 'on …' and 'one …' account for the majority of the occurrences of /n/ assimilation, this is not the case in the sessions over the last few months of recording. In fact, over these sessions it is strings containing the word 'can …' which account for nearly half of the instances where assimilation of /n/ was recorded in CW's speech from 3;0 to 3;4. Examples of CW's realizations of potential environments for assimilation of /d/ and /n/ are presented in Table 1.

Also evident from the start of the study are environments which are realized neither with adult-like assimilation (such as the examples above) nor with open juncture (as in, 'one missing' realized as [wʌnmɪsɪŋ]), but with a variety of apparently non-adult-like realizations. In the six /d/ assimilation environments which CW produces when he is aged 2;7 to 2;8 the target word-final /d/ is realized as a glottal stop, for example, 'need crane': [niʔkʋeɪn]. CW uses a number of different realizations for environments in which assimilation of /n/ might occur. These types of realization are shown in Table 2.

TABLE 2. *Examples of 'other' realizations in /n/ assimilation environments*

| Group | Realization of environment | Example | |
|---|---|---|---|
| 1 | C elided | 'in my' (2;6) | [ʋəmaɪ] |
| 2 | C elided; ʔ inserted | 'man come' (2;9) | [mæʔkʌm] |
| 3 | C elided; V nasalized | 'on crane' (2;7) | [ɔ̃kʋeɪn] |
| 4 | C elided; ʔ inserted; V nasalized | 'in box' (2;8) | [ĩʔbɒks] |

These realizations were not observed in the results from Newton & Wells (1999) and would not be expected to occur in adult speech. In CW's speech they only occur from the age of 2;5 to 2;9. Figure 1,[1] where these non-adult

[1] In the interests of clarity of presentation, in Figure 1 and subsequent Figures, data has been combined from sessions within each month, to give a total score per month.

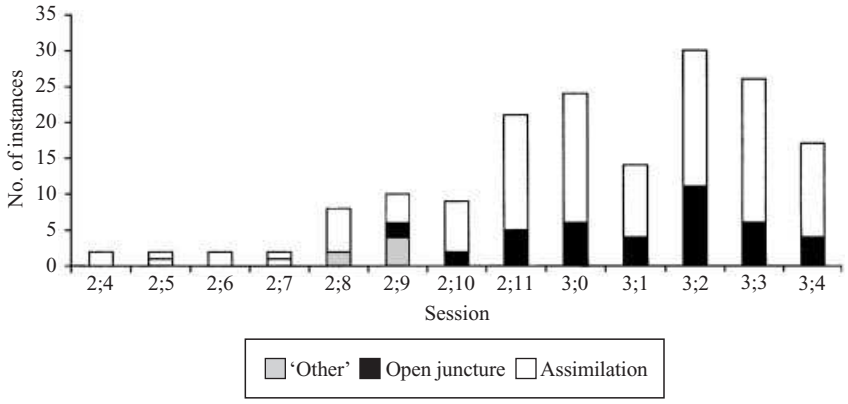


Fig. 1. Realizations of alveolar assimilation environments.

realizations are labelled 'other', illustrates this developmental trend for both /n/ and /d/ assimilation environments. Open juncture realizations only emerge when CW is 2;9, four weeks before the 'other' category disappears altogether (when CW is 2;10). When CW is 2;9, the three different realizations co-occur, suggesting that this is a transitional stage, developmentally.

We can conclude firstly that from the onset of the study, CW's realization of /n/ and /d/ codas in assimilation environments is generally different from the realization in non-assimilation environments: the open juncture realizations, which phonetically are closest to prevocalic or pre-pausal realizations, only appear when CW is 2;9. Secondly, CW's realizations of the assimilation junctures become progressively more adult-like through the period observed: the 'other' close juncture realizations disappear from age 2;10.

*Elision*

From the beginning of the period under study, CW was able to realize complex codas in word final position, by signalling each of the constituent consonants. He did this routinely when the target cluster was in a non-elision environment, i.e. prepausally and prevocalically. Examples are given in Table 3.

Table 3 also shows that instances of plain adult-like elision can be observed in CW's speech from the onset of the study (for example, 'dropped sausage': [dɒpsɒsɪdʒ]) as can realizations where the entire word-final consonant cluster (CC#) is elided and the preceding vowel nasalized (for example, 'can't find': [kɑ̃faɪnd]). The latter only occurs where the first consonant of the cluster is a nasal. This type of realization may also occur in adult speech in this type of environment.

TABLE 3. *Examples of CW's realization of target word-final consonant clusters in non-elision and elision environments*

| Environment/age | Utterance | Gloss |
|---|---|---|
| Non-elision environments | | |
| 2;4 | [ɛɬənt] | elephant |
| | [ʋaʊnd] | round |
| 2;6 | [hænd] | hand |
| 2;7 | [dʒɒmpt] | jumped |
| 2;9 | [dɒpt] | stopped |
| 2;11 | [fəst] | first |
| 3;1 | [pʊʃtɪʔ] | pushed it |
| 3;3 | [dʊpptə] | dropped a |
| Elision environments | | |
| 2;4 | [kɑntɸaɪnd] | can't find |
| | [dʊpsɒsɪdʒ] | dropped sausage |
| | [pəʊʔpæt] | Post Pat (= Postman Pat) |
| 2;5 | [tɑ̃du] | can't do |
| 2;6 | [ɸɒvəʔʊum] | front room |
| 2;7 | [lɒʔbɜti] | lost Bertie |
| | [lɒçbɜti] | lost Bertie |
| 2;8 | [wɒmpleɪ] | want play |
| | [nɛʔpeɪdʒ] | next page |
| 2;9 | [wɒʔpɜpʊ] | want purple |
| | [ɸaĩdʒæʔ] | find Jack |
| 2;10 | [ɸaʊnʌmbə] | found number |
| | [ɸaʊndwʌn] | found one |
| 2;11 | [dʒʌskɑptɪn] | just Captain |
| | [kɔdn̥neɪjʊ] | called snail |
| 3;0 | [kɑ̃faɪnd] | can't find |
| 3;1 | [dʒʌsgəʊ] | just go |
| 3;2 | [kɑntgɛt] | can't get |
| | [peɪmmɪstə] | paint Mister |
| 3;3 | [wɒnðæʔ] | want that |
| 3;4 | [wəʊntgɛt] | won't get |

As with assimilation, there is a developmental pattern evident in the realization of the elision juncture type. This involves instances where CW realized the initial two consonants of the sequence as a glottal stop, with the word-initial consonant remaining, for example, 'lost Bertie': [lɒʔbɜti]. Though a type of glottalization is frequently produced by adult speakers of this variety of English (discussed in Roach (1973), for example, 'next page': [nɛʔkstpʰeɪdʒ], 'can't sing': [kɑnʔtsɪŋ]), the juncture used by CW in this group of utterances is one that does not occur in the speech of adults, or in that of the children observed by Newton & Wells (1999).

The environments in which this phenomenon occurs suggest there are phonetic factors determining when the glottalization might occur. In the majority, the target first word ends with (k)st#, with the cluster nt#

accounting for the few others. There is no consistent pattern in the type of consonant which follows the word boundary, though this is often /p/ or /b/. Word-final lingual consonant clusters which involve /s/ seem to be particularly susceptible to this phenomenon, perhaps because of the fine control required of the tongue to produce /st/ together.

However, it should be noted that these sequences do not invariably result in a glottal realization. For example, while 'lost Bertie' in one recording session is produced with a glottal stop, in the following session it is produced with an elision, thus: [lɒçbɜti].

Figure 2 shows that realizations of CC# as a glottal stop are evident from the beginning of the study, when CW is 2;4. During the period that it occurs as a possible realization (2;4–2;9), CW produces glottalization for some of the utterances, but not all: the majority are realized with more adult-like elisions. From the age of 2;10, glottalization vanishes completely. (Note that in the figure the group 'elision' includes both those environments in which elision occurs and those in which the word-final cluster is elided and the preceding vowel is nasalized).

Open juncture occurs in two early sessions, but is not common during the period that the glottalization occurs (CW produces no open juncture from age 2;7 to 2;9). Instances of open juncture do occur consistently in all later recording sessions from 2;10 on, but in a proportion lower than that observed in Newton & Wells (1999), which was approximately 20–25%.

This late emergence and relatively uncommon use is not surprising, as open juncture in environments where elision could occur involves the production of at least three consecutive consonants. The simplification of this kind of juncture – whether by ordinary elision or the glottalization observed previously – would not be unexpected, and therefore open juncture would need to be mastered, just as the appropriate realization of close juncture was mastered earlier.

The analysis of elision leads to similar conclusions as the analysis of assimilation. There is copious evidence that CW was consistently able to produce complex codas, consisting of two or three consonants, in non-elision environments. On the other hand, in elision environments, CW used an elision juncture in the large majority of cases. Furthermore, his phonetic realizations of elision junctures became more adult-like with increasing age; for example, the glottalized elisions disappeared, and the proportion of more adult-like elisions increased proportionately after the age of 2;9.

In one respect, the pattern for elision differs from the pattern for assimilation. We saw that CW's ability to produce an open juncture (i.e. without assimilation) in a target assimilation environment emerged relatively late. By contrast, we find instances of open juncture in elision environments in some of the earliest sessions (when CW is 2;4 and 2;6). They then disappear, to reemerge later (when CW is 2;10). Yet even in the early

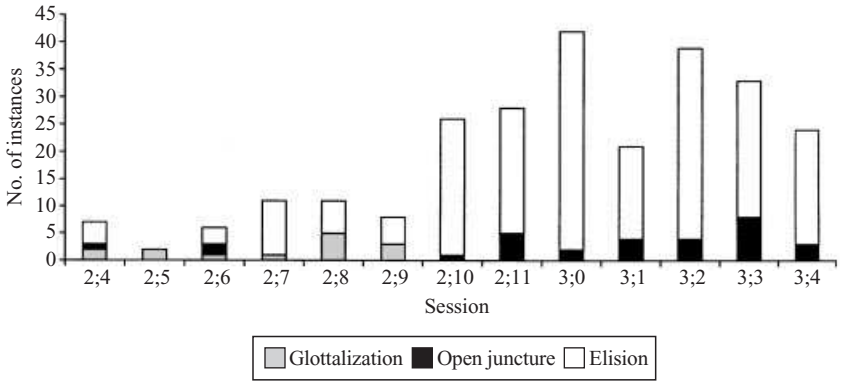


Fig. 2. Realizations of elision environments.

TABLE 4. *Examples of CW's realizations of target /j/, /w/ and /r/ in syllable onset position and in intervocalic (within word) position*

| Position/age | Utterance | Gloss |
|---|---|---|
| Syllable onset position | | |
| 2;4 | [ju] | you |
| 2;11 | [jɛt] | yet |
| 3;2 | [jɒgəʔ] | yoghurt |
| Intervocalic position | | |
| 2;10 | [ijəz] | ears |
| 2;11 | [laɪjən] | lion |
| Syllable onset position | | |
| 2;6 | [ɛdwəd] | Edward |
| 2;9 | [wɔtə] | water |
| 3;0 | [wɪnɪŋ] | winning |
| Intervocalic position | | |
| 2;5 | [luwi] | Lewi |
| 3;1 | [flæwə] | flower |
| Syllable onset position | | |
| 2;4 | [hɛʔvi] | Henry |
| 2;9 | [vɛd] | red |
| 3;2 | [vaɪbinə] | Ribena |
| Intervocalic position | | |
| 2;8 | [hævvɒd] | Harold |
| 2;10 | [kævɪ] | carry |
| 3;1 | [lɔvə] | Laura |

sessions, the open juncture realizations were always in the minority, compared to close juncture realizations (i.e. elisions). Thus we are justified in concluding that, as with assimilation, the close juncture realizations of target elision environments are the predominant or unmarked pattern from the outset.

TABLE 5. *Examples of CW's realization of potential environments for liaison with /j/, /w/ and /r/*

| Liaison/age | Utterance | Gloss |
|---|---|---|
| Liaison with /j/ | | |
| 2;4 | [taɪdijʌp] | tidy up |
| 2;6 | [dʌntijæʔ] | Dumpty at |
| | [aɪʔə] | I a |
| 2;7 | [sijɪt] | see it |
| | [hiʔɪn] | he in |
| 2;8 | [taɪdiʔʌp] | tidy up |
| 2;9 | [deɪʔɔ] | they all |
| | [deɪjɔ] | they all |
| 2;10 | [wijɑ] | we are |
| | [hɛnviʔæn] | Henry and |
| 2;11 | [flaɪjɪn] | fly in |
| 3;0 | [sijæni] | see Annie |
| | [meɪbiʔɪʔ] | maybe it |
| 3;1 | [bijə] | be a |
| 3;2 | [aɪʔit] | I eat |
| | [maɪjaɪz] | my eyes |
| 3;3 | [æniʔænd] | Annie and |
| | [sɪlɪjoʊ] | silly old |
| 3;4 | [pleɪjə] | play a |
| Liaison with /w/ | | |
| 2;4 | [duwɪt] | do it |
| 2;5 | [duwɪt] | do it |
| 2;6 | [duwə] | do a |
| 2;7 | [duʔæni] | do Annie |
| 2;9 | [duwɪt] | do it |
| | [bluwænd] | blue and |
| 2;10 | [gəʊʔʌp] | go up |
| | [bluʔæn] | blue and |
| | [njuwɛndʒɪn] | new engine |
| 2;11 | [gəʊwəgɛn] | go again |
| | [juʔɪz] | you is |
| 3;0 | [jɛləʊwænd] | yellow and |
| 3;1 | [gəʊwɪn] | go in |
| | [fəʊtəʊʔɒv] | photo of |
| 3;2 | [duwɪt] | do it |
| 3;3 | [naʊwaɪ] | now I |
| 3;4 | [huʔɑ] | who are |
| Liaison with /r/ | | |
| 2;4 | [dɛəʔɪz] | there is |
| 2;5 | [nʌməʔeɪt] | number eight |
| 2;8 | [bɑbvəʔəbaʊʔ] | Barbara about |
| 2;9 | [dɛəʔɪt] | there it |
| 2;11·4 | [kələʔɪz] | colour is |
| 2;11·28 | [ðɛəʊɪz] | there is |
| 3;0 | [ðɛəʊɪt] | there it |
| | [dvɔvə] | draw a |
| 3;1 | [wɛəʊɪt] | where it |
| | [ðɛəʊɪzən] | there isn't |
| 3;2 | [mɪstəʔʌpəti] | Mr Uppity |
| | [hiəʊɪt] | here it |
| 3;3 | [ɔvə] | or a |
| | [ɑftəʔaɪ] | after I |
| 3;4 | [lɔvəʔəʊnli] | Laura only |

*Liaison*

In the adult varieties of English to which CW was most exposed, the glides /j/, /w/ and /r/ are not found before consonants, or word finally in prepausal position. They occur prevocalically, both within and between words, the latter being the liaison environment that is of interest here. There is evidence from CW's realizations of the target glides in within-word prevocalic environments that, from the onset of the period under study, he was able to produce an appropriate glide as illustrated in Table 4.

*/j/ liaison*

Liaison with /j/ occurs in CW's speech right from the beginning of the study – from the age of 2;4; for example, 'tidy up': [taɪdijɒp]. Examples are presented in Table 5. The developmental picture is presented in Figure 3.

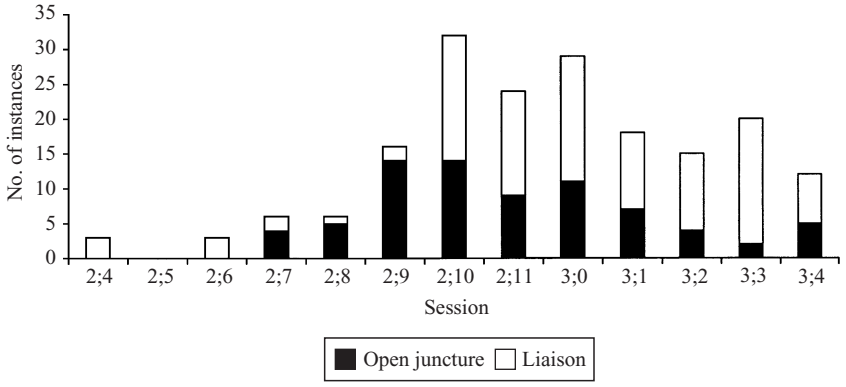


Fig. 3. Realizations of /j/ liaison environments.

All of the relatively few instances of target liaison sites from 2;4 to 2;6 are realized with liaison. From 2;7 to 2;9, the number of target sites increases, but now the large majority of realizations are with open juncture. In the later recording sessions (from 2;10) the proportion of target sites realized with liaison is consistently high – about 80–85%. This is similar to the proportion used by adults, and by older children (Newton & Wells, 1999).

Where /j/ liaison is not reported to have occurred open juncture is produced, with a glottal stop inserted at the word boundary, for example, 'he in': [hiʔɪn]. Few consistent patterns concerning the environments where /j/ liaison might occur could be determined. Word pairs with a personal pronoun and the appropriate form of the verb 'to be' are produced with liaison when they are preceded by 'there', so that utterances such as 'there *they are*' and 'there *he is*' involve liaison. Closer examination of the

environments where CW does not produce /j/ liaison indicates that the majority of these, at least in the first six months of recording, are instances where the copula has been omitted, for example, 'I upstairs', 'he upside down' (see Table 5). Later on, grammatically immature utterances are not as strongly associated with a lack of /j/ liaison.

*/w/ liaison*

/w/ liaison also occurs from the onset of two-word utterances, though again not in all possible environments: see Table 5. Figure 4 shows that in the early

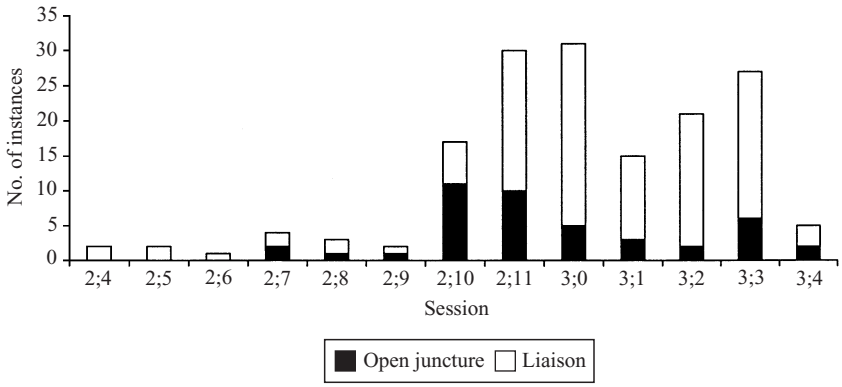


Fig. 4. Realizations of /w/ liaison environments.

sessions this type of liaison prevails, but the number of target environments is very small, and occurrences are directly related to the incidence of the string 'do it'. This string may be taken to be a 'gestalt' utterance of the type described in Peters (1983). From about the age of 2;11 more kinds of environments are produced with liaison (for example, 'do another', 'yellow and'). The proportion of environments realized with liaison is about 60% from then until the end of the study. This is lower than the approximate 85% incidence reported for the same between-word juncture produced by three- to seven-year-olds in Newton & Wells (1999). Apart from the case of 'do it', consideration of vowel quality or lexical conditioning sheds no light on when /w/ liaison might occur. When liaison does not occur CW produces glottal insertion giving open juncture, for example, 'go up': [dəʊʔɒp].

*/r/ liaison*

Target /r/ is realized by a glide in prevocalic environments WITHIN words from the onset of recording, as is evident from Table 4. However, liaison does not occur in any sessions for the first eight months of recording, for either linking (e.g. 'for a': /fɔrə/) or intrusive (e.g. 'saw a': /sɔrə/)

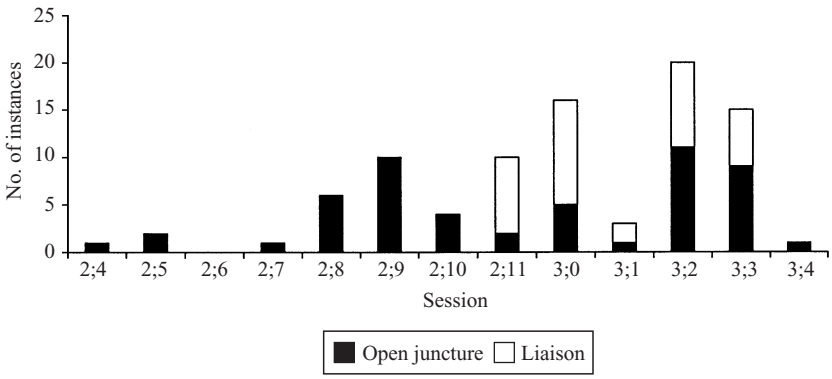


Fig. 5. Realizations of /r/ liaison environments.

environments. The juncture is always marked with a glottal stop, for example, 'painter in': [peɪntəʔɪn]: see Table 5.

Figure 5 indicates how analysis of the final five months of recording sessions show a sudden emergence of /r/ insertion (both linking and intrusive /r/) at around the time of CW's third birthday. There are many more possible sites here than were found in the earlier sessions. However, it is not thought that this has an effect on the likelihood of producing this liaison since identical sites before and after age 2;11 have different realizations. Furthermore, the sudden introduction of /r/ liaison is so striking that it seems unlikely to have been caused by an increase in the number of possible sites. After its emergence, there is no sudden 100% use of /r/ liaison. Neither are there any consistent patterns concerning pre- or post-boundary vowel quality which might explain the insertion of /r/.

Throughout the longitudinal study CW's pronunciation of /r/ has been with the labiodental glide [ʋ], both in syllable onsets and intervocalically. This is also the case for instances of linking and intrusive /r/, e.g. 'driver in': [dʋaɪvəʋɪn] (3;0); 'draw a': [dʋɔʋə] (3;0); 'there it': [dɛəʋɪʔ] (3;3). This parallels the situation that is found in those adult varieties of British English in which the labiodental glide is an acceptable realization of /r/ (Foulkes & Docherty, 2000). In these accents [ʋ] occurs irrespective of environment, i.e. within words and in liaison (Foulkes, personal communication).

These results clearly indicate that for CW, the pattern of development of /r/ liaison was different from the other types of liaison investigated: /j/ and /w/. It has been noted that liaison involving /j/ and /w/ occur in CW's speech from the beginning of this study: around the time of the onset of two-word utterances. In the case of /r/ liaison, from the onset of the study until the age of 2;10 only open juncture occurred. The dramatic arrival of close juncture (liaison) at age 2;11 was observed, after which both close and open juncture co-occurred.

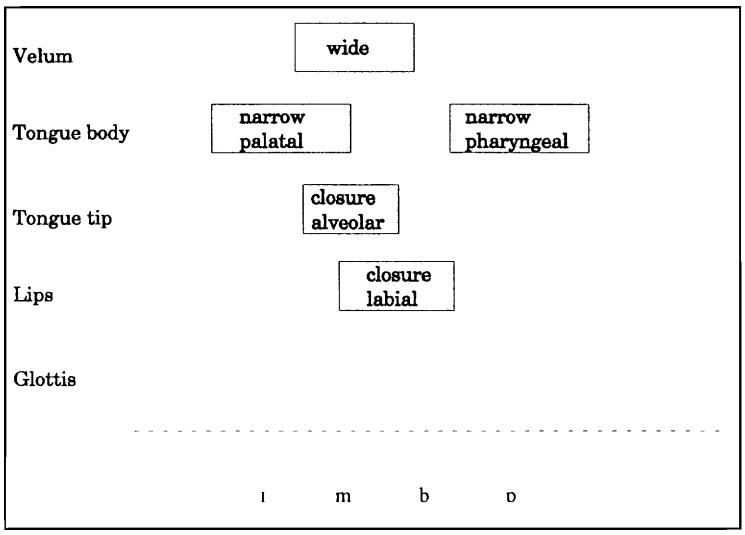


Fig. 6. Adult fast speech production of 'in box' – [ɪmbɒks].

## DISCUSSION AND CONCLUSIONS

Instances of adult-like assimilation and elision occur in CW's speech right from the beginning of the recording sessions, when he has recently started to produce two- and multi-word utterances. Also observable up to the age of about 2;9–2;10 are realizations of assimilation and elision environments which are not adult-like. Consistent use of open juncture occurs much later and is by far the less common type of realization.

As mentioned in the Introduction, articulatory phonology gives accounts of assimilation and elision as they occur in adult speech based on the fact that gestures both decrease in magnitude and overlap by a greater amount in connected speech. As far as phonological development is concerned, Studdert-Kennedy & Goodell (1992) suggest that there are three skills that children need to master: the magnitude of gestures in relation to each other, intergestural overlap and the articulation of individual gestures. The third of these skills is already apparent in the speech production of children of CW's age, as is evident from the data presented in Tables 1, 3 and 4 and in the Appendix. Production of between-word junctures, where the intergestural overlap and other relationships are across a word boundary rather than within a word, would seem to be particularly revealing regarding a child's mastery of the first two skills. Children beginning to produce two- and multi-word utterances will now need to deploy these skills across word boundaries. The developmental process of mastering these skills may lead to the production of 'errors' by the child. For example, at age 2;8 CW produces the

string 'in box' (he has deleted the article 'the' here; the full utterance is 'leave it in box'): [ĭʔbɒks].

Figure 6 shows how articulatory phonology would account for adult-like assimilation in this environment (say, in the string 'in box thirteen'). All the gestures which would occur in a case of open juncture (/ɪnbɒks/) are produced by the speaker, but the gestures are closer together, as they are articulated more quickly in faster speech. Jun (1996) gives experimental evidence to show that perceived assimilation is a result of gestural reduction as well as overlap, and argues (p. 378) that gestural reduction 'play[s] the decisive role in casual speech place assimilation.' In our example, the gestures are presumed to be reduced and to overlap to such an extent that the gesture for the alveolar closure is hidden by those for the open velum and the labial closure, giving the perception of an assimilatíon n → m. Both Figures 6 and 7 are speculative in the absence of actual articulatory data. However,

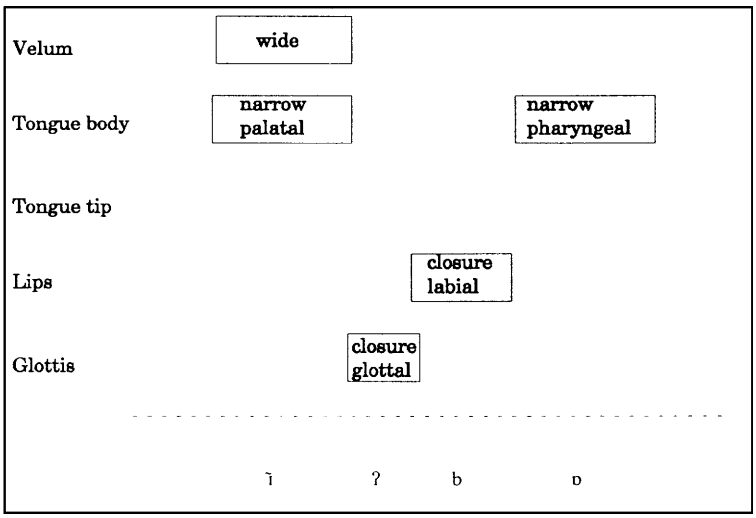


Fig. 7. CW's production of 'in box' – [ɪʔbɒks].

though the boxes used in the diagrams here are clearly abstractions of what the articulators are actually doing, they provide a simple picture of the phasing relationships between the gestures.

Figure 7 shows how CW is assumed to have produced this string (CW is 2;8); it is clearly an attempt at close juncture. This illustration highlights two points of interest here. Firstly, the alveolar closure is replaced with a glottal stop. This is the most minimal type of closure possible to the child. Studies have shown how, in children's speech, the glottal stop often replaces various oral stops (see Goldsmith, 1990; Stemberger, 1993). Ease of articulation

could explain why CW has used a glottal stop in place of the alveolar in this sequence. Secondly, though the /n/ has been replaced by a glottal stop, the gesture for the velic opening remains, which CW overlaps completely with the vowel /ɪ/ preceding the consonants, to give a fully nasalized vowel.

In reporting her acoustic study on coarticulation, Nittrouer (1993) concludes that the gestural patterns and intergestural coordination of children up to age 7;0 have not yet reached mature status. It is therefore not surprising to find that CW has not yet mastered the articulation of some gestures, or at least those gestures in succession – in consonant sequences. He has also yet to master the relationship between gestures, particularly across a word boundary.

Given the results for assimilation and elision, it is possible to make the following – tentative – conclusions about their development in this young child's speech. Between-word junctures – in some form – occur from the onset of two-word utterances. These may be of the type observable in adult speech. They may also be imperfect (i.e. non-adult) versions of close junctures, because of the child's imprecise articulations of individual gestures and imprecise intergestural overlaps. Close juncture appears then to be the default realization in these environments, suggesting that these juncture types are not learned phonological rules, but happen more or less automatically. Furthermore, two- and multi-word utterances present new challenges for the child. Just as intergestural relationships and gestural articulations needed to be mastered for single-word utterances, they must also be progressively mastered across word boundaries. The final result will normally be the types of phenomena observed in adult speech at close junctures. Our data show that CW has managed to master these aspects of his production by the age of about 2;11.

If close juncture is the default realization in these environments, then open juncture must be learnt. It appears later than close juncture, and even then is the less common realization of the two. This tallies with the theory of articulatory phonology, which asserts that the articulatory engines are tuned to allow for the overlap of gestures; however, it is not yet clear whether this is true of children.

We now turn to the data relating to liaison. Production of /j/ and /w/ liaison by CW occurs at least from the age of 2;4. This may be for relatively 'low-level' phonetic reasons: one of the simplest ways to get from a close front lip-spread vocalic articulation to another vocalic articulation is via an unrounded palatal glide [j]; likewise, one of the simplest ways to get from a close back lip-rounded vocalic articulation to another vocalic articulation is via a rounded labial-velar glide [w]. Liaison involving /r/, on the other hand, does not occur at all until CW is 2;11, and indeed, the phonetic explanation offered for /j/ and /w/ does not hold here. This is because some of the word-final vowels which precede /r/ liaison (e.g. /ɑ/ as in 'car' and 'shah', /ɔ/ as

in 'core' and 'law') share fewer phonetic properties with the common phonetic realizations of /r/, i.e. labiodental or postalveolar approximants.

Theorists have proposed phonological and phonetic accounts of /r/ liaison. For example, Harris (1994) accounts for /j/ and /w/ liaison as the spreading of an element from the first vowel in V#V onto the vacant onset of the following syllable, since there is a 'universal preference' for filled syllable onsets. /j/ liaison occurs in environments after high front vowels, and /w/ liaison in environments after high back vowels. What Harris claims is that in the environments preceded by the other, non-high vowels, /r/ is the default hiatus breaker, as neither /j/ nor /w/ can be used here. Broadbent (1991) proposes that there IS a phonetic link between the /r/ and the type of vowel that it follows, which would explain why /r/ is used rather than, say, /t/ or /d/. She suggests that /r/ liaison (both the linking and intrusive variety) is a manifestation of the 'same glide formation process' (p. 292) that accounts for /j/ and /w/ liaison. Using the notions of HEAD and OPERATOR elements in vowels, she claims that the occurrence of /r/ is directly related to the vowel context in which it appears; some element from the preceding vowel spreads, just as it does for liaison involving /j/ and /w/.

Gick (1999) gives experimental evidence for the phonetic basis of intrusive /r/ in American English, indicating that the pharyngeal component in /r/ is articulatorily similar to that of schwa. He further states that since /ɑ/ and /ɔ/ surface with schwa offglides, this phonetic similarity applies to all the vowels preceding the insertion of /r/. He concludes therefore that 'no special phonological status is needed for *r* ... in order to get the behaviour of intrusive r' (p. 50) and that /r/ insertion can be described along similar lines to glide formation. While the accounts of Broadbent and Gick may both be theoretically appealing, the suggestion that /r/ liaison can be described with /j/ and /w/ liaison as simply the audible results of patterned variations in timing (Gick, 1999: 52) is not born out by the developmental data here. If this were the case, one would expect to observe /r/ appearing at around the same time as the other types of liaison. In fact, it does not; it emerges much later.

Some further evidence for the different status of /r/ liaison in CW's phonological development is from the absence of evidence for over-generalization of these juncture types in our data. We found no instances of overgeneralization of assimilation, elision or /j/ and /w/ liaison to in-appropriate environments, of the kind reported by Bernhardt & Stemberger (1998) for the child Morgan. This child overgeneralized the adult type of palatalization found in e.g. 'want you' to inappropriate environments as in 'like you': [laɪkʃu:] (p. 639); and from 2;11, overgeneralized the production of velar stop /g/ following the velar nasal found in e.g. 'longer' to environments inappropriate in the target dialect, e.g. 'long ears': [lɑŋg ɪəz] (p. 653). In CW's speech we found no comparable overgeneralization of non-

default forms of final consonant to default environments. Thus for assimilation, in prevocalic position we never observed pronunciations such as 'one apple' → [wʌmapl]; nor in prepausal position: 'I want a banana, this [wʌm]!'. Had they occurred, such productions might be taken as evidence that the child is applying a productive phonological rule. As it is, the absence of overgeneralization is consistent with our interpretation of elision and alveolar assimilation as low-level phonetic phenomena.

In the case of liaison, one hypothetical case of overgeneralization would be where one of the liaison forms is overgeneralized to environments where another form should be used, e.g. /fɔjɛgz/ for 'four eggs', or conversely /θrirɛgz/ for 'three eggs'. We found no instances of such overgeneralizations in CW's speech. In the case of /r/, there is, however, one particularly relevant environment. In this accent of English, the base form of the indefinite article is /ə/. If /r/ liaison were a low-level phonetic phenomenon, we might expect that in a prevocalic environment, a child who is not yet using the adult alternation /ən/ would instead use /r/ liaison, e.g. [əvɛndʒɪn] for 'a(n) engine'. During the period where CW does not use /r/ liaison anywhere (up to age 2;11), the juncture between indefinite article and vowel-initial noun was always realized with a glottal stop. Indeed, this continued to the end of the study, i.e. during the period (from 3;0) when CW was regularly using /r/ liaison in appropriate environments. This suggests that CW was applying the rule to appropriate environments, and avoiding it in a grammatically inappropriate but phonetically appropriate environment (i.e. prevocalic, but following the indefinite article). This could be taken as further evidence that /r/ liaison is a higher-level phonological phenomenon for CW.

We did record one instance where CW extended /r/ to the indefinite article environment. This occurred at 3;0, i.e. just at the point where /r/ liaison began to appear:

| | | |
|---|---|---|
| Inv: | is he a car? | |
| CW: | no, he's a engine | [hizəʔɛndʒɪn] |
| Inv: | a what? | |
| CW: | he's a engine | [hizəʔɛndʒɪn] |
| | <pause> | |
| | he's a engine | [hizəvɛndʒɪn] |

CW only turns to the /r/ liaison form after the investigator has twice solicited a repair of his original, glottal stop version – once by an explicit question, then by leaving a pause. Under this interactional pressure, CW seems to be trying out /r/ liaison as a possible version of the indefinite article juncture. It was not his preferred choice, and it is not the one that he subsequently adopted.

In conclusion, the developmental research described here provides an

account of the development of between-word junctures in one typically developing child. The results indicate that close juncture may be the default realization of between-word juncture environments. This would support the hypothesis that the English connected speech phenomena that we studied are phonetically motivated. Our results further suggest that children have gradually to master the articulatory details that are appropriate for the relevant close junctures. We found no developmental evidence that the 'close juncture' connected speech forms of assimilation, elision and /j/ and /w/ liaison are the product of any kind of transformation of or derivation from an underlying 'citation' form or isolated word form. Rather, they constitute a parallel set of phonetic forms that occur in specified between-word environments (cf. Local (1992), for an account of English assimilation along these lines). For these reasons, it is probably inappropriate to describe the phenomena in question as 'processes'.

The exception to our developmental account is /r/ liaison, which does not occur in CW's speech from the onset of two-word utterances, but only emerges at around age 3;0. It is thus a candidate for a genuinely phonological juncture: a language-specific pattern that has to be learnt by the child, since it requires the child to make a phonological abstraction (/r/ liaison) over phonetically disparate instances (tokens of the set of final vowels which in Southern British English are followed by /r/ liaison) and to refrain from using it in grammatically illegal places, e.g. following the indefinite article.

Only further research will enable us to determine whether this pattern is common to children learning this variety of English, or whether the discrepant behaviour of /r/ is an idiosyncrasy of CW. The small amount of relevant research that has been published to date encourages us to keep an open mind. In a study of 'labial glides' in the speech of one child from Yorkshire (England) aged 5;4–5;11, Kelly & Local (1989) note that in casual running speech Manda used a labiodental glide at the juncture between indefinite article and noun in phrases such as 'an apple', 'a house' and 'a hexagon'. A very similar labiodental approximant was used by Manda in words such as 'fairy' and phrases like 'here it is' (pp. 245–6). For Manda the linking /r/ patterned like other instances of within-word intervocalic /r/ and was used irrespective of grammatical factors, i.e. following the indefinite article. The distribution of /r/ in Manda's speech is thus different from the distribution we found in CW's speech. This may be attributable to the difference in age, in dialect, or to individual differences in learning.

The phonological development of individual children is – potentially – unique, and consequently any connected speech phenomena they produce may be unique. The study by Kelly & Local suggests that Manda may be treating /r/ liaison differently from CW. The patterns of overgeneralization reported for Morgan by Bernhardt & Stemberger indicate that some juncture types, comparable though not identical to the ones we

studied, may be treated by some children as productive phonological phenomena. In the extensive literature on English-learning children's segmental phonological development within single words, individual differences have been reported in order of acquisition, and also in the occurrence of simplifying patterns or processes. At this early point in the history of the study of the development of connected speech phonology, it would therefore be unwise for us to generalize our results beyond the speech of CW. Nevertheless, at single word level, the aggregation of single case investigations and group studies has shown that certain simplifying patterns do recur regularly across children learning English, that they tend to disappear in a relatively predictable order, and that the order of acquisition of segments is relatively consistent. On these grounds, it is reasonable to assume that similar phenomena to those observed in CW's connected speech may occur in the speech of other children learning English. With these caveats in mind, we present the findings of our investigation of CW as a pointer for future research.

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# APPENDIX

## CW'S REALIZATIONS OF TARGET PHONEMES AT THREE POINTS DURING THE STUDY

| Age | Individual consonants | Word final consonant clusters | | |
|---|---|---|---|---|
| | | Cluster | Example | Gloss |
| 2;4 | Word Initial | mz | deimɻ | James |
| | | nt | ɛɬənt | elephant |
| | | nd | ʋaʊnd | round |
| | | nz | ɛndʒɪnz | engines |
| | | ŋk | dʊɪŋk | drink |
| | | ps | tʃɪpç | chips |

Word Initial

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| m *m* | | n *n* | | | | | |
| p *p* | b *b* | t *t, d* | d *d* | tʃ *tʃ* | dʒ *dʒ, d* | k *k, t* | g *g, d* |
| f *f, ɸ* | v *w* | θ | ð *d* | ʃ *tʃ* | | | |
| | | s *d, ɕ* | z | | | | |
| w *w* | | r *ʋ* | | j *l* | | h *h, ts* | |
| | | l *l* | | | | | |

Word Final

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| m | | n *n* | | | | ŋ *ŋ* | |
| p *p, ɔ* | b | t *t* | d *d* | *tʃ* *tʃ* | dʒ | k *k, ɔ* | g *g* |
| f *ɸ* | v | θ | ð | ʃ *ʃ* | ʒ | | |
| | | s *ɕ* | z *j* | | | | |
| | | r | | | | | |
| | | l *l,ʊ* | | | | | |

## APPENDIX (*cont.*)

| Age | Individual consonants | Word final consonant clusters | | |
|---|---|---|---|---|
| | | Cluster | Example | Gloss |
| 2;9 | Word Initial | mp | dʒʌmp | jump |
| | | mz | vaɪʔ | rhymes |
| | | nt | ɛɬənt | elephant |
| | | nd | hænd | hand |
| | | ndʒ | pʊɪndʒ | orange |
| | | nz | daʊmeɪʃənz | Dalmations |
| | | ŋk | pɪŋk | pink |
| | Word Final | pt | dɒpt | stopped |
| | | ps | vʊps | whoops |
| | | ts | paɪvəts | pirates |
| | | ks | bɒts | box |
| | | gz | bægs | bags |
| | | vz | glʌvs | gloves |

Word Initial

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| m *m* | | n *n* | | | | | |
| p *p* | b *b* | t *t* | d *d* | tʃ *tʃ* | dʒ *dʒ* | k *k, t* | g *g, d* |
| f *f, ɸ* | v | θ *f* | ð *d, s, t* | ʃ *tʃ* | | | |
| | | s *ɕ* | z | | | | |
| w *w, v* | | r *v* | | j *j, l* | | h *h* | |
| | | l *l* | | | | | |

Word Final

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| m *m* | | n *n* | | | | ŋ *ŋ* | |
| p *p* | b | t *t, ʔ* | d *d* | tʃ | dʒ | k *k, ʔ* | g *g* |
| f | v *ʔ* | θ | ð | ʃ | ʒ | | |
| | | s *s,* | z *z, ɕ d,* | | | | |
| | | r | | | | | |
| | | l *ʊ* | | | | | |

| Age | Individual consonants | Word final consonant clusters | | |
|---|---|---|---|---|
| | | Cluster | Example | Gloss |
| 3;4 | Word Initial | mp | bʌmp | bump |
| | | nt | ɛɬənt | elephant |
| | | ndʒ | ɒʊɪndʒ | orange |
| | | nz | ʊɪnz | wins |
| | | ŋk | pɪŋk | pink |
| | | ps | ʊɒps | whoops |
| | | ts | lɒts | lots |
| | Word Final | ks | bɒts | box |
| | | kt | pɜfək | perfect |
| | | gz | lɛgz | legs |

Note that for the individual consonants, the target phoneme is given in the top left corner of each box, with CW's realizations in the centre.