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Acquiring Phonology

A cross-generational case-study

Neil Smith

CAMBRIDGE

ACQUIRING PHONOLOGY

Children often mispronounce words when learning their first language. Is it because they cannot perceive the differences that adults make or is it because they can't produce the sounds involved? Neither hypothesis is sufficient on its own to explain the facts. On the basis of detailed analyses of his son's and grandson's development, Neil Smith explains the everyday miracle of one aspect of first language acquisition. Mispronunciations are now attributed to performance rather than to competence, and he argues at length that children's productions are not mentally represented. The study also highlights the constructs of current linguistic theory, arguing for distinctive features and the notion 'onset' and against some of the claims of Optimality Theory and usage-based accounts. Smith provides an important and engaging update to his previous work, *The Acquisition of Phonology*, building on ideas previously developed and drawing new conclusions with the aid of fresh data.

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ACQUIRING PHONOLOGY

A Cross-Generational Case-Study

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For Ann Law

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Preface

Long ago I published a book (Smith, N.V., *The Acquisition of Phonology: A Case Study*, Cambridge University Press, 1973), documenting the linguistic development of my elder son Amahl (A). More recently I have been documenting the linguistic development of *his* elder son Zachary (Z), and have observed interesting similarities and differences between the two cases. More importantly, the advantages of hindsight in combination with advances in the field have enabled me to revise or reinterpret some of my earlier conclusions. The results of this "Acquisition of phonology from A to Z" follow.

I should start by admitting that there are several possible limitations of the study. Interacting with a grandchild is not the same as living with one's own offspring, and my contact with Z was relatively sporadic compared to my continuous contact with A. However, in the three years or so during which I collected data, I had over 150 sessions with him and rapport was excellent, so I don't think I have missed much of significance in the areas I concentrated on. This leads directly to the second limitation: the focus of the study is largely restricted to segmental phonology, with no systematic discussion of prosody.[1] This is partly a reflection of my competence, partly a function of time and equipment. I am aware that research into first language acquisition is more sophisticated and hi-tech than it used to be (see e.g. Chun, 2007), but I still think there is room for the kind of detailed diary study that I carried out before. I am therefore not entirely convinced by Snyder's (2007: 51) use of the past tense when he writes "diary studies were valuable as a source of impressionistic data, before modern recording technologies became available". I confess that, apart from a tape-recorder, I made no use of the kind of instrumentation that would have made various perceptual and other tests possible. In general I do not think this has seriously impaired the analysis but it does mean, for example, that I was unable systematically to investigate for the existence of 'covert contrasts' in the

1 If McMahon (2007:181) is right that "prosodic and segmental phonology are separate components neurologically [and] acquisitionally" this limitation is venial.

sense of Scobbie *et al*. (2000; cf. Macken & Barton, 1980). Finally, and most obviously, phonological theory has moved on since 1970 and I may not have kept up with it as much as is desirable. None the less, there is value in using a descriptive framework that is largely traditional or theory-neutral, and I have included critical discussion of issues arising in current theories, especially Optimality Theory (OT). I am comforted by the thought that dinosaurs can be interesting.

To offset these limitations, there are some positive aspects of the study. To the best of my knowledge it is the first cross-generational study of any aspect of language acquisition. Too much should not be read into this fact: there are no genetic, epigenetic or environmental claims lurking in such a minute sample, but direct comparability (same author, same family) with the earlier study should ensure that any generalisations are genuine. There is also the fact that the current study started earlier (with babbling) so the nature of the early stages should be clearer, and I have deliberately synchronised some of the stages of analysis of the two subjects to highlight parallels and differences between A and Z (A's stage 1 is chronologically the same as Z's stage 4). At a minimum, I hope I will have provided more useful grist for the reanalysis mill. A major feature of the 1973 study (hereinafter 'APh') was the set of linguistically analysed longitudinal data – data which have been widely exploited ever since. Fikkert (2007: 538) made a plea for more databases, and this book includes another one. I would be delighted if it elicited even a fraction of the reactions that its predecessor did.

The structure of the book is as follows. Chapter 1 provides an overview of my main theoretical presuppositions, chapter 2 summarises the findings of APh, and chapter 3 discusses some of the subsequent developments in our understanding of the acquisition of phonology, in large part on the basis of reactions to APh. Chapter 4 presents an analysis of Z's developing phonology from the first babbling to his mastery of the (segmental aspects of the) adult language. This leads in to chapter 5, a discussion of the nature of the acquisition of phonology, which is followed by a diachronic lexicon, a variety of appendices and the usual list of references.

Although the major developments of Z's phonology are given in both prose and formal rules, I have reduced the plethora of formalisation that characterised the earlier monograph, so this one should be a little more user-friendly. There is inevitably a large amount of data which have necessitated the pervasive use of phonetic transcription. For representations of the adult language – basically the 'Received Pronunciation' ('RP') of British English – I use the system of Wells (1990), with representations in oblique strokes /x y z/; for the children's

pronunciation I use the alphabet of the International Phonetic Association (IPA) with representations in square brackets [x y z]; for intermediate stages in derivations involving the children's putative own system, I use elements of the IPA with representations in pipes | x y z |. Where the context makes it obvious what kind of representation is involved (e.g. in the diachronic lexicon) I have omitted the distinguishing brackets. It should be noted that these conventions mean that an example such as adult /pen/ (*pen*) might be produced 'correctly' as [pɛn] by the child even though this correctness is disguised by the transcriptional difference between 'e' and 'ɛ'.

There are, of course, many differences between the monographs and their implications. The most significant is the claim that the major determinants of the children's productional divergences from the forms of the adult language (their mispronunciations) are a matter of perfomance rather than of competence. Justifying this conclusion forms part of a discussion of the nature of representation and metarepresentation, and leads to the suggestion that the children's output is not in fact 'represented' at all. For those who are happy to take the data and their analysis on trust the main conclusions can be found in chapter 5. Most will be more sceptical.

Finally, a note on pronominal usage: I have used '*he*' rather than '*she*' or '*he or she*' to refer to the generic child acquiring his phonology. My excuse is that I have sons and grandsons but no female descendants. No one is meant to feel excluded.

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My major debt is to Zak and his/my family: Amahl, Anne, Josh and Saras (a.k.a. 'Grandma').

Zachary and Amahl at the ages of 2 years 3 months and 36 years respectively

1 *Preliminaries*

1.1 Background

I assume that humans have as one module of the mind/brain a faculty of language in the sense of Chomsky (e.g. 2000). The domain of this module is knowledge of language: more specifically of 'I-language' – the individual's internalised knowledge of his or her mother tongue. As an idealisation characteristic of all scientific endeavour, this module, which is a psychological construct, can be treated independently of other cognitive systems and can itself be broken down into a number of sub-systems. That is, the language faculty has internal structure such that it makes sense, for the sake of theoretical investigation, to isolate language from memory, morality and music, and phonology from syntax, morphology and semantics (see Chomsky, *passim*; Hauser *et al*., 2002; Smith, N.V., 2004; Carruthers, 2006, 2008). On these assumptions phonology constitutes a natural sub-part of the study of I-language, and one area of phonological investigation is devoted to studying the acquisition of phonological knowledge by the child exposed to primary linguistic data from the ambient language.

The traditional formulation has it that this module consists of two components: a lexicon and a computational system (C_{HL} – the Computation for Human Language).The lexicon consists of entries which relate LF (logical form) to PF (phonetic form): more accurately, representations of meaning to representations of sound (or sign). The computational system comprises the syntax and the phonology, which together use these entries to build up paired representations of the meaning and pronunciation of sentences. Except for some discussion of the role of gesture and its position in the grammar, the focus of what follows is restricted to the phonology.

1.2 Phonological theory and phonological acquisition

It is generally accepted that phonological theory and child phonology should and can inform each other (e.g. Menn, 1980; Hayes, 1999; Gierut, 2008), even if

they do so less than is ideal (Fikkert, 2007: 537). This need can be seen clearly in the problem raised by the tension between description and explanation, and the centrality of acquisition in resolving this tension. Linguistic theory, including phonological theory, disposes of a plethora of descriptive devices with overlapping purview – hence potential redundancy. If it can be shown, for instance, that some of these devices are not learnable or give rise to insuperable processing problems, and are implausibly innate, then they should be dispensed with in favour of others that do not suffer from such disadvantages. The problem is pervasive, but can be seen at its starkest in any theory (like that in APh) which makes crucial use of extrinsic rule ordering. Given ten rules, there are 10! (10 factorial, i.e. 3,628,800) ways of ordering them.[1] As Chomsky put it in an early article with George Miller, "we cannot seriously propose that a child learns the values of 10^9 parameters in a childhood lasting only 10^8 seconds" (Miller and Chomsky, 1963: 430).[2] It follows that theories of the acquisition of phonology that have any aspiration to achieving psychological reality must eschew rule ordering. Similar problems arise with theories that make implausible assumptions about any other aspects of learnability: the nature of the child's representations, the limits of variation, the relation between perception and production, etc. (For perceptive general discussion see Velleman and Vihman, 2007.)

1.3 Perception and production

Although the isolation of phonology from other systems is essential, some aspects of phonological acquisition can be explained by reference to properties external to the developing child's strictly linguistic abilities – specifically, perceptual and motor maturity. There is a universal asymmetry in perception and production such that children can demonstrably perceive contrasts that they do not, often cannot, produce (for an overview of the infant's perceptual abilities, see Eimas, 1996; Jusczyk, 1997). In reaffirming this truism it is important to stress that 'perception' is not a simple notion. At a few weeks of age infants are sensitive to the statistical properties of the input language and are able to extract relevant information from it. Thus Saffran *et al*. (1996) demonstrated that 8-month olds could identify 'words' consisting of sequences of three syllables purely on the basis of the relative frequency of such sequences.

1 There are ways of decreasing the numbers involved but, as I postulated twenty-nine ordered rules, the magnitude of the problem should be clear.

2 The notion of parameter appealed to is not the same as the current notion discussed below. The length of childhood is perhaps a little brief: 10^8 seconds is a little over 3 years.

Subsequent research (as reported in e.g. Saffran, 2001) has shown that this ability generalises to non-linguistic domains, most notably music, and presumably reflects a domain-general cognitive ability.

To a first approximation it is fair to say that 6-month olds can cope with anything that the world's languages can throw at them, showing categorical perception of contrasts in, for instance, Voice Onset Time at a few weeks of age. However, it is striking that infants at 6–8 months perceive phonetic contrasts better than they do at 10–12 months and often better than adults (Werker and Stager, 2000: 183; for a summary, see Pater, 2004). In fact, such a developmental progression is characteristic of infant abilities more generally. At 3 months children have sensitivity to a greater range of faces (e.g. Caucasian, African and Chinese) than at 6 or 9 months (Kelly *et al*., 2007; Pascalis *et al*., 2005), a period during which their abilities for recognising 'own-race' faces improves.[3] The parallel with language is strikingly close. Further, perceptual sensitivity seems to be dependent on what the infant is doing. An ability which is demonstrably deployed in simple discrimination tasks (differentiating [ba] and [pa], for instance), may not be used in a word-learning task: "Infants are listening for different information in phonetic tasks as compared to phonological tasks" (Werker and Stager, 2000: 190). Even children at 20–6 months often confuse minimally distinct words unless they know them well (Barton, 1976): that is, familiarity based on frequency is one relevant determinant of 'perception'. None the less, it seems to be the case, as Mani and Plunkett (2007: 252) put it, that "part of the infant's phonological repertoire appears to be in place before lexical acquisition is set in motion". How much of that repertoire is established is contentious and probably varies from child to child. Pater (2004: 223) argues that at 14 months "the consonantal place distinction is not encoded in lexical representations, though it is present in phonetic representations". A further complication is provided by perceptual magnet effects (Kuhl, 1991) – a kind of shrinking of the perceptual space so that there is poor discrimination near phonetic category prototypes of the native language. This is a further manifestation of categorical perception (cf. e.g. Feldman and Griffiths, 2007) but one where the role of the native language is paramount.

The relation between perception and production has various implications for any theory of the acquisition of phonology. Does the asymmetry affect the child's knowledge (competence) or only his use of that knowledge in performance? What is the nature of the child's lexical representations? How many levels

3 In face recognition the sensitivity generalises to other species, especially monkeys, suggesting that it is a property of primates (or mammals) rather than just humans.

of representation is it necessary or desirable to postulate? In particular, is there a single lexicon or should one postulate a dual lexicon? Is the Optimality-Theoretic resolution of the "comprehension/production dilemma" (Smolensky, 1996) convincing? In APh I claimed – incorrectly as it transpired – that the child's perceptual abilities were essentially flawless. I return to this in detail in chapter 2; for the moment we turn to the first issue listed: the traditional (Chomsky, 1965) distinction between competence and performance.

1.4 Competence and performance

The first issue to be addressed is whether the acquisition of phonology should fall under a theory of competence or a theory of performance, or should be compartmentalised judiciously between the two. Pronunciation is relational in nature: it relates abstract mental representations to articulatory and auditory sequences which have acoustic properties; that is, the child's representation(s) must be or become "legible" (Chomsky, 2002) at the motor and cognitive interfaces. In the case of the establishment of pairings between representations of sound and representations of meaning – that /ˈpeŋgwɪn/ conveys the meaning PENGUIN – it is clear that we are dealing with knowledge of language in the traditional Chomskyan sense, so we are investigating the learning child's competence as we study this aspect of his developing abilities. Matters are less transparent when we study the child's pronunciation of *penguin* as he acquires his phonology. If (like Z at one stage) the child pronounces it [ˈb̥ɛmiː] this could be because of his different competence – his representation, for whatever reason, is different from that of the adults around him – or it could be that his competence (in so far as it pertains to the phonology of the lexical representation) is the same as the adults' and the pronunciation is a matter of performance. A combination of these two options is also plausible: the child's representation may be partly correct and partly incorrect. For example, it might be both significantly underspecified and also subject to distortion in performance. It also bears mentioning that the effect of the ambient language on the child's babbling may be important. Boysson-Bardies (1999) shows that the phonetic properties of the child's babbling are in part a function of the sound system he is exposed to before elements of his vocabulary have been established, indicating that cognitive representations are not necessary concomitants of pronunciation.

The allocation of responsibilities to competence or performance relates to at least two further issues. The first is whether the child 'has his own system'. Are his deviations from adult pronunciation a function of his manipulating an idiosyncratic phonology or simply a distorted reflection of the adult system

being acquired? This amounts to asking whether the 'realisation rules' attributed to the child (see below) are a matter of 'incompetence'or 'malperformance' (APh: 140; cf. the discussion in Hale and Reiss, 2008). The second pertains to the role of UG (the "theory of the initial state" – Chomsky, 2000: 81) in the child's arrival at whatever state of knowledge underlies his performance. To what extent (if any) is the child's developing phonology determined by properties peculiar to language, and to what extent is it determined by properties which are system-wide? To take a specific example: are the perceptual abilities mentioned above peculiar to language or (more plausibly for those of them which are shared with chinchillas – Kuhl and Miller, 1975) general to the whole of audition? On the production side, the child's nascent imitative abilities might be at least in part the result of the action of mirror neurons (see e.g. Iacoboni, 2008) which are not restricted to language, or they could be tied to the linguistic domain. There is intriguing evidence from the acquisition of sign language that there is an "innate agenda" (Petitto, 2005: 95; cf. Morgan, 2006) which is neutral between the modalities of speech and sign, but is specific to language in that it has no known reflexes elsewhere in the organism. This early language-specificity is corroborated by later dissociation of pointing and signing – both in sign language acquisition where there are rare cases of pronoun reversal (Meier, 2002; cf. Chiat 1986), and in sign language loss in aphasia where, depending on the site of the lesion, the same physical movement may be retained as a gesture and lost as a sign or vice versa (Poizner *et al*., 1987).

The ultimate aim is to explain the child's behaviour and this will necessitate some consideration of both competence and performance. Their interplay is rarely transparent but, to anticipate the discussion to come, I think that (virtually) all non-adult pronunciations are a function of performance: 'malperformance' in the terms used above. This is despite the systematicity of the child's production and despite the fact that there may be grammatical (competence) determinants of phonological patterns. For example, the development of final /z/ in A's production was determined in part by whether it corresponded to the plural morpheme, as in *peas*, or to one segment in a mono-morphemic word, as in *please*. Importantly, just because the operation of the child's production system is partially determined by considerations of competence it doesn't follow that the processes are themselves part of the child's competence.

If the child's output is a matter of (mal)performance it can be characterised by a neural network which associates a phonological representation as input with articulation as output. Because the child's output is systematic, deviations from the adult forms can be described in terms of 'rules' which have the appearance of constituting a competence grammar. This appearance is reinforced by the

effects of grammatical knowledge, so that the input to the postulated neural network cannot simply be an adult 'phonemic' string, but must be a grammatically parsed string including such information as {plural}, 'belongs to a functional category' (see the next section), and so on. If correct, this position has significant implications for the nature of the acquisition of phonology, in particular the levels of representation it is necessary to postulate.

1.5 Levels of adequacy

Any theory should meet certain 'levels of adequacy' (Chomsky, 1964, 2004, 2009a; see also Smith, N.V., 1989: ch.11; 2004: 58f.): observational, descriptive and explanatory,[4] where the last of these is standardly taken to be equivalent to 'acquisitional adequacy', the property of a theory that accommodates the possibility of first language acquisition. Ideally the theory should also attempt to go 'beyond explanatory adequacy' (Chomsky, 2004), deriving specific properties of language, child phonology in the present case, from outside the phonology (e.g. phonological processes which are epiphenomena of grammatical ones) or even from outside the language faculty. An example of the former, where phonological phenomena are a reflex of grammatical facts, was illustrated above by the appearance of final [z] in A's developing language. In adult English, final [z] may be either the last segment of a monomorphemic word (e.g. *cheese*), or any one of four different morphemes: plural (as in *eyes*), third person singular (as in *throws*), the reduced form of *is* (as in *Daddy's going*) and the possessive (as in *Daddy's one* or *It's Daddy's*). The fact that these different examples were all treated developmentally differently by A (see APh: 67ff.) suggests strongly that non-phonological factors need to be taken into account. A different kind of example showing the relevance of morphological structure in accounting for phonological development comes from A's treatment of unstressed initial syllables, which were systematically replaced by [riː]: e.g. *attack* → [riːˈtæk] (APh: 172f.).

Similarly, in Z's development, initial /ð/ was systematically omitted (unlike initial /θ/ or non-initial /ð/) giving rise to pronunciations such as [ɛn] for *then* and [is] for *this*. When I invented neologisms such as *thub* ([ðʌb]) beginning with /ð/ to represent new toys, Z consistently produced them with initial [z], so

4 Although these levels represent increasing degrees of success, progress is not necessarily linear. Hayes (1999: 247) makes the nice point that we often have phonetic explanations for phonological facts even when we are unable to incorporate these explanations into a descriptively adequate formal phonology.

his omission of all and only initial examples of /ð/ is presumably due to the fact that all /ð/-initial words in English belong to 'functional categories'. A parallel example is provided by his idiosyncratic distinction between *you*, *your*, *yours*, *yourself* on the one hand and all other words beginning with /j/ such as *yap*, *young*, *yoyo*, etc. on the other. All the former lost the initial consonant entirely, giving [uː, ɔː, ɔːz, ɔːˈsɛlf]; all the latter replaced the /j/ by [l], giving [læp, lʌn, ˈləuləu], etc.

Examples of data from phonological acquisition which can be explained by appealing to facts outside the language faculty are manifold, even if frequently contentious. The most obvious examples are phenomena which are explicable on the basis of the child's perceptual immaturity or motor inability. The widespread pronunciation of words like *bottle* and *puddle* as [bɔkəl] and [pʌgəl] may well be due to a failure to perceive the difference between [d] and [g] before a 'dark' [ɫ], though we shall see below that such an explanation is only partial. Similarly, simple articulatory inability may be sufficient to explain why children typically go through a stage in which all of *mash*, *mat*, *mass* and *match* are pronounced identically as [mæt]: the child may be incapable of producing the fricatives and affricates which distinguish the items in the adult language. A second example can be taken from variation in fine phonetic detail: different degrees of nasalisation of vowels adjacent to nasal consonants may have no phonological significance but simply reflect motor development constrained by a universal physiological principle of least effort.

It is in principle not difficult to test for the role of such 'external' factors, even if some of the further subtleties which need to be teased out are a matter of dispute. However, there is a clear difference between such examples and 'chainshifts' of the kind seen in 'puzzles' or metathesis. A pronounced *puddle* as [pʌgəl] but *puzzle* as [pʌdəl], indicating that motor inability *tout court* was implausible as an explanation for the former mispronunciation. Similarly, as the result of a regular process of metathesis, he pronounced *icicle* as [aikitəl] though he produced the invented word '*aikitəl*' as [aikikəl]. The same conclusion that 'motor inability' is only a partial explanation for the child's productions can be derived from cases of free variation between a correct and an incorrect form. For instance, Z's pronunciation of *rain* as [rein] or [wein] (while *wet* appeared only as [wɛt] and never as [rɛt]) shows that something more than articulatory incompetence must be at stake. It may of course be that in this case what is lacking is precisely the ability to control the production of [r] consistently but such an account does not fully generalise, as there are further examples of mispronunciations which are not obviously due to production difficulty and are implausibly attributable to perceptual confusion.

The first of these is recidivism, a diachronic variant of the free variation just mentioned. In this case the child produces the correct adult pronunciation at one stage and then regresses to an incorrect form: for instance, Z pronounced *red* correctly as [rɛd] for some four months before adopting the pronunciation [wɛd]. It is not impossible that motor control should be lost but it is not the most plausible hypothesis. The second kind of example is also a special case of the free variation mentioned in the previous paragraph, illustrated in Z's case by an asymmetry in his treatment of Cl/Cr clusters. The sequences [br] and [pr] were used for both /br, bl/ and /pr, pl/ respectively, but [bl] and [pl] were never used for /br/ or /pr/. Given a pattern where /bl/ is pronounced as [br] or [bl], but /br/ is pronounced only as [br], it is not plausible to attribute the pronunciation of *blood* as [brʌd] merely to motor inability to produce [bl]. More interestingly, this example demonstrates that the child must distinguish the clusters 'br' and 'bl' in his lexical representations though he may not be able to control the production of one of them ([bl]) adequately.

A third class of examples is provided by variation where the child's pronunciation is determined by properties of the adult form unpronounced by the child: for example, Z pronounced *all* either with or without the final /l/, as in [ɔː ə ləud], *all the load*, versus [ɔːl in ɛː], *all in there*. The variation was not random; rather, /l/ was omitted before an adult consonant but retained before an adult vowel, even though the relevant adult consonant (/ð/ in this case) was not itself pronounced. Further examples, like the contrast between ['pɔːriʔ] (*pour it*) and ['pɔː ə tiː] (*pour the tea*), suggest that the phenomenon was more general, though in this case the presence of linking [r] in the input makes interpretation more difficult.

Scobbie (2007: 21) suggests that the child's mental representations could be "non-deterministic", but the claim seems implausible in the light of this evidence. It may be that there is a stage when certain (e.g. parametric) decisions have not yet been made, and may perhaps never be made (see Smith, N. V. and Cormack, 2002), but the lexical representations must be determinate to allow a coherent account of the range of data cited above. Take, for instance, the final example of *all the load*: a natural assumption might be that the initial segment corresponding to adult /ð/ is underspecified, hence indeterminate – it could be that there is just C there. Despite its superficial plausibility such an analysis would predict other errors: that /ð/ should on occasion be replaced by some other consonant and not just deleted, but such errors were not attested.

1.6 Levels of representation and the units of representation

These examples raise complex issues about what precisely the child acquiring his first language is representing. To investigate this we need as a preliminary to

specify what the child is taken to be acquiring when he 'acquires phonology'. I assume that he must learn the phonological representation of the lexical items of the ambient language in terms of 'phoneme-sized' units decomposed into distinctive features. These representations are neutral as between perception and production and so the child also has to learn to relate them to auditory percepts and to sets of articulatory instructions. These instructions need to specify the fine phonetic detail characteristic of the adult language. This includes such subtleties as the distinction between clear [l] and dark [ɬ] in English or between alveolar [t] in English and dental [t̪] in French, even though these differences are not consciously accessible. That they are none the less part of the speaker's tacit knowledge is evident from our sensitivity to individual differences or to foreign accents, where these are characterised precisely in terms of such sub-doxastic properties. The child also has to learn the patterns of stress and intonation of the target language and how to modulate the phonological and phonetic properties of lexical representations in syntactic context. About these I shall have little to say, though they do raise the question of the relation between the phonetic and the phonological and the extent to which it makes sense to draw such a distinction in the adult language. On this latter point there is little consensus. Whatever decision is taken in this regard, we then need to investigate whether the same levels are plausible for characterising the child's nascent phonology or whether he disposes of more or fewer levels than the adult. Here there is even less agreement. Comparable questions then arise with regard to the units of representation it is necessary to postulate: distinctive features, elements, phonemes, and so on.

Along with the majority of phonologists I propose simply to accept the validity of the phonetics–phonology distinction without much further discussion, though evidence will be presented concerning the number of levels of representation it is necessary to postulate. On one interpretation of this evidence, the phonetics–phonology distinction is moot (for interesting discussion see Hale and Reiss, 2008: ch. 6). For present purposes, I assume the classical distinction between lexical and 'surface' levels, a distinction reaffirmed more recently by Boersma (2006: 1) who writes that "the minimum number of representations that we need to do interesting phonology [is] two phonological representations connected to each other and to two semantic and two phonetic representations". The phonological representations are underlying and surface; the phonetic representations are auditory and articulatory. This still doesn't exhaust the issue of what kinds of representation the infant speaker-hearer has to manipulate and whether these change over time. For instance, adults might deploy a system with at least phonological and phonetic representations,

whereas the child might go through a stage which is 'pre-phonological' (or at least pre-segmental – cf. the discussion of recidivism in section 5.1.3) at which any representation is an undifferentiated gestalt, or purely phonetic without phonological structure. Another possibility, discussed in section 5.1.2 below, is that the child's own pronunciation is not represented at all, in which case the articulatory representation becomes superfluous.

Whatever the decision on that issue, the assumption that we need both auditory and articulatory representations raises the problem of the need to define the distinctive features whose combinations enter into both phonological and phonetic representations. Here there are at least four possibilities: that the features be defined articulatorily, acoustically, auditorily or abstractly. For some the auditory percept of an utterance is crucial, for others its acoustic properties. Kingston (2007) provides a useful overview, concluding (p. 432) that the evidence suggests that what is important is "the auditory effects of the signal's acoustic properties". Given the need to provide a processing basis for both hearer and (adult) speaker, as well as a means for lexical storage accessible to both, some amalgam of the kind Boersma presupposes is perhaps plausible. (See Harris, 2007: 124ff., for discussion.)

For both adult and child I assume that we need distinctive features of the general kind presented in Chomsky and Halle (1968, hereafter 'SPE') as updated and presented in Hall (2007), and that these are at the base of a phonological hierarchy. This consists of at least phonological words, which consist of feet, which consist of sequences of syllables, in turn broken down into onsets and rhymes (consisting of an obligatory nucleus and an optional coda), and where all of these constitute 'phoneme'-sized segments composed of said distinctive features. I am agnostic about the need for a constituent 'rhyme',[5] but Z's phonological development provides evidence for the necessity of postulating onsets as constituents. In my APh (pp. 170, 188f., 190, 191) I argued for (and against) distinctive features, and for segments and syllables.

The phonological hierarchy will also need to interface with the syntax in order to accommodate the kind of morphological effects (plurals, the *attack* examples) discussed above. Words, and perhaps higher units both phonological, such as 'intonational phrases' as in Truckenbrodt (2007: 436), and syntactic (phrasal projections), are presumably necessary but I have nothing useful to say about them.

5 I suspect that it is necessary, but A's and Z's phonological development provided no direct evidence.

Apart from the details of the theoretical vocabulary used in phonological representations it is also necessary to address the issue of the completeness of such representations: in particular, is 'underspecification' (in either adult or child phonology) licit? (See Steriade, 1995; cf. Hale and Kissock, 2007; Hale and Reiss, 2008: 56.) I shall argue – somewhat tentatively – (section 5.1.5) against underspecification in child phonology. There are also issues concerning the trading relations among the theoretical constructs one deploys: are there principled grounds for making a choice among the complicating of rules, of levels or of processes (see Gnanadeshikan 2004: 102)?

1.7 Learnability

There has been a transition in the conceptualisation of first language acquisition as a process resulting from teaching,[6] to one resulting from learning, to one consisting simply of growth. While 'motherese' or child-directed speech is often claimed to be a basic teaching device, there is little evidence that it has the effects claimed (see Smith, N.V., 1989, for discussion) and, although it could provide useful negative evidence, teaching is probably relevant only for second language acquisition. Learning, by contrast, is obviously a necessary component of first language acquisition, but only when the term is suitably construed. While it is obvious that lexical representations must be 'learned' (no one is born knowing that the French for 'frog' is *grenouille* – nor, of course, that the English for 'frog' is *frog*), this is a form of learning that involves some form of association but not the processes of induction, conditioning, generalisation, hypothesis formation and testing, etc. which are characteristic of traditional learning theory (see Smith, N.V., 2004: 120f. for discussion). Moreover, some attributes underlying knowledge of phonology, such as sensitivity to particular contrasts, may not even need exposure to input for their 'acquisition'. Such knowledge then requires appeal to innateness or 'growth': the spontaneous, endogenously controlled, emergence of specific abilities within some 'critical period' or window of opportunity (Smith, N.V., 1998). This in turn brings with it a potential contrast between 'continuity' and 'maturational' accounts (see below, section 1.9).

Assuming that 'learning' has a role to play, we have a further choice among learning by 'discovery procedures', by 'evaluation procedures' and by 'selection procedures'. Discovery procedures constitute a set of principles that could be applied to a corpus of utterances to yield a grammatical description of that

6 Cf. Ryle's (1961: 5) dictum "A language is a corpus of teachable things."

corpus.[7] Finding such procedures was the avowed aim of American Structuralism and, I suspect, of OT which claims that the learner's task is to *determine* a language-specific hierarchy of the universal set of violable constraints. A typical statement is Kager's observation that the task of the learning algorithm is "to deduce the constraint hierarchy" (1999: 301). Evaluation procedures (characteristic of early generative grammar) constitute a set of principles that could look at a corpus and some proposed grammars of that corpus, and determine which was the best: 'best' because 'psychologically real'. An analogy from arithmetic calculation might be useful. The task of computing 17 × 13 might be solved by the use of look-up tables or memory, of multiple addition (as in a simple mechanical calculator but not, presumably, in simple humans), of analogies to computing scores in games of darts, and so on. Importantly, different people use different strategies, and the same person may use different strategies on different occasions. Selection procedures (exemplified by Principles and Parameters theory) involve a set of principles which allow the learner to select among a number of antecedently given, usually binary, choices: e.g. head-first/head-last. If parameter-setting is really deterministic (cf. Smith, N.V. and Law, 2007, forthcoming) then Principles and Parameters theory would also approximate to a discovery procedure.

Whichever of these choices one makes, it is essential to postulate only those phonological constructs which are learnable, or arguably innate, and to use this criterion to choose among grammatical, including phonological, theories. There are three components to any account of learnability, as given in (1):

1a. Universal Grammar (UG), which limits the class of possible grammars
b. The ambient data, from which relevant inputs can be drawn
c. One or more learning theories, which map (1b) into a grammar via (1a)

For language, the conceptually simplest (but almost certainly wrong) possibility is that there is no contribution from UG – learning a language would be no different from learning anything else. For instance, Lieberman (2000: 5) claims that the neural activity involved in the process of learning a language is "similar to that by which a person learns to play a violin or a dog to retrieve balls", implying that no special provision needs to be made for language (for some anti-reductionist discussion, see Smith, N.V., 2005: ch.11). Alternatively, you might have some, but only minimal, contribution from UG, with a 'brute-force' learner – that is, a learner who can make an exhaustive search of the possible analyses by trial and error (see e.g. Kremer, 2000). This position is implicit in

7 Linguists may not have discovery procedures but children must.

usage-based approaches in which phonology emerges from the operation of "mechanisms [of change] … attributable to human neuromotor, perceptual and cognitive capabilities" which are "also operative in nonlinguistic behavior and are thus not specific to language" (Bybee, 2001: 190–1). There are two issues: whether learning is possible without attributing prior structure to the learning organism, and whether such structure is domain-specific, i.e. linguistic, or domain-general (see further Hauser *et al*., 2002, and the discussion below).

The ambient data contain all the information relevant to distinguishing different languages and are obviously a necessary component in the child's learning. However, even here there is an important role for UG as it serves the purpose of defining, first, what constitutes 'linguistic' input (see Chomsky, 2009b: 384) and, second, what are the units in terms of which the learning child categorises the incoming data, and hence determines to a large extent what these data are. For example, consider a child confronted with a language that makes a contrast between [s] and [θ], distinguished by some feature, say, [strident]. If the feature was not available to the child at some stage of acquisition then, by hypothesis, it could not distinguish tokens of [s] from tokens of [θ] and so words distinguished by them would be learnt as homophones. If the features come on-line by some process of maturation then these temporary homophones will have to be re-learnt. Such 're-learning' would predict patterns of error – such as failures of 'across-the-board' acquisition – that occur only infrequently, suggesting that the contrast is perceptually available *ab initio* (for extensive discussion, see Hale and Reiss, 2008).

There remains the task of characterising the third component – the learning theory, a function which maps the initial state (S_0) into the final (steady) state (S_s) on the basis of experience (cf. Yang, 2002: 5). This will display properties which are in part theory-neutral and others which differ according to the linguistic theory that the learning theory is associated with. In the former category come assumptions about memory (Markovian or otherwise) and the role of noise (the incidence and importance of ungrammatical input, for instance – cf. Niyogi, 2006); in the latter come assumptions about homogeneity, reliance on some form of traditional association, the appeal to principles such as the 'whole-object constraint' and the 'mutual exclusivity principle' (e.g. Markman, 1992), and socio-pragmatic conditions determining the child's receptivity to linguistic input (e.g. Tomasello, 2003). For some usage-based approaches association may exhaust the theory (e.g. Smith, L.B., 2000) and learning is then construed as a simple process of induction over perceived data. Most serious work on learnability, however, involves a contribution from the latter theory-dependent category, most obviously exemplified by the contrast between

the setting of antecedently given parameter values, or the (re-)ranking of (equally antecedently given) violable constraints.

One variable component of learnability pertains to the 'idealisation to instantaneity' (Chomsky, 1986: 52; cf. Smith, N.V., 2004: 12) which says that intervening stages have no effect on the final steady-state (S_s) grammar. Most generative theories, including OT, assume such an idealisation, whereas usage-based approaches do not. To the extent that the idealisation is empirically justified it provides evidence against such latter theories. For all theories intervening developmental stages can cast light on the initial state (S_o), including, of course, whether any aspect of that state is peculiar to language; it is not so easy to determine whether they influence or can cast light on the final steady state.[8] If 'instantaneity' is an appropriate idealisation then usage-based models are simply wrong in this respect. Macken (1995: 695) observes that "stochastic learning is cumulative and where paths differ, outcomes differ". To anticipate the discussion below, it seems systematically to be the case that particular patterns in children's developing phonology have no effect on the final steady state. For example, differences in the strategies chosen for cluster reduction or consonant harmony leave no traces in the mature child. Thus A reduced /sm/ clusters to [m] and Z reduced /sm/ clusters to [s] with no detectable difference to their ultimate (current) pronunciations. It is, of course, impossible to establish a negative claim of this kind: the best one can do is to look for and fail to find counter-instances. The absence of such instances in the literature is not without significance but here, as elsewhere, an integrated compromise is likely to be a closer approximation to the truth. It is faintly ironic that the current investigation subscribes to the idealisation to instantaneity but provides a mass of data which could give comfort to usage-based theorists or developmentalists such as Karmiloff-Smith (1992) or Locke (1993).

There are other ways in which learnability can be used as a criterion for the success of different theories – a kind of 'learnability filter' in Alderete's (2008) sense (cf. Boersma, 2003). For instance, OT assumes the prior learning of phonological representations before constraints are ranked. But the details of those representations themselves presuppose some of the rankings, giving rise to a contradiction in the theory. For example, whereas English lexical items may begin with /sp-/ but not /*ps-/, Modern Greek allows the inverse possibility (lexical items may begin with /ps-/ but not /*sp-/). If this distribution

8 This issue interacts potentially with the question of whether the learning algorithm has a memory. The idealisation to instantaneity entails that it needs no memory, but where intervening stages affect the final steady state this may or may not be the result of memory effects.

of data follows from the differential ranking of constraints (in terms of 'sonority distance', for instance), then there is no way of accounting for how it is acquired.

Chomsky (e.g. 2006: 183, 2007) has recently emphasised the importance of separating the "format of grammar" from the problem of acquisition, separating principles from parameters. That is, if language has the general properties of other biological systems with their long evolutionary history, then the complexity of the 'language-learning' task is reduced as the role of constraints external to the language faculty, including the role of 'learnability', becomes more important (see Fitch *et al*., 2005).

1.8 Universals and innateness

The separation of principles from parameters and the repeated reference to UG make it mandatory to raise the question of innateness: what aspects of language (if any) are innate and what their specific properties are. Since Chomsky (1959) and more explicitly Fodor (1975, 2008) (cf. also Smith, N.V., 2005: ch. 8; Carr, 2000) it has been clear that it is logically necessary to attribute considerable innate knowledge to the language-acquiring child. Equally obvious is the fact that the universality which follows from innateness claims and which accounts for 'general' properties of language must be viewed in the context of the 'particular', because of both the existence of different languages and the variation characteristic of different children learning the 'same' language, whether that variability is a function of performance, competence or both. McMahon (2007: 165) makes the interesting claim that appeals to innateness are better justified in the discussion of the acquisition of prosody than of segmental structure because the former requires access to 'hidden structure', whereas the latter is if anything overdetermined by the primary linguistic data. As a result, "innate mechanisms are not only inappropriate for segmental phonology, but also quite clearly unavailable to the child" (McMahon, 2007: 166). This view is, I suspect, somewhat overstated: for a possible counter-example to the claim see the discussion of universal 'tendencies' below.

Claims of innateness rely classically on the putative poverty of the stimulus, and on the Fodorian logic of the impossibility of learning a system of greater expressive power than you already have (for discussion, see Smith, N.V., 2004: 43f.; Hale and Reiss, 2008: 27ff.),[9] but they are not restricted to these arguments. It is undeniable that children may produce a phonological output for which there

9 It is not obvious that the notion 'expressive power' generalises to phonology at all.

is no direct evidence in the input: e.g. consonant harmony, 'non-English' sounds or sequences such as the voiceless sonorant [m̥] (for A) or the cluster [dʒr] (for Z), but this does not constitute a poverty-of-the-stimulus argument as there are simpler explanations for why such forms appear, as Blevins (2004: 227) argues in her discussion of hyper-learning[10] and the "illusion of child phonology". She attributes children's deformations to 'articulatory simplification' ("to avoid difficult sounds", p. 228), and cites several cases where children can hear their own inaudible-to-adult contrasts (p. 230). She concludes that "hyperlearning in phonology … is generally not in evidence" (p. 223) and that there is no poverty of the stimulus. One can accept the spirit of Blevins' position while taking cognisance of certain problems: the notion of simplicity appealed to is in need of fleshing out, as the examples just cited ([m̥] and [dʒr]) are not obviously simple, and there are equally many instances where the child cannot hear his own 'inaudible' contrasts.[11] Moreover, even Blevins (2004: 231) admits innateness for distinctive features and the prosodic units which function as the domain for stress and intonation. Whatever one's phonological theory there must be some structure ascribed to the initial state, in part a domain-general computational ability, in part a vocabulary of linguistic primitives. For most practitioners the structure will be minimal properties of UG, either 'default' settings of parameters or the ranking of markedness and faithfulness constraints.

A more cogent empirical argument for innateness than the poverty of the stimulus comes from parsability (cf. Smith, N.V., 1990; Hale and Reiss, 2008: 86ff.). In order to use the primary linguistic data as a basis for determining the properties of the language being learnt the child has to be able to analyse or parse those data appropriately – as vowels or consonants, stressed or unstressed, coronal or dorsal, and so on. The issue then becomes precisely which constructs it is minimally necessary to specify as innate. In APh I was reticent about innateness, claiming it only tentatively for rule ordering (now perhaps defunct); for Cairns' (1969) neutralisation rules (probably defunct), and for four universal tendencies (summarised in the next chapter) constraining the function of the rules of child phonology. There was a further caveat that innateness was barely empirically different from 'learnt early', but that caveat seems logically to have been unnecessary. Morgan's (2006) demonstration that the tendencies generalise to British Sign Language make the claim of an innate basis extremely

10 That is, learning which results in knowledge beyond what is available in the input.

11 In their discussion of the merger of (e.g) /r/ and /w/ as [w], Hale and Reiss (2008: 61) assert that the child may be making distinctions that are inaudible to the transcriber. This may be so, though A responded to his own (tape-recorded) pronunciation the same way an adult would.

persuasive, so at least the last of these innateness claims still looks plausible now. There are also other, experimental, sources of evidence for innateness, typified by the work of Berent and her colleagues (e.g. Berent *et al*., 2007). They investigated the perception of highly marked onsets such as [lb] and [bd], neither of which occurs in English, and demonstrated that the universal preference for [bd] over [lb] modulated English speakers' perception of such clusters despite their absence from the language.

1.9 Continuity

There has been considerable debate in the literature (Pinker, 1984; Radford, 1990; Tsimpli, 1996; Hoekstra and Hyams, 1998; Tomasello, 2000a, 2003) on whether child language is 'continuous' with adult language, exploiting the same theoretical vocabulary and concepts, or whether it is subject to maturational development such that – in certain respects – child language is different in kind from adult language. 'Continuity' entails that particular aspects of knowledge are present *ab initio* (whether or not there is direct evidence for them). 'Maturation', by contrast, entails that particular aspects of knowledge come on stream at particular stages of development as the result of the interplay of linguistic input and endogenous processes. A typical example outside of phonology would be the maturation of A-chains in syntax (Borer and Wexler, 1987); an example from outside the language faculty would be the development of 3-D vision. Despite Tomasello's blunt claim that "[t]here is not one shred of evidence for the continuity assumption" (Tomasello, 2003: 323–4) the default hypothesis has to be in favour of continuity. This is necessary for a variety of reasons. First, the debate is about *knowledge* of language, not merely about performance, and most claims for maturation have been based simply on production data. Second, continuity is necessary in order to avoid the problem of correctly characterising the transition from an idiosyncratic system to an 'adult' system: how and at what stage a child's grammar becomes similar in kind to the putative model.

Given these observations it is hard to find clear examples of maturation in phonology. There are of course physiological developments, such as the increasing control of 'speech breathing' (Messum, 2007) but I take these to lie outside the domain of phonological acquisition proper. An example that might appear to be problematic for the assumption of continuity is provided by the existence of phenomena such as consonant harmony that are essentially unattested in adult languages, but here there is overwhelming evidence that this is *not* a reflection of the competence of the child, whose lexical representations

demonstrably correspond to the adult form and not to his own output. So there is a corresponding support for continuity (cf. Hale and Reiss, 2008: 55; APh; Dodd, 1975).

It is logically possible to argue for mixed systems such as 'weak continuity' (e.g. Clahsen and Pencke, 1992; for discussion, see de Villiers, 1992) which attempt to get the best of both worlds. In syntax the classic example adduced in favour of maturation is the emergence of functional categories (see e.g. Radford, 1990; Tsimpli, 1996). If continuity and maturation exhaust the logical possibilities then this could perhaps be construed as evidence for maturation. However, even in syntax it is not clear what precisely is 'maturing' in this case, and in phonology there is no comparable phenomenon. Accordingly, I adhere to the strong version of continuity: children's developing phonologies are of the same nature as those of the adults around them.

Having set the theoretical stage I turn next to a summary of the conclusions of APh.

2 *The main claims of Smith (1973) and the evidence for them*

2.1 Introduction

The analyses in APh were couched in the rule-based framework of classical (SPE) generative phonology. Its major claims came in two parts: first that, by the time he begins to speak, the child's lexical representations must be in terms of the adult surface forms of the target language and, second, that the child does not have his own phonological system. This is not to deny that "children play an active role in acquiring the phonology of their language" (Stoel-Gammon and Sosa, 2007: 250). Children differ in ways that go beyond differences in the input, so some contribution from them is clearly necessary. It is not obvious, however, that matters of lexical selection, regression, avoidance, and so on give rise to an idiosyncratic phonological system defining their competence. What is in part idiosyncratic is the set of performance strategies that each child exploits to circumvent the problems of production. A number of other claims followed, most notably that the child's developing perception must be at least adequate for him to discriminate and encode all the contrasts of the language being acquired. Illustrating and justifying these claims it was then suggested that the child's own pronunciations and mispronunciations are correctly characterised in terms of the application of an ordered set of 'realisation rules', supplemented by phonetic detail rules. These sets of rules take the adult form as input and give (a representation of) the child's productions as output.

Because of its regularity, consistency and predictability it is generally uncontroversial that the child's phonological behaviour is consistently rule-governed,[1] rather than being the result of random variation. Less obviously, his linguistic development over time consists in modifications to and elimination of the realisation rules. That is, only the rules change over time and not, for instance, the feature composition of the segments that the rules range over. The

1 The claim at this level of generality is not intended to favour rule-based over constraint-based systems.

realisation rules are constrained by distinctive feature theory and by four universal 'tendencies': the implementation of vowel and consonant harmony, cluster reduction, systemic simplification, and grammatical simplification.

A corollary of the claim that the child does not have his own system is that only the lexical representations and the realisation rules are 'psychologically real': the child's own productions have no status. This claim goes beyond mere segmental constituency to include prosody as well. Fikkert (2007: 544) observes that "prosodic structure, particularly syllable structure, is usually predictable from the string of segments and not used contrastively". Accordingly, if such prosodic structure is characteristic only of the output and the output has no psychological status, there is no need to include an account of it in describing the child's competence.[2] Higher in the phonological hierarchy, the child's command of intonation is, of course, also part of his competence, but intonation is not *lexically* represented.

The realist stance implicit in any claim of psychological reality also entails that the acquisition of phonology is a window onto competence, providing evidence for or against constructs of linguistic theory. In APh evidence was offered *inter alia* for the validity of a phonological hierarchy, for the definition of distinctive features, for rule ordering and the notion conspiracy. Evidence was offered against marking conventions, and against some abbreviatory notations: specifically, the use of Greek letter variables and of curly brackets to capture disjunctive generalisations.

2.2 The nature of lexical representations

Let us begin with the evidence for the now widely accepted but still contentious claim that the child's lexical representations are the same as the adult surface forms, hence represent neither his own productions nor the adult's underlying forms if these are different from the surface forms. This position is plausible despite the fact that the bedrock for the analysis are the child's regular, hence rule-governed and predictable, mispronunciations in production. Given the examples in (1) it is not hard to predict the pronunciation in (2):

1. feet → wiːt
   finger → ˈwiŋə
2. fire → wæː

2 There may be a certain tension with this claim when we look at the child's metalinguistic ability in which details of syllable structure (in particular, onsets) seem to play a crucial role (below p. 114).

The relation between adult and child forms is not bi–unique, but frequently many–many. That is, a pronunciation by the child might be the reflex of several adult forms and, more surprisingly, a single adult form might be pronounced in several different ways by the child. An example of the former kind is given in (3) where all of adult /t, d, s, z/ etc. are realised as [d]; an example of the latter kind is given in (4) where adult /l/ was realised (consistently) as [l], [d] or [g][3] depending on context:

3.

teeth	→	diːt
door	→	dɔː
scissors	→	'didə
zoo	→	duː

4.

lorry	→	'lɔliː
light	→	dait
like	→	gaik

Such many–many correspondences can give rise to puzzling anomalies such as the '*puzzle*-puzzle' illustrated in (5), where the child can produce the correct form in one context but not in another:

5.

puddle	→	pʌgəl
puzzle	→	pʌdəl

That is, he can say *puddle* correctly but only as his reflex of a different adult word. Such examples may appear to belie the claim that the child operates in terms of the adult system but, as will become apparent, this is not an appropriate conclusion.

More direct evidence that the child is manipulating representations identical (or isomorphic) to those of the adult language comes from the 'across-the-board' nature of the changes to his developing system. This is clear in examples like those in (1) where an adult contrast was neutralised, with /f/ and /w/ falling together as [w]. When he learnt to produce the labio-dental [f] appropriately in examples like *feet*, [f] appeared at much the same time in all and only words beginning with /f/ in the adult language, while words beginning with /w/, such as *window* and *wash*, continued to be produced with [w]. Importantly, no example of adult /w/ surfaced with [f], not even when there was a brief period while the contrast was becoming fully established during which some words beginning with /f/ appeared with either [f] or [w] in free variation. Similar to this asymmetric development of particular contrasts is the existence of asymmetric alternation at a single stage. For instance, [r/l] were in free variation for adult /r/

3 I am simplifying the phonetic minutiae for convenience. See APh for the details.

(*right* was produced as [rait] or [lait]), but only [l] occurred for adult /l/ (*light* was produced only as [lait], never as [rait]).

There were some exceptions to the generalisation that /f/ was produced as [w], but these too provide relevant evidence. Surprisingly, from the beginning *feather* failed to appear with the expected [w], being pronounced as in (6):

6. feather → ˈtɛdə

This is one of very few cases where it is necessary to postulate a mismatch between child and adult representations. It appears that *feather* had been restructured (mistakenly represented[4]) as *seather* (/ˈseðə/): that is, with an initial /s/ rather than /f/, and /s/ at the relevant stage was systematically replaced by [t]. The crucial point is that neither [s] nor [f] appeared in A's output but the longitudinal development of his representations indicated that these were none the less couched in terms of these adult elements.

The centrality of the representations of the adult language is even apparent in the anomalous appearance of non-English sounds and sequences. For instance, at one stage A regularly produced voiceless sonorants such as [ɬ, m̥, n̥] as in (7) and an initial velar nasal as in (8):

7. slug → ɬʌg
   Smith → m̥is
   sneeze → n̥iːd

8. neck → ŋɛk
   snake → ŋeːk

These were not random exceptions but rather the effect of coalescing properties from each element of the target form (the voiceless sonorants) or of regular consonant harmony (the velar nasal).

Clear evidence that the child is focusing on and manipulating representations of the adult language comes from at least three other areas: his ability to identify contrasts in the adult language that he did not produce himself,[5] his understanding of his own speech and his grammatical (morphological) behaviour. The first of these is illustrated by A's ability to retrieve on request the correct

4 Presumably this was ultimately a perceptual confusion: the auditory properties of [s] and [f] are close (see e.g. Stelmachowicz *et al*., 2007), though this was not acknowledged in APh.

5 This seems to be at variance with the observation by Fikkert (2007: 541), citing Dresher (2004), that "only contrastive features can be represented", where this presumably means features contrastive for the child. If I am right that the child has no system of his own, the notion 'contrastive for the child' is not well-defined.

picture of a *mouth* or a *mouse* at a time when he pronounced both of them as [maut]. That is, his own pronunciation masks his perceptual ability correctly to discriminate /s/ and /θ/. This ability is more interestingly reflected in his developing morphology. At a stage when /θ/ and /t/ (as well as /s/) were neutralised as [t] so that we had the examples in (9):

9. cloth → klɔt
   cat → kæt

the former was pluralised by the addition of the ending normal for words ending in coronal continuants, whereas the latter had no overt plural marker at all, as seen in (10):

10. cloths → klɔtid
    cats → kæt

The plural form of *cat* is presumably derived via the sequence of operations: /kæts/ → |kætt| → [kæt], whereas the plural form of *cloth* is formed via a generalisation of the pattern found with e.g. *horse* as in (11):

11. horse → ɔːt
    horses → ɔːtid

but his form [klɔtid] could clearly not be an imitation of what he heard in the way that [ɔːtid] could be.

A's reaction to his own speech was likewise revealing. If his pronunciation neutralised an adult contrast – e.g. between /s/ and /ʃ/, both pronounced at the relevant stage as [s] – and if you played him a tape-recording of himself producing such a neutralised form, his interpretation of it was as the adult form. Only if there was no adult equivalent (in his vocabulary) would he identify the word as referring to his own version. The same point is illustrated by the conversation in (12) from APh (136–7) when A was 3¼, though in this case it is my imitation of his pronunciation that he is reacting to:

12. *NVS* What's a [səːt]?
    A {immediately points to his shirt}
    NVS What's a [suː]?
    A {immediately points to a shoe}
    NVS What's a [sip]?
    A When you drink {imitates}
    NVS What else does [sip] mean?
    A {puzzled, then doubtfully suggests *zip*, though pronouncing it quite correctly}
    NVS No: it goes in the water.

A A boat.
NVS Say it.
A No. I can only say [sip].

This reaction is apparently at variance with the claims of e.g. Scobbie *et al*. (2000) and Blevins (2004: 230). The latter observes that "the apparent difference between the child's phonology and that of the adult is an illusion: these children can perceive the adult contrast … and attempt to reproduce it … the children themselves can hear the contrast they are making and recognize the … sounds as distinct". A could certainly perceive the adult contrast but he gave no indication that he was making a parallel contrast in his own pronunciation of *sip* and *ship* that was inaudible to me. Other children may of course have more refined productive and discriminatory abilities.

This makes it clear both that his immediate reactions – even to his own production – were in terms of adult-type representations, and that he had some metalinguistic awareness of these and of his own pronunciation. As discussed below, this does not, however, justify the further claim that he 'had his own system'. It is of course not possible to establish such a negative conclusion – the second main claim of the opening paragraph – but reviewing what would constitute evidence for the positive equivalent and showing that none of it is cogent comes as close as is feasible to doing so. In the case of A there was no good evidence for the simplification of the morpheme structure conditions or phonetic details characteristic of his putative system, except those which were motivated by properties of the adult language (see APh: 178–80).

The simple model that emerged from this study can be represented as in Figure 1 (from Smith, N. V., 1978: 46).

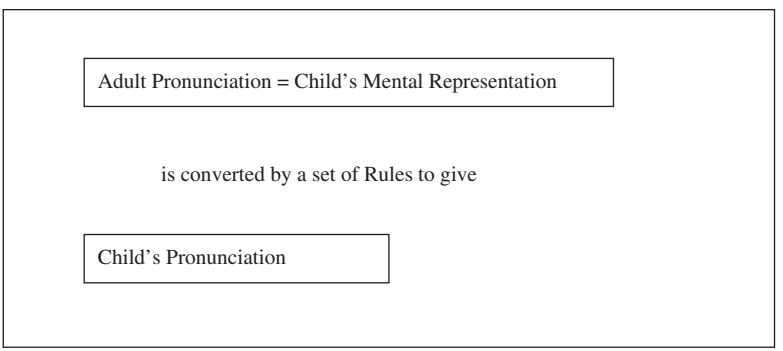


Figure 1 *Model of the child's lexical phonology*

2.3 Realisation rules

The mapping from the child's lexical representation (the adult surface form) to his pronunciation was effected by a set of extrinsically ordered 'realisation rules'. For instance, given that the child consistently produced *squat* (/skwɒt/) as [gɔp], this was captured by a derivation illustrated informally[6] in (13), where each of the rules was operative in a wide range of examples:

13a.	/skwɒt/	→	|skwɔp|	(harmonising a coronal to a preceding labialised sequence /kw/)
b.	|skwɔp|	→	|kwɔp|	(deleting pre-consonantal /s/)
c.	|kwɔp|	→	|kɔp|	(deleting post-consonantal sonorants)
d.	|kɔp|	→	[gɔp]	(neutralising the voicing distinction)

'Phonetic detail' rules then provided more information about the final ouput: e.g. that [gɔp] was really [g̊ɔp] with an initial voiceless lenis articulation. Two major disadvantages of such rules of an SPE type are first, that they are too powerful: any input can be converted to any output, and second, that (extrinsic) rule ordering gives rise to serious problems of learnability. These problems persist even despite its being the case that the 'power' of the rules is offset to some extent by the fact that their formal properties are constrained by distinctive feature theory and the properties of the phonological hierarchy, and that their functional properties are constrained by the requirement that they instantiate one or more of four universal tendencies.

Distinctive feature theory allows the characterisation of 'natural classes' of elements which appear to be manipulated by the child acquiring his first language yet which are not obviously captured by alternative systems of representation. An obvious example is provided by the class [+coronal][7] whose use allowed a maximally simple description of the set of consonants which underwent consonant harmony: /t, d, s, z, ʃ, θ, tʃ, dʒ, r, l, j, n/. By implication, classes not easily described by simple feature specifications should not occur, except infrequently. In addition to distinctive features, APh (191–2) also appealed to syllables though without giving them explicit formal status. As we shall see when we look at Z's phonology in detail we also need at least enough sub-syllabic structure to define the notion 'onset'.

6 A fully formalised version of all the rules appears in APh.

7 To enable direct comparability with the analyses of APh I retain [coronal] as a binary feature rather than its now standard treatment as unary (see Sagey, 1986; Roca and Johnson, 1999: 635; Hall, 2007).

The functional constraints, which capture Kisseberth's (1971) idea of 'functional unity' (or 'conspiracies'), stipulated that all realisation rules implemented one of the four processes mentioned above (vowel and consonant harmony, cluster reduction, systemic simplification, and grammatical simplification) and illustrated in (14a–d) respectively:

14a.	open	→	'ubuː	duck	→	gʌk			
b.	blue	→	buː	spoon	→	buːn			
c.	there	→	dɛː	chair	→	dɛː	yes	→	dɛt
d.	nose	→	nuː	eyes	→	ai[8]			

It may be necessary, or at least desirable, to expand the range of such tendencies to include a fifth category of 'template creation' to accommodate the phenomenon whereby some children coerce all (or some particular class of) words to conform to one particular pattern in apparent independence of the fine detail of the input. An example is provided by Macken's (1992; cf. Menn, 2004) subject who produced any word containing a labial and an alveolar with the labial as the first consonant, the alveolar as the second consonant, and all other consonants omitted. I argued explicitly against this possibility in APh (p. 175) (with a possible caveat about reduplication), but acknowledged the existence of rare exceptions in the form of Priestley's (1977) 'idiosyncratic strategies' (Smith, N. V. and Wilson, 1979: 253). The exceptions seem to be less rare than I thought, though neither A nor Z had recourse to such template creation, and the theory clearly needs to allow for them.

APh appealed to conspiracies but the theory at that time was inadequate to formalise them. Recent developments, especially in Optimality Theory, have improved the situation considerably (for discussion, see Pater, 2002; Yip, 2006: 1474–5; and below), though this apparent victory may be pyrrhic if the notion turns out to be unnecessary.

The disadvantage of deploying a theory that allows rule ordering is more severe as the range of possible grammars licensed by such a theory is astronomically large. However, in the formalisation of Z's phonological development no appeal to rule ordering proves necessary (for discussion, see below) and it seems reasonably clear that A's data could be reanalysed without it too. If correct, this removes a major objection to the (type of) framework used. It is similarly possible to avoid having recourse to such abbreviatory devices as the (linking) use of marking conventions, or the use of {curly brackets} to represent

8 The argument was that the omission of the final /z/ was a partial function of the plural morphology. The reverse situation in which phonological facts constrain (or facilitate) the acquisition of the grammar is common; cf. Monaghan *et al*. (2005).

that some rule operates in disjoint environments. In neither case is there any evidence that they reflect psychologically real generalisations made by the speaker-hearer and, for reasons of parsimony, the theory is better off without them.

Subject to certain caveats about the perfection of the child's perception (see below), the claim that the child has control of lexical representations equivalent to the adult surface form is not overly contentious. It does not follow from this that he does not also have further representations equivalent to his own output. I wish to defend the position that no such additional representations are necessary, but the evidence – especially the putative contrary evidence – will only become available once we have looked at Z's phonology, so discussion is postponed until chapter 5.

2.4 The role of perception

APh (134) hypothesised that "the child doesn't begin to speak until he has learnt to perceive at least the majority of the contrasts present in the adult language", hence the possibility that his lexical representations could be essentially equivalent to the adult surface forms. This hypothesis was tested and largely supported by Barton (1976), but in his review of APh Braine (1976) observed that some of the data cried out for a perceptual explanation. The most notable examples were the differential treatment of clusters consisting of a nasal followed by a voiced or voiceless consonant as shown in (15):

15a. mend → mɛn
b. meant → mɛt

where the nasal before a voiced consonant is long and perceptually salient, while that before a voiceless consonant is short and relatively inaudible. He accordingly argued for a 'partial perception hypothesis' which claimed that the child's perception system was 'only partly accurate' (Braine, 1976: 492). This suggestion was corroborated in detail by Macken's (1980) discussion of 'puzzles'. In a meticulous and elegant reanalysis of the *puzzle-puddle-pickle* evidence she demonstrated that, whereas A plausibly could discriminate between *puzzle* and *puddle*, he almost certainly couldn't (or didn't) discriminate between pairs like *puddle* and *puggle*.[9] *Puggle*, of course, is not a word of English but,

9 This observation was, I think, correct despite the explicit claim I made (APh: 150) that A could "easily identify such pairs as *riddle* and *wriggle* correctly". On occasion he doubtless did, but not with the consistency I had suggested.

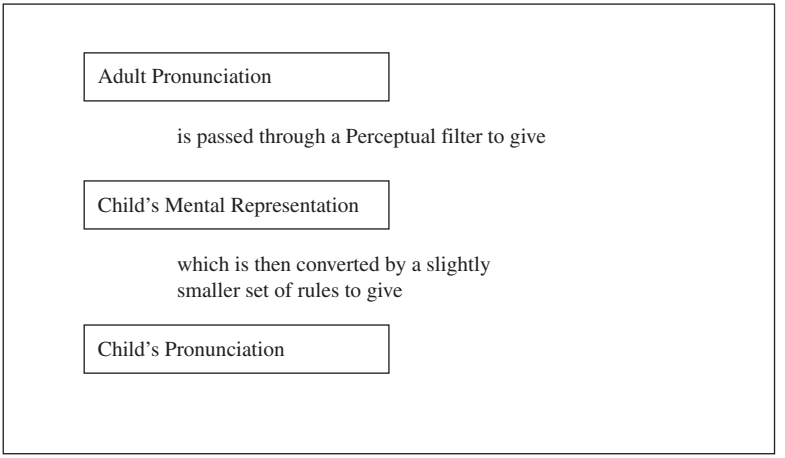


Figure 2 *Revised model of the child's lexical phonology*

crucially, A sometimes mispronounced words like *pickle* as *pittle* ([pitəl]), making it clear that his representation was not identical to the adult form, but had been subject to the constraining effects of his perceptual system which restricted the form of his lexical representations. Hence Figure 2, (from Smith, N.V. 1989: 47), where the Adult Pronunciation is passed through a Perceptual Filter to give the Child's Mental Representation which is then converted by Realisation Rules to give the Child's Pronunciation.[10]

Macken (1980) established the need for an explicit role for perception in any account of the mismatch between the child's production and the putative target forms of the adult language. Kiparsky and Menn (1977) and Menn (1980; cf. Menn and Matthei, 1992) made a different but related proposal to account for the mismatch: the manipulation by the child of two lexicons – an input lexicon and an output lexicon (cf. Howard and Franklin, 1988: 20). The main motivation for this unparsimonious system (see Kager *et al*., 2004b: 14) is 'inertia' (the persistence of a (mis)pronunciation beyond the expected time of its disappearance). A special case of this phenomenon is what APh refers to as 'restructuring', an example of which is provided by the development of *feather* discussed on p. 22 above. In addition, Bruce Hayes has argued that postulating two lexicons, related in such a fashion that the child's newly mastered

10 Both I and II are oversimplifications in that they ignore the difference betwen realisation rules proper and 'phonetic detail' rules. I think there is anyway a case to be made for claiming that the distinction is spurious. See chapter 5, especially section 5.1.5, for discussion.

pronunciations gradually replace the old forms in the output lexicon, provides an explanation for some of the details of the phonetic progression of acquisition by A. Specifically, it explains the observation in APh (p. 141) that typically "the first word to occur with no harmonised variation at all was one which was almost certainly new to his vocabulary". He writes (p.c.) that this "makes sense under the view that for a completely new word, there's no older entry that needs to be dislodged" (from the output lexicon). Further, the hypothesis "correctly predicts a loose correlation between frequency and slowness for a word to get updated – frequent words get entrenched earlier and more deeply, and thus require more time for the new entry to replace the old". However, this prediction would follow equally well from an analysis with a single lexicon and a network whose connection strengths were partially determined by frequency. As Kager *et al*. (2004b: 14f.; cf. Menn, 2004: 58ff.) argue that a two-lexicon solution makes unfortunate predictions elsewhere, I am reluctant to adopt such an account and restrict myself to a single lexicon.

A closely related and equally unparsimonious idea is provided by the suggestion that the child has two grammars (e.g. Hayes, 2004; Boersma, as cited in Menn, 2004: 63). Though I am aware that I was probably the target of Menn's (1980: 23) epigraph "Beware Procrustes bearing Occam's razor",[11] it is desirable – if possible – to avoid the multiplication of such entities. Apart from lack of parsimony, described as "unattractive (perhaps, indeed, incoherent)" by Smolensky (1996: 720), such duplication of lexicons or grammars allows in principle for a situation in which the child understands one language and produces a different one – Hindi and English, for example. More realistic, but still implausible, would be a situation where the child understood (only) variety A of a language but produced (only) variety B.

That there is a role for (inadequate) perception in any explanatory account of the child's acquisition of phonology seems to me now to be incontrovertible, but I remain entirely unconvinced by the case for multiplying grammars or lexicons beyond necessity. Be that as it may, and however defensible or indefensible the analyses in APh were, they had the merit of being sufficiently explicit to constitute a descriptive and explanatory challenge to others working in a variety of frameworks.

11 *Entia non sunt multiplicanda praeter necessitatem*. William of Ockham, 1285–1347 – "Entities are not to be multiplied beyond necessity" (i.e. restrict your theory to what is 'conceptually necessary'). Procrustes was an Attic bandit who made people fit his iron bed by either lopping off their feet or stretching them on the rack. He was slain by Theseus.

3 *Competing theories*

The modifications suggested by Macken and others preserved the basic rule-based generative framework of APh. I look next at other proposed generative revisions before turning to constraint-based and usage-based alternatives.

3.1 Rule-based (generative) theories

Rule-based ('generative') theories have the great advantage of being explicit and descriptively rich: there is almost nothing they cannot describe. This, of course, makes the problem of explanation more acute, and even the descriptive richness doesn't guarantee that the correct natural classes of data or phenomena will be characterised by the theory. For example, my description of consonant harmony in APh achieved at best descriptive adequacy. Spencer (1986; see also Smith, N.V., 1989: 125f.; Goad, 1997) provided evidence for a change in the – still generative – theory used in child phonology: the need to appeal to autosegmental representations rather than relying on the purely linear approach of SPE phonology. Spencer emphasised the fact that some of the formal statements of consonant harmony were baroque in their complexity. In particular, the rule ensuring that [l] emerged for all of /l, r, j/ in examples like [lɛluː] for *yellow* and [lɔliː] for *lorry* had to be complicated because the harmony operated in both directions: from left to right in *lorry*, from right to left in *yellow*. But the process is intuitively a unitary one, and he suggested that if 'laterality' were treated autonomously such that the feature [lateral] was associated with all the consonants in the domain simultaneously this unity could be satisfactorily captured. A similar autosegmental analysis also solved a problem presented by the kind of example illustrated by *squat* in (13) in chapter 2 above. For the words in (1):

1.

queen	→	giːm
twice	→	daif
quick	→	gip
squeeze	→	giːp

the final consonant of the adult word ended up in A's pronunciation as a labial, presumably because of the /w/ following the initial consonant in the input. This is patently another case of consonant harmony, though as the post-consonantal /w/ disappeared in A's speech this was not immediately obvious. By detaching 'labiality' from the sequence of segments and giving it its own autosegmental tier, Spencer was able to simplify the statement of the process. More interestingly, this separation predicted correctly that A's ability to produce consonant clusters involving a /w/ should emerge at the same time as the disappearance of the pronunciations in (1). Under the original description this simultaneity was simply an accident.

The advent of autosegmental phonology thus allowed generative phonology to cope with some data that had seemed problematic for it by allowing processes that are intuitively the same to be treated unitarily. This advantage did not, however, generalise, and a putative example of this limitation (see e.g. Pater, 2002; Kager *et al.*, 2004b) is the inability adequately to accommodate the 'functional unity' (Kisseberth, 1971) of certain sets of phonological rules. This was mentioned in APh (177, 204) because, as mentioned in chapter 2, a crucial (universal) constraint on realisation rules was that they 'conspire' to implement particular functions, but such conspiracies could not be formally implemented in the generative phonology of the time. This led to 'constructivist' alternatives (Kiparsky and Menn, 1977) in which output constraints had a formal role. For instance, the child's difficulty in producing consonant clusters could be solved by postulating a constraint prohibiting them, where this could be implemented by deleting either one of them, by inserting an epenthetic vowel, by metathesis, and so on. Importantly for what follows, such constraints were viewed as the result of the child's "limited ability to plan and execute a complex motor activity" (Menn, 1978: 164): that is, as mainly a performance problem.

A second perceived limitation of early generative theories was the problem of learnability: as Gnanadesikan referring to A put it (2004: 101): "[t]he child is seen as having formulated a large number of rules for which he has never received any evidence". This problem appears at its starkest in the child's development of a rule (or rules) of consonant harmony for which there is no evidence in the input. This problem is related to the contrast (ignored in APh) between 'invented' rules – like my realisation rules, which are peculiar to the child and probably not correctly viewed as 'learned' at all – and rules characteristic of the adult phonology which really are learned. A third limitation was a side-effect of the descriptive profligacy of rules: their failure adequately to characterise the typological variety of the world's languages. Solutions to all

of these problems were provided by the development of Principles and Parameters theory in the 1980s and by constraint-based theories, specifically Optimality Theory, in the 1990s.

3.2 Parameter-setting models

A radical innovation of generative theory was the introduction in the late 1970s of the Principles and Parameters model. The major advantage of the framework lies in its potential for solving "Plato's problem": how children can acquire their first language with such remarkable speed and efficiency. In line with developments in other domains, especially immunology, this is seen as a task of *selection* rather than a task of instruction: the full range of linguistic possibilities comes pre-specified (they "belong to the genotype"; Anderson and Lightfoot, 2002: 36) and the child's task is just to choose the right ones (see Piattelli-Palmarini, 1989). The idea is that everything is already laid out in the child's mind and language acquisition consists simply in making particular choices "off the peg". The huge phonological variety among the world's languages can then be reduced to a set of (usually binary) alternatives, solving the problem of typology as well as Plato's problem. However, there is an implicit corollary to the effect that children may have knowledge not directly licensed by the input data, and it is clear that those who do not accept this abstractness and are anyway anxious to minimise appeals to innateness will be unmoved by the claims of parametric models (cf. Blevins', 2004, critique of 'hyper-learning').

A classic example of a worked-out parametric model is Dresher and Kaye (1990: 142–3) who suggest some ten or more "Parameters of metrical theory" to account for the variety and acquisition of stress systems. Their parameters include those in (2):

2.
- P1 The word-tree is strong on the [Left/Right] (where the choice 'Left' is characteristic of languages with initial word stress)
- P2 Feet are [Binary/Unbounded] (where the choice 'Binary' licenses alternate weak and strong syllables)
- P5 Feet are Quantity Sensitive [Yes/No]

Evidence which is sufficient for the learner to identify the correct value for Quantity Sensitivity (P5) comes from the correct perception of at least two words with the same number of syllables, but with different stress patterns, such as *América* and *Manitóba*.

Various extensions and modifications of parameter theory have been suggested (see *inter alia* Charette, 1991; Fikkert, 1994; Pan and Snyder, 2004;

Snyder, 2007). Given the focus of the current work, it is most relevant to illustrate the genre with an example concentrating on segmental phonology: Sanoudaki (2007). She developed a framework within CVCV theory (Scheer, 2004) which successfully predicted the order of acquisition of different clusters of non-rising sonority in Modern Greek. She observed that clusters of the type /sp, st, sk/ are acquired productively before clusters of the type /xt, ft/ and explained this as a result of the former requiring a subset of marked parameter settings.[1] In general, because of the presumed absence of usable negative data in first language acquisition, the child always homes in on the (unmarked) combination of settings, a strategy which eventuates in his mastering the correct subset of the relevant forms.

Apart from their implications for learning, an attractive aspect of parameter-setting models is that they generalise to provide an account of language typology. The same choice which eventuates in a child correctly producing /xt/ clusters, for instance, also characterises the set of languages (such as Modern Greek) which have such clusters. Despite the conceptual appeal of parameter theory and its success in accounting for aspects of the acquisition of both phonology and syntax, there have been few worked-out applications of it to the acquisition of phonology. This area has been dominated for the last few years by the rise of Optimality Theory (OT), which has spawned a vast amount of work in all domains of phonology. This constraint-based work has provided a new format for describing phonological acquisition and has simultaneously suggested solutions to the problems raised by typology and by learnability.

3.3 Constraint-based theories, especially Optimality Theory

OT originated as a general theory of phonology but, with its emphasis on the relation between input and output forms, lends itself particularly obviously to acquisition. Its major results arise from the tension between two kinds of constraint, faithfulness and markedness, where the former regulates the relationship between input (underlying) and surface forms – militating against deletion or insertion processes, for instance – and the latter imposes restrictions on output forms – disfavouring complex clusters, for example. The phonology of a particular language consists of an ordered ranking of all the constraints. In adult phonology the input can be taken to include the lexical representation, in

1 Specifically, languages with initial /sT/ clusters (T is an obstruent) are characterised by the parameter setting [Nuclei +govern] whereas languages with initial /TT/ clusters require both this and the setting [Initial ON No] (ON is Onset Nucleus).

acquisition it can be construed more literally as the input to the child – the primary linguistic data. There is general, but not total, agreement (see chapter 5, section 5.1.5) that in the initial state (i.e. before the child starts acquiring the phonology of the ambient language) all markedness constraints outrank all faithfulness constraints, and that acquisition consists in pairwise re-ranking of those constraints according to a well-defined algorithm.[2]

As seen above, conspiracies of the kind proposed by Kisseberth and exploited informally in APh are formally somewhat intractable in a rule-based framework. In constraint-based theories by contrast they are expected, and generalisations which were expressed as the fortuitous outcome of different rules can be captured by the operation of a single simple constraint ranking in OT. For instance, A's pronunciation of *meant* and *mend* as [mɛt] and [mɛn] respectively (see ch. 2, p. 27, above) was accounted for in APh by postulating two unrelated rules reducing clusters of a nasal plus consonant to a single element as shown in (3):

3a. [+cons] → Ø / [+nasal] [$\overline{+\text{voiced}}$]
b. [+nasal] → Ø / ___ [−voiced]

In OT this conspiracy is accounted for by ranking the single constraint *COMPLEX[3] above the relevant faithfulness constraints preserving one or other of the members of the cluster. Such further constraints (MAX-$C_{[+NASAL]}$ and MAX-C[4]) as in (4), are still needed to accommodate the different outputs ([mɛt] and [mɛn]), but the crucial advantage is that the OT constraint correctly captures the generalisation in a way that rule-based systems in principle cannot.

4a.

Input: /mend/	*COMPLEX	MAX-C
mɛnd	*!	
☞ mɛn		*

4b.

Input: /ment/	*COMPLEX	MAX-$C_{[+NASAL]}$
mɛnt	*!	
☞ mɛt		*

2 It is worth noting (cf. Stemberger and Bernhardt, 1999: 419) that children's productions may be more faithful than the typical adult pronunciation – e.g. in the absence of weak forms or reduced vowels.

3 This is a 'cover constraint' (cf. McCarthy, 2008: 261) subsuming *COMPLEX ONSET and *COMPLEX CODA. Only the latter is directly relevant here, but the former features below.

4 Cf. McCarthy (2008: 111).

To accommodate both outputs with a single ranking we need slightly to refine the tableaux in (4a, b) as in (4c, d), where MAX-C is replaced by MAX-$C_{[-VOICE]}$ and both this and the constraint MAX-$C_{[+NASAL]}$ dominate the general faithfulness constraint MAX. MAX-$C_{[-VOICE]}$ is omitted from (4d) as it has no effect.

4c.

Input: /ment/	*COMPLEX	MAX-$C_{[-VOICE]}$	MAX-$C_{[+NASAL]}$	MAX
mɛnt	*!			
mɛn		*!		*
mɛd		*!	*	*
☞ mɛt			*	*

4d.

Input: /mend/	*COMPLEX	MAX-$C_{[+NASAL]}$	MAX
mɛnd	*!		
mɛd		*!	*
mɛt		*!	*
☞ mɛn			*

The validity of this argument for an OT analysis is predicated on the assumption that the constraint accounting for the conspiracy has some psychologically real status. This is a moot issue, as is the question whether appropriate OT constraints can be generalised to cover all the 'tendencies' postulated in APh.[5] Kiparsky (1972, 1973) and more recently Hale and Reiss (2008: 14; Reiss, 2008: 288; cf. also Vaux, 2008) have argued that there is no need to capture conspiracies as they are epiphenomena of the tendency of languages to have 'transparent' rules (i.e. rules that are surface-true), itself the result of considerations of learnability. If this claim is correct it implies that conspiracies have no psychological reality, hence no causal powers that go beyond the easy learnability of transparent rules.

5 In APh I wrote (p. 177) that "the acquisition of phonology is characterised by two 'infantile conspiracies', followed by a set of neutralisation rules". It is clear that this has to be interpreted as two *kinds* of conspiracy and, accordingly, OT would need to postulate more than two sets of conspiratorial constraints.

The issue can be further illustrated by a comparison of the development of some initial clusters by A and Z, specifically clusters of /s/ plus consonant. A's treatment of all /sC/ clusters was uniform, going through a stage /sC/ → [C] (deleting the /s/) whether C was sonorant or obstruent,[6] whereas Z treated /sC/ like his father where C was an obstruent, but deleted the consonant where it was sonorant: /sC$_{[+son]}$/ → [s]. First, note that although the simple statement *COMPLEX (postulated to deal with final clusters) generalises automatically to such cases, its interaction with other constraints is entirely independent, so the economy that the generalisation would effect is minimal or non-existent. That is, there is no correlation between the mastery of final nasal plus consonant clusters and initial /s/ plus consonant clusters. More generally, the notion 'cover' constraint seems to be spurious. Second, the difference between the learners means that what could be characterised by a simple single rule for A was the result of a conspiracy of two rules for Z. This is unexceptionable but it was also the case that different constraint re-rankings were necessary to accommodate the different longitudinal development of the two children. For instance, A's development involved the temporary demotion of the constraint banning voiceless sonorants (*[+son, −voice]); Z's involved interaction with the constraint banning velars. Whether the conspiracy effects any real economy in this situation is dubious, especially as A's development exemplified a problematic U-shaped curve[7] in which voiceless sonorants were disallowed, then licensed, then disallowed again. No such problem obtained in the rule-based alternative where this progression was explained as being the result of rule simplification – see APh (p. 157). In fairness it should perhaps be added that parametric accounts fare no better, being just as complex and stipulative as OT.

The problem of the status of conspiracies is more general. APh postulated four functional universals (or 'tendencies') which the realisation rules implemented. It is not obvious, however, that systemic simplification as characterised by a constraint banning fricatives and affricates, for instance, has any advantage over a rule (or rules) with the same role (see Vaux, 2008: 56f.). Further, APh (p. 177) suggested that only harmony and cluster reduction rules form conspiracies. If correct, this is problematic, as no such restriction falls out from the claims of OT. Moreover, it is clear that the fourth tendency – to effect grammatical simplification – is not 'conspiratorial' at all. The much-bruited ability of OT to capture conspiracies may not be an advantage after all.

6 Though there was one stage when voiceless sonorants [l̥, m̥, n̥] appeared.

7 See Menn (2004: 63ff.) for discussion of this problem.

A further point in favour of OT is supposedly its capturing of the parallelism between acquisition and typology. A central tenet of the theory is that all constraints are violable, all constraints are available in every language, and the same markedness constraints apply in both domains. As a result there is an explicit 'factorial typology' of languages: given n constraints, the theory predicts the existence of n! languages. To the extent that this prediction is borne out, so is the theory supported (or not, of course). Here there are conflicting considerations at work. On the negative side, a potential drawback is that the predictions are too unconstrained and could be described as "anything goes". Without more, and more principled, conditions on the expressive power of constraints, OT represents no advance over rule-based theories. On the positive side in contrast, one might be able to argue that a putative advantage of the OT position is that it inhibits the postulation of spurious typological categories. Traditional typologies refer, for instance, to 'tone' (versus intonational) languages, to 'click' languages and so on, but not to 'voicing' languages or 'aspiration' languages. These contrasts were not principled ones – that is, they followed from no theory – and OT's claim of factorial typology inhibits the linguist from postulating such unprincipled types. All these typological categories are equally arbitrary, as is highlighted by the interaction of the 'richness of the base' (ROTB) hypothesis and the details of the constraint ranking postulated for any particular language. ROTB is the claim that the set of inputs to the grammars of all languages is the same, so there can be no linguistically significant generalisations or differences in the lexicon, no morpheme structure conditions, no differences in the inventories of elements apparently exploited, and so on. These exclusions may themselves be too extreme, but it follows that OT makes no provision for the statement of spurious typologies such as 'click' languages, where the spuriousness of the unwanted type is probably a function of perceived exoticism. In no framework is it necessary to postulate such and such a typology, but the arbitrariness of the enterprise is appropriately highlighted in OT.

3.3.1 Learnability in OT

A further advantage of OT over traditional rule-based accounts, though not over parameter-setting ones, is that it has developed an explicit algorithmic theory of learnability. There are two components forming the cornerstones of learnability in OT: Robust Interpretive Parsing (RIP; Tesar and Smolensky, 1998) and the Constraint Demotion Algorithm (CDA), which interact to allow learning. CDA is closely related to Boersma's Gradual Learning Algorithm (GLA) (Boersma, 1997; Boersma and Hayes, 2001) except that the latter works on a continuous rather than a discrete scale. RIP enables a parser to use a grammar to assign

structure to forms that are not grammatical according to that grammar; CDA stipulates that constraints that are violated by some structural description must be demoted in the ranking. That is, information can be extracted from the *violation* of constraints in the optimal output. The learning algorithm compares the attested output to various suboptimal candidates. Constraints which are violated in the optimal output must come to be dominated by some other constraint.

In the original version of the theory the initial state had all constraints unranked, but Gnanadesikan (1995) proposed that in the child's initial state the markedness constraints outrank faithfulness constraints. For current illustrative purposes the choice between these alternatives is irrelevant. The difference between child and adult phonology lies in the relative rankings of constraints against markedness and constraints demanding faithfulness to the input. As acquisition progresses the appropriate markedness constraints are demoted. Demotion to a position immediately below the highest ranking constraint that gives rise to the violation results in a new ranking. Re-ranking is only allowed if there is positive evidence in the form of a constraint violation in the optimal output. For example, given an initial set of mutually unranked constraints $\{C_1, C_2, C_3, \ldots C_n\}$, then demoting C_2 below C_4 gives $\{C_1, C_3, C_4, \ldots C_n\} >> \{C_2\}$. If C_3 is then demoted below C_4 the result is the 'stratified hierarchy' $\{C_1, C_4 \ldots C_n\} >> \{C_2, C_3\}$. By hypothesis, all output forms of the target language reflect a single constraint hierarchy (Kager, 1999: 299). To illustrate, Kager (1999: 325ff.) discusses the three constraints for Dutch in (5a) specifying that coda consonants must be voiceless {*VOICED-CODA}, that the input and output versions of segments must not change their value for the feature [voice] {IDENT-IO(voice)}; and that intervocalic consonants are voiced {INTER-V-VOICE}:

5a. {*VOICED-CODA} >> {IDENT-IO(voice)} >> {INTER-V-VOICE}

How does the child learn this? The crucial data are the two pairs of singular–plural forms in (5b):

5b.				
	pet	/pet/	[pet]	'cap'
	petten	/petən/	[pe.tən]	'caps
	bed	/bed/	[bet]	'bed'
	bedden	/bedən/	[be.dən]	'beds'

Evidence for the ranking {*VOICED-CODA} > {IDENT-IO(voice)} comes from the singular form *bet* in the tableau in (6a); while evidence for

{IDENT-IO(voice)} > {INTER-V-VOICE} comes from the plural form *pe.tən* in the tableau in (6b):

6a.

Input: /bed/	*VOICED-CODA	IDENT-IO(voice)	INTER-V-VOICE
a. ☞ bet		*	
b. bed	*!		

6b.

Input: /pet-ən/	* VOICED-CODA	IDENT-IO(voice)	INTER-V-VOICE
a. ☞ pe.tən			*
b. pe.dən		*!	

But if the child assumes that the [d] in [be.dən] comes from /t/ by intervocalic voicing, then {IDENT-IO(voice)} must be demoted below {INTER-V-VOICE}, giving the incorrect fragment in (7):

7. {*VOICED-CODA}, {INTER-V-VOICE} >> {IDENT-IO(voice)}

This ranking fails for [pe.tən], predicting *[pe.dən] instead, as shown in tableau (6c):

6c.

Input: /pet-ən/	*VOICED-CODA	INTER-V-VOICE	IDENT-IO(voice)
a. ☞ pe.tən		*!	
b. ☹ pe.dən			*

Hence the correct grammar emerges from the (non-)existence of a voicing alternation in the pairs in (5b).

This algorithm works satisfactorily, even elegantly. There is, however, a problem: the task of learning the lexical representation of individual items is taken to be solved: "The algorithm assumes that the *input* is *given*" (Kager, 1999: 298; cf. McCarthy, 2002: 202, who assumes that "the input and output are already known to the learner"). This means that the task the child is taken to face can be specified in the form of the question: "given the availability of a set of surface forms of the target language, and a set of universal constraints, is it possible for the language learner to discover the correct constraint ranking of the target language?" Kager (1999: 297). The constraints are universal, so there is no real problem there, but the question of how the child got the 'set of

surface forms' remains unanswered. The tension arises because the availability of the set of surface forms presupposes that the child has already solved some (perhaps many) aspects of the constraint ranking problem. At the very least he must have determined the set of elements that constitute the inventory[8] of phonemes (or other units) used in lexical entries, and the permitted combinations of such units where these (as indicated on p. 14 above in the discussion of /sp/ versus /ps/ clusters) differ from language to language. For instance, if a child is learning a language like English which has voiced codas, then knowing the lexical representations of appropriate English words should ensure that {*VOICED-CODA} is not ranked as highly as in Dutch, but that fact presumably has to be learnt. The problem is supposedly obviated by ROTB and even in the absence of this assumption can be mitigated in part by 'lexicon optimisation' (cf. e.g. McCarthy, 2002: 77), which favours harmonic over dis-harmonic relations, and by the general requirement that whereas underlying forms may be restructured over time, constraint rankings cannot be changed. None the less, as these assumptions are themselves not unproblematic, the learning algorithm for OT is not an unmixed blessing as it leaves a crucial component of the learning task unaddressed.

3.3.2 Opacity and the perception–production asymmetry

A further general problem for OT is opacity: that is, where forms appear on the surface which look as if they should have undergone a rule but didn't, or which did undergo the rule but look as if they have not (for discussion, see Dinnsen, 2008). Such cases are typically handled by (extrinsic) rule ordering in a rule-based system, but are less tractable in systems that eschew ordering statements or, like OT, have no rules. A classic example is provided by 'puzzles' (see p. 21 above), where the facts are accounted for by making the rule velarising /d/ to [g] precede, and hence 'bleed', the rule converting /z/ to [d], but no comparable account is possible in OT. There are various suggestions for dealing with the problem: for instance, it is soluble within 'Serial OT' using constraint conjunction[9] (McCarthy, 2002: 166f.), but the best-known treatment of such 'chain shifts' is Smolensky's (1996) resolution of the perception–production asymmetry in child phonology (for discussion, see Hale and Reiss, 2008 – esp. p. 67). Smolensky suggests that "what differs between 'production' and 'comprehension' is only *which structures compete*; structures that share the same

8 The situation is not materially improved by the fact that the inventory of segments has no status in OT but emerges as an epiphenomenon of the induced ranking.

9 Itself an undesirable increase in the expressive power of the theory.

underlying form in the former case, structures that share the same surface form in the latter case" (Smolensky, 1996: 722–3; cf. McCarthy, 2002: 215).

Smolensky illustrates the essence of his proposal on the basis of an example where a child understands [kæt] (for *cat*) but produces [ta]. The production is accommodated by ranking NoCoda and *Dorsal above the faithfulness constraints PARSE and FILL, ensuring that all segments in the input are parsed and no new segments are inserted. The child's correct comprehension is accounted for because the only competing structures are those which are pronounced [kæt] (/kæt/ itself, a misparsing of /skæti/, etc., but importantly not [ta]). All the putative inputs violate NoCoda and *Dorsal, but [kæt] from /kæt/ wins over [kæt] from (e.g.) /skæti/ because the latter violates (lower-ranked) faithfulness constraints.

As Iggy Roca (p.c.) points out, Smolensky's argument has a serious flaw (quite independent of the competence implications that Hale and Reiss criticise). The core of Roca's criticism is that what is evaluated in OT is the pool of candidates output by GEN (the universal candidate generator), crucially *not* the primary input, which is usually taken to be the underlying representation. Smolensky's reversal for comprehension, taking the surface form as input, while ingenious, reveals a mistaken procedure. The surface form will be input to GEN, and not to EVAL, the function which uses the ranked constraints to evaluate output candidates and select the optimal candidate. The input to EVAL will again be the pool of candidates (the same candidates) output by GEN. The conclusion has to be that the proposal is unsuccessful.

A less arbitrary solution to the chain-shift problem is provided by Jesney's (2007) account of the *puzzle* puzzle in terms of perceptual faithfulness. She proposes a "Faithfulness to Input Prominence Hypothesis": child chain shifts are driven by specific faithfulness constraints which refer to *perceptually prominent* input feature combinations. Input feature values can be preferentially preserved in the output, leading to chain shifts, just when they are subject to these constraints. The suggestion is intriguing but accounts only for child chain shifts that can be perceptually motivated. In the current case, the coronality of strident segments is more perceptible than that of non-strident segments, hence *puzzle* retains a coronal [d]. It's not clear how the proposal fares for instance with an example from Z, who produced /ʃ/ as [s] but /s/ as [t], as in 'horse-shoe', [hɔːt suː], as /ʃ/ and /s/ are equally salient perceptually[10] and adult minimal pairs were indeed discriminated. The example is not decisive evidence against Jesney's claim because of the positional differences in Z's pronunciation of the

10 See e.g. Cooke and Scharenborg (2008), who report essentially identical auditory discriminability for intervocalic /s/and /ʃ/.

adult fricatives: /ʃ/ was produced as [s] everywhere, thereby neutralising the /s~ʃ/ contrast initially, whereas /s/ was correctly produced as [s] initially but as [t] finally. None the less, it seems unlikely that her hypothesis will cover all the relevant cases.

There are other putative advantages to a constraint-based framework. Kingston (2007) suggests that OT has the advantage of allowing the intermingling of phonological and phonetic constraints, finessing the problem of drawing any kind of demarcation between them. As explained earlier, in APh there were two types of rule mapping the child's lexical representations to his pronunciation: realisation rules and phonetic detail rules. The former, for instance, neutralised the voicing contrast (cf. (13d) in ch. 2), the latter then spelt out the fine detail of the child's pronunciation of the neutralised segments (initial voiceless lenis, medial voiced, final voiceless). This is both uneconomical (and sometimes involves a 'Duke of York' derivation[11] (Pullum, 1976; cf. also Dinnsen *et al*., 2001)) and inconsistent with the claim that the child does not have his own system. That is, the boundary between the output of the realisation rules and the input to the phonetic detail rules implicitly postulates a level of representation, and it's not obvious that such a level has any status at all. The advantage of OT would then be that all the facts could be captured by constraints of an undifferentiated kind: essentially they could be restricted to the 'allophonic' ones. If the mapping from the adult form to the child's output has the processes (reinterpreted as constraints) as in the tableaux in (8) below it is unnecessary also to have any statement neutralising the voicing distinction.[12]

8a.

Input: /bʌmp/	*Onset/voiced	*Onset/fortis	Faith
bʌp	*!		
pʌp		*!	
☞ b̥ʌp			*

Accounting for the initial consonant being voiceless lenis

11 That is, a derivation in which some entity A is changed by a rule into some other entity B, only to be changed back by another rule into A again.

12 It is worth noting that OT typically presupposes that it is appropriate to talk of child speech displaying fewer contrasts than adult speech. A typical example is Stemberger and Bernhardt (1999: 418).

8b.

Input: /teɪbl̩/	*Medial/lenis	*Medial/voiceless	Faith
☞ b̥e:bu			**
b̥e:b̥u	*!		***
b̥e:pu		*!	***

Accounting for the medial consonant being voiced

8c.

Input: /bʌmp/	*Coda/voiced	*Coda/lenis	Faith
bʌb	*!		
bʌb̥		*!	
☞ bʌp			*

Accounting for the final consonant being voiceless

Two questions immediately arise: is this simplification appropriate and, assuming that it is, can it be captured equally easily in a rule-based framework? The answer to both seems to be positive. Although the suggestion may have originated with OT it can be equally well implemented in a rule-based system.

This discussion should have made two points clear. The first is that the child's production is as it is because of articulatory and perceptual ease, and failure to acknowledge this explicitly is a reflection of the "regrettable gap between phonology and phonetics" (Hayes, 1999: 246).[13] The second is that postulating a level of representation for the child's system – an intervening stage represented here in pipes, e.g. |gɔp| – is pernicious for the same reason that the phonemic representations of American Structuralism were shown by Halle (on the basis of Russian voicing assimilation) to be pernicious in inhibiting the statement of generalisations (Halle, 1959; cf. Smith, N.V. and Wilson, 1979: 139–40).

The implication of these points is perhaps more radical, as Hale and Reiss (2008) repeatedly emphasise. Most of the rules or contraints of child phonology are motivated by performance considerations rather than competence ones. If OT is committed to a competence account of acquisition in virtue of its use of constraint (re-)ranking, then a more radical rejection of the theory may be called

13 Hayes cites (1999: 267) the example of A's voicing of stops as an example of distribution maximising ease of articulation. He also suggests that the gap between phonetics and phonology is bridged by the 'grammar design' of language learners (ibid.: 247).

for, assuming that not all theories are equally so committed. I return to the issue in the discussion of what levels of representation it is necessary to impute to the child; in the interim, suffice it to say that the rules of rule-based theories may in principle have various different kinds of status – competence, incompetence, malperformance, and so on.

As hinted above, a disadvantage (as perceived by some researchers) of both parameter-setting and constraint-based models is the extent to which they presuppose a rich innate base, with the associated appeal to poverty-of-the-stimulus arguments (see especially Blevins, 2004: 219ff.). The alternative is one or another form of 'conservative' data-driven learning, for instance Culicover's (1999) "conservative attentive learner", which makes minimal appeal to any linguistically specific innate ability (cf. Snyder, 2007, and, for critical discussion, Thornton, 2008). This is an obvious signpost to a discussion of so-called usage-based models.

3.4 Usage-based and connectionist models

Being usage-based and being connectionist are conceptually independent but I treat them together for two reasons. First, they typically co-occur in the literature: Tomasello, for instance, in his 'usage-based' theory writes that "the best-known theoretical alternative to generative grammar is of course connectionism" (2003: 324). Second, both accounts start from a desire to eschew the kind of nativist assumptions characteristic of the generative enterprise and lay particular emphasis on the learner's exploitation of frequency effects in the input (cf. the discussion of the statistical basis of the work of Saffran and her colleagues above). Moreover, this statistical underpinning allows connectionist networks to operate in such a way that activation spreads through the lexicon causing phonologically similar words to be treated similarly – thereby replicating some of the properties of a rule-based framework.

There are domains such as vocabulary where frequency effects are important. Both A's and Z's vocabulary was impressive: at the age of 4 Z was using e.g. *obsessed*; *exhibition* and similar words appropriately (even if the latter sometimes appeared as *expedition* instead). It is clear that many of these usages were simply imitations of his parents' (frequent) observation that, for instance, "Joshua is obsessed with grapes." In general, rote memorisation forms a useful base for internalising and consolidating particular patterns, and the greater the frequency of such patterns the more likely they are to be established. There is then an (undenied) element of truth to usage-based approaches. However, I have previously expressed some scepticism about the coherence of Tomasello's (2000a, b) usage-based position on the acquisition of syntax (see Smith, N.V.,

2005: 87–8), and I think it faces equally intractable problems when it is extended to the acquisition of phonology.

The core claim of usage-based approaches is encapsulated in Bybee's (2000) observation that "Language use can … explain some well-known properties of phonological patterns" (p. 250) or that "[t]he act of using a word, either in production or perception, has an effect on the stored representation of the word" (p. 251; cf. Stemberger and Bernhardt, 1999: 435f.). It follows that the frequency with which forms appear should have an identifiable effect on their (phonological) properties. Moreover, in reflecting the frequency of the linguistic forms the child hears and produces, usage-based theories have the advantage of modelling gradient and highly variable phenomena. (For further discussion see Bybee, 1999, 2001; Zamuner *et al*., 2005.)

Usage-based approaches are not monolithic, so criticisms of one may not generalise to all, but it is not unfair as a first approximation to treat them on a par. I will briefly mention three problems, beginning with lexical representation. For Bybee (2001) words are stored in full phonetic detail with no abstract underlying form. To the extent that children can identify adult pronunciations that they cannot produce, and do this with adults they have never heard before, this seems problematic. The claim is even unparsimonious with regard to their own production. Every utterance is phonetically different, so there must be *some* generalisation over phonetic categories, but, in the absence of an underlying form, defining the boundaries of such generalisation risks being arbitrary. Assuming that this problem can be solved, there remains that of justifying the claim that the phonetic detail is 'stored' rather than that it emerges piecemeal from a unitary representation. If at some stage a child (e.g. Z in session 46) pronounces *Grandpa* as any of ['tæmbaː/ 'tʰæmbaː/ 'dæmbaː/ 'tæmpaː/ 'tæmpʰaː/ 'tʰæmbaː/ tæm'paː/ dæm'paː] and also shows comparable variability in the pronunciation of other items containing plosives (including new words), it is implausible to postulate that he has eight (or more) forms stored in his mental lexicon. There were early precursors of Bybee's position, such as Ferguson and Farwell (1975: 429), who suggested that variability of the kind cited made it difficult to postulate unique underlying forms for the child. Significantly, they provided no discussion of the child's perceptual abilities – for instance, his ability to discriminate relevant minimal pairs. Some forms may be stored with full phonetic detail, but it seems that usage-based theories are antithetical to capturing whatever generalisations do exist.

A second area of difficulty comes from the existence of (in)correct children's forms whose appearance fails to correlate with frequency, especially where there is the further complication of U-shaped learning. For instance, at stage 5, Z pronounced /f, v/ as alveolar plosives ([t] or [d]) postvocalically, so that *heavy*

appeared as ['hɛdiː], *over* as ['əudə], *roof* as [ruːt], *brief-case* as ['biːtteit], etc. A few items, notably *hoover*, never showed this replacement so there occurred examples such as: [nɔt ɛviːbɔdiː əudə huːvə] – "knock everybody over (with the) hoover" where /v/ was replaced by [d] and maintained as [v] in the same utterance. If high-frequency words, on the one hand, and non-words with high phonotactic probability, on the other hand, are produced more accurately than low-frequency words or non-words with low phonotactic probability respectively (as suggested by e.g. Gierut *et al*., 1999; Zamuner *et al*., 2005), this would suggest that the correct pronunciation of *hoover* and *everybody* was the result of frequency effects. But it seems unlikely that *over*, previously pronounced as the less surprising ['əuwə], had significantly lower token frequency than the other items. Moreover, it is not obvious that usage-based theories have anything to say about the U-shaped learning curve illustrated here: it cannot be attributed to frequency in the input, and how the child's own pronunciation should affect the form is obscure.

Such difficulties for usage-based theories are reminiscent of those of the third kind: those they face when accounting for second language acquisition. Brown (2000) suggests that there are serious problems for an emergentist (usage-based) analysis of second language acquisition because of the differential success of speakers of Chinese (Mandarin), Japanese and Korean in mastering the different English contrasts [f/v, s/θ, l/r], none of which occurs in any of their first languages. All groups coped successfully with the [f/v] contrast, no group mastered the [s/θ] contrast, and only the Chinese (but not the Japanese and Koreans) mastered the [l/r] conrast. Brown's explanation for this asymmetry was based on the assumption that UG provides learners with a set of specific phonological features but that, after a critical period, the infant's ability to exploit those features disappears. The relevant feature combinations for the [l/r] contrast, for instance, occur in Mandarin but not in the other languages. Crucially, frequency of exposure seems to be irrelevant (for discussion, see Hawkins, 2008).

Despite these criticisms, I think that usage-based accounts have advantages which can be usefully adopted by other theories. MacWhinney (1999) proposes a sophisticated artificial neural network[14] of a kind I shall appeal to later, with eight specific design features[15] (pp. 111–12), and which is compatible with

14 Cf. also Bybee's (2001: 64) reference to "a set of neuromotor production schemas".

15 These are that the network consists of *units* (neurons), which are *connected* by unidirectional pathways. The neurons may be of *three* types: input, output or 'hidden', and each connection is *weighted*, so that a *net input* can be defined. Each unit has an *activation level* between 0 and 1, subject to stipulated *thresholds and biases*. Crucially, a *learning rule* is defined to ensure that a given input produces the correct output.

rule-based approaches. I differ from him in two respects: first, I wish to exploit such networks only for production and not for perceptual representations;[16] second, his framework is a 'self-organizing feature map' (cf. Kohonen, 1982), but the self-organisation cannot be total and there must be some antecedent structure ('seeds' in Kohonen's, 1982: 62, sense) in the system if we wish to account for the uniformity found across different children. It may well be that the advantages that accrue to the use of such networks is not peculiar to usage-based theories (cf. the remarks about non-linear dynamics in section 3.5), but their introduction and exploitation should be given due credit.

3.5 Interim conclusions

Each of the theories discussed has putative advantages: rule-based theories are explicit and descriptively rich, but are too powerful to be interesting unless further constrained; a major advantage is their ability to handle 'puzzles' and other push-chain phenomena. Parameter-setting models are a first attempt seriously to address Plato's problem, but suffer from the same descriptive overkill as the rule-based theories they developed from. Constraint-based theories are similarly explicit and have the advantage of being able to characterise conspiracies (even if the virtue of this ability is moot) and (again like parameter-setting models) have an associated learning-theoretic algorithm; their major defects are the failure to deal adequately with opacity phenomena and the problem of how children acquire their lexical representations. Both kinds of theory make radical appeal to the innateness of the constructs exploited. This is in contrast with usage-based models that make such appeal minimal and also have the advantage of making explicit predictions about frequency effects both in the input and in production. Their main disadvantage is that the predictions seem often not to be borne out, and eschewing innateness claims may be ill-advised.

Reviewing the claims in APh in the light of these theoretical innovations suggests the need for reinterpretation at a foundational level. A major change from APh is the reorientation of the explanation of the data of productive child phonology to performance considerations rather than competence considerations, and the associated abandonment of the claim of psychological reality for the realisation rules. There I talked about "the structural pressure" of the realisation rules (p. 149) and claimed that "only the realisation rules have

16 Such a network could be used for the implementation of perceptual representation but not as a replacement for symbolic structures. For production, if there is no psychological reality to the output, symbolic status of the forms is unnecessary.

real validity" (p. 205). They are valid in the sense that they derive the correct output, "whether they do so remotely in the way the child's brain effects the relationship or not" (APh pp. 137–8). That is, the validity may be not psychological but architectural, and the realisation rules can be reinterpreted as a set of constraints characterising a neural network which is causally efficacious without being cognitively represented. Once one gets to the stage where knowledge of language is neurally implemented, it is probably the case that everything is done by a neural network. The distinction I am drawing between a representational system and a neural network consists in the difference between symbolic and sub-symbolic systems, which are accessible (in principle) to conscious awareness and are sub-doxastic respectively. More tangibly (as discussed in the account below of Z's metalinguistic abilities), symbolic representations may serve as the input to further phonological processes, whereas 'neural' constructs may not. Crucially, the system allows for generalisations of both a symbolic and a sub-symbolic kind: it is *not* reductionist.[17] The remarks about 'competence' in APh (e.g. p. 148f.) are based on too simplistic a notion of 'articulatory ability' (ibid. p. 154). Hale and Reiss's (2008) performance-oriented analysis undercuts the need to postulate psychological reality for the realisation rules. The use of distinctive features in the realisation rules is also compatible with their position, as the same set of features can be appealed to in either rules or networks. The reason there are so many realisation rules (see Gnanadesikan, 2004: 101; cf. APh 162) is presumably because they are the result of various different performance strategies to solve the production problem. Crucially, this reinterpretation means that Gnanadesikan's objection that the child has "formulated a large number of rules for which he has never received any evidence" is defanged: there are no such rules.

There are, of course, outstanding issues. If there are no output representations, what drives development? That is, what makes the neural network or its equivalent change? Does instantiation in a neural network make the same predictions about being 'rule-governed' as a rule-based system does? Is the trajectory of articulatory development the same in systems using realisation rules and networks? A final issue is whether a neural network has any coherent counterpart to the kind of rule simplification discussed in APh (e.g. p. 155) or

17 It is possible to differentiate symbolic from sub-symbolic semantic representations on the criteria of semantic evaluability and compositionality. There seems to be no phonetic correlate of the former, but metalinguistic manipulation seems to presuppose something akin to the latter.

can replicate the effects of rule ordering. In neither case am I competent to judge though I suspect that the answer is yes in both cases.

Answers to all these questions may come from the kind of work done by Gafos and his colleagues (e.g. Gafos and Benus, 2006) exploiting the mathematics of non-linear dynamics. In this work, they develop a system linking discrete symbolic representations with the experimentally observed continuously variable constructs of pronunciation. It is not clear whether they are committed to an output representation of the kind I wish to avoid. Whatever the answer to that question, it is now time to turn to Z.

4 *Z and his development*

4.1 Family background

Zachary Voyne Smith, usually known as 'Zachary' or 'Zak' ('Z' hereinafter), was born on 30 August 2001 in London, England, and lives in St Albans, Hertfordshire. His father, Amahl Smith, was the subject of APh, and is finance director of a grant-making charity. Except for two years in the USA he has lived and worked in Southern England and his speech approximates reasonably closely to RP. Z's mother, Anne Smith (née Bradley), was born and brought up in Ilkley, Yorkshire, and is chief executive of a small medical charity. Her speech is characteristic of educated Northern Britain: her accent is essentially similar to RP except for the use of [æ] for RP /ɑː/ (cf. Wells, 1990: xii). There are also some intonational and lexical differences, but these are not relevant to the present study. Both parents work part-time so that they can devote appreciable time to their children.

Z has one sibling, a younger brother Joshua, also known as 'Josh', who was born on 7 April 2004 when Z was 2 years 8 months old.

Apart from the family there has been social, including linguistic, input to Z from friends, from the local community playgroup (from age 2 years 6 months), and from nursery school (from age 3 years 5 months). No specific effects of this input are noticeable in Z's speech.

4.2 Data and their collection

Data were collected in much the same fashion as in APh: regular note-taking in phonetic transcription during interaction with the child from the age of 7 months, when babbling began, to 4 years, by which time the adult segmental system was essentially in place. There were 154 such sessions which have been divided for the sake of analysis into 13 'stages'. Details of the date of each session are provided on p. 128. Frequent tape-recordings were also made and used to corroborate the details of particular pronunciations. In general these recordings were not as useful as might have been hoped: Z's early phonology

was rather opaque and often only the help of the immediate context made it possible to identify what he was attempting to say.[1]

4.3 Analysis

For each 'stage' I have attempted to identify and formalise whatever regularities were apparent, estimate and justify the reason for his particular deviations from adult forms and norms, and discuss the reasons for any (lack of) systematicity. The formalisation is basically 'generative' but also uses quasi-phonemic representations and distinctive features where appropriate. I have provided frequent anecdotal examples of his speech and language as these provide an intuitive feel for the stage of development the child has reached. Detailed exemplification is provided in the diachronic lexicon (see ch. 6, section 6.3).

Z, who is right-handed, passed all the normal cognitive (smiling, reaching, exploring, finding hidden objects) and motor (sitting, standing, walking) milestones age-appropriately. He was fascinated before 1 year of age with ticking clocks, people singing, any unusual sound, and with modifications of his own 'speech' caused by talking into tubes. It follows that his hearing is good and he was clearly monitoring his own output. Standard linguistic milestones (the onset of babbling, appearance of first words and gestures, the first two-word utterances) all appeared within normal limits. However, his developing phonology was unusually limited, opaque and immature. The most striking manifestation of this was that about 50 per cent of his output was still inscrutable at age 3 years. This contrasts with expected 80 per cent intelligibility (Gibbon, 2007: 245) and borders on the pathological. The details will become apparent in the analysis below, but his lack of intelligibility was largely due to massive neutralisation caused in part by the complete absence from his production of any velars (/k, g, ŋ/) until age 3 years 4 months (cf. Stoel-Gammon, 1996), and by some unusual idiosyncratic pronunciations such as [həmp] for *help*. But he has ended up 'normal' and very verbal.

4.4 Stages of development

Stage 0: Babbling, up to first words. Age 6½–13½ months.

The first systematic and identifiable babbling was recorded on 16.3.02 (6½ months) though parental report indicates that babbling had started one or two days previously, and squealing and cooing had been observed for some weeks before this. The babbling was usually of the form: (V)CVCV, where V was

1 Z was 'mushy' in Menn's (2004: 62) sense.

[a], but occasionally [e] or [i]; and C included: labials, labio-velars, dentals, one or two velars, a variety of (inconsistent) combinations – both coarticulated and sequential; but especially labio-dental frictionless continuants. Similar babbling continued intermittently, with an increase in the incidence of alveolars and bilabials to 7 months. The first laterals in babbling, [lala], and more bilabial nasals, [mama], occurred around 7–7½ months. At 10½ months his babbling was somewhat clearer and more consistently disyllabic; with more alveolars (especially [n, t, d]) to add to his previous, maintained, repertoire. By 10¾ months his babbling included frequent nasally released velar plosives, as well as [edzedze], [nana], etc. There was some use of various different articulations and phonation types (ingressive and egressive) to differentiate hunger, the desire to be picked up, to go somewhere, to indicate pain or the desire for X, but it was too unsystematic to make interpretation reliable. By 11 months his babbling showed considerable reduplication [mama, nana, tata, dada, edz'edz'e] with occasional trisyllabic [mamama] and frequent quadrisyllabic [dadadada] examples. He was now beginning occasionally to show alteration in the place of articulation: [manana], and sporadic labio-dental nasals [ɱaɱa] and frictionless continuants [ʋaʋa]. There was some vowel variation: [nɛnɛ], and even the odd diphthong, [ao, ʔaom, ʔɛu] etc. Final [m] tended to be unreleased, and the attack was very strong, and clearly glottal. He still had many nasally exploded velar plosives. Prosodically he mainly had trochees, with the first syllable usually stressed and higher pitched, giving a down-stepped sequence [mámamà]. He also had a lot of whispered bilabial percussives, occasional alveolar whispered clicks, etc. There was a great deal of practice of laryngeal control – sounding as though he was straining – and perhaps non-pulmonic (egressive and, rarely, ingressive) air-stream mechanisms, with an occasional pharyngeal component, and with the sound modulated by different lip configurations.

His understanding and early production of lexical items of the language overlapped with his babbling. By 7 months he gave clear evidence of identifying the referent of *Grandma*, *Grandpa*, *Zachary*, *Daddy*, and *Horace* (the grandfather clock). He was generally very responsive, and was consistently amused and pleased at being addressed as 'Zachary Voyne Smith', or at my starting to sing 'The Grand Old Duke of York'. By 10½ months he obviously understood a variety of words:[2] *teddy bear*, *piano*, *Horace*, *give* …, as well as

2 But cf. Hurford's (2003: 51) observation: "it is highly probable that the transcriber imposes decisions informed by his own knowledge, and thus the true raw material which a child processes is not represented". The same remark is relevant when considering the analyst's interpretation of the child's output. See also the discussion in Hale and Reiss 2008: 59 (fn.2) on the status of [x].

kin terms, and gestures. For instance, when asked – without my looking at it or indicating where it was – "*Where is your teddy bear?*", he immediately looked round for it, went to fetch it and handed it to me, and continued by playing 'give and take'. There may also have been an incipient deictic [de]. It was at this period that he showed most marked fascination with the sound of my watch held against his ear, the grandfather clock, and especially the variation in his voice provided by phonating into tubes, bottle lids, and so on: anything that distorted the normal sound. He was very sensitive to sound variation of any kind, and was particularly pleased if I imitated his babble and made funny noises (lip trills, clicks, etc.)

By 13–13½ months he was using [bah] for 'bye-bye' fairly consistently, while babbling continued with many nasals [m, n, ŋ] and the occasional nasally exploded velar. Based on his ability to retrieve, identify and play with them, he clearly understood a large number of words, (*penguin*, *teddy*, *alligator*, *globe*, *telephone*, etc.). His hand–eye coordination, e.g. putting a key in a lock or (obsessively) putting a cassette in a tape-recorder, was becoming excellent. By the beginning of stage 1 [baba] or [bæbæ] were consistently used for 'bye-bye' and also for the disappearance of anything and everything. He also used [wowo] consistently for 'dog'. His pronunciation of this word was usually whispered or sotto voce, and the [w] was strongly rounded, but the intention was unambiguous. His real phonology was beginning.

> Stage 1: Sessions 1–10. Age 14½–22 months. Up to but excluding his first two-word utterance. In fact, session 1 consisted of some 5 mini-sessions, session 2 of 2 mini-sessions. The longest gap between mini-sessions was approximately one month.

At 15 months his productive language was still minimal, but his ability to communicate was impressive, as suggested by the following episode. He *loved* the *Times Atlas* (it is huge). One day, he pointed to a door and, when I didn't respond, took my finger, pulled me out of the armchair, led me through the next room, into a second room, pointed at the door to a third room – which I opened – and then pointed up at the *Times Atlas* on a high shelf. When I deliberately didn't do anything, he turned round, sat down and patted the floor, so that I got the book down and opened it for him. When I put it away, saying "bye-bye book", he repeated [ba ba bu]. He did this a couple of times and, perhaps, [bu] occurred once or twice in isolation for *book*.

By 16 months he consistently used [da] (low rise fall) for 'dangerous', and ['hoː 'hoː] for 'huge'. [da] or [dæː] (slow rise fall, with worried look and voice quality) were frequent over the following weeks and appeared to mean

'potentially hurtful'. 'Bye-bye' ['bæ 'bæ] was common and appropriate. It may have been in minimal contrast with [baba] for 'Grandpa', though this may just have been wishful thinking. He used a general egressive air-stream mechanism (breathy voice) for 'hot'.

By 17 months he was using [məː] for 'more' (in requests for 'more milk', 'more cherries', etc.). At the same time babbling continued with a wider range of sounds, including voiceless fricatives ([s]), and he appeared to be experimenting with a variety of intonational contours.

By session 2 (18½ months) his use of gestures had become quite complex. In a situation where he knew he was not allowed to do something (e.g. hold a knife), he would point to himself, shake his head, then point to (e.g.) me and nod his head with enthusiastic (but opaque) vocalisation, conveying reasonably unambiguously the message: "I'm not allowed to do this, but you are." His understanding of adult lexical items was likewise good: helping me make a cake in the kitchen, he unerringly fetched from the correct place (when requested to): butter (from the fridge in the next room); sugar (from the cupboard in the next room); the essence (from the correct drawer in the kitchen); a spatula (from a different drawer in the same chest); the flour (from a different cupboard in the kitchen); the eggs (from a different fridge); dried fruit (from a different cupboard). He also correctly anticipated my need for sundry items such as an oven glove and the mixer. This last was indicated with an appropriate imitative sound (prolonged voiced bilabial fricative) and associated hand movements – both hands pointing in and down at an angle, simulating the movement of the twin beaters in his toy mixer: that is, he used his gesture, not an ad hoc imitation of my mixer. There was no obvious attempt at this stage to integrate the signs into 'sentences', but his parents reported the combination of the sign for 'mixer' and the word for 'bread' – [d̥oː].

His vocabulary was too small and the system too limited to make it worthwhile formulating a set of rules or constraints, but the diachronic lexicon provides plenty of data. It may well be that "an incipient phonological system can be identified within the single word period, and that it can be seen to emerge out of phonetic structure" (Vihman and Velleman, 2000a: 305) but the detail required for explicit and exhaustive rules is still inadequate. As Stoel-Gammon and Sosa (2007: 247) put it, "an attempt to use a set of realization rules to describe the productions of a younger child in the very earliest stages of language acquisition would not be an easy task". However, it does make sense to attempt the beginnings of a phonological analysis in terms of the syllable structures he used and the inventory of segments that were under reasonably systematic (productive) control. If I am right about the child not having his own system (see above), and if Hale and Reiss (2008) are right in

their reanalysis of the subset principle ("interpreted as a requirement of maximal specificity in initial representations", p. 95) then it may well be that this inventory has no status. None the less it gives an intuitive feel for the child's developing performance and a useful base for reanalysis by those who disagree. That it should have *no* bearing on his competence is surprising and correspondingly important if true.

In sessions 1 and 2 his syllable structure was essentially limited to CV(CV) and the inventory of segments comprised the consonants: [b, d, m, h, w] and the vowels: [æ, ə, o, u, ɔː]. By sessions 3 and 4 he had added [s, n] and [i] and there were one or two instances of CVC. By session 5 (20½ months) he had added [au] and shown some phonetic variation (e.g. [θ] in 'scissors'), but otherwise his segmental phonology was much the same. The major change was in the complexity of the intonation contours over babbled strings and (probably) the range of variation in the babbled vowels. It felt very much as if he was practising his intonation. A clear example of such practice occurred just after the end of the first stage when, at 22½ months, he had a long night-time soliloquy, apparently practising: [dæː] (low to high, many times); [dædædædæ] (low–high–low–low); lots of babbled sequences, mainly variegated but some of them canonical, up to 7 or 8 syllables in length – e.g. [dænədæmə], [mæmæ], [həum], [henæ]. Patterns included: CV, VC, CVC, CVCV, VCV; intonational sequences of LH, LHLL, HLHLLL, and so on. The range of consonants excluded velars, but included frequent bilabials, alveolars and glottals.

Apart from this the later sessions of stage 1 were mainly characterised by an increase in phonetic variation (with such examples as [siz] for 'scissors' and [ʃɯʘ] for 'shears' (session 7); [huːʊə] for 'hoover'; the appearance of diphthongs (e.g. [heĩ] for 'honey', session 9), and so on. By the end of the stage the consonant 'system' comprised [b, d, m, n, s, h, w] and the vowel 'system' consisted of [i, æ, u, ə, ɔɪ, o, ei, au], though the contrastive status of [o/u] was moot and differences of length were inconsistent. I have put 'system' in scare quotes for two reasons: first, it was often not at all obvious whether two sounds were intended to be the same or different (allophonic or phonemic variation in traditional terms); second, one of the main conclusions of this study, as of APh, is that the child does not have his own system but merely converts the adult representations into something pronounceable but not 'represented'. I return to the issue in chapter 5.

> Stage 2: Sessions 11–17. Age 22 months up to his second birthday (30 August 2003).

Session 11 saw his first two-word utterance: [dəu həum] – *go home*. This was commentary on – or confirmation of – my observation that we had to go home; i.e.

it was not an order. First he said it on two intonation groups in quick succession: [dəu] + [həum], each on a slow rise fall; then he said it again [dəu həum] with a rise on [dəu] and a rise fall on [həum], sounding like a single utterance. A minute or two later he volunteered [dəu həum] followed by [brrm], where [brrm] (voiced bilabial plosive followed by a voiced bilabial trill) was his 'word' for car. In this case [dəu həum] was definitely a unit (low + rise fall) and [brrm] was on a low fall. There had for some time been examples where Z integrated gestures into his sentences (I take it that [brrm] was a kind of 'gesture'), and he had many manual ones, as documented at the end of the 'diachronic lexicon'.[3]

His phonological repertoire was largely unchanged from stage 1. Syllable structure was overwhelmingly CV, but CVC – where the coda consonant was [m] – occurred regularly in e.g. *home* ([həum]), *bang* ([bæm]), *Mum* ([məm]); and *Dad* occurred once as [dæd]. The inventory of consonantal segments which occurred sufficiently regularly to give rise to systematically identifiable words was: [b, d, m, n, l, h, w, (s)]. Of these, [s] occurred consistently only in *snake* ([sɪ]) and *scissors* ([sɨs]). [w] was rare initially, but occurred in e.g. *to wind* ([wæɪ]). The one new addition was [l] as in ['lælæ] (*teddy bear*).

The inventory of vocalic segments was much less easy to characterise, but included: [iɪ, i, e, a, aɪ, æ, æɪ, o, oɪ, ɔɪ, u, uɪ, ə, əɪ, əu, ei, eĭ, au]. Which of these were systematically contrastive was unclear – probably |i, iɪ, u, uɪ, ɔ, ɔɪ, æ, ə, əu, au|.[4] In addition, there were examples like [æ:] (on a long falling tone) for *cat*, and [wo:/φu:] for *dog*, that fell outside the system proper. That is, diphthongs were becoming established and a length/quality contrast seemed to be appearing even if it was not properly controlled.

The following sets of vowels ([ei/eĭ]; [iɪ/i]; [ɔɪ/oɪ]; [u/uɪ/ə]) probably encoded minimal contrasts, but the vocabulary was still too restricted to be confident. For instance, nasalisation was restricted to one example, [heĭ] 'honey', and the [e] in [hei] was slightly more open than that in [heĭ].

[hei]	- *helicopter, Helen;*	[heĭ]	- *honey*		
[iɪ^{n}]	- *in*	[d̥i]	- *dig*		
[mɔɪ]	- *more*	[moɪ]	- *mower*		
[b̥u]	- *book*	['huɪwə]	- *hoover*	[həum]	- *home*

3 Cf. Goldin-Meadow's (1999) observation that the use of gestures with words predates multi-word utterances.

4 The use of pipes to indicate elements of the child's system is problematic if, as is claimed, the child has no system of its own. For discussion, see chapter 5.

Stage 3: Sessions 18–31. Age 24–6 months.

This was the last stage when the data collected and analysed came from a period prior to that when I started the investigation of A. Even at the end of this stage Z himself was very hard to understand, but he was keen to communicate and throughout the stage gradually expanded his phonetic repertoire. He practised all sorts of sounds, including on an ingressive air-stream mechanism, and produced a plethora of sub-linguistic noises – [e, e, ẽ, ẽ, a, a, a …] and lateral clicks – apparently for fun. He still had long 'conversations', rehearsing what he had seen or been told; especially with juxtapositions of positive and negative for pairs of people doing different things. He also began to attempt to imitate individual words in a way he used not to, providing various sounds and sound sequences, but when he tried to pronounce *screwdriver* and *flapjack* the results were indecipherable. He also began using alternate pronunciations – either in play or in practice, as in: ['hʌniː] / [hʌ'niː] for *honey.*

He frequently produced utterances containing sequences of [ha] or [hã] with some consistent intonation patterns, and apparent dialogues with himself, but little penetrable content. More puzzlingly, for some months one of the most characteristic aspects of his speech was the use of [hæ] (often nasalised, and with some other phonetic variation) as a kind of dummy auxiliary (or just a filler syllable) as seen in the examples in (1), taken from some seventy recorded in this stage. The translations 'yes', 'have', etc. represent my attempt to provide an interpretation of his utterances. Fortunately the context usually made it clear roughly what was intended. The numbers in parentheses identify the session in which the utterance was recorded:

1.	[hæ̃ 'dædaː]	- yes, Grandpa {= Grandpa can do it} (19)
	[iːuː di hæ̃]	- big spade yes {said with a happy smile as he picked up my spade and started digging with it} (20)
	[biː hæ]	- build have {= "let's do some building", on picking up a building toy} (21)
	[nəu boː hæ]	- no ball has {= it doesn't have a ball in} (22)
	[dæ məmiː hæ̃]	It's Mummy and Daddy {pointing to the relevant picture} (23)
	[nəu hæ]	- No {response to "Did you bring your slippers?"} (24)
	[dædiː hɛ]	- Grandpa is {= You're called 'Grandpa'} (25)
	[dəu au hæ]	- go out {= let's go out} (26)
	[ræma ha]	- Grandma {response to "Can you say 'Grandma'?"} (26)
	[bo bijə buː hɛ]	- (they're) Bob the Builder boots {putting them on} (27)
	[bɛmiː hɛ]	- penguin hɛ {In reply to "Who made that noise?" – the penguin did} (28)

[æ niː hæ]	- I (want to be on your) knee (29)
[uː bo bijə ræma hæ]	- big Bob the Builder Grandma {= The big Bob the Builder toy came from Grandma} (30)
[in ə boʔ ha]	- in the box {reply to 'where's Tigger?'} (31)

More transparently, he now used [æ(ː)] for himself fairly consistently and began to display some metalinguistic (and arithmetic) ability, as exemplified in the dialogue in (2), prompted by my puzzlement at his using different onsets for *Grandma* (['ræma]) and *Grandpa* (['dæmbaː]):

2.

NS	Can you say *Grandpa*?	Z	– [nəu]
NS	Can you say 'no'?	Z	– [nəu nəu]
NS	Can you say 'no no'?	Z	– [nəu nəu nəu]
NS	Can you say 'no no no'?	Z	– [nəu nəu nəu nəu]
NS	Can you say 'no no no no'?	Z	– [nəu] (vehemently)

There are still inadequate data to write formal rules, but it is appropriate to give some indication of the general properties of his output. Syllable structure is still overwhelmingly CV(C), with a few examples of V and (C)VV. Only monosyllabic and disyllabic forms occurred. Disyllabic words – CVCV, CVCVC, CVCCVC, etc. were all stress initial with the single exception of *aeroplane* ([ɛ'bein]). Unstressed syllables were frequently omitted but not systematically. Of the approximately 44 adult disyllabic and polysyllabic words (types, not tokens) identifiably attempted, 33 were rendered as disyllables and only 11 lost one or more syllables. Of these, one (*screwdriver*) was produced as a disyllable (['duːdaː]) and four had disyllabic variants (e.g. *garden* was pronounced as both [daː] and ['daːhə]). Only one item (*away*) lost its initial syllable. Three adult monosyllables were perhaps realised as disyllables (*green*, *horse*, *huge*)[5] but the status of all these is vexed.

The inventory of consonants was largely unchanged from stage 2 [b, d, m, n, l, h, w, (s)] with the addition during the stage of [r, j, ʔ]. All of these occurred syllable initially and all except [b, r, ʔ] occurred medially. Coda consonants were restricted to [m] (e.g. [həum] – *home*), and [ʔ][6] (e.g. [b̥ɔʔ] – *pot*), except for one instance of [p] in [dip] (*drip*); and one instance of final [l] in [lælæl] 'teddy'. [j] occurred only intervocalically – so might be best treated as a transitional element, but there was a consistent contrast (probably one versus two syllables) between ['bijə] – *builder* (in *Bob the Builder*) and [diə] *dear* (in *Oh dear*).

5 The details of Z's pronunciation of these and subsequent examples can be found in the diachronic lexicon (see ch. 6, section 6.3).

6 There were also a few instances of [k̚] (an unreleased velar) in final position (e.g. [rɔk̚] – *rock*).

Velars never occurred in initial or medial position (cf. e.g. [dəu] for *go*, [dʌm] for *come*), and the unreleased final [k˺] which apeared sporadically was in free variation with [ʔ] or, more frequently, zero. [ʔ] was postvocalic only and usually derived from /t/, though in session 26 there were a couple of examples where final [ʔ] appeared for /g, k(s)/ (*pig*, *box*). [s] was marginal, occurring extra-systemically in imitations such as [sː] for *snake*. There was also sporadic use of [ç], mainly on imitation, with *sand* appearing as all of [çɛn], [sɛn], [hɛn] and [dʲɛ]. There were sporadic attempts at other consonants (e.g. [ç, dᶻ], but nothing consistent).

The inventory of vowels included [iː, i, e, a, aː, æ, æː, ɔ, oː, ɔː, u, uː, ə, əː, əu, ei, au, ə] but most of these were not under phonological control. At best, [i, iː, u, uː, ɔ, ɔː, æ, ə, əu, au, iə] were contrastive. There were also occasional examples of a nasal offglide, as in [dɛⁿ] for 'tent'.

> Stage 4: Sessions 32–40. Age 26–7 months: i.e. starting where I began with A – 2 years 60 days.

Z's general linguistic development can be gauged from the syntactic fact that the first subordinate clauses appeared at this stage.

The syllable structures used were: V, CV, CVC, VC, CVCV, CVCCV. The only consonant sequences that occurred consistently in examples of CVCCV were [-mb-] and [-nd-]. Despite the existence of CVC, about a third of adult CVC syllables were realised as CV. There were 158 words (types not tokens) ending in a consonant, of which 104 had a consonant in Z's production and 54 had no consonant. These figures probably underestimate the amount of deletion, as many of the words Z uttered were indecipherable, in part precisely because they lacked final consonants. Moreover, there were many examples where the same word appeared either with or without a final consonant (*back*, *down*, *hold*, *out*, *spoon*, *Zak*, etc.). In words containing a syllable of the form CVCC, the final consonant was often lost and the pre-final one retained (*band*, *leaves*, *round*, *want*) or vice versa (*hold*), or both were lost (*drink*); some disyllables of the adult form CVC. CVC showed up as CVC.CV (*flapjack*, *penguin*); and many words were produced with a final glottal stop, corresponding to any of a range of final adult consonants (*duck*, *glove*, *knot*, *want*, etc.). There seemed to be no articulatory or acoustic basis for determining which words lost coda consonants, as consonants of all places and manners of articulation were sometimes lost and sometimes preserved.

The inventory of consonants in Z's output was:

Syllable initial:	[b, d, m, n, w, l, r, j, f, s, z, h]
Syllable final:	[p, t, m, n, l, f, (z), ʔ] with the addition of [b, d, v, z] by the end of the stage. There were also one or two

> random occurrences of other phones: initially [ʃ, θ]; finally [v^{z}, k̚]. Final [v^{z}] may have been the first sign of (correct) plural formation. The major change for this stage was the systematic appearance of the fricatives [f, s, z]. For instance, *jigsaw* was [ˈd̥idɔː] at the beginning of the stage and later became [ˈdiʔsɔː]. It is important to emphasise that the presence of the pairs [p, b], [t, d], [s, z] does not imply that these were phonologically contrastive. Rather they were in allophonic or free variation as can be inferred from the rules below.

The inventory of vowels was: [iː, i, ə, u, uː, æ, ɛ, ɔ, oː, ʌ, aː, iə, ai, əu, au]. Again, not all of these were phonologically contrastive: most, in particular the pairs [æ/aː], [oː/uː], [ə/ʌ], [æ/ɛ], were hard to differentiate out of context. It has been plausibly suggested (e.g. Nazzi, 2005) that consonants are more crucial than vowels for the acquisition of lexical items (but cf. Mani and Plunkett, 2007). This perhaps justifies to some extent the concentration on consonantal phenomena in the rules formalised below.

At the same age, A had a simpler system |b, d, g, m, n, ŋ, w, l| with comparable allophonic variation, but he was generally easier to understand, partly because of the presence of velars, partly because his pronunciation was more consistent.

For Z, stress was usually initial, but one or two words were consistently iambic (e.g. [moˈmo] – *remote (control) for the garage door*; and, when exasperated, he called me [dæmˈbaː]). Intonation was largely appropriate. An example showing a contrast between mid rise and mid fall is provided by the pair of utterances from session 39: [dɔp rein, meibiː æ dəu aut hæ fʌn] – *stop rain, maybe I go out have fun* ("If it stops raining maybe I'll go out and have fun") and [dɔp rein, bei aut] – *stop rain, play out* ("It's stopped raining, let's play outside"). The first of these was his spontaneous remark on my observing that it was still raining and [dɔp rein] occurred on a mid rise; the second [dɔp rein] which occurred on a mid fall was part of his first utterance when he saw me the next morning.

Although Z still produced a high proportion of opaque examples, it is now feasible to begin formulating a set of explicit rules to characterise his output. The numbers on the rules below do not encode any ordering relation: as discussed below, extrinsic rule ordering can almost certainly be dispensed with; so they simply provide a convenient means of referring to diachronic development. I have

put deletion rules first (syllable deletion, then segment deletion), followed by neutralisation rules, followed by minor modifications.

At earlier stages up to a quarter of unstressed syllables had been omitted, and although syllable omission was still noticeable only a smaller proportion now disappeared. Of 73 disyllables (types not tokens), 63 remained disyllabic in Z's production and 10 were reduced to a monosyllable. Of these 63, 3 had an initial unstressed syllable (*away*, *idea*, *undone*); of the 10 reduced forms 3 (*away*, *today*, *without*) lost an initial syllable, and 7 a non-initial syllable (*garden*, *Grandpa*, *scissors*, *sitting*, *tickle*, *tortoise* and *zebra*). There was no obvious reason determining why some disyllables were preserved and others reduced. Of the preserved disyllables 27 ended in a schwa [ə], 16 ended in a short vowel followed by a consonant, 12 ended in [iː] and 8 in a long vowel. All of these possibilities also featured among the words which lost a syllable. Of 10 trisyllabic and quadrisyllabic items, 7 became disyllables (*another*, *apricot*, *banana*, *computer*, *harvester*, *screwdriver* and *Zachary*) and 3 (*aeroplane*, *helicopter* and *screwdriver*) retained their syllabic structure. Three of the seven lost an initial unstressed syllable (*another*, *banana*, *computer*).[7] Two trisyllabic items (*crocodile*, *elephant*) were reduced to a single syllable. These tendencies can be captured by the following rules.

R1. $\sigma \rightarrow \emptyset \; / \; [-\overline{\text{stress}}]$

Unstressed syllables are (selectively) deleted. This rule was lexically restricted to a subset of the items it could affect. Only the development at stage 6 (q.v.) indicates that it merits explicit formalisation.

R2. $[+\text{consonantal}] \rightarrow \emptyset \; / \; \_\_\_ \;]_{\sigma}$

Syllable-final consonants are deleted. As indicated above, this rule too was lexically restricted to a subset of the items it could affect. All consonants of the adult language that can appear in coda position (i.e. excluding /w, r, j, h/) and whose reflexes were in his repertoire both appeared and failed to appear in coda position in particular examples.

R3. $/s/ \rightarrow \emptyset \; / \; \_\_\_ \; C_{[-\text{sonorant}]}$

/s/ is omitted before non-sonorant consonants: *plaster*, *screwdriver*, *spanner*, *spider*, *spoon*, *stay*, etc. The restriction to non-sonorants became more obvious later but, at the current stage, is illustrated by *slowly* – ['səuliː] and *sleep* - [d̥iːp]. This rule is essentially exceptionless.

7 *Banana* was anomalous in preserving its initial consonant.

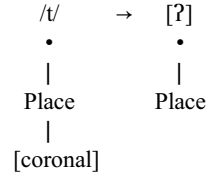
R4. $C_{[+sonorant]} \rightarrow \emptyset \ / \ C \_\_\_$

Post-consonantal sonorants (/w, r, l, j/) were omitted: *Grandpa*, *broom*, *clean*, *new*, *plate*, *tree*, *fly*, *bring*, *grass*, *black*, *zebra*. This rule too was essentially exceptionless with the possible exception of *throw*, which behaved intermittently differently from *three* and *through*.

R5. [−coronal, −anterior][8] → [+coronal, +anterior]

Velars are replaced by alveolars. Although some unreleased final velars appeared briefly (*Muck*, *pig*, *duck*), in general velars were replaced by coronals or a glottal stop (*go*, *going*, *echo*, *bring*, *key*, *wrong*; *bucket*, *box*, *lock*, *monkey*). As formalised, the rule fails to accommodate the glottal variant. This is attributed to a general process reducing structure (see de Lacy, 2006: 356 for discussion) of the kind seen in (3) below.[9] Some support for this suggestion comes from the fact that final /t/ also appeared either as [t] or as [ʔ] (*hot*, *shut*, *gate*, *bit*, *cot*, *hurt*), and sporadically, final /p/ likewise appeared as [ʔ] (*cup*). For further discussion see the account of R5 at the next stage, stage 5.

3.



Although there were examples of voiced and voiceless consonants in Z's output, the adult voicing contrast was neutralised so that e.g. *digger* and *Tigger* or *tree* and *key* were indistinguishable out of context. In conformity with the treatment of A, I have represented this as a rule making all segments voiced. Phonetically the distribution was typically for obstruent consonants to be voiced or voiceless lenis initially, fully voiced medially, and voiceless (fortis or lenis) finally.

R6. [+segment] → [+voiced]

All segments are phonologically voiced.

If there is no significant distinction between my earlier realisation rules and phonetic detail rules, it would be appropriate to map directly from the adult form to Z's pronunciation. This mapping would need to encode the fact that in initial

8 See fn. 7 to chapter 2 above; [±anterior] would now be a dependent of [coronal].

9 The status of this process is somewhat different from that of the other rules as it doesn't deal with elements of the target language.

position all of /t, d, k, g, dʒ/[10] surfaced as [d] or [d̥] and /p, b/ surfaced as [b] or [b̥]; medially (with one or two exceptions) the voiced equivalents [d, b] appeared, whilst finally all of [t, d̥, ʔ], [p, b̥, p̚, ʔ] and [k̚] appeared but, with one exception, the fully voiced [b, d] never occurred finally. The exception was *light* which appeared once as [leid] in the utterance [leid ɔn] – "(turn the) *light on*" where the effect of the following vowel is probably crucial. Similarly, unreleased [p̚], [k̚] appeared only for /p/ and /k/ respectively; and while zero showed up for all obstruents (presumably as a result of R2), [ʔ] appeared for all of /p, t, k, tʃ/ but never for /b, g, dʒ/. It occurred once for /d/ in *bread* ([bɛʔ] but I take this to be a performance error. That is, despite the massive neutralisation in output, which superficially might seem to militate against the claim that the child's representations were in terms of the adult system, it looks as if the influence of the adult lexicon is pervasive. A formalisation of these tendencies would be to replace R6 by R6a–c:

R6a. [+consonantal, −sonorant] → [+voice, ±spread][11] / # ___

R6b. [+consonantal] → [+voice] / V ___ V

R6c. [+consonantal, −sonorant] → [−voice, ±spread] / ___ #

Consonants are voiced lenis initially (R6a), fully voiced medially (R6b), and voiceless finally (R6c).

As is clear from the exemplification in the previous paragraph, there was further neutralisation of coronal contrasts in the adult language. At the beginning of the stage all coronal obstruents were neutralised as [t/d/d̥]. During the stage, Z's pronunciation developed such that the strident continuant coronals /s, z, ʃ/ neutralised to [s/z/z̥] (again with no contrast of voicing), cf. e.g. *sharp*, *shut*, *sit*, *see*; *zebra*, *Zak*,[12] and all the remaining non-sonorant coronals /t, d, tʃ, dʒ, θ, ð/ still surfaced as [t, d, d̥], as exemplified by *cheese*, *digger*, *jump*, *jigsaw*, *measure*, *watch*, *jeep*, *throw*. (See also the alternation with R9 below – *measure* becomes first ['meijə] then ['mædæ].)

The more general, earlier, form of the rule would be as in R7; the later form would be as in R7a–c, where the complexity arises because there is no obvious natural class to characterise the set {/t, d, tʃ, dʒ, θ, ð/}, hence R7b deals with /θ, ð/, and R7c with the remainder /t, d, tʃ, dʒ/:

10 /tʃ/ appeared only as [d̥] but I take this to be an accidental gap in the data.

11 For the feature [spread] see Hall (2007). [spread] is not obviously ideal for capturing the fortis/lenis contrast and should perhaps be replaced by [heightened subglottal pressure] as in APh.

12 The only example of /ʒ/ (in *(tape)-measure*) occurred as [d] (['mædæ]).

R7. [+coronal, −sonorant] → [−delayed release, −strident, −continuant][13]

Coronals are neutralised to [t/d].

R7a. [+coronal, +strident, +continuant] → [+anterior]

R7b. [+coronal, −sonorant, −strident, +continuant] → [−continuant]

R7c. [+coronal, −continuant] → [−delayed release]

/s, z, ʃ/ are neutralised to [s/z/z̪] (R7a); /θ, ð/ are realised as [t/d] (R7b), and /t, d, tʃ, dʒ/ are neutralised to [t, d, d̪] (R7c).

Even R7 (and its variants) does not exhaust the cases of neutralisation to [t/d/d̪] in Z's output. Although he had previously produced examples like *over* and *roof* roughly correctly (as ['əuwə] and [ruːf]), from session 37 he began to replace non-initial /f, v/ with [t/d], pronouncing these examples as ['əudə] and [ruːt]. The process was sporadic and never applied to some common examples like *hoover* but, as will be seen below, it extended to a much wider range of items during the next stage. Accordingly we have the lexically restricted process given in R8:

R8. [+anterior, −coronal, +continuant] → [+coronal, −continuant] / V ___

/f, v/ are realised as [t, d].

It is tempting to see R8 as a generalisation of the coronalisation of velars (R5) and the neutralisation of coronals (R7), but the rule seems too idiosyncratic for this to be plausible. For some discussion see stage 6 below when the rule had more general application.

There were a number of other processes that applied inconsistently or to ill-defined sub-parts of Z's lexicon. The most frequent of these are summarised in the following statements ('rule' is perhaps too strong a term).

Intervocalic consonants tend to be replaced by [j]. Examples include *Builder*, *mixer*, *digger*, *Pilchard*, *Tigger*, *pillow*, *hello*, *lorry*, *helicopter*. The replacement was not entirely consistent even for these examples (cf. e.g. *hello*), and there were just as many examples where the rule did not apply: *muddy*, *water*, *buggy*, *Daddy*, *measure*, *butter*, *plaster*, *lizard*, all of which surfaced with intervocalic /d/ or, with *digger* and *curtain*, with zero. There seemed to be a correlation between the quality of the vowel and the incidence of this rule: [j] occurred predominantly after [i, e] and not after [ʌ, ɔː, əː, aː], with only one or two problematic examples. This may indicate that the [j] was simply a transitional

13 Affricates would now be characterised by the association of two segments to a single unit on the timing tier (see Clements and Keyser, 1983; Roca and Johnson, 1999: 209). I keep the old feature [del(ayed) rel(ease)] for comparability with APh: cf. fn. 7 to chapter 2 above.

glide, a possibility reinforced by the fact that /j/ was not established for some time after this stage. The rule can be formulated as R9:

R9. [+consonantal] → [−consonantal, +sonorant, −nasal, −lateral, +coronal] / V ___ V

Medial consonants are realised as [j].

R7b above converts /ð/ to [d], but intervocalically /ð/ was frequently deleted (e.g. *other*), and throughout the study /ð/ was systematically deleted in initial position, where it marks functional categories (see ch. 1 above). This deletion is effected by R10, which, however, ignores both the initial/medial difference and the optionality of the process in medial position:

R10. [+coronal, −sonorant, +voice, −strident, +continuant] → Ø / ___ V

/ð/ was deleted prevocalically.

R8 above optionally converts /v/ to [d] but, if this strategy was not adopted, /v/ surfaced as [w] – see e.g. *over*, *hoover*. This is effected by R11a:

R11a. [+consonantal, −sonorant, +continuant, −coronal, +anterior, +voice] → [+sonorant] / V ___

/v/ becomes [w] postvocalically.

In fact there was also at least one occurrence of /r/ surfacing as [w] (*rain* became [rein] or wein]), suggesting that R11 should be modified to include /r/. As{/v, r/} cannot be stated as a natural class except disjunctively, and as the environment is anyway different, I just add R11b:

R11b. [+sonorant, +coronal, −nasal, −lateral] → [−consonantal] / ___ V

/r/ becomes [w] prevocalically.

Postvocalic /nd/ tends to [n] (e.g. *under*, *candle*, *band*, *stand*, *hand*, *round*) with /d/ preserved only rarely (*hand*, *round*).This is captured by R12, which might be simplified by the omission of [+voice] if the lone example *want* pronounced as [wɔn] is significant:

R12. [+consonantal, −sonorant, +coronal, +anterior, +voice] → Ø / [+nasal] ___

/nd/ simplifies to [n].

There is a residue of examples which are not accommodated by any of the foregoing. Unlike A, Z appeared not to use consonant harmony systematically, but there were some isolated examples: *bang*, *bin*, *mud*, *remote*. It is important to distinguish consonant harmony as a process from the superficial appearance of harmony induced by neutralisation rules. For A the pronunciation [gʌk] for

duck was the result of harmony to the velar /k/; for Z the pronunciation [dʌt] for *duck* was due simply to the replacement of all velars by a coronal, irrespective of the environment. Apart from these cases of putative harmony, there were a few pronunciations which were fairly consistent but with insufficient examples to establish rule-governed status: *hoover*, *honey*, *helicopter*, *snake*; there were many idiosyncratic occurrences both of individual words: *green*, *blue*, *huge*, *teddy*, *banana*, *screwdriver*, *flapjack*, *sugar*, *apricot*, *penguin*, *throw*, etc. and of [hã] and its variants ([hæ, hɛ, …]); and there were some pronunciations produced on imitation only: *sand*, *quack*. I have left all these unformalised.

I suggested above that ordering these rules should not be necessary, so it behoves me to substantiate the claim. Cases where these rules might appear to need to be ordered include those in (4):

4a. R5 (velar coronalisation) and whatever rule (unformalised here) effects the consonant harmony seen in *bin*, *bang* → [bim], [bæm]. In fact, the correct results accrue irrespective of the order of application.

b. Together R3 (deleting pre-consonantal /s/) and R4 (deleting post-consonantal sonorants) account for the fact that (e.g.) /sp/ → [p], /sl/ → [s] and /pl/ → [p]. As formulated the rules again give the right result in whatever order they are applied.

c. Similarly, R5 (velar coronalisation) and R6 (voicing neutralisation) give the correct output for e.g. *echo* (['ɛdəu]) under either ordering.

d. R7 (neutralisation of coronals) and R3 (deletion of pre-consonantal /s/) seem to need to be applied in the order R3 > R7 as R3 specifies the particular item /s/. However, if R7 precedes R3 the latter can be generalised from /s/ to [+coronal], so again there is no need for extrinsic ordering.

If no need for ordering is persuasive, there is *a fortiori* no possibility of accounting for developmental changes in terms of rule reordering, a possibility envisaged in APh for just one phenomenon. Specifically, A's pronunciation of *truck* as [g̊lʌk] in place of the earlier [g̊ʌk] was supposed to motivate the reordering of the deletion of post-consonantal sonorants from before to after the rule effecting velar consonant harmony (APh p. 72). In fact the original ordering was necessitated by the desire to treat all sonorants, whether syllable initial or post-consonantal, on a par and is easily avoidable. It should also be possible with minor reformulation to revise the other rules for A so that no extrinsic ordering is necessary. Given the desuetude of rule ordering (but see Nevins and Vaux, 2008: 8), I leave that as an exercise for the masochistic reader. The most intractable example is the *puzzle* puzzle, but here I am content to follow Hale and Reiss's (2008) suggestion that this is a matter of performance and rely on the neural network to produce the correct result.

Stage 5: Sessions 41–50. Age 27–8 months.

Z's general intellectual development can be gauged from the fact that he now matched animal dominoes appropriately (i.e. pigs adjacent to pigs, penguins to penguins, etc.); he correctly identified the pictures and buttons from 1 to 6 in the *Bob the Builder* book/toy, carefully comparing the shape of the number on the toy and in the book before pressing the appropriate button; and he could count from 1 to 10 (albeit with the frequent omission of 6 and 7). The exchange in (5) was typical of many:

5. Z [wʌn, d̥uː, fiː, fɔː, fæɣ̥, eit, næn, d̥ɛn] *– 1, 2, 3, 4, 5, 8, 9, 10*
NS "What happened to 6 and 7?"
Z [fəu in ə bin] - *(I) threw (them) in the bin*

Syntactically, *wh*-words were beginning to appear (though not yet in questions) as exemplified by [siː wɔt ˈrænmaː duː] – *(I'll) see what Grandma's doing* (as he ran after her into the kitchen). Phonologically, a voicing contrast was beginning to appear but was not fully established: for instance, *Grandpa* appeared in session 43 as all of [ˈdæmbaː], [ˈdæmpaː], [ˈtæmbaː] and [ˈtæmpaː].[14]

The syllable structure was largely unchanged with (C)V(C(C)) and CVV as the basic patterns. Except for CVCC (where the CC cluster was [mb, nd, nt] for *scrambled*,[15] *mend*, *want*) all these are most simply described as a combination of syllables consisting of (C)V(C). There was one example of CCC with the final C a syllabic [l] (*handle*). The intervocalic C_1C_2 clusters are no longer just [-mb-, -nd-] (for *Grandpa*, *donkey*), but include: [-md-, -nm-, -nw-, -ds-, -pd-, -pm-, -tt-, -ʔt-] (for *sometimes*, *Grandma*, *Cornwall*, *jigsaw*, *flapjack*, *tape-measure*, *brief-case*, *tractor*). That is, there are heterorganic as well as hom-organic examples, and no elements in C_1 position that do not occur word finally or elements in C_2 position that do not occur word initially. For instance, as [l] does not occur finally, there is no [-ld-] (so *shoulder* → [ˈsəudə]), and there is no example of [ʔ] for C_2. The main difference from the previous stage was an increase in polysyllables and a wider use of non-initial stress: e.g. *escalator*, *kangaroo*, *wintertime*, *sellotape*, *helicopter*, *Portobello*.

The inventory of consonants in Z's output was: [p, b, t, d, m, n, l, r, f, v, s, z, w, j, h, ʔ]. [b, d, m, n] occurred in all positions; [p, t] occurred at first only finally, but began to occur elsewhere around session 46, (with 'practice' on aspiration); [l] did not occur finally; [j] occurred only medially. While [f] occurred only initially, [v, w] occurred initially and medially, but it was not obvious that there

14 There was even greater variation, including marked aspiration, in session 46 – see the diachronic lexicon.

15 Only with following *egg* ([ɛd]).

was any consistent contrast among these three. [s] occurred everywhere, but not always as the reflex of /s/; [z] occurred only initially, with an incipient marginal exception for *shoes* → [suːᶻ]. There were still no velars.

The inventory of vowels was: [i, iː, u, uː, ʌ, æ, aː, ɔ, ɔː, əu, ə, əː, au, ei, ɛ, ɛː]. Which of these examples was contrastive is moot. Z's vowel articulation was still very variable: e.g. *time* → [teim], and there was no obvious advance over the preceding stage.

The following changes occurred to the rules operative at stage 4:

R1, deleting unstressed syllables, was still marginally operative and still subject to idiosyncratic lexical variation. Six items lost their initial syllable (*again*, *apart*, *banana*, *computer*, *today*, *tomorrow*); four retained it (*already*, *another*, *idea*, *inside*); one (*away*) was inconsistent. Of 108 initially stressed disyllabic and polysyllabic words, 102 retained the final syllable(s). The 6 that lost it were: *Willy* → [wi], *music* → [məi], *singing* → [si], *sitting* → [sit],[16] *scrambled* → [dəmb], and *scissors* → [siz]. Two of these were inconsistent (*sitting*, *scrambled*); one was anomalous (*scissors*); *Willy* was in minimal contrast with *Billy* (→ [ˈb̥iliː]). There were four items (*fire*, *flower*, *oil*, *shower*) which are arguably monosyllabic in the target language but appeared as disyllables in Z's speech. Three items (*battery*, *dinosaur*, *Sellotape*) lost a medial syllable (always [ə]), and one (*brief-case*) acquired an extra medial syllable (also [ə]).

R2, deleting coda consonants, was similarly subject to idiosyncratic variation. Some 23 words surfaced with the final consonant deleted, but the only consistent omission was of /l/, accounting for 9 examples. /t/ was omitted in 5 words, but 2 of these were disyllables (*carpet*, *Piglet*), 1 was part of a cluster (*paint*), 1 was sporadic (*bit*), and 1 was anyway anomalous (*that*). /k/ was omitted in 2 words, 1 of them a disyllable (*flapjack*) and 1 sporadic (*book*). Each of /d, g, n, s, z, θ, ʃ,[17] ʒ/ was omitted once. To the extent that the process is a rule rather than a tendency, it would appear that the structural description [+consonantal] had been complicated to [+consonantal, +sonorant, −nasal]. Consonants that did appear in coda position were [p, b, t, d, m, n, (s, z),[18] ʔ]. By the end of the stage [ɣ̥, tˢ] were appearing sporadically. It is not of course the case that these consonants corresponded one for one with the adult forms, as the adult reflexes of these consonants were:

[p] = /p, b/	[b] = /b, v/	
[t] = /t, k, g, s, f, θ, ʃ/	[d] = /d, g, ð, f, v/	
[ʔ] = /t, k/	[m] = /m, ŋ/	[n] = /n, ŋ/

16 In *sitting room* (inconsistently). *Sitting* as a verb remained disyllabic ([sitin]).

17 In *finished* – i.e. a cluster.

18 The parentheses indicate that these were not as fully established as the others.

This stage confirmed the assumption that R3 should delete /s/ only before non-sonorant consonants. The evidence came from examples like *swing* and *switch* ([sit]) with /sw/ onsets realised as [s], in addition to the earlier examples with /sl/ onsets. There was one exception: *slipper* (['libə]).

R4 The deletion of post-consonantal sonorants persisted unchanged.

R5 The absence of velars continued to be a striking property of Z's output, though it is important to stress that his perception of the coronal–dorsal contrast was fine. Assuming simply that /k, g, ŋ/ were replaced by [t, d, n] gives no wrong results: the voicing neutralisation – to the extent that it persisted – and the phonetic variability as between fortis and lenis articulations are accounted for appropriately on any ordering of the respective rules. The only doubt is whether the absence of [ʔ] for /d/ was accidental.[19] The presence of a glottal stop (hardly a coronal) was treated in (3) above as the normal consequence of a process reducing structure. Such a process accounts for the facts either on the assumption that, as in APh, there is a contrast between realisation rules and phonetic rules, or on the assumption that (3) is simply a side-effect of the general mapping between adult and child forms. One disadvantage of this analysis might be the 'Duke-of-York' (Pullum, 1976) sequence whereby the change from [−coronal, −anterior] to [+coronal, +anterior] needs to be 'undone' for [ʔ]. Apart from that it accommodates all the changes listed below:

/k, t/ → [t] /#___	*cat*, *crusher*, *scraper*; *take*, *truck*, {no /str-/ occurred}
/k, t/ → [d][20] /#___	*cake*; *tap*
/k, t/ → [t] /V___V	*Becky*; *Sellotape*
/k, t/ → [d] / V ___ V	*sticky*; *beetle*
/k, t/ → [Ø/t/ʔ] /___#	*book*, *cake*, *Zak*; *that*, *cat*, *not*
/k, t/ → [d] / n___	*donkey*; *wintertime*
/g, d/ → [d] /#___	*got*, *Grandpa*, *glue*; *do*, *drill*
/g, d/ → [d] / ___ #	*big*, *egg*; *hard*
/g, d/ → [d] /V___V	*sugar*, *buggy*; *Daddy*
/g, d/ → [Ø/t/ʔ] /___#	*big*, *zigzag*, *plug*
/g, d/ → [Ø] / ___ C	*jigsaw*; {*cardboard* – later}
/ŋ/ → [n] /___#	*long*, *wrong*
/ŋ/ → [n] /___ C	*monkey*, *finger*; (cf. *Monday*)

R6, neutralising the voicing contrast, was just beginning to waver. As is clear from the earlier observation that voiced consonants [b, d] occurred medially and voiceless ones [p, t] predominated finally, the phonetic voicing difference in Z's speech was not consistently contrastive: cf. [deit] (*cake*), [diə] (*Tigger*), [sæʔ] (*Zak*), [d̥aːd̥] (*card*), etc. However, there were now suggestive

19 There had been one example of d / → [ʔ] *bread* at the previous stage – session 37.

20 Or [d̥] – i.e. with the same allophonic variation.

indications of a developing contrast in e.g. *big* ([bid]) and *bit* ([bit/bi/biʔ]). Out of context, however, it was still hard to tell what was intended. Most significant was perhaps the variation in the pronunciation of unambiguously identifiable words such as *Grandpa* which included all of the following: ['dæmbaː / 'dæmpaː / dæm'baː / 'tæmbaː/ 'tæmpaː/ 'd̥æmbaː/ 'tʰæmbaː/ 'tæmpʰaː/ 'tʰæmbaː/ tæm'paː]. He was clearly 'experimenting' with voicing and aspiration, and there may have been a statistical trend to pronunciation correct with respect to these features, but it was not yet under control. Further, many cases, both 'correct' and 'incorrect', may reflect assimilation effects, as evidenced by the appearance of 'final' [d] before a vowel or sonorant: [hud ʌp] – "*(put my) hood up*"; [wi hæd liːd ɔn] – "*Willy (the dog) had a lead on*"; /p/ being voiced to [b] intervocalically ([æ buː nəu] – "*that's Pooh's nose*" (correctly identifying a jigsaw piece), etc. In sum, R6 was probably unchanged, though R6c, devoicing final consonants, was perhaps becoming optional.

R7, neutralising coronals to alveolar obstruents, had been split into three sub-parts:

R7a. [+coronal, +strident, +continuant] → [+anterior]

R7b. [+coronal, −sonorant, −strident, +continuant] → [−continuant]

R7c. [+coronal, −continuant] → [−delayed release]

Ignoring the loss of some final consonants occasioned by the operation of R2 (*nose*, *garage*, *bath*, *finish*, *house*), and assuming the 'allophonic' rules encapsulated in R6 that license the alternation of [t, d, ʔ], these rules account correctly for all the following:

items with adult /t, d/ (*hood*, *tummy*, *got*, etc.)	{No change}
items with adult /tʃ/ (→ [t]) (*chair*, *Pilchard*)	{R7c}
items with adult /dʒ/ (→ [d]) (*pyjamas*)	{R7c}
items with adult /ð/ (→ [d]) (*another*, *with*)	{R7b}
items with adult /z/ (→ [z]) (*zip*, *Zak*, *please*)	{No change} and
items with adult /ʃ/ (→ [s]) (*sharp*, *show*, *shut*).	{R7a}

Items with adult /θ/ showed some inconsistency, probably a reflex of perceptual confusion, becoming [s] in *thank you*, [t] in *mouth* and *three*, and [f] in *through*, *throw* and *three*. More interestingly, there was evidence for an incipient distinction among initial, medial and final positions. /z/ was usually correctly [z] initially and sometimes finally, but surfaced as [d] medially (*razor*, *Dizzy*); /ʃ/ was [s] initially, but became [t] elsewhere (*crusher*, *wash*, *squash*); /s/ was usually [s] initially (*saw*, *see*, *soap*, etc.), but was often [t] finally (*mouse*, *face*, *brief-case*). There were also one or two anomalies: *house* showed final [s] ([haus]) and *same* showed initial [d̥] ([d̥eim]). However, in conjunction with the treatment of /ʒ/ in *measure* as [d] (['mɛdə]), these data suggest that R7a

needs to be split into two parts, distinguishing intervocalic and other positions. Accordingly, R7a is modified to R7a' where the second clause applies according to the elsewhere (Penguin) principle.[21] There were not enough data to motivate refinements or changes to the other sub-rules of R7.

R7a'. [+coronal, +strident, +continuant] → (i) [−continuant, +anterior] / V ___ V
(ii) [+anterior]

R8, converting /f, v/ to alveolar plosives ([d] or [t]) postvocalically, was now illustrated by a much wider range of examples: *heavy* (['hɛdiː]), *over* (['əudə]), *roof* ([ruːt]), *brief-case* (['biːtteit]), *drove* ([dəud]), *off* ([ɔd̥]), *Ivan* (['ædiː]). A few items, notably *hoover*, never showed this replacement (likewise at this stage: *off*, *everybody*, *five*, *butterfly*), and the rule offers yet another example of idiosyncratic variation. Consider the example from session 46 discussed in the previous chapter: [nɔt ɛviːbɔdiː əudə huːvə] – "knock everybody over (with the) hoover", where /v/ is replaced by [d] and maintained as [v] in the same utterance. This might suggest that the correct pronunciation of *hoover* and *everybody* was the result of frequency effects but, as emphasised earlier (p. 46), this seems unlikely. I accordingly leave R8, lexically constrained as it is, unchanged.

R9, whereby intervocalic consonants tend to become [j], is effectively dead. There were just two examples: *screwdriver* (['duːdeijə]) and *digger* (['diːjə]). These were two of his most frequently uttered words, presumably 'frozen' accordingly.

R10, deleting prevocalic /ð/, is also effectively dead. There were only two relevant intervocalic examples (*another* and *otherwise*) in both of which /ð/ was realised as [d]. Hence the role of R10 can be subsumed under that of R7b, with /ð/ being treated the same finally as intervocalically. (Initial /ð/ is a different story, as will be seen below.)

R11a, [+consonantal, −sonorant, +continuant, −coronal, +anterior, +voice] → [+sonorant] / V ___ converting /v/ to [w], applied minimally – only to *hoover* and *excavator* – as R8 converted many instances of intervocalic /v/ to [d]. Moreover it applied somewhat inconsistently, with e.g. *hoover* appearing as all of ['huːwə], ['huwə] and ['huːvə], and *wintertime* surfaced as ['vindəteim]. This last example might suggest that there may have been some perceptual confusion as between /v/ and /w/, but as /w/ never surfaced as [d] this seems unlikely. I assume therefore that this was a matter of motor control, as is also plausible for R11b ([+sonorant, +coronal, −nasal, −lateral] → [−consonantal] / ___ V), whose sporadic replacement of /r/ by [w] is now exemplified by many more examples: *rain*, *run*, *carol*, *read*, *already*, etc. although an equal number

21 That is, the sub-parts of the rule are intrinsically not extrinsically ordered.

appeared with [r]. There were also two examples (*colour*, *Portobello*) suggesting that R11b should be simplified by the omission of [−lateral], but I leave it as is. /r/ is always problematic and there were some examples (*very*, *carry*, *later on*) in which it was simply omitted intervocalically.

R11b. [+sonorant, +coronal, −nasal, −lateral] → [−consonantal] / ___ V

R12, reducing sonorant-obstruent clusters to the sonorant element (usually [n]), has now disappeared. All of *monster*, *finger*, *window*, etc. occur with a cluster.

Stage 6: Sessions 51–61. Age 2 years 4 months to 2 years 5½ months.

An indication of Z's general cognitive and motor development can be found in his ability to sort 'Russian dolls' correctly, and to build (and manipulate with either hand) his wooden train track. Grammatically, his mastery of plurals was progressing; phonologically, voicing was established, final clusters appeared more systematically, and there was a developing use of contrastive stress: e.g. [iʔ dɔn həum, tu**ː it** həum] – *It's gone home, to its home*.

Syllable structure was basically unchanged from the previous stage, except for one or two minor additions such as CVCVCVCCV (['hɛjətɔptə] for *helicopter*), but these simply represented more combinations of (C)V(C). Otherwise the only change constituted additions to final CC clusters, where we now had [nd, nt, nz, md, mp, dz, pt]. These include both mono-morphemic clusters – e.g. [dz] in *please*, [nt] in *print* – and bimorphemic clusters – e.g. [nz] in [sinz] for *things*, and [md] in [deimd] for *games* and [tʌmd] for *comes*.

The inventory of consonants in his output was unchanged from stage 5, namely: [p, b, t, d, m, n, l, r, f, v, s, z, w, j, h, ʔ]. Of these, [p, t, d, s, m, n, v] all occurred initially, medially and finally; [b], [w, r, l] and perhaps [j][22] all occurred initially and medially; [f, z] occurred initially and perhaps finally; [ʔ] occurred medially and finally; and [h] occurred only initially. In addition there was considerable phonetic variation, so that in different positions the following variants were observed:

Initially:	[t, t^s, t^h, th] rather than just [t]; [p, p^h] rather than just [p]
Medially:	[p, p^f] rather than just [p]; [l, l^w] rather than just [l]
Finally:	[d, d^z] rather than just [d]; [t, t^s, ʔ] rather than just [t]

A typical example of free variation between [t] and [ʔ] and [m] and [n] in a single utterance is provided by his description in session 58 of what he had for

22 The only initial example was in ['jɛləu] – *yellow*. Otherwise initial /j/ was replaced by [l], as in [lɔːn] – *yawn*, [lɛt] – *yes*, etc.

lunch: [hæm sænit, ɛd sæmiʔ, hʌniː sæniʔ] i.e. *ham sandwich*, *egg sandwich*, *honey sandwich*.

There were also some incipient medial and final clusters:

Medial: [mb, nd, nf, nʔ, ds, tw, fw, bl]. These were probably not true clusters but heterosyllabic sequences i.e. CVC_1+ C_2VC. Evidence for this claim comes from the fact that e.g. [bl], as in *probably* (['pɔbliː]), occurred as an initial cluster only much later (from session 72).

Final: [mp, md, nz, nt, nd, ts, dz, pt, ʔt]. These were mainly reflexes of inflections – plural or third person agreement. It is important to distinguish cases such as [ts]/[t^s] and [dz]/[d^z] where [s/z] marks a plural as in *clocks* ([tɔts]), cf. *clock* ([tɔt]), and where the affricate is a reflex of a single consonant, as in *fleece* ([fiːt^s]). That is, the appearance of [ts] and [t^s] (equivalently [dz] and [d^z]) is sometimes merely a matter of the phonetic realisation of (e.g.) a fricative, sometimes a mark of morpho-phonological contrast. Z's production was as usual inconsistent, so *clocks* appeared appropriately but *socks* appeared only as [sɔt]. It was not until considerably later (session 91) that [ts] and [t^s] occurred unambiguously as a systematic mark of the plural, as in *pot* and *pots* pronounced as [pɔt] and [pɔt^s] respectively.

In those cases where [ts]/[t^s] is the reflex of a single adult consonant the appropriate treatment is presumably to attribute the change to a modification of the phonetic output of the rules (especially e.g. R7). Where it is the reflex of a (morpho-)phonological sequence there might be implications for e.g. R2 (deleting syllable-final consonants) but, as the rules are designed in the first instance to map lexical representation to the output, I have not modified them. There appeared to be no significantly greater likelihood of complex articulations occurring for sequences than for single segments or vice versa.

The inventory of vowels in Z's output was largely unchanged from stage 5, the only differences being the absence of [ɛː] (compensated for by the presence of [eː]) and the additional occurrence of [æː, ã, ai, iə]. This gave rise to the sets:

Monophthongs: [i iː u uː eː ə əː ʌ ɛ ɔ ɔː æ æː aː ã]
Diphthongs: [əu ei au ai iə]

The nasalised [ã] occurred only in [hã] – his generalised auxiliary. As before, the control of these vowels by Z and their interpretation by me was far from straightforward. For instance, although /eə/ was regularly realised as [aː], e.g. *bear* (in session 55), many articulations were inconsistent, with [aː] for /ɜː/ (as in *dirt*), [ɔ] for /ɒː/ (as in *bought*), [eː] for /e/ (as in *ten*), [æ] for /æ/ and /aɒ/, etc. An illustrative example from session 54 is provided by: [æ bɔt æ hʌniː in ə bæʔpæʔ] – *I brought that honey in my backpack*.

Additionally there was considerable fine phonetic variation, seen most strikingly in various offglides; e.g. [ˈpæ^{eə}d] – *pliers*, [bi^{u}d] – *build*, [ˈpæʔe^{i}] – *paté*, [ˈsæəd] – *salad* (all from session 58); *Neil* occurred as [niːə] in session 54 and as all of [niːu], [niːo], [niːɔ] in session 59; *five* became [fæid] but *nine* became [næːn] in session 60, and so on.

The developments at this stage can be characterised in terms of changes to the rules given earlier as follows:

R1, deleting unstresssed syllables, fared differently depending on the syllable, initial or non-initial, affected. The rule no longer applied to non-initial syllables, except for the single example of *orange* pronounced (session 51) as [ɔnd] (in free variation with [ˈɔnid^{ʒ}]), and several polysyllabic items (*elephant*, *normally*, *library*, *probably*, *Christopher* and *Teletubbies*) in which a medial unstressed syllable was elided. As far as unstressed initial syllables were concerned, a roughly equal number of words underwent or failed to undergo this rule. All of *again*, *another*, *away*, *Glenferrie*, *myself*, *together* and *without* preserved the initial unstressed syllable; all of *cement-mixer*, *computer*, *eleven*, *enough*, *professor*, *tomato* and *tomorrow* lost it. There was evidence that Z's representation included the unstressed syllable even when he didn't pronounce it: first, *tomorrow* surfaced as [ˈmɔrəu] and [tuːˈmɔrəu] in free variation in session 54; second and more revealingly, he was aware of the difference between his own and his mother's pronunciation, as shown in the dialogue in (6) from session 59:

6.
ANNE: Look, there's a cement mixer
Z: [ˈmɛnt midə]
ANNE: What does Mummy call it?
Z: [siˈmɛnt midə]

There was a later repetition (session 64) of the conversation with me in which he produced [sɛnt midə]. The different development of initial and non-initial syllables suggests that the rule (still subject to considerable lexical idiosyncrasy) be split into two:

R1a. $\sigma \rightarrow \emptyset \; / \; \sigma \; [\overline{-\text{stress}}] \; \sigma\,(\sigma)$

R1b. $\sigma \rightarrow \emptyset \; / \; \# \; [\overline{-\text{stress}}]$

R2. Most final consonants were now preserved, as before with the exception of /l/ in *all*, *Amahl*, *oil*, *owl*, *tool*. Occasionally final /l/ was vocalised to [u] as in *steal*, *twelve*, *wheel*, *will*, parallel to the treatment of pre-final /l/ in *build*, *field*, *fold*. With one exception – *Pilchard* pronounced ['pildə] – clusters of /lC/ were reduced to Z's reflex of the /C/ in *milk*, *wolf*. The treatment of /l/ contrasted with his treatment of clusters of /NC/ which were either reduced to the nasal, as in *can't*, *want* and *went*, or retained, as in *dump*, *lunch* and *print*. The only other final consonants deleted were in *Christmas*, *finished*, *glasses*, *medium* and *possum*. All of these are disyllabic and relatively infrequent. Two items showed optional deletion: *coming* and *dark*. Again, the presence of such free variation gives evidence that Z's representations generally include the final element. It is probably safe to say that R2 was dead and its apparent effects were due to lexical restructuring.

R3, deleting /s/ before non-sonorant consonants, was preserved unchanged and with no exceptions. Examples showing its deletion before non-sonorants include: *Scoop*, *scream*, *screwdriver*, *spare*, *special*, *spider*, *Spud*, *squash*, *straight*, and medially in *toaster* and *plaster*. Examples showing its retention before sonorants include: *slap*, *sleeping*, *slow*, *snake*, *snowball*, *snowman*, *sweet* and *swim*.

R4. The deletion of post-consonantal sonorants persisted unchanged. The only significant exception is *Grandma* → ['ræmaː]. Examples like *patchwork* → ['pætwəːt] suggest the need for a syllabic basis for the rule.

R5. This rule which eliminates all velars likewise persisted essentially unchanged. The only development is the appearance of [ʔ] for /k/ (as also for /t/) in intervocalic and pre-consonantal position (*rocket*, *pocket*, *jacket*, *doctor*, *tractor*, *monster*). As before, see (3) (p. 62 above), I take it that this was the result of a phonetic default rather than of a realisation rule, though the phenomenon might be considered as some slight evidence for the child having his own system: that is, realisation rules would map adult /segments/ to child |segments| which would then be subject to uniform phonetic detail rules. As expected /ŋk/ was produced as [nt] (as in *thank you*), /ŋz/ was pronounced as [nz] (as in *things*), etc. The only exception was *bang* produced as [bæm].

R6. A voicing contrast was established by around 2 year 5 months (session 59) with consistent minimal pairs such as: ['tidə] – *Tigger* versus ['didə] – *digger*; [tiːm] – *scream* versus [diːm] – *dream*. However, somewhat later (stage 7, session 62), Z still often pronounced the initial segment of *Pooh* and *bear* the same – [buː baː] – *Pooh bear*. His typical pronunciation is illustrated by the adult-like [it did bait haːd] – *it did bite hard* (of a tape-measure that cut his finger) or his usual forms for *cat* ([tæt]) and *dog* ([dɔd]). However, intervocalically there was no consistent contrast at all, with voiced consonants substituting for voiceless (e.g. *chocolate*, *composter*, *naughty*, *open*, *picture*, *sofa*, *water*), again with some 'correct' exceptions (e.g. *helicopter*, *missing*, *Sellotape*). A characteristic pair was provided by his pronunciation of *soap* and *soapy* ([səup] and ['səubiː]) respectively. There were also many voicing 'mistakes' in initial and final position (e.g. *milk* - [mid], *coming* – [dʌmin]).

The formal reflex of this development is that the earlier rules R6a and R6c (accounting for initial and final voicing neutralisation respectively) are being eliminated, while R6b is maintained.

R6b. [+consonantal] → [+voice] / V ___ V

R7. The set of rules neutralising coronal contrasts was still operative but with some complications. The basic generalisation was that continuants remained continuant ([s, z]) initially, but were realised as stops ([t, d]) elsewhere; non-continuants were realised as simple stops everywhere. That is, there were the following correspondences:

/t, d/ were simply maintained – e.g. *take*, *Daddy*. There was the usual 'allophonic' variation: [ʔ] for /t/ finally (e.g. *rocket*); [d] for /t/ intervocalically (e.g. *Weetabix*).

/s/ was realised as [s] initially (e.g. *saw*, *soap*, *silly*, *Saras*) and sporadically in final position (e.g. *purse*, *ice*), but finally and medially it usually became [t] (e.g. *horse*, *glass*, *fleece*, *hommous*, *missing* and *ice*) with the usual free variation with [ʔ] (e.g. *rice*) and [d] (e.g. *professor*).

/z/ similarly was realised as [z] initially (e.g. *Zak*) and sometimes finally (e.g. *please*, *things*); but medially it was always [d] (e.g. *music*, *scissors*, *nozzle*, *busy*, *pansy*, *Dizzy*) and it was often [d] finally (e.g. *wings*, *things*).

/ʃ/ was realised as [s] initially (e.g. *sharp*, *shop*, *should*, *shave*, *Shivers*) but as [t] finally (e.g. *fish*, *squash*[23]), and [d] intervocalically (e.g. *special*).

/ʒ/ occurred only intervocalically, as [d], (*measure*).

/tʃ/ was realised uniformly as [t]: (e.g. *chip*, *kitchen*, *torch*, *patchwork*, *lunch*).

/dʒ/ was realised uniformly as [d]: (e.g. *job*, *juice*, *jigsaw*, *flapjack*, *orange*), with one example of new allophonic variation in final position: (viz. *orange* (['ɔnidᶻ])).

/θ/ vacillated as before between [s] (e.g. *thing*, *thank you*) and [f] (e.g. *thirty*, *three*, *thumb*).

/ð/ was deleted initially (e.g. *that*), and appeared as [d] intervocalically (e.g. (*an*)*other*).

The earlier R7a' is simplified to operate postvocalically, giving R7a''; R7b is split according to voicing, deleting /ð/ initially, changing /θ/ to [f] or [s] initially, and remaining as before elsewhere; R7c remains unchanged.

R7a''. [+coronal, +strident, +continuant] → (i) [−continuant, +anterior] / V ___
(ii) [+anterior]

R7b'. (i) [+coronal, −sonorant, −strident, +continuant, +voice] → Ø / # ___
(ii) [+coronal, −sonorant, −strident, +continuant, −voice] → [strident, ±coronal]/# __
(iii) [+coronal, −sonorant, −strident, +continuant] → [−continuant]

23 [s] on imitation.

R7c. [+coronal, −continuant] → [−delayed release, +anterior]

It might be more transparent to replace R7b with separate rules for /θ/ and /ð/ with part (iii) as an elsewhere condition for each.

R8. This rule ([+anterior, −coronal, +continuant] → [+coronal, −continuant]/ V ___) converting /f, v/ in non-syllable-initial position to [t, d] applies fully regularly. There were 22 words which it affected (10 with /f/ (*sofa*, *knife*, *off*, etc.), 12 with /v/ (*over*, *Ivan*, *move*, etc.), and the only exceptions were *avocado* and *Safeway.* This process is somewhat unusual so one would hope that it arose as the natural result of the simplification of some rule(s). The obvious candidate, especially in view of the positional restriction to non-initial labio-dentals, is that R7 (specifically, R7a'') loses the specification [+coronal]: i.e. all non-initial obstruents are neutralised to [t, d]. However, this would also incorrectly convert /p, b/ to [t, d], so we would need to formulate the rule as in (i) below, so that it refers to non-plosive ([+del rel]) coronals (/t, d/, of course, need not be mentioned), and then generalise this as in (ii) below, so that all non-plosives become [+cor, −del rel]. In brief:

(i) [+coronal, +del rel] → [−del rel] / V ___ {i.e. non-initially}
(ii) [+del rel] → [+coronal, −del rel] / V ___

This is an odd-looking rule change: the generalisation to all [+del rel] segments is fine, but the switch of [+coronal] from the input in (i) to the output in (ii) is bizarre. Moreover, the attempted generalisation is suspect because it takes place at a time when the real coronals are undergoing positional changes. Accordingly it seems better to leave R8 unchanged, and try to make the oddness of the pronunciation result from something else. The natural candidate is perhaps OT's 'the emergence of the unmarked'. However, that this is plausible, and hence the basis for an argument in favour of an OT analysis, seems unlikely, as the emergence occurred after the faithfulness constraint preserving labio-dentals had been at least partially satisfied, inasmuch as a few words (*leaf*, *off*, *roof*, *over*) had occurred earlier with a labio-dental or bilabial.

The cumulative effect of these rules is that Z's [d] could be the reflex of any of the adult items: /t, d, k, g, f, v, s, z, ʃ, ʒ, tʃ, dʒ, ð/ or clusters containing them, such as /dr, dj, gl, gr/ (*naughty*, Da*dd*y, *chocolate*, *tiger, sofa*, *over*, *professor*, *music*, *special*, *measure*, *Pilchard*, *flapjack*, *other*) or (*dream*, *Duplo*,[24] *glue*, *Grandpa*). Difficulty in understanding him is not surprising in these circumstances.

The remaining rules (R9, 10, 12) were already defunct. R11b, changing /r/ to [w], had only a single example (*wrong* became [wɔn]) and even this occurred in

24 Not attested till a later stage.

an utterance where /r/ was correctly realised: [dʌn it ə wɔn wei raun] – *(I've) done it the wrong way round*. However, there are still several items (*carry*, *Glenferrie*, *very*, *orange*) in which intervocalic /r/ is deleted, two (*Saras*, *mirror*) in which it was replaced by [w], and one or two where it was correctly realised as [r] (*aeroplane*). There were insufficient examples and too much variation to make it worth formalising rules for this.

Stage 7: Sessions 62–75. Age 2 years 5½ months to 2 years 7 months.

Z's cognitive development was reflected in the fact that, when doing jigsaws, he now seemed to be more sensitive to colour (and the picture more generally) than to shape, ignoring straight edges, even when asking to do the frame first. Linguistically, his syntax was developing apace with passives ([it hæd tuː biː iːtən] – *it had to be eaten*) and plurals ([ɛd/ɛdz] – *egg/eggs*) consolidated, and the first examples of *wh*-questions ([wiḍ piʔtə id iʔ] – *which picture is it?*; [waː də tɔdiː pæt] – *where's the coffee pack(et)?*) and topicalisation ([tɛn didsɔːz ai hæ dʌn] – *ten jigsaws I have done*). Phonologically, his use of intonation was more sophisticated (e.g. [ai taːnt, … ai tæn] – *I can't, I can* [low fall, followed by triumphant high fall, as he successfully pulled his socks on alone]; and he regularly used high fall rises appropriately. Segmentally, initial clusters were appearing but in general post-consonantal sonorants were still deleted: e.g. *splash* ([pæt]).

Syllable structure was largely unchanged from stage 6 except for the incipient appearance of post-consonantal sonorants (see the discussion of clusters immediately below) giving rise not only to (C)V(C(C)) syllables but also to $C^{w/r/l/}V(C(C))$[25] syllables. There was also an increase in the variety of final consonant sequences.

The inventory of consonants in Z's output was unchanged from stage 6, namely: [p, b, t, d, m, n, l, r, f, v, s, z, w, j, h, ʔ]. All of these occurred initially except [j]; [ʔ] occurred initially once for emphasis: viz. [ʔid biʔ] for *this bit*. As initial /ð/ was systematically deleted I take it that this was not a replacement for an adult consonant. All occurred medially except [f, s, l, h] ([f] occurred in *butterfly*, but syllable initially, reinforcing the relevance of the syllable as well as the word in stating regularities of his pronunciation). All occurred finally except [w, r, j, h]. [j] occurred once as a linking glide at the end of *take*; [θ] occurred once as a phonetic variant for /st/ in his pronunciation [ts^{r}ʌθ] for *crust*.

The following clusters, in various positions, began to appear.

25 C^{w} sequences were restricted to [bw] (for /br/) and [dw] (for /gl/); that is, *not* for adult sequences including [w].

Initial: [dr, d^r, d^z, t^r, t^s, br, b^l, p^l, fl, f^r, fr]. [d^w] occurred once for /gl/; [b^w] occurred once for /br/. As regards syllable structure, it is not entirely clear what the status of the distinction between e.g. [dr] and [d^r] is (see the appendix on clusters in ch. 7, appendix 7.1, and the discussion of R4 at stage 10, pp. 93 f. below). In general Z's development was characterised by the appearance of [C^{son}] (e.g. the complex segment [d^r]) before [C son] (e.g. the complex onset [dr]). In the case of [t^s] and [d^z] the question does not arise with the same cogency, as English does not have complex onsets of this type. It does arise, however, in final position where it may be possible to adjudicate on the status (same or different) of e.g. [dz] and [d^z].

Medial: [mp, mb, nt, nd, mt, nt^s, ld, lβ,[26] nʔt, st, tl, ʔt, ʔd, ʔn, dn, df]. As before, these are most economically treated as sequences of syllable-final + syllable-initial consonants rather than tautosyllabic clusters.

Final: [mp, mz, nd, nt, nz, ns, nʔ, lt, ld, pʔ, b^z, ts, t^s, dz, d^z, ʔt, st]. These clusters fall into two classes: those where the second element of the cluster is itself a morpheme (plural or past), as in (7a), and those where it is part of a monomorphemic word, as in (7b):

7a. Plural: [mz] (*pyjamas*), [nz] (*things*, *pins*), [nd] (*wings*, *things*), [md] (*worms*), [ld] (*scales*, *Pickles*), [dz] (*eggs*), [ts] (*bricks*).
Past: [nd] (*joined*), [pʔ] (*dropped*), [ʔt] (*cooked*).

b. Mono-morphemic: [mp] (*help*), [nt] (*crunch*, *want*, *quince*, *think*), [nd] (*round*, *behind*), [ns] (*quince*), [nʔ] (*think*, *cement*), [ld] (*cold*), [lt] (*wolf*, *else*), [st] (*vest*), [ʔt] (*fix*).

As can be seen, a couple of clusters ([ld, ʔt]) occur in both categories; one cluster ([nd]) occurred in three roles; and one ([nʔ]) occurred mainly, but not exclusively, as a reflex of a negative clitic as in *don't*, *won't*, etc.

The inventory of vowels is even richer than before, though with the usual caveats about (in)consistency and (lack of) contrast:

Monophthongs: [i, iː, u, uː, eː, ə, əː, ʌ, ɛ, ɔ, ɔː, æ, a, aː]
Diphthongs: [əu, ei, au, ai, iə, æə, ɔi, əi]

26 In *silver*. I take it that [β] is a random variant of [v].

The main changes from stage 6 are the disappearance of [ã] and [æː], the appearance of [a] and a considerable number of diphthongs and triphthongs arising mainly from the vocalisation of /l/: [iᵘ, æᵘ, aiᵘ, ɛᵘ, əːᵘ, iːᵘ, aːᵘ]. In addition there was a lot of what I take to be unsystematic phonetic variation such that [ɔi] alternated with [ɔᵉ]; [ai] with [aⁱ], [æⁱ] and [æᵉ]; [æə] with [aiə], etc. There were also examples such as [ɛiː] (in *jelly*) and [ɛə] (in *Sellotape*) which, for rhythmic reasons, I take to be sequences of vowels rather than diphthongs.

At the previous stage R1, deleting unstressed syllables, had been split into two: R1a deleting medial unstressed syllables in polysyllabic items, and R1b, deleting unstressed initial syllables:

R1a. $\sigma \rightarrow \emptyset \quad / \sigma [\overline{-\text{stress}}] \sigma (\sigma)$

R1b. $\sigma \rightarrow \emptyset \quad / \# [\overline{-\text{stress}}]$

There is no longer significant evidence for R1a. The only examples (all at or before session 68) were: *helmet* (once only), *video*, *spatula* and *packet*.[27] However, evidence for its continued existence still appears at the next stage (p. 84). R1b is a little more robust with a few forms still showing its effect (*cement*, *because*, *giraffe*, *another*, *before*, *tomato*, *remember*), but it is fading.

R2, deleting final consonants, is essentially defunct.

R3, deleting /s/ before obstruents, is retained unchanged.

R4 The deletion of post-consonantal sonorants is becoming optional for the liquids /l, r/; it is still absolute for the glides /w, j/ (even though postconsonantal [w] occurred sporadically in the output). The first clusters involve stops, with the fricative /f/ occurring from session 70. [bʳ] and [dʳ], subsequently [br] and [dr], came on line for /br, bl; gr, dr, dʒ/ essentially simultaneously, with [tˢ] and [dᶻ], subsequently [ts] and [dz], for /skr, str, tʃ, kl; dʒ, dr, gr/ shortly thereafter. [tʳ], subsequently [tr], appeared next for /tr, kr, str, skw/, and then [fr, fl, pl]. There were also a number of unsystematic phonetic variants: [bʷ, bˡ, dʷ, dʷr, tsʳ]. Somewhat surprisingly, there were also some clusters – perhaps 'complex articulation' would be a more accurate term – for single phonemes: [tˢ] for /k, tʃ/, [dᶻ] for /dʒ, g/. The difference between liquids and glides suggests that R4 be split into two:[28]

R4a. $C_{[+\text{sonorant, } +\text{consonantal}]} \rightarrow \text{Opt } \emptyset \quad / C \_\_\_$

R4b. $C_{[+\text{sonorant, } -\text{consonantal}]} \rightarrow \text{Obl } \emptyset \quad / C \_\_\_$

27 And this may have been intended to be *pack* rather than *packet*.

28 If desired, it would be technically possible to preserve the unity of R4 by using angle brackets.

R4a could be further refined by the brief addition of [−continuant] to the contextual consonant, but the extra complexity disappeared again so rapidly that it may not be significant. A more worrying issue that is raised by the apparently idiosyncratic treatment of some segments and sequences is the validity of a rule-based rather than an item-by-item analysis. That is, there may be a minority of areas where a simple list is as explanatory as a highly restricted rule. Be that as it may, Z's treatment of /tʃ, dʒ/ requires complication of R7 specifying the treatment of coronals.

R5 The elimination of velars remains unchanged. The only anomaly is the example of [teij] for *take* in session 62, which is reminiscent of the effect of R9. However, there was only one example and R9 affected medial consonants, so the parallelism is moot.

R6 A voicing contrast is now largely established, with many minimal pairs such as [tæt] (*catch*) vs. [dæd] (*drag*), but there is still a great deal of inconsistency. Initially, *Gruff* was pronounced as either [tʌf] or [dʌf], perhaps indicating that R6a (accounting for voicing neutralisation in initial position) is still optional. In final position there was no such voicing variation – *duck* was pronounced [dʌʔ] or [dʌt] but never [dʌd]. Intervocalically, [tʌp ə tiː] and [tʌb ə tiː], [wɔːdə] and [wɔːtə] seemed to be in free variation, suggesting that R6b is also optional.

R7 The neutralisation of coronals is somewhat complicated.

/t, d/ are simply maintained with the same 'allophonic' variation as before.

/s, z/ are consistently maintained in initial position (as before). Medially, (as before) /s/ surfaces as either [t] or [d], and /z/ appears as [d]. The only exception for /z/ is that it is consistently produced as [z] in the stressed final syllable in *magazine*, and appears as zero in the pre-consonantal position of *as well*. In final position /s/ is more frequently [s], though [t] is still common and some words such as *this* occur with any of [d, s, ʔ] but not [t]. The main change is that [s] is no longer just sporadic but common, even if not for the appropriate adult consonant. A characteristic example is *horse shoe* produced as ['hɔːt suː] with [t] for /s/ but [s] for [ʃ]. Final /z/ is either [d] (*choose*) or more commonly [z] (*cheese*) or incipiently [dᶻ] (*cheese*).[29]

/ʃ/ and /ʒ/ are realised as before: /ʃ/ is [s] initially, [d] medially and [t] finally; /ʒ/ occurred first as [d] and, towards the end of the stage, as [z] (*garage*).

As before, /tʃ/ was realised uniformly as [t], with the first appearance of [tˢ] (*check*) in initial position towards the end of the stage. Medially and finally it

29 The use of affricates/clusters for adult single phonemes may be a further indication that Z is dealing with onsets and codas as units rather than sequences of phonemes – cf. the discussion of his metalinguistic abilities in chapter 5, especially the *frog/foam* contrast. (For the structure of onsets and codas see Zec, 2007: 165.)

occurred with free variation between [t] (*crunchy*, *reach*) and [d] (*watching*, *reach*), and in final position with [ʔ] (*much*). Also as before, /dʒ/ appeared systematically as [d] though, parallel to the development of /tʃ/, both [dᶻ] and [dʳ] (*join*) appeared towards the end of the stage. This can be accommodated by making R7c optional with respect to the feature [delayed release] but still obligatory with respect to [anterior].

R7c'. [+coronal, −continuant] → <Opt> [<−delayed release>, +anterior]

/θ/ vacillated as before between [s] (*think*) and [f] (*through*), but was consistently [t] in final position (*mouth*, *bath*). As before, /ð/ was deleted initially and appeared as [d] intervocalically.

/r/ occurred usually as [r] (*roof*, *Zachary*) but sometimes as [w] (*right*, *lorry*).

/l/ occurred usually as [l] (*like*, *slowly*, *peel*). Intervocalically it occurred sporadically as [j] (*yellow*) or zero (*jelly*); finally it was still sometimes vocalised (*well*).

/j/ occurred consistently as [l] (*yellow*, *yum*) but as zero in *you(r)*.

/n/ was retained as [n] in all positions.

These changes are too idiosyncratic to be worth explicit formalisation: that is, they appear to instantiate no regular processes; alternatively, distinctive feature theory is inadequate to capture whatever generality exists. As has been observed earlier, Z's output was strikingly less predictable than A's.

R8 This rule de-labialising /f, v/ disappeared during this stage. Initially there were examples with [t, d] for /f/ or /v/: [ɔd, ɔt] for *off*, [səudə] for *sofa*, [tɔdiː] for *coffee* and [wu(l)t] for *wolf*. By the end of the stage all relevant examples (*seven*, *heavy*, *oven*, *knife*, *coffee*, etc.) had labio-dentals or [w].

Stage 8: Sessions 76–93. Age 2 years 7 months to 2 years 9½ months.

Z's cognitive development was reflected in the fact that he now regularly indulged in pretence:[30] for instance, pretending that his Winnie-the-Pooh soft toy was a cow. A more complex example was provided by his response to my pretending to be a dragon: [aim ə wulf ət dɔbəlz ʌp drædənz] – *I'm a wolf that gobbles up dragons*. Syntactically, he produced his first multiple *wh*-question: [huːz dəuin tə wɔd ʌp wɛn] – *Who's going to wash up when?*; his first extraction from an embedded clause: [huː did uː sei wəː in ə daːdən] – *Who did you say were in the garden?*, and his first *if*-clause. He was also developing some metalinguistic awareness, imitating the next-door neighbour's Scottish accent, and commenting on the different vocabulary used by various members of the family: [dræmpaː, mʌmiz iz ə bʌʔiʔ, ɔːz iz ə bɔʔs] – *Grandpa, Mummy's*

30 Though examples of pretend play began at the latest at age 2 years 3 months (pretending to eat people), and perhaps earlier if the dialogue with 'no' (p. 58, session 31) is a form of teasing pretence.

is a "bucket", yours is a "box" (noting our different terms for the lawn-mower box). His own speech showed considerable variation as between his mother's and father's pronunciation: e.g. [ai wil həlp uː paːnt ə plænt^{s}] – *I will help you plant the plants*. He also began to use calling intonation for the first time. The most striking features of this stage are the appearance of affricates and the addition of more clusters.

Syllable structure was essentially unchanged. The only noteworthy development was that post-consonantal [w] now occurred appropriately for adult /w/ and not just adult /l, r/, as in ['pɛndwin] for *penguin*. It is also striking that he appeared to be treating onsets as the targets for his pronunciation, as all of /tr, tʃ, k, kl/were realised on occasion as [t^{s}] and all of /dr, dʒ, gr/ as [d^{z}] (e.g. *tree*, *cherry*, *camera*, *climb*; *drink*, *juice*, *grape*). That is, Z may have been treating the set of complex onsets as a natural class, replacing them with his own complex onset so that *climb up a tree*, for instance, became [t^{s}aim ʌp ə t^{s}iːr] with /kl/ and /tr/ treated identically.

The inventory of consonants in his output was largely unchanged from stage 7, namely: [p, b, t, d, m, n, l, r, f, v, s, z, w, ts, dz, h, ʔ]. That is, [j] had disappeared, and the affricates [ts] and [dz] appeared from session 82.[31] All of these occurred in initial position throughout the stage, except [ʔ] which occurrred only syllable-finally. [r] appeared but for a while it occurred more consistently in clusters than as a singleton. All elements occurred medially except [h], with [s, z, dz, f] appearing from sessions 81–6 on. All occurred finally except [w, r], though [s] appeared only from session 80 on. There was, as before, considerable phonetic variation with examples of marked aspiration and affrication: e.g. [p^{h}, t^{h}] for /p, t/; and [t^{s}, d^{z}] alternating with (and usually preceding) [ts, dz] for a variety of adult segments and sequences.

Ignoring the affricates, we had much the same set of initial clusters as before: [dr, t^{r}, br, b^{r}, b^{l}, pl, p^{l}, p^{w}, f^{r}, f^{w}], though there was no example of [fl]. Previously where e.g. [dr] alternated with [d^{r}] and [fr] with [f^{r}], we now had only [dr] and [f^{r}]. I take it that this is a matter of fine phonetic detail and not phonologically significant. Post-consonantal [w] was beginning to appear (for /l/) after labials (*fly*, *play*, *pliers*), perhaps as a coarticulation effect.

Medial clusters, as suggested before, essentially exhausted all and only the possibilities provided by the combination of a coda consonant followed by an onset. The possible codas were [p, t, b, d, m, n, s, z, f, l, ʔ] (i.e. not [ts, dz, v]),

31 The status of these affricates as unitary segments or clusters is moot: for instance, they occurred as the reflex of both single adult phonemes: [iːts] for /iːtʃ/ (*each*), [id^{z}] for /iz/ (*is*), and of sequences of phonemes: [bʌts] for /bʌts/ (*butts*), [dzeip] for /greip/ (*grape*).

and the possible onsets were [p, t, b, d, m, n, s, w, r, l] plus [d^z, d^w] (i.e. not [z, f, v, t^s, d^z]). It is not obvious whether these were random gaps.

Final clusters consisted of any of: [p, t, d, m, n, s, f, v, l, ʔ] (no [b, z]) followed by any of: [p, t, d, s, z, ʔ] (and once [t^r]). Non-occurrent sequences appeared to be random gaps or just reflexes of the absence of e.g. final [mb] from the adult language.

The vowels present in Z's production were [i, iː, u, uː, ɛ, ɛː, ɔ, ɔː, æ, ʌ, ə, əː, aː] plus [ai, au, ei, əu, uə] and, as at the previous stage, sundry diphthongs where there was an [^{u}] offglide as the result of a vocalised /l/. The vowel system was phonetically virtually complete but the phonological status of the various elements was not always clear, especially as there was considerable variation in articulation: e.g. /aɪ/ realised as [ai, æi, $æ^i$] etc. Some contrasts were clearly established, as evidenced by such utterances as [uː sud teit ə suːd ɔf insaid] (*you should take your (?) shoes off inside*) showing a minimal pair [sud]/[suːd], but most were moot.

R1a, deleting non-initial syllables, is now operative only to delete medial unstressed syllables in words of three or more syllables (*chocolate*, *dangerous*, *different*, *elephant*, *hospital*, *measuring*, *medicine*, *normally*, *secateurs*, *vegetable*). A roughly equal number of words retained such unstressed syllables (*Annabel*, *apricot*, *crocodile*, *holiday*, *Janneke*, *recipe*, *vinegar*,[32] *xylophone*). I leave it unchanged except for a specification of optionality:

R1a'. σ → Opt Ø / σ [−stress] σ (σ)

R1b, deleting unstressed initial syllables, applies to a diminishing number of words (*around*, *computer*, *disaster*, *elastic*, *electric*, *tomato*) with a greater number not undergoing the rule (*about*, *allowed*, *along*, *injection*, etc.) apparently on a piecemeal basis. Again, I leave it unchanged except for the specification of optionality:

R1b. σ → Opt Ø / # [−stress]

R2, deleting final consonants, is no longer operative except for a few words (*has*, *have*, *work*) and even these usually have a final consonant.

R3, deleting /s/ before obstruents, is unchanged and exceptionless in initial position (*Scoop*, *scream*, *spanner*, *spider*, *stick*, *strawberry*, etc.). For the first half of this stage it was similarly exceptionless in non-initial position (*breakfast*, *condensed*, *hospital*, *monster*, *parsnip*, *sister*) but, from session 84, [s] appeared systematically before medial and final obstruents (*composter*, *custard*, *disaster*, *dressed*, *pasta*, *plaster*, *whisky*). The revised form of the rule simply specifies that it operates only initially:

R3'. /s/ → Ø / # ___ $C_{[-\text{sonorant}]}$

32 With metathesis.

R4a and R4b, deleting post-consonantal liquids and glides, are largely unchanged except for an asymmetry between the treatment of post-consonantal /r/ and /l/. Specifically, [br] and [pr] are used for /br, bl/ and /pr, pl/ respectively, but [bl] and [pl] are never used for /br/ or /pr/. R4b is still exceptionless for the glide (/j/) – e.g. *new*, but clusters with post-consonantal liquids are becoming established, and clusters with /w/ are beginning to pattern with the liquids. One item, *penguin*, appeared with a correct post-consonantal [w] – viz. ['pɛndwin], but [w] may have been being treated as a syllable onset. There appears to be no difference between clusters of the form [Cr] and [C^{r}], which have the same privilege of occurrence: wherever [tr] occurs [t^{r}] occurs, and likewise for the other consonants. The large majority of post-consonantal liquids (and some /w/) are now produced, but in most cases there are also examples where the sonorant is deleted. This is exemplified in the second pair in {curly brackets} in (8) below. That is, examples in the right-hand column are ones where the adult cluster was pronounced without the sonorant – e.g. [buː] for *blue*. Where no such singleton realisation occurs I indicate this with 'None'. If there is no right-hand column it is because the category is catered for by other rules. Voicing is appropriate except medially – e.g. *apricot*. Thus we have:

8.

[br] for /br, bl/	{*bring*, *black*}	cf. {*bring*, *blue*}
[bl] for /bl/	{*blood*}	
[pr] for /pr, pl/	{*pressure*, *playing*}	cf. {*present*, *plaster*}
[pl][33] for /pl/	{*plate*}	
[dr] for /dr, gr, dʒ/	{*dragon*, *Grandpa*, *Joshua*}	cf. {None, None, *Joshua*}
[tr] for /tr, kr, str, skr, kl, kw, skw, tʃ/	{*truck*, *crane*, *strawberry*, *scrape*, *close*, *quiet*, *squash*, *check*}	cf. {None, *scarecrow*, *strawberry*, *scream*, *cling*, None, None, None}
[t^{s}] for /kl, tr/	{*clean*, *tree*}	
[dz] for /gr, dr, dʒ/	{*Grandma*, *drink*, *juice*}	
[fr] for /fr, θr/	{*fridge*, *throw*}	cf. {*fridge*, *throw*}

To make /r, l, w/ (excluding /j/) constitute a natural class, it is necessary to assume that /r/ is [+anterior] (contrary to APh, but in line with Hall, 2007). The distinctive behaviour of /Cj/ clusters is then captured by modifying R4a to delete all sonorants except /j/ and restrict R4b, suitably complicated, to /j/. To capture the /l, r/ asymmetry is slightly more complicated, especially as the apparent optional conversion of /r/ to [l] but not of /l/ to [r] was restricted to post-labial position. That is, /tr, dr/ and /kr, gr/ never surfaced as [tl, dl], presumably because of the absence of the sequence /tl, dl/ in the adult language. The addition of R4c accommodates the situation but is not very elegant.

33 Occasionally [pw].

R4a'. $C_{[+sonorant,\ +anterior]} \rightarrow$ Opt Ø / C ___

R4b'. $C_{[+sonorant,\ -anterior]} \rightarrow$ Obl Ø / C ___

R4c. $C_{[+sonorant,\ +consonantal,\ +lateral]} \rightarrow$ Opt [−lateral] / $C_{[+anterior,\ -coronal]}$ ____

R5, eliminating velars, is maintained unchanged.

R6, neutralising the voicing contrast, has disappeared except for some medial examples.

R7, neutralising coronals, is still complicated.
/t, d/ are still realised systematically correctly, except that:

- /t/ → [ʔ] finally in free variation with [t] (*bucket*)
- /t/ → [d] sporadically intervocalically (*water*, *Weetabix*) and once finally (*white*)
- /t/ → [t^s] sporadically for initial /tr/ (*tree*)[34]
- /d/ → [t] once (*read*)
- /s/ → [s] without exception in initial position, but medially all of [t, d, s, z] occur, respectively (*nicely*, *listen*, *inside*, *sausage*), and finally all of [t, d, s] occur, respectively (*mouse*, *this*, *this*)
- /z/ → [z] without exception in initial position, but medially both [d, z] occur, respectively (*bulldozer*, *puzzle*), and finally all of [d, z, d^z] occur, respectively (*is*, *has*, *secateurs*)
- /ʃ/ → [s] without exception in initial position, but medially and finally all of [d, t, s] occur, respectively (*washing*, *injection*, *Joshi*; *push*, *brush*, *squash*)
- /ʒ/ did not occur initially, but became [z] or [d^z] medially and finally, respectively (*television*, *tape-measure*; *garage*)
- /tʃ/ → [t^r, t^s] initially (*check*, *cherry*); [t, ^{ʔ}d, s] medially (*kitchen*, *Richard*, *crunchy*) and [t, t^s, ts] finally (*watch*, *lunch*, *each*)
- /dʒ/ → [d, d^r, d^z] initially (*juice*); [d, z, d^z] medially (*engine*, *pigeon*, *Angela*) and [d, z] finally (*page*, *bandaged*)
- /θ/ → [s] initially, it didn't occur medially, and as any of [t, f, s] finally (*cloth*, *mouth*, *teeth*)
- /ð/ → zero initially with sporadic exceptions: [d, z] (*there*); [d, z] medially (*brother*, *together*) and [d] finally (*with*)
- /r/ → [r, w] both initially and medially (*roof*, *tomorrow*)
- /l/ was realised correctly in all positions but was occasionally vocalised to [u] finally, and was deleted when part of a cluster (*film*, *only*)
- /n/ was invariably correct
- /j/ was systematically [l] initially and medially except for one occurrence of [j] (*Janneke*)

34 If Z is analysing clusters as unitary onsets rather than as sequences of phonemes, this may not be the appropriate description; rather the onset /tr/ is realised as [t^s].

The behaviour of /s, z, ʃ, ʒ/ is accommodated by making the first line of R7a'' optional:

R7a'''. [+coronal, +strident, +continuant] → Opt (i) [−continuant, +anterior] / V ___
(ii) [+anterior]

The behaviour of /θ, ð/ is accommodated by omitting reference to [coronal] in the second line of R7b', and adding a reference to the same feature in the last line:

R7b''. (i) [+coronal, −sonorant, −strident, +continuant, +voice] → Ø / # ___
(ii) [+coronal, −sonorant, −strident, +continuant, −voice] → [+strident] / # ___
(iii) [+coronal, −sonorant, −strident, +continuant] → [−continuant, ±coronal]

The behaviour of /tʃ, dʒ/ is less straightforwardly dealt with, especially if the intuition is correct that Z is dealing in terms of the notion (complex) onset, and that affricates have been assimilated to this category. In that case the previous R7c', repeated here:

R7c'. [+coronal, −continuant] → <Opt> [<−delayed release>, +anterior]

would need to be replaced by a rule specifying that adult complex coronal onsets are replaced by Z's equivalent complex coronal onset. There is no satisfactory way of doing this in a traditional rule-based analysis, so I leave it unformulated.[35] I also have ignored in the formulation the phonetic detail of the non-initial realisation of adult affricates.

R8, coronalising labio-dentals, is no longer operative.

Stage 9: Sessions 94–108. Age 2 years 9½ months to 3 years and ½ month.

Z's cognitive development was reflected in the fact that, appropriately for his age, he 'failed' the Sally-Anne test. During session 101 I 'hid' his grandmother's glasses in place X with her and Z both watching. She was sent out of the room, the glasses were moved to place Y and, after establishing that Z remembered where they had been put first, I asked "Where do you think Grandma will look for them?" He replied instantly "place Y" and, when I asked "Why?", he replied "Because you put them there."

He was also developing considerable metalinguistic awareness. One example occurred when he overheard me telling a friend how he (Z) (pretended that he) was Bob the Builder in the morning and Fireman Sam in the afternoon. He immediately asked why I had said 'the afternoon' rather than 'this afternoon'.

35 See also the preceding footnote. OT frequently refers to the notion (complex) onset, but even here there is to my knowledge no elegant way of capturing the conversion of a coronal affricate and a sequence of a coronal plosive followed by /r/ to the same affricated output.

His own odd pronunciation of (*this*) *afternoon* (see the diachronic lexicon) suggests that he had probably represented it as an unstructured phrase.

Syntactically he was progressing rapidly, while still making age-appropriate mistakes in e.g. the usage of *ask* and *tell* and the construction of possessives. For instance in sessions 94 and 95 he produced [huː iz dætiz hæt] – *whose hat is that?* (Literally: *Who is that's hat?*), and [wiː tæn tɛl dʳæmaː if siː wɔnts sʌm lɛtis] – *we can tell* (*sic, scilicet* 'ask') *Grandma if she wants some lettuce*.

By the end of this stage /ʃ, ʒ/, and marginally /tʃ/, were beginning to appear appropriately. The affricates [ts, dz] were used more consistently for /tʃ, dʒ/, and also for the adult clusters /tr, dr, gr/. Despite this progress his treatment of clusters and the continued neutralisation of velars resulted in many adult forms being realised identically – e.g. [ai tæn traim ɔn ə trɛː traiʔ ˈiːziliː] *I can climb on a chair quite easily*. He now (e.g. session 104) often spoke on an ingressive air-stream mechanism (with no voicing), as he ran out of breath. Presumably this was an *ad hoc* strategy to overcome his only partial control of 'speech breathing' (Messum, 2007).

Syllable structure was still adequately represented by the formula $(C^{(w/r/l)})V$ (C(C)), though there were indeterminacies occasioned by the status of some 'clusters': that is, whether the complex articulations [ts] and [tˢ] should be treated as one segment or two. The pronunciation [dɛts] for *gets* (where [t] and [s] belong to different morphemes) is intuitively a sequence of two consonants, but the pronunciation [tiʔtsin] for *kitchen* (where the same complex articulation [ts] is the reflex of the single adult phoneme /tʃ/) is intuitively unitary. Similarly, Z's identical treatment of the initial elements /dʒ/ and /gl/, as in *jump* and *Glasgow* (respectively [drəmp] and [dræzdəu]), is analytically opaque. If it is correct to claim that the child does not have his own system in any meaningful sense (see the discussion in ch. 5 and the remarks on medial clusters immediately below), the question does not arise: his representations are adult-like and his pronunciations are simply a function of processes without any psychological (i.e. cognitively represented) status.

The inventory of consonants in Z's output was the same as at stage 8, with the addition of [ʃ] and [ʒ], the reappearance of [j], and the consolidation of [tʃ], namely: [p, t, b, d, m, n, s, z, ʃ, ʒ, tʃ/ts, dz, f, v, w, r, l, j, h, ʔ]. All of these occurred in initial position throughout the stage, except [ʔ, ʒ, tʃ]. [ʃ] appeared from session 106. All occurred medially except [h]; [ʃ, ʒ] appeared from session 106 on. All occurred finally except [w, r, j, h]. Again, [ʃ, tʃ] only appeared from sessions 106 and 108 on. The presence of [j] is somewhat dubious: with the single exception of *Janneke* it appeared only as a transitional element in examples like *wire*. There was, as before, considerable phonetic variation,

with e.g. the affricates [t^{s}, d^{z}] alternating with (and usually appearing earlier than) [ts, dz]. The fricatives [ʃ, ʒ] and the affricate [tʃ] appeared sporadically right at the end of the stage, the latter replacing [ts].

The previous initial clusters were [dr, t^{r}, br, b^{r}, b^{l}, pl, p^{l}, p^{w}, f^{r}, f^{w}], and if affricates are treated as clusters, this inventory should be extended to include [ts] and [dz]. These combinations were extended in two ways: first, some of these clusters were used for 'new' adult forms: [dr] for /gl, dj/, [br] for /bl/, [ts] for /tj/, [fr] for /fl/, [tr] for /str/, [fw] for /fl/; second, [s^{r}/sr] appeared for the first time for all of /fl, sl, str/.[36] The only changes to final clusters were the addition of two three-member clusters [nts] (for /nts/ and /ŋks/) and [ntʃ] for /ntʃ/, and the extension of pre-existing clusters to new adult forms: e.g. [lt] for /lt/ (previously used for /lf, ls, lk/).

Medial clusters were still just a combination of current codas with current onsets, giving rise e.g. to both [ms] (*something*) and [sm] (*Christmas*). As these combinations became more complex there were more possibilities including tri-consonantal sequences – [ltl, nst, nʔl, zbr, ndr, ntr, pdz] (for *Ilkley*, *monster*, *sprinkler*, *raspberries*, *hungry*, *control*, *flapjack*) where the syllable boundary occurs after either the first or second element [p.dz, z.br] versus [lt.l, nʔ.l] respectively. If an analysis in terms of codas and onsets is correct, this implies that the sequence [nst] (as in *monster*) must be syllabified as [ns.t] and not [n.st], as initial [st] clusters didn't appear until session 126; at this stage *Mr Strong* is still [mistə trɔn]. There were no examples of quadri-consonantal sequences.

R1a, deleting unstressed non-initial syllables, long dead for disyllables, is virtually dead for everything. The only items with incorrect syllabification are *ambulance* ['æmbins], *everything* ['ɛvrin] and *decided* ['saidid]. Two other examples, *machines* [ə'siːnz] and *control* [ən'trəul], kept the unstressed syllable but lost the initial consonant. There is no longer justification for postulating a rule.

R1b, deleting unstressed initial syllables, is dead.

R2, deleting final consonants, is dead.

R3', deleting initial /s/ before obstruents, remains unchanged except for the single example of [sr] (in [sreit]) for /str/ (*straight*) from session 107. Even this usually occurred as [treit].

R4, is still complicated. Previously (stage 8) we had the rules (cf. p. 86 above):

R4a'. $C_{[+\text{sonorant, }+\text{anterior}]} \rightarrow \text{Opt} \quad Ø / C \_\_\_$

36 There was one occurrence of [dʒ] for /gr/ (*green*), and one of [d^{z}r] for /dʒ(i)r/ (*giraffe*).

R4b'. $C_{[+sonorant,\ -anterior]} \rightarrow$ Obl Ø/ C ___

R4c. $C_{[+sonorant,\ +consonantal,\ +lateral]} \rightarrow$ Opt [−lateral] / $C_{[+anterior,\ -coronal]}$ ___

At the beginning of stage 9 there were still a few examples of free variation between [C] and [C^{son}] (*play* as [pei] or [plei]; *crusher* as ['tʌsə] or ['trʌsə]), but by the end of the stage virtually all adult clusters were realised with a cluster, suggesting that R4a' had disappeared, and that R4b' is optional. However, there are additional asymmetries: /kw/and /tw/ were both realised as [tr], with no exception; /kl/ and /gl/ were realised as [tr] and [dr], again with no exception. Given the impossibility of /tl/ this is perhaps not surprising, but it is none the less of interest especially as, significantly, [tr] and [dr] were also used for /tʃ/ and /dʒ/ – i.e. for phonemically unitary onsets. /pl/, /bl/ and /fl/ were realised as [pl, pr], [bl, br] and [fl, fr, fw] respectively.[37] Clusters with a post-consonantal /r/ (/pr, br, fr, kr, tr, dr/) occurred exclusively with [Cr], never [Cl]: good evidence, as argued earlier, that Z had the adult pronunciation for his lexical representation. /gr/ was realised as [dr] or [dz] (*Grandpa*); once or twice /dr/ surfaced as [dz] (*drink*). Examples with post-consonantal /j/ were rare, but usually appeared with a bare obstruent ([t] *rescued*; [s] *suitcase*); [dr] *Duplo* or [ts] *tuna*. These facts suggest that R4c was being generalised to apply not just to laterals after labial consonants but to all post-consonantal sonorants. Accordingly, we now have the following:

R4a'. Disappeared.

R4b''. $C_{[+sonorant,\ -anterior]} \rightarrow$ Opt Ø / C ___

R4c'. $C_{[+sonorant]} \rightarrow$ Opt [r] / C ___

The appearance of the affricates [ts, dz], with the putative need to make reference to onsets such as /gr/ as gestalts, is less amenable to simple formalisation.

R5, eliminating velars, is maintained unchanged.

R6, neutralising the voicing contrast, has disappeared.

R7, neutralising coronals, allows considerably less variation than at the previous stage.

/t, d, l, n, s, z/ are systematically correct in all positions, except that occasionally:

/t/ → [ʔ] medially and finally in free variation with [t] (*batteries*, *bucket*).

37 In two words, *flapjack*, *flames*, /fl/ was realised as [s].

/ʃ/ is realised as [s] in all positions. At the end of the stage it begins to appear as [ɕ] or [ʃ], again in all positions.

/ʒ/ occurred only medially as [z] (*courgette*).[38]

/tʃ, dʒ/ occurred as [ts, dz] in all positions, and as [tr, dr] initially.

/θ/ was realised as [s] in all positions; initially once as [f].

/ð/ was realised as zero initially, and as [d] or [z] medially.

/r/ was realised as [r] or [w] initially and medially; occasionally as zero medially (*very*).

/j/ was realised as [l] (*yet*, *yellow*) or zero (*you*, *use*) initially. [j] occurred medially for part of /aɪə/ in *wire*.

These changes suggest that line (i) of R7a''' has disappeared while line (ii), fronting /ʃ, ʒ/ to [s, z], is retained. R7b'', deleting initial /ð/, is maintained, but line (ii), changing /θ/ to [s] initially, is now context free, and line (iii), changing /θ, ð/ to [t, d], is now restricted to /ð/. R7c', converting /tʃ, dʒ/ to [t, d], keeps the reference to [anterior] but loses the specification for [delayed release] as the forms produced are indeed affricates, but [ts, dz] rather than [tʃ, dʒ]. I have left the other changes unformalised. We now have:

R7a''''. [+coronal, +strident, +continuant] → [+anterior]

R7b'''. (i) [+coronal, −sonorant, −strident, +continuant, +voice] → Ø / # ___
(ii) [+coronal, −sonorant, −strident, +continuant, −voice] → [+strident]
(iii) [+coronal, −sonorant, −strident, +continuant, +voice] → Opt [−continuant]

R7c''. [+coronal, −continuant] → [+anterior]

RR8ff. are all dead.

Stage 10: Sessions 109–16. Age 3 years and ½ month to 3 years and 2 months.

A good indicator of Z's cognitive development is given by an example of his retrieval from long-term memory in session 112. We were playing and came across some juggling clubs. Z asked what they were and I said "clubs – for juggling". Long pause, then he said: "Like Uncle Ivan does." It was several months since he had last heard that Ivan juggled.

However, the most striking aspect of this stage was the manifestation of his metalinguistic abilities as exemplified by his identification of the initial segment(s) of a large variety of words, for each of which he said: "It begins with …". See the discussion in chapter 5, section 5.1.6.

38 [ʒ] occurred for /dʒ/ (*energy*) and for /r/ (*siren*).

The inventory of consonants in Z's output was [p, t, b, d, m, n, s, z, θ, ð, ʃ, ʒ, tʃ, dʒ, f, v, w, r, l, h, ʔ]. All of these occurred initially except [θ, ð, ʒ, ʔ]; all occurred medially except [θ, ð, h]; and all occurred finally except [w, r, dʒ, h]. These omissions appeared to be systematic except for the absence of [dʒ] finally, which I take it was an accidental gap, though as exactly the same pattern persisted through the next stage, this assumption may be wrong. Thus, Z now appeared to have the full consonantal inventory of adult RP except for the palatal glide /j/ (one example, *usually*, occurred) and the velars /k, g, ŋ/. However, this description is somewhat misleading as [θ, ð] occurred only marginally;[39] all the palato-alveolars ([ʃ, ʒ, tʃ, dʒ]) were in frequent free variation with [s, ɕ; z; ts, t^s, tɕ; dz, d^z] respectively; [ʒ] occurred infrequently (and in one word, *siren*, it appeared for adult /r/). Most strikingly, not only did /ʃ/ get realised as any of [s, ʃ/ɕ] (*Joshua*, *sheep*, respectively), but [ʃ] occurred not just for /ʃ/ but also sporadically for all of /sl, sm, sw/ (*sleep*, *small*, *swing*). As before, Z appeared to be generalising over 'onsets'.

Assuming that affricates were single segments and not sequences, the previous initial clusters were [dr, t^r, br, b^r, b^l, pl, p^l, p^w, f^r, f^w, sr]. These were now supplemented by the incipient sporadic use of [ʃl/ʃr] for /sl/, and of [s^w, sn, sm] for /sw, sn, sm/, though none of these was fully established, as such clusters all usually reduced to [s]. Some of the earlier clusters were extended in their usage, e.g. [pr] being used for /pj/. The only change to the set of final clusters was the addition of [-bz] and [-lvz], probably the filling of random gaps.

Medial clusters, as before, were best described as a combination of current codas with current onsets. The codas found were: [p, b, t, d, f, s, m, n, l, ʔ]; the onsets found were: [p, b, t, d, f, s, m, n, w, r, l, tr, dr, tʃ, dʒ], and gaps would appear to be non-systematic.

R1 and R2 are both dead.

R3', deleting /s/ before obstruents, is still operative initially, but not word-internally: contrast e.g. *spider* and *starving* with *newspaper* and *yesterday.*

R4, deleting post-consonantal sonorants, is disappearing. The only remnants are: first, that /j/ is systematically deleted (*new*, *newspaper*, *piano*), though /pj/ appears sometimes as [pr] so that R4c' seems to be generalising; second, /pr/ appeared as [p] in two complex words (*pretend*, *temperature*) and /fl/ appeared

39 And they occurred not at all at the next stage.

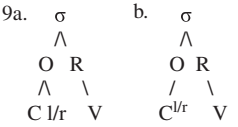
once as [f] (*fly*);[40] post-consonantal /l/ usually surfaces as [r]: only *plants* occurred with [pl]. Otherwise we have:

/kl, kr, tr, kw, skw, tw/ appear as [tr]
/gl, gr, dr/ appear as [dr]
/pl, pr/ appear as [pr]
/bl, br/ appear as [br]
/fl, fr, θr/ appear as [fr]
/vr/ appears as [vr], and
/sl/ appears as [sr].

The basic facts are captured by eliminating R4b and leaving R4c' unchanged. However, things are not quite as straightforward as this may suggest: /kl, kr/ also appeared as [ts/tʃ], /gr/ sometimes surfaced as [dʒ], and /tʃ/ and /dʒ/ as [tr] and [dr]. Again it looks as if Z is manipulating (classes of) onset rather than sequences of phonemic segments. The main generalisation is still given by R4c':

R4c'. $C_{[+sonorant]} \rightarrow$ Opt [r] / C ___

but how to capture the 'natural classes' /dʒ, gr/ (both become [dr]) and /tʃ, kr/ (both become [tr]) is not obvious. A simple treatment of the syllable as in (9a) or (9b):



allows for feature constraints on the C (allowing stops to be separated from fricatives, and labials from dorsals and coronals), but leaves unaddressed the problem of the parallelism between [tʃ] and [tr, kl], etc. [kl] is intuitively to be analysed as in (9a), [tʃ] as in (9b). It may not be irrelevant that Z seemed systematically to progress from an articulation as in (9b) to one as in (9a): early [t^r, d^r] becoming later [tr, dr]. Whatever the correct longitudinal analysis may be, it seems reasonably clear that Z provides some evidence against Yip's (2003: 782) claim that: "[i]n the absence of positive evidence for the need to refer to O/R constituent structure, Occam's razor demands that we excise them from the entities available to the grammar". The moraic models that Yip discusses (see further below) fail to make the Cl/r sequence a constituent and so render Z's development opaque.

40 And once as [l] (*flapjack*), a word whose pronunciation was generally anomalous.

R5, eliminating velars is maintained unchanged.

R6 is dead.

At the beginning of the stage the rules subsumed under R7, accounting for coronals, were virtually unchanged. By the end of the stage there was a tendency for the palato-alveolars (/ʃ, ʒ, tʃ, dʒ/) to be correctly pronounced, suggesting the elimination of R7a'''' and R7c''. By contrast, R7b''', accounting for the behaviour of /θ/ and /ð/, is essentially unchanged: there was one (elicited) occurrence of [θ] finally, and /ð/ was still produced as zero initially and as any of [ð, d, v] finally (all for *with*). In addition, there were still glottal stops in free variation with [t] in medial and final position; /r/ still occurred as [r] or [w] initially and as [r] or zero medially; /j/ was consistently [l] initially but zero in *you*, *your*, *yours*, *yourself*.

The remaining rules have disappeared.

Stage 11: Sessions 117–28. Age 3 years 2 months to 3 years 4 months.

Cognitively, his development still seemed to be age-appropriate. In session 120 I carried out a conservation-of-volume experiment. After establishing that he would judge correctly whether two identical cups had the same or differing amounts of water in, I then poured the contents of those he deemed to be the same into two receptacles – short fat and tall thin. Predictably, Z failed, saying that the tall thin container had more in. By contrast, in session 124 he demonstrated resistance to the deceptiveness of a standard illusion, responding [ɛː ə seim] – *they're the same* to the question "Which of these [two curved rails] is bigger?", when these were arranged to appear visually different.

Syntactically, his progress was similarly normal. For instance, he was tested for his understanding of minimal pairs of the type: *Can you give the dino the dog? / Can you give the dino to the dog?* and performed without error. Similarly, *tough*-movement became established: e.g. [tɔfs aː iːziː sinz tə dɛt] – *Coughs are easy things to get*.

This stage saw a further considerable number of metalinguistic judgements and, from session 125 on, the emergence of the first [sC] clusters.

The inventory of consonants in Z's output was [p, t, b, d, m, n, s, z, ʃ, ʒ, tʃ, dʒ, f, v, w, r, l, h, ʔ]: that is, the same as at the preceding stage except that the incipient appearance of [θ, ð] was not maintained. [j] occurred marginally in a couple of words but was not yet under control. All of the consonants occurred initially except [ʒ, ʔ, tʃ]; all occurred medially except [h]; and all occurred finally except [w, r, dʒ, h]. These omissions appear to be systematic – even the absence of [dʒ] finally (cf. the previous stage) where it is typically replaced by [ʒ]. There are still some interesting anomalies: /gr/ → [dʒ] (*grown-up*) but

/dʒ/ → [dr] (*Josh*). As before, /st/ is produced correctly finally (*August*) but loses the /s/ initially (*start*), but some [sC] clusters appear. Indeed, by the end of this stage, Z had complex forms like [spræʃt] and [sprint] for *splashed* and *splint*, but still could not say [kaː] (produced as [taː]).

Given the absence from the adult phonological system of /ʔ/ but its pervasive and persistent appearance in Z's output over a period of nearly two years, it is appropriate to see at this stage, when his productive performance is more transparent, what its analysis should be. The most usual source for [ʔ] is /k/, so it is tempting to see [ʔ] simply as Z's equivalent of /k/, but such an account is inadequate to the facts. In this stage I noted 59 instances of [ʔ]. Of these, 4 replaced medial /k/ (*bucket*, *picnic*, *Zachary* [twice]; 29 (22 words) replaced final /k/; 13 (11 words) replaced /k/ in medial or final clusters (/kl, kr, ks, kt, ŋk/ – *chocolate*, *quickly*; *secret*; *blocks*, *fireworks*, *injection*, *mixer*, *oxygen*; *Connector*, *doctor*; *think*); 11 (8 words) replaced final /t/ (*bit*, *bucket*, *can't*, *fart*, *got*, *not*, *quite*, *that*) and 2 occurred as reflexes of /tʃ/ (*kitchen*, *march*). There were also four words in which final /k/ was replaced by [t] (*clock*, *earthquake*, *make*, *walk*). I conclude that the simplest account is one where /t, k/ are merged (by the operation of R5) and the result is subject to phonetic variation.

In initial clusters there was some phonetic variation in the appearance of [fr] for /fl/ and /θr/ (earlier [f^{r}] for both), of [sːm] for /sm/ (earlier [s(m)]), and of [tr] and [pr] for /stj/ and /spr/ respectively.[41] The most salient change, however, was the appearance for the first time of [s] + obstruent clusters: [sp] for /sp/, [spr] for /spl/, [st] for /sk/and /st/, and [str] for all of /str, skw, skr/. The appearance of these clusters was fairly abrupt (see the discussion under R3 below), and the first few occurrences were typically produced with some effort with a lengthened [sː], as in [sːpeis] and [sːt^{h}ɔp] for *space* and *stop*. It is striking that triconsonantal clusters appeared at the same time as bi-consonantal ones, and that these exemplified the same use of [r] for all post-consonantal sonorants as with simple clusters. The only new final cluster was [ʒd] for /dʒd/ in *damaged*, notable only because it illustrates the same replacement of /dʒ/ by [ʒ] as occurred elsewhere.

Medial clusters remain a simple function of coda + onset, though this simple statement conceals two interesting points. First, as both codas and onsets can be segmentally complex this predicts, correctly, the occurrence of clusters of four elements: [-nzpr-] as in *transplant*. Second, the decision as to the location of the syllable boundary between coda and onset is not always transparent. In the case

41 There was also one occurrence of [d^{ʒ}r] for /gr-/.

of e.g. [ʔr] (as in *secret*) it is clear that the syllabic division must be [ʔ.r] ([ʔ] never appears in an onset); in the case of [fr] either [f.r] or [.fr] (i.e. no coda constituent) may be appropriate, and indeed both may be correct for examples with different stress patterns and/or different morphological structure (e.g. *Africa* and *afraid* respectively). In the case of [nd] the converse situation may obtain: i.e. [n.d] or [nd.] with no onset (as perhaps in *bandage*). Only instrumental data, sadly unavailable, might help to decide.

R3 became optional in initial position from session 125 and then disappeared. There were 35 relevant items all without [s] up to session 124; thereafter there were 10 items without [s] and 16 with [s], including several doublets (e.g. *scrambled (egg)*, some with self-correction: ['stræmbəl 'ɛd / 'træmbəl 'ɛd]). Only [p] and [t] occurred following [s], with [st] covering /sk/ as well as /st/. Triconsonantal sequences were usually maintained with [r] for the post-consonantal sonorant. As expected, /sC/ clusters continued to be correctly produced medially and finally throughout the stage (*August*, *yeast*, *plaster*, *basket*, etc.). Z had no words in his vocabulary with initial /sf/ or /sθ/; but medially /θ/ was realised as [s] before obstruents (*birthday*, *earthquake*).

R3''. /s/ → Opt Ø /# ___ $C_{[-sonorant]}$

The deletion of post-consonantal sonorants is restricted to /j/ (*human*, *William*, *computer*), but otherwise all post-consonantal sonorants – even /j/ – are realised as [r] (*Duplo*, *Tuesday*, *piano*), as expressed by R4c', now no longer optional. The only examples of post-consonantal [l] are in *aeroplane* and *playschool*, except for three anomalous examples (*sparkler*, *Piglet*, *spatula*) where the [l] is almost certainly syllable initial. Accordingly we have:

R4c''. $C_{[+sonorant]}$ → [r] / C ___

I leave unformalised the fact that all of /sl, sw, sm/ (but not /sn/) surfaced as [ʃ], as did /fl/ once in *flapjack*.

R5, eliminating velars, is maintained unchanged.

R7, accounting for coronals, is mainly unchanged.

/t, d, s, z, l, n/ are realised appropriately in all positions, with the familiar alternation between [t] and [ʔ] medially and finally for /t, k/.

/θ, ð/ are realised as [s, z] in all positions.

/j/ as before is zero or [l] initially.

/r/ is usually [r] initially and medially but still occasionally appears as [w] initially (*read*) or zero intervocalically (*very*).

/ʃ, ʒ/ occur correctly medially and finally (although [ʒ] usually represents /dʒ/) but /ʃ/ is replaced by [s] initially (except one example each of *should* and

shave appearing as either [sud] and [seiv] or [ʃud] and [ʃeiv]). Strikingly, [ʃ] occurs regularly initially but for /sl/ and /sw/ rather than for /ʃ/.

Similarly, /tʃ/ was realised correctly as [tʃ] except initially where it was realised as [tr]. /dʒ/ occurred in initial position correctly as [dʒ] (e.g. *Josh*) or as [dr] (e.g. *jungle*); medially it was systematically correct; finally it occurred as [ʒ]). This suggests that the only surviving part of this rule is the simplified second line of R7b''', giving R7b'''':

R7b''''. [+coronal, −sonorant, −strident, +continuant] → [+strident]

Stage 12: Sessions 129–41 Age 3 years 4 months to 3 years 7 months.

Cognitively, Z's arithmetic ability was progressing: on testing (with the Bob the Builder numbers game in session 135) he could correctly identify the numerosity of any set up to 10 and identify the correct numerical symbol to go with it.

In view of the remark about his mastery of *tough*-movement in the preceding stage it is interesting that his interpretation of such structures was not the same as the adult interpretation. In session 131 I tested him with *easy-to-please* examples ("*Is Bob easy/difficult to see?*" when Bob was lying face-down, face-up, blindfolded, etc.). He answered consistently with subject orientation (i.e. it was easy/difficult for Bob to see). I also tested him (session 135) for his mastery of compounds (Gordon, 1985) for which he consistently used the regular singular or an irregular plural: someone who eats spiders is a "spider eater", someone who eats elephants is an "elephant eater", but someone who eats mice is a "mice eater".

The highlight of this stage is that velars finally appear.

He began to use velars sporadically (e.g. ['græmpaː] for *Grandpa*) from session 129, but the vast majority were still systematically replaced by the corresponding coronals (/t, d/). This is despite the fact that he used e.g. [gæk] as a frequent nonsense word, and appeared to have no difficulty in producing it, or any need to concentrate to pronounce it. Yet he was still unable to imitate 'cake', producing it consistently as [teit] (session 132): that is, his lexical knowledge appeared somehow to inhibit imitation. In session 129 he was still using [d, t] for /g, k/ more than 95 per cent of the time, and [n] for /ŋ/ 100 per cent of the time. Strikingly, the appropriate use of velars began in clusters and their appearance was hardly 'across-the-board'. A typical example of variability was recorded in session 130: ['drænmaː ən 'græmpaː] – *Grandma and Grandpa*, with no assimilation of the /n/ in *and* before the velar. By session 136, when he had essentially mastered velars, he not infrequently used [k] for /t/ (before a syllabic [l]): ['hɔspikəl] for *hospital*; [lɛŋkəl] and even (once) [lɛŋtəl]

for *lentil*. A striking example of inconsistency was provided by his saying in the space of five minutes [likəl mʌntiː] for *little monkey* (referring to his brother), but [kʌp əv tiː] for *cup of tea*. This looks suspiciously like the perceptual problem that was characteristic of his father and has interesting implications for certain of his lexical representations.

The inventory of consonants in Z's output was [p, t, k, b, d, g, m, n, ŋ, s, z, ʃ, ʒ, tʃ, dʒ, f, v, w, r, l, j, h]: i.e. the adult system except for the absence of [θ] and [ð]. There were still one or two examples of [ʔ] but it had almost gone. [k] and [g] appeared first initially and then medially and finally. [ŋ] occurred only as an assimilated form before [k] or [g] (*pink*, *longer*); cf. his pronunciation [jʌnə] for *younger*. [j] was gradually becoming established, but there was no example of [θ] and only one sporadic occurrence of [ð] (*brother*): /θ/ was always replaced by [s], /ð/ by [d] or [z]. Clusters and complex segments were still subject to considerable variation: for instance, /dʒ/ was usually correct as in *jug* ([dʒʌd]) but was sometimes realised as [dr] in *Josh* and *job*, whereas /dr/ itself was realised as [dʒ] in *dragon* ([dʒægən]). This too may reflect perceptual confusion as well as articulatory incompetence, though his pronunciation of *dragon* a year earlier as [drædən] makes it hard to be sure.

Except for clusters involving the still non-existent [θ] this stage saw the first appearance and general consolidation of all the remaining initial clusters of the adult language. First [gr] appeared and then [kr] (for both /kr/ and /kw/); then all of [gl, kl, kw, pj, sl, sk, skr, sw, skw, skj, stj].[42] Remaining gaps such as [bj] are presumably accidents of Z's vocabulary. Despite this progress there were still many instances of incorrect reflexes for adult clusters: of sequences already established, [tr] now appeared for /tj/, [st] for /stj/ and [str] for /stj/. New clusters (new at least in terms of phonetic detail) were [stʃ] for /skw/, [sːw] for /sw/ (repeating an earlier trend for lengthened pre-consonantal [s]) and [sk^{h}] for /sk/. The only new final clusters were the appropriate [ks, kt, gz, sk, ŋk, ŋks]. Again, remaining gaps appear to be accidental. As before, medial clusters are a function of coda plus onset and included: [kl, kt, ks, sk, skj, ŋk, ŋkr] in *chocolate*, *tractor*, *oxygen*, *stethoscope*, *rescue*, *monkey*, *concrete*.[43]

R3'', deleting pre-obstruent /s/, having become optional now gradually disappears.

R4c'', converting post-consonantal sonorants to [r], is still operative but, crucially, only when the sequence [Cr] corresponds to a licit sequence /Cr/ in the adult

42 For the exact sequence of appearance, see the Appendix on 'Clusters' (section 7.1).

43 There was as usual some phonetic variation: [ʔks] for /ks/ in *oxygen*; [nkr] for /ŋkr/ in *concrete*.

language. Thus [tr] appears for /kw/ and [pr] for /pj/,[44] but /nj/ (as in *knew*) and /hj/ (as in *huge*, *human*) were produced as [n] and [h]. It was operative until about session 133 when post-consonantal [l] was (re-)established, and until the end of the stage for post-consonantal [w], which appeared sporadically from session 140. Post-consonantal [j] appeared towards the end of the stage.

R5, eliminating velars, finally became optional. Note that the first appearance of [g] was in *Grandpa*, one of the earliest and most practised words. This would be unexpected if the claim (e.g. by Hayes, 2004; see the discussion on p. 29) that the earliest established words are the last to conform to new patterns is correct.

R7 still eliminates the inter-dentals but is dying. The properties of the anomalous clusters described above are left unformalised.

Stage 13: Sessions 142–54. Age 3 years 7 months to 4 years.

Finally, the remaining elements of the adult system appeared with the mastery of inter-dentals and, by his fourth birthday, Z was close to the adult system, but even at this time there were a number of notable deviations from the target.

Initial /ð/ was still consistently zero, though it was beginning to appear correctly both medially and finally. There was one occurrence of [ðə] for *the* in session 154.

/θ/ likewise was still usually replaced by [s], but there were occurrences of [θ] in all positions, even initially in session 154.

/ŋ/ was invariably [n] in the progressive form of verbs, but was beginning to appear correctly as [ŋ] elsewhere: e.g. *long* and *strong* at session 149.

/ʃ/ was still occasionally replaced by [s] in all positions except finally (*vanished*, *special*, *sharp*).

One example of initial /sf/ was realised as [f].

There were one or two random, idiosyncratic mispronunciations: e.g. [waiɬ] and [faiɬ] for *wire* and *fire* - i.e. dark [ɬ] for final [ə].

There were still some examples of [t] for /k/ and many hypercorrections involving velars: *total*, *middle*, *gone* ([gɔŋ]).

There appeared to be a number of recidivistic pronunciations, probably with words that had no minimal pair and were either stored underspecified or were being corrected piecemeal over time. In either case they constitute counter-examples to my position. It may be that such perseverations as [win] and [trʌm] (for *wing* and *crumb*) are a function of the connectionist network needing time to be re-channeled or unlearned. If so, it should be the case that they should be

44 There are exceptions even then: *computer* appeared just with [p] until [pj] was mastered.

more common with (previously) more frequent words, with the least frequent being the least likely to perseverate. This is, of course, on the additional assumption that mini-networks are laid down for each lexical item. If this speculation is correct then it may be possible once again to defend the claim that perception is close to perfect.

There are no more regular, productive phonological rules. Z's acquisition of his segmental phonology is virtually complete.

5 *The nature of the acquisition of phonology*

All children are different, even – perhaps especially – father and son, but when it comes to language acquisition all seem to accomplish comparable tasks in roughly comparable time-frames. On the basis of my study of A, I made some fairly detailed and explicit claims and predictions about how children acquire phonology. I now look at the extent to which the study of Z constitutes a corroboration or a refutation of those claims.

As outlined in chapter 2, the main claims of APh were that the child's acquisition of phonology was rule-governed; his lexical representations were largely equivalent to the adult surface forms, which were related to his own pronunciation by an ordered series of realisation rules and phonetic detail rules. These rules conspired to bring about certain results and jointly helped to define his competence, but the child had no system of his own. These claims gave rise to a model in which perception played a minimal role, but this position was modified in the light of criticism and reanalysis to give a model which allocated an important, if minor, role to the child's perceptual abilities.

Several decades of research by others, together with my own revisiting of the terrain in the form of my study of Z, has reinforced some of these claims but has triggered a revision or reconceptualisation of others. The main conclusions can be summarised as in (1–3), each of whose sub-parts will be illustrated and justified in the following sections. Although conceptual issues raise technical problems, and sometimes vice versa, those in (1) are largely conceptual, those in (2) are more technical, and (3) attempts to provide a model to replace that on p. 28.

1a. The child's performance is rule-governed but, as this way of expressing it suggests, the rules are a matter of performance rather than of competence.

b. The child has no system of his own; hence there are no output representations, no contrast between input and output lexicons, and no dual grammar. As a corollary, the child's lexical representations are in general equivalent to the adult surface form.

c. There is none the less a clear, if minor, role for perception, so not all the child's representations are 'correct'.

d. The distinction between realisation rules and phonetic detail rules is unmotivated, indeed undesirable. Both may be replaceable by a single, undifferentiated, neural network.

e. The drive for communication in the absence of a fully functioning phonological system is powerful. One manifestation of this is seen in the importance of gestures.

f. The children's metalinguistic ability is considerable and provides an insight into their phonological knowledge (and may make some of the other claims listed here problematic).

g. Most of the phenomena identified as being in need of explanation in APh are still salient. Apart from the predictability characteristic of all rule-governed activity, these include: the existence of grammatical constraints on phonological development, recidivism, the 'across-the-board' nature of change (albeit in somewhat attenuated form), the existence of systematic exceptions, and variation both in a single child and across children. These phenomena, suitably interpreted, simultaneously constituted the evidence for the various theoretical claims made in APh. Even where the phenomena are confirmed or extended, as in the amount and significance of variation which is greater than I had previously thought, their interpretation has changed in significant respects.

2a. The children's productions provide evidence for the units of analysis that the phonology needs to assume: distinctive features, syllables and, most strikingly with Z, the notion '(syllable) onset'.

b. On a performance analysis, the conspiratorial 'function' of realisation rules is an epiphenomenon. Conspiracies are formally unnecessary if there are 'no functional constraints beyond transparency'.

c. There is no rule ordering. This is strongly suggested by considerations of learnability and necessitates a certain amount of reanalysis of some of the data in APh.

3. The union of the properties in (1) and (2) requires a model which combines the best of several different theories. Central to such a model is an explicit statement of the rules and representations it is necessary to postulate. Whether any such unifying model is coherent and consistent is an interesting issue (see figure 3 below).

5.1 Conceptual issues arising from the phonological development of A and Z

5.1.1 Competence and performance (again)

The child's developing phonology is rule-governed. The claim is not contentious[1] and is clearly corroborated, but this way of phrasing it is misleading if the

1 The claim at this level of generality is not intended to favour rule-based over constraint-based systems: a more neutral locution might simply be 'systematic' or 'pattern-implementing'. I return below to the question whether 'rule-governed' is an appropriate locution for processes implemented by a neural network.

rules, specifically realisation rules or their equivalent, are taken to be rules of the child's grammatical competence. The current theoretical interpretation of this systematicity has changed radically. If the child has no system of his own, and his lexical representations are in terms of the adult surface forms, the logical conclusion is that, as Hale and Reiss (2008) suggest, the major determinant of children's divergent productions is performance rather than the competence account argued for explicitly in APh (pp. 148ff.). Some aspects of the child's performance are clearly a function of his competence – e.g. his lexical representations, whether these correspond exactly to the adult form or not – but the major determinant of productional deviation from those adult forms is a matter of performance.

5.1.2 The child's 'system'

The child has no system of his own, except in so far as this reflects the absence of a characteristic of the system he is exposed to. Absent characteristics may, of course, differ from child to child. In fact, APh was inconsistent on this issue. I claimed explicitly, and argued at length, that the child had no system of his own, but the difference I drew between realisation and phonetic detail rules presupposed that the child did have his own system. That is, making the claim, for instance, that the child's phonology made no voicing contrast is tantamount to assigning it an autonomous status distinct from that of the adult language. Accordingly, I now believe that no such distinction between rule-types is either needed or desirable. This conclusion is important for several reasons: first, it is incompatible with usage-based approaches; second, it implies that OT's treatment of phonological acquisition in general, and Smolensky's (1996) treatment of the perception–production asymmetry in particular, are wrong; third, it suggests that the basic assumption of 'continuity' is right.

Let us begin with the 'absent characteristics'; for instance, Z's lack of velars until the age of 3 years and 4 months. Rather than being a characteristic of an autonomous system this should be viewed as the side-effect of the inability to control the articulation of a gesture which was appropriately mentally represented – as witness the child's ability correctly to discriminate pairs like *train* and *crane* that he pronounced identically. Such an account needs refining to accommodate 'chain shifts' of the kind exemplified by 'puzzles', but I am persuaded that Hale and Reiss's reinterpretation of such data is plausible. That is, A was capable of producing the sound sequence [pʌdəl], but he could not "reliably pronounce his mental representation [z] in *puzzle* as a bodily output of a *z*-type" (Hale and Reiss, 2008: 63ff.). Comparable remarks obtain with regard to Z's pronunciation of *horse-shoe* as [hɔːt suː] (with [t] for /s/ but [s] for /ʃ/), or

his later replacement of /ʃ/ with [s] (for *she*) but /sl/ with [ʃ] (for *sleep*). In the former case, the inability to control the articulation of different fricatives was context-dependent: at the time he produced *horse-shoe* /s/ (and /ʃ/) were always pronounced as [s] initially but [t] finally. In the latter case, the inability to articulate the appropriate sequences, [s] and [ʃ], was exactly parallel to the *puzzle* example.

Usage-based approaches (e.g. Bybee, 1999; Tomasello, 2003) argue that using (e.g. pronouncing) a word has an effect on its stored representation, but there is no evidence that Z's pronunciation of words like *cake* as [teit] for some fifteen months had any such effect at all. Two caveats are necessary: first, I would not deny that the effects of misperception might be reinforced by the child's own pronunciation, so his rendering [mʌntiː] for *monkey* after he had begun to master velars may have been due in part to his saying the word frequently in this way. However, the prime example of this pronunciation was as part of the phrase [likəl mʌntiː] for *little monkey*, and *little* was otherwise invariably correct, so this explanation seems unlikely to generalise to the vocabulary as a whole. Second, Z's conversion of a coronal affricate and a sequence of a coronal plosive followed by /r/ to the same affricated output (*tree* and *cherry* pronounced as [tˢiː] and [tˢɛiː]) might be suggestive of his using his own system, but these forms appear never to have given rise to subsequent confusion or mispronunciation.

The claim that the child has no output representation is inimical to OT analyses because the theory is based on the assumption that constraints relate mentally represented entities. Absence of one set of the mental representations to be related then leaves the assumption, and the theory, in limbo. Given its connectionist connections (see Prince and Smolensky, 2004: 235f.) it might be expected that the theory could be made compatible with the claim that there are no psychologically real output representations. I leave it to aficionados to determine exactly how. The central issue is the relation between symbolic and sub-symbolic systems and the correct extent of the term 'knowledge (of language)' in this context. It is not obvious that a "network's knowledge" (Prince and Smolensky, 2004: 238) is a coherent epistemological notion.

There are further implications of the claim. First, it is incompatible with the idealising assumption of OT that, by the time the child comes to rank the relevant constraints, he already has the representations which are the target of acquisition. Second, it is at variance with OT's claim that child phonologies are instantiations of the factorial typology predicted by the re-ranking of a universal set of constraints. If what the child produces is not represented it cannot be such an instantiation. Third, on a rule-based or a constraint-based theory it ought to

follow that the same parsimonious analyses apply to the adult phonology as well as to the child's. That is, adult output should also not be represented (for further discussion, see p. 118 below). This assumption would in turn obviate a certain tension with regard to the continuity hypothesis. Ascribing adult-equivalent representations to the child is tantamount, in this domain, to adopting continuity: the system attributed to the child is the same as that attributed to the adult. But denying that the child's output is represented and claiming that his phonological development is a matter of performance seem to suggest that this development could be a purely maturational, physiologically based, process. If adult output were represented then we would need to account for the maturing child's progression from 'non-represented' to 'represented'. If the adult output, like the child's, is not represented there is no challenge to continuity.

If there are no output representations this raises the general issue of what levels of representation it is necessary and appropriate to attribute to the child. From "The logical structure of linguistic theory" (Chomsky, 1955) to *The Minimalist Program* (e.g. Chomsky, 1995; Chomsky *et al*., 2005), this issue has been central to linguistic theorising. Employing Occam's or Chomsky's (minimalist) razor, I have defended the position that only the adult surface form is represented and that the child's own pronunciation has no status. The child may say [gʌk] for *duck*, but only /dʌk/ (and not [gʌk]) is mentally represented as a linguistic construct. This claim leaves open the possibility that the child may on occasion observe and represent his own output in much the same way as he observes any other part of the changing environment as a non-linguistic construct (for further discussion see p. 116 below).

5.1.3 Lexical representations

The child's lexical representations are overwhelmingly the same as the adult surface form but, as has been clear since Braine's (1976) and more especially Macken's (1980) work, there is a not insignificant role for perception. How wide-ranging perceptual factors are is contentious because it is hard to distinguish them from faulty accessing of a correctly stored form (see the discussion in Pater, 2004). Thus, the considerable variation in Z's speech could in principle be attributed either to representational underspecification or to incorrect rendition of correct forms. The latter seems to provide a more accurate account of the facts, so it is relevant at this point to recapitulate the evidence for the child's lexical representations being the same as the adult surface forms, using data from Z instead of from A.

First, despite pronouncing e.g. *train* and *crane* identically as [tʳein], Z was able to identify and retrieve the appropriate toys with perfect

consistency.[2] Second, he showed the same asymmetric alternation as A did in his treatment of some clusters. For instance, while /Cr/ was always produced as [Cr], /Cl/ varied between [Cl] and [Cr] as shown in (4):

4. black → blæʔ/ bræʔ bread → brɛd / *blɛd

That is, the child's pronunciation [Cr] disguised a consistent difference in mental representation as between /Cl/ and /Cr/. Third, Z showed the same asymmetric development over time as A. For instance, adult /b/ and /bl/ were initially neutralised as [b]. Later /b/ remained as [b], while /bl/ was realised correctly as [bl], but /b/ was never pronounced as [bl], as shown in (5):

5. T_1 black/back → bæʔ
T2 black → blæʔ back → bæʔ/ *blæʔ

Fourth, as is implicit in the previous examples, Z produced newly mastered sounds and sound sequences 'across-the-board': new pronunciations appeared in (almost) all and only the correct words. As can be seen in the detailed analysis of chapter 4, the across-the-board nature of development is less clear-cut with Z than with A, but its overwhelmingly regular incidence is still theoretically important. Fifth, as described in chapter 1, section 5, Z showed variation conditioned by unpronounced properties of the adult form, resulting in examples of opacity such as (6):

6. [ɔː ə ləud] – *all the load* versus [ɔːl in ɛː] – *all in there*.

That is, /l/ is deleted before an (unpronounced) adult consonant but retained before an adult vowel. This is reminiscent of A's plural formation where examples like *cat/cats*, *horse/horses*, *cloth/cloths* were realised differently (as [kæt/kæt, ɔːt/ɔːtid, klɔt/klɔtid]) according to the final consonant of the adult form. Such examples are presumably the result of grammatical constraints on the phonology. In the case of A this was further illustrated by the effect of morpho-syntactic category on the realisation of final /z/ (see above, p. 6). In Z's case the most striking manifestation of grammatical interference was the use of the 'filler morpheme' or dummy auxiliary [ha], but additional evidence came from the selective treatment of initial /j/ and /ð/. That is, he omitted any initial consonant or glide in his pronunciation of *you/ your/ yours/ yourself*, while maintaining some segment (usually [l]) for all other words beginning with /j/, and he omitted initial /ð/ entirely, presumably because all such words are 'functional categories' in the adult language. Sixth, 'incorrect' forms like

2 And similarly with many other pairs: *book/boot*; *Helen/helicopter*; *sheep/sleep*, etc.

['mɔrəu] for *tomorrow* often appeared in free variation with correct forms: e.g. [tuː'mɔrəu],[3] suggesting that the former pronunciation is unlikely to be due to the absence of the correctly stored adult form.

Seventh, and finally, Z frequently showed the effects of recidivism. That is, he acquired a correct pronunciation and then regressed to (a potentially different) mispronunciation: for example, *red* was produced as [rɛd], then as [wɛd] and finally as [rɛd] again. In APh this phenomenon was explained in terms of changes to the child's competence as determined by the manipulation of particular features: "rather than make the odd claim that the child really has lost again some articulatory ability after he has once mastered it … we can invoke the psychological validity of the realisation rules and the structural pressure of their longitudinal development in terms of hypotheses based on the distinctive features available" (APh: 154). Others (e.g. Jusczyk, 1997; Vihman, 1996) have suggested that such U-shaped learning is a function of the child's transition from a stage when he is deploying a whole-word system to one which is segmentally based (cf. Barton, 1976; the discussion of 'discontinuity' by Vihman and Velleman, 2000b; and Plaut and Kello's remark, 1999: 408–9, that U-shaped learning is 'ubiquitous'). This 'transitional' hypothesis seems implausible in A's and Z's cases as they were already beyond any prephonological stage when the clearest instances of recidivism took place. However, as Hale and Reiss (2008: 65f.) emphasize, my competence account is – in part – similarly suspect and should yield to a performance explanation. A competence account is accurate in so far as the lexical representation is concerned: *red* is presumably /rɛd/ throughout. It is incorrect in so far as the 'loss of some articulatory ability' needs to be contextualised to specific examples and not treated as an absolute. Indeed, if the realisation rules are really 'malperformance' rules and the child's output forms have no psychological status, this conclusion is forced. The most likely reason for the recidivist pronunciation [wɛd] is that it is inherently easier than [rɛd] and occurred when the child was devoting his subconscious attention to mastery of other aspects of the system, either phonological or syntactic or both. An additional piece of evidence in favour of a performance account comes from the child's interpretation of recordings of his own utterances as corresponding to the adult meaning rather than his own (e.g. A's 'sip' example – p. 23 above). The assumption that the child's lexical representations are equivalent to the adult's while his own forms have no status is sufficient to explain his behaviour.

3 The replacement in child language of schwa by a full vowel is not uncommon: see e.g. Levelt (2008).

5.1.4 The perception–production mismatch: gestures

If perception is virtually impeccable and the child's lexical representations are adult-like we need an account of why there is a mismatch between percept and product. Before rehearsing the various alternatives in section 5.1.5 let us turn briefly to the role of gestures (far greater for Z than for A): that is, where the mismatch is greatest with no vocal correlate of the word for intended referent at all. It appears that the demands of communication induce surprising performance strategies in a child with a limited phonological system. A striking example of this was provided at the age of 1 year 10 months 24 days when Z was having his eyesight tested. As is normal when testing children of that age the stimuli used were pictures of sundry objects that the child had to identify. Z's spoken language was inadequate to the task but he was immediately able appropriately to indicate (e.g.) a duck by providing his gesture for it (an undulating movement of the right hand).

As outlined in chapter 1, section 1.1, the child's lexical representations license a mapping between PF and LF. The LF (meaning) is a semantic representation which also provides access to encyclopaedic (conceptual) information. That is, I assume that a concept (e.g. LAWN-MOWER) is a triple (see Sperber and Wilson, 1986) of logical, linguistic and encyclopaedic information. A gesture is then an alternative 'PF',[4] whose properties are typically derived iconically or by association from encyclopaedic knowledge of the entity referred to.

Gestures are sometimes claimed to be precursors, or even prerequisites, to language acquisition (e.g. Tomasello, 2008). However, Tomasello's claim that pointing and pantomiming are necessary for the establishing of linguistic convention seems unlikely to be true in the light of the linguistic abilities of blind (Landau and Gleitman, 1985) or spastic (Lenneberg, 1967) children. Despite their prevalence and inherent interest, gestures probably have few implications for the nature of language more generally. Goldin-Meadow observes that children use deictic and iconic gestures before speech, but metaphoric and 'beat' gestures only after the onset of speech. Moreover, they may "produce gesture–speech combinations in which gesture conveys information which is *different* from the information conveyed in speech" (1999: 423; see also Behne, 2008), and such combinations predate two-word utterances. Most of Z's gestures (see the end of the diachronic lexicon in ch. 6, section 6.3, for a full list) were imitative: e.g. WATERING (of flowers), or RUBBING (of sore

4 Or a simultaneous sub-part of the PF. That is, a gesture may co-occur with a more standard phonological form such as that represented in the present example as [moː]. Z's gestures appeared not to have the systematic syntactic motivation that Jouitteau (2004) describes.

eyes – to refer to his father by indicating his problem with hay-fever). Others recalled a particular activity (NAIL-CUTTING to refer to his grandmother, who usually cut his nails), or WRINGING of hands to refer to his uncle, who had 'poorly hands', and so on. All his gestures were iconic rather than just deictic, and referred to objects and actions rather than events. I observed no examples of the gesture–speech combinations Goldin-Meadow describes.

5.1.5 The perception–production mismatch: theoretical alternatives

My original suggestion, recapitulated above, was that the child is applying a set of realisation (and phonetic detail) rules, subject to universal functional constraints, effecting a mapping from the lexical representation to an output representation which is the interface for articulation. My current view (cf. Smith, N.V., 2003) is that there are no output representations at all: the child's output is simply a non-represented function of a performance-based neural network mapping lexical phonological structure to articulation. This position is close to Hale and Reiss's (1995: 18) claim that there is a contrast between the 'output of the grammar' and the 'output of the body', so that "deviations from target forms … are to be attributed to performance effects" (ibid.); or to Donegan's (1997: 214) assertion that "the child's underlying forms are accurately specified and … articulatory constraints cause substitutions that prevent their accurate realization".

Other putative explanations for the perception–production asymmetry include those in (7), all of which presuppose (or assert) that the child's output is represented.

7a. The child has more than one grammar.

As seen in chapter 2, section 2.4, this claim comes in a variety of flavours: the child has two grammars, or just two lexicons, which develop in partial independence. There are more sophisticated variants of this basic position. Pater (2004) develops an account within OT that avoids the problem of accommodating the parallels between within-word and between-word processes, and Anttila (2007) discusses the relative merits of multiple grammars, partially ordered grammars and grammars couched within Stochastic Optimality. Occam would turn in his grave at the thought of any of these alternatives, and there are also empirical objections, again as documented in chapter 2, but there is supposedly one major advantage of dual models: the treatment of variation.[5] Phonetic

5 On variation in general see Goad and Ingram (1987); Demuth (1997); Kerswill and Shockey (2007); on the beneficial effects of variation, see Pierrehumbert *et al*. (2000: 292); on the use of systematic variation see Fikkert (2007: 541).

variation in Z was dramatically more, and phonological differentiation dramatically less, than in his father:[6] for instance, the articulation of particular segments, the development of clusters and the pronunciation of specific words are all less uniform in Z than in A. None of this, however, justifies the theoretical inelegance of a dual lexicon whose benefits can be reproduced either by simple rule optionality or by its network equivalent.

7b. The child's lexical representations are seriously underspecified (e.g. Ingram, 1974; for discussion, see Fikkert, 1995; Steriade, 1995; Goad, 1996).

This claim also predicts variation in production. Unfortunately, the variation that is found is not restricted to that which is predicted (see the discussion of Z's treatment of initial /ð/ above, or the account of consonant harmony in Fikkert, 1995). There is also a theoretical objection: if it is correct to treat children's lexical representations as equivalent to the adult surface forms, in part because they can be shown to perceive minimal contrasts that they do not produce, as with both A and Z, the 'lexical minimality' (Steriade, 1995: 114) that underpins underspecification is irrelevant.[7]

7c. The child has to unlearn innate constraints (Stampe, 1969).

Stampe argued that children's pronunciation reflects their gradual suppression of the effects of a set of innate universal 'natural processes', such as assimilation, on the basis of their exposure to a specific language. Appealing though this biological program may be, Stampe's position was somewhat overly 'deterministic', to use Kiparsky and Menn's (1977) term, with the result that it was incapable of handling the kind of recidivism (U-shaped learning curve) found in many children's phonology, including both A and Z. Further, as his theory was predicated on the assumption that the phenomena of acquisition and of fast speech are manifestations of the same 'natural' processes, he had no account of consonant harmony, which is entirely lacking from the latter (for discussion, see Menn, 2004). Stampe is silent on the question whether the child's production 'form' constitutes a level of representation or not, but the logic of his position seems to demand that it is.

6 See for instance the entries for *book* and *milk* in Z's diachronic lexicon (below) in comparison with the same entries in APh, where only the forms [b̥uk] and [buk] occur for the former and [mik], [mlik] and [milk] for the latter.

7 Lexical minimality claims that "underlying representations must reduce to some minimum the phonological information used to distinguish lexical items" (Steriade, 1995: 114). The other assumption underlying Steriade's discussion – 'full specification' (i.e. "the output of the phonological component must contain fully … specified feature matrices") is denied by the claim that there is no output representation.

7d. The child is indulging in constraint re-ranking (Smolensky, 1996; Tesar and Smolensky, 2000; Gnanadesikan, 2004).

The statement in (7d) pertains to the acquisition process in general. The best-known solution to the specific issue of the mismatch between perception and production, and hence for the asymmetry between lexical representation and the forms that the child produces, is that formulated by Smolensky (1996: 729–30) as: "grammars are parallel optimisations over structural descriptions containing both input and surface forms".

As indicated above (pp. 40–1) there are technical problems with this claim and Hale and Reiss (1998) have additional parsing objections, but let us anyway look at it a little more closely. Occam would like it to be that in the child's initial state all constraints are unranked (as e.g. in Tesar and Smolensky, 1993), but this gives rise to the subset problem (Kager *et al*., 2004b: 42). This is the problem of how, on the basis of only positive evidence, a child can arrive at the knowledge that some logical possibility is impossible in the language being learned. The problem can be solved by appeal to the subset principle, according to which the child always hypothesises that the language being acquired is a subset of all the possible languages compatible with his current knowledge,[8] so the consensus is that in the child's initial state markedness constraints outrank faithfulness constraints, as there will always be positive evidence for any faithfulness constraint outranking some markedness constraint (Tesar and Smolensky, 2000: 76; Gnanadesikan, 2004). The consensus is not total as can be seen from Hale and Reiss's observation (1995: 22–3; cf. their 1998: 665; 2008: 79) that "a compelling case can be made for the assumption that all faithfulness constraints are ranked, in UG, above all well-formedness constraints". There appears to be an impasse.

However, Occam's razor can be wielded in different ways: my minimal(ist) resolution of the impasse claims that the child's output forms are not 'represented' at all. As a consequence neither my realisation rules (nor equivalently OT constraints[9]) have any psychological status. The child's own pronunciations are the result of the operation of a neural network in the spirit of MacWhinney (1999) which yields the appropriate outputs. But these outputs do not define a level of representation (Smith, N.V., 2005: 141). If there is no representation there needs to be no ranking and Occam can rest in peace.

8 For detailed discussion see Hale and Reiss (2008: ch. 2).

9 I assume that for OT to work even a restriction to faithfulness constraints (limited to input → output mappings) would still necessitate the psychological reality – hence representational status – of both.

There are several possible objections to such a strategy, some of which I address below, but we can dismiss one directly. The suggestion amounts to what Sanoudaki (2007: 79) refers to as a "grammar-external account of output", saying that, on the assumption of continuity, it is 'redundant'. However, there is a question of truth as well as economy. That is, the fact that output forms can be characterised using the same devices as are used to describe underlying forms does not justify postulating an extra level of representation if that can be avoided. As is explicit in Minimalism, learnability and evolutionary considerations both work in favour of 'external' accounts. Moreover, when the child is processing language in real time, the onset of the operation of the neural network would mark the transition from competence to performance: the grammar hands over a representation to the performance system – the production system in this case – and its responsibility finishes at that point. The formal properties of realisation rules and neural networks may overlap (not surprisingly – they effect the same mapping) but their psychological status is radically different. This position is closely parallel to that of Hale and Reiss (2008: esp. 83), where the relation between underlying representations (their X) and the output of the grammar (their Y) is different from that between the latter and the "output of body" (their Z). Both are mappings, but Y is a mental representation of the child's and Z is (the linguist's representation of) an acoustic (or articulatory) event.

Although my proposal is a radical alternative to the standard positions, there are some parallels in the literature. For instance, Stemberger (1992: 166) suggests that "the child has no overt [= 'represented'] procedures for adapting perceived forms to a form that he or she can produce". But the data listed above showing that the child's lexical representations are the same as the adult surface forms and the consistency of children's production make it implausible that their pronunciations are simply "errors of access" to the lexical representation as Stemberger claimed (1992: 185). Both Stemberger's and my positions are clearly performance oriented, as is Lindblom's (1992: 135) theory which "derives phonetic forms as adaptations to universal performance constraints". This is persuasive except that Lindblom's use of an analysis-by-synthesis approach with a feedback loop is fatally flawed in that it predicts that the child will get permanently stuck with 'puzzles' (see Morton and Smith, 1974). That is, as he monitors his own output the child attempting to say e.g. '*puzzle*' will hear himself produce 'puddle' and so will attempt to self-correct. This repair will give rise either to a repetition of the same sequence, *ad infinitum*, or to the production of '*puggle*', an equally anomalous output.

The most extensively argued position for a performance account is Hale and Reiss (1995: 18), who observe that "[i]t is an empirical question, in our view,

whether or not in each case the output which forms the basis for the constraint rankings in that paper [Gnanadesikan, 1995] represent[s] output of the grammar or output of the body". "Deviations from target forms … are to be attributed to performance effects, including nonlinguistic cognitive[10] and motor processing" (1998: 658; cf. their 2008).

There are also performance-compatible accounts within OT. In Stochastic Optimality Theory (Boersma and Hayes, 2001) the random value temporarily added to the ranking value of constraints (the selection point) is, I assume, not mentally represented. That is, the input to the Gradual Learning Algorithm – arbitrarily ranked constraints – is not psychologically real. This is just as well if up to 100,000,000 learning trials and 50,000 test cycles are needed to establish the correct ranking (Anttila, 2007: 532–3). The absence of psychological reality is made explicit, at least as regards the innate status of constraints, in Boersma's (2006: 20) claim that "[t]he learning algorithm predicts rankings of faithfulness constraints by frequency and auditory cue quality, without the need for innately ranked positional faithfulness constraints (Beckman, 1998), rankability by extralinguistic knowledge of auditory distances (Steriade's, 2001, P-map), or rankability by linguistically computed confusability (Boersma, 1998)".

So it would appear that there are precedents of a similar nature in the literature which lend a *prima facie* plausibility to the suggestion. But wielding Occam's razor can give rise to problems: maybe Occam is Procrustes in disguise. What phenomena are we unable to describe or explain properly if we abandon the symbolic claim about output representations and the processes responsible for them?

There are several issues involved. The first, already mentioned earlier, is whether the child's 'system', in particular his apparent phonological inventory, has any status. Consider the derivation for *squat* given in (13) of chapter 2 above. The adult form in /…/ is demonstrably what the child represents; the pronunciation in […] is observable, whether or not it is mentally represented by the child. What about the intervening forms in pipes | … |, the child's putative phonological representation? Do they have any status, or are they 'pernicious' as suggested above (p. 43)? Consider a specific example: even though a child may produce no [s] whatsoever – its 'system' has no fricatives – it correctly recognises, so must have as part of its representation, the adult /s/. The absence of productive ability is clearly not evidence for the absence of representation. As a second example,

10 Examples of such 'cognitive' effects include imitation, avoidance and the extra burden of accessing low-frequency words. For the first see Zonneveld's (in press) "Catching heffalumps" and its discussion of the role of imitation in reflecting properties of the grammar; for the second, see e.g. Schwartz and Leonard (1982); for the third, see Stemberger and Bernhardt (1999: 434).

consider the same child who may perceive the adult voicing contrast and also produce voiced and voiceless (etc.) segments, but make no contrast between them in his production – they are the result of 'low-level' phonetic rules (cf. the earlier discussion). Is there any psychological or linguistic content to the statement "the child's system has no voicing contrast"? Equivalently, is there a distinction between those rules (constraints, processes, whatever) that neutralise /t, d/ and those which specify their phonetic detail – the difference between 'realisation' rules and 'phonetic' rules? Given that the child's competence as reflected in his lexical representations includes a voicing contrast the answer must be negative. In other words if the child's pronunciation is not mentally represented, the nature of the realisation rules has changed – they are not so much 'rules' in the traditional sense as purely performance entities. This conclusion is reminiscent of the Hallean argument against a phonemic level of representation and is also compatible with parts of the laboratory phonology literature, which suggests that there may be no clear dividing line between the phonological and the phonetic. Superficially paradoxically, this is also supported by the Werker and Stager (2000) results showing that at 14 months infants may be able to discriminate contrasts in phonetic tasks but not in word-learning tasks. That is, there is a dissociation between the lexical, which involves the complexity of representation, and the acoustic, which involves no such complexity.

The second potential problem is the existence of 'production schemata', 'templates' or 'idiosyncratic strategies' (see p. 26 above): for instance, a constraint to the effect that all the child's productions conform to the pattern of a trochaic foot. This might suggest that the child is manipulating, or is at least aware of, the output forms (see Vihman, 1996), something which the claim that there are no output representations implicitly denies. But no assumption of such awareness is necessary: no further process or rule of the phonology ever needs to refer to the forms produced, so they need no formal status, and their properties should fall out automatically from the neural architecture.

The third, and most significant, problem is that both A and Z showed considerable metalinguistic ability. APh was dotted with examples of A's metalinguistic awareness, and Z was no less perceptive in his linguistic introspection. It is likely that in both cases their ability was triggered or enhanced by the concentrated attention I paid to their speech, but this does not detract from the genuineness of their judgements or the validity of the conclusions one can draw from those judgements. Metalinguistic judgement is relevant if it ranges over the child's output, as such a possibility would seem to be excluded if the output is not represented. Before looking at his judgements

in detail, it is appropriate to emphasise that the examples of Z's metaphonological ability (assuming that that is what it is) are drawn from a much earlier stage than most of the work described in the literature – e.g. Gombert (1992) – and are, obviously, independent of reading. A full list of his metalinguistic observations is given in section 7.3, where the precise session number of each example can be found.

5.1.6 Metalinguistic abilities

In discussing the child's metalinguistic abilities it is necessary to distinguish among his awareness of the pronunciation of others, as in the imitative form seen in (8), of his own output, as in the playful (9), and of the contrast between them, as in (10). As the first of these simply requires sensitivity to the adult surface form, only the latter two are relevant here, and are most informative only where his pronunciation differs from the target form.

8. Imitation: [ai 'lait 'hɛlən, hɛ'looo] – I like Helen, hellooo (imitating the next-door neighbour's characteristic greeting with a Scottish accent [= pure vowel [o] on a long slow fall]). [Z – 31 months]

9. Playing games with words: [its nɔt 'tə'ma:təu its 'pə'ma:təu] – It's not 'tomato' it's 'pomato' [Z – 42 months]

10. Showing awareness of the contrast between his and others' pronunciation:
    NS "What's that?"
    Z 'mɛnt midə - *cement mixer*
    NS "What does Mummy call it?"
    Z 'sɛnt midə - *cement mixer* [Z – 29 months]

These last two both seem to show the child's awareness of his own output, as does the 'output monitoring' seen in (11):

11. When he was 2 ½ years old I had the following conversation with A, as I was puzzled by his ability to pronounce the nasal in 'hand' ([ɛn]), but apparently not that in 'jump' (APh: 10):
    NS Say 'jump'
    A [dʌp]
    NS No, 'jump'
    A [dʌp]
    NS No, 'jummmp'
    A Only Daddy can say [dʌp]

It is clear that his final [dʌp] is intended to represent the adult form 'jump', or it just wouldn't be true. But equally it looks as if he is referring to his own pronunciation, as otherwise the remark makes no sense. But referring to his own output is precisely what he ought not to be able to do if it is really not

represented and has no psychological status.[11] A comparable metalinguistic commentary from Z in session 126 is illustrated in (12):

12. I heard him say 'usually' twice, once with and once without initial /l/. After some discussion (see below), he turned to me and asked "What does 'usually' really begin with?" I said [jə]. He then said: "I can't say [lə], I can only say [lə]."

These examples appear at first blush to refute the claim that there is no need for any output representation. However, there are considerations suggesting that the claim may none the less be correct. Any processing model must contain a response buffer in which there is an 'echo' of the preceding few seconds' exchange, and it is this, rather than an encoded representation, which is used to monitor one's own output. That is, what is in the response buffer (which is probably equivalent to Baddeley's, 2007, Phonological Loop) is an echo of the sound, not a representation of the sound: what Hale and Reiss (e.g. 2008) call the 'output of the body', not the 'output of the phonology'. This echo is then matched against what is represented (and has also just been heard) – the adult form.

Such 'echoic monitoring' should also account for 'repairs', such as (13), rehearsals, such as (14), and some metalinguistic explanation, as in (15):

13. ['dædiː lit, 'laitid ə 'tændəlz] – *Daddy lit, lighted the candles* [Z – 3 yrs][12]

14. ['aːntiː 'jænitə] – *Auntie Janneke* – alternating in a whisper between ['jænitə] and ['lænitə]. [Z – 35 months]

15. Z mentioned [draːs], I misunderstood what he was saying, and hazarded 'grass'? He replied: [nəu 'draːs, laiʔ 'windəuz aː meid ɔv] – No, 'glass' like windows are made of. [Z – 37 months]

Other metalinguistic commentary, like that in (16), is less amenable to non-representational treatment:

16. His parents pronounce *glass* differently. On discussing this Z said: [ai sei glæs fə windəu ən glaːs fə driŋkin glaːsiz] – *I say* [*glæs*] *for window and* [*gla:s*] *for drinking glasses*. (Thirty seconds later he repeated the claim the other way round.) [Z – 43 months]

11 I am grateful to Eva Kehayia for drawing my attention to the fact that the same phenomenon is characteristic of certain paraphasias.

12 Despite Clark's (2003: 144) remark that self-corrections appear from age 1 onwards, I suspect that they do not appear *systematically* until the age of 3 or so: after the majority of childhood mispronunciations have disappeared.

But the most problematic kind of example is provided by his volunteering the sounds with which words begin as in "I spy" games. The first of many examples – about a hundred (see Smith, N.V., 2005, and appendix 7.4) – occurs in (17):

17. ['sæmbəl 'ɛd] – *scrambled egg* – self-corrected, on being asked to repeat this version, to ['træmbəld 'ɛd]. He then spontaneously volunteered: [it bi'dinz wið tʳ] – *it begins with [trᵊ]*.

There were many comparable examples as in (18), in some of which he gave a metalinguistic commentary on his own and my differing pronunciations, including correcting me when I failed to conform to his analysis of onsets:

18a. Z 'farm' begins with [fə] just like 'fire'
NS What about 'frog', is that the same?
Z [nəu, frɔd bi'dinz wið fr] - No, 'frog' begins with [fr]

b. He said explicitly that 'sleep' and 'sheep' are the same when he says them and different when I do. At first he said they were different for him until he tried saying them slowly. Later he experimented with 'squash' and 'cloth' (both [trɔʃ] for him), and said that I say them differently but he says them the same, after practising both *sotto voce* or in a whisper [trɔʃ].

c. Comparable results were obtained with /s/ and /sp/. That is, Z appeared to be treating /sp/ as a unit. This has been suggested as the correct analysis for the adult language (cf. Fudge, 1969: 273). As far as I know, no one suggests that /pr/ or /fr/ are segmental units in the same way. They are, of course, *onsets* and it seems clear that Z was referring not to initial segments but to initial onsets.

d. He was adamant that [ʃudə], *sugar*, and [ʃiːt], *sweet*, both begin the same (with [ʃ]) both for him and for me.

e. He volunteered that 'foam' [fəum] and 'fireman' ['fæːmən] begin the same (with [f]), and unlike 'flower' ['fræwə], which begins with [fr], like 'three' ([fri:] for him). He was categorical in all these judgements, and corrected my wife when she suggested that 'foam' and 'flower' begin the same.

f. Discussing *usually* (see (12) above) he voluntered that: "[luːzəliː] begins with 'l', like 'lion' and 'yellow' ([lɛləu])".[13]

g. I said: "I spy with my little eye something beginning with [pʰə]." When Z gave no response, I said 'piano' (which he was thumping at the time). He immediately responded with: [prænəu bi'dinz wiv ə pʳə] ("*piano* begins with a 'pr'"), apparently correcting me.

The most difficult examples to accommodate if his own pronunciation is not represented are those in (18d, e, f), where there is no immediately preceding adult rendering of the word, hence no relevant 'echo' in the response buffer.

13 He later began to sound out non-initial consonants, often saying that the word ends in the non-word-initial but syllable-initial consonant: ['jɛləu … jə æn lə] – "yellow … [j] and [l]".

These examples also raise the problem of why the matching between his pronunciation and what he hears doesn't give rise to pervasive self-correction, even to the point of confusion in the same way that I claimed analysis-by-synthesis would (p. 112 above). It is possible that Z was relying on non-linguistic aspects of memory in reporting what words begin with: exploiting a temporary 'representation of the output' distinct from a linguistic 'output representation'. If this is not an appropriate characterisation of what is going on, these data seem to be a serious challenge to a model with a response buffer but no output representation. It is worth persisting in the attempt to preserve the claim of 'no output representation' because of the implications of such a model given in (19):

19a. The theory is simpler with fewer levels of representation, assuming that a response buffer and some sort of output network are independently needed.

b. There are more general theoretical implications: first, the dual lexicon hypothesis becomes otiose; second, the system the child is acquiring becomes more easily learnable; third, the evidence for 'output constraints' and 'conspiracies' is drastically reduced. As its ability elegantly to characterise conspiracies is one of the major selling points of OT this is not a trivial conclusion. In fact, the implications for OT may be more radical.

c. A fundamental property of OT is that it presupposes an output representation. If there is no such entity, then OT seems to be unable even to describe the phenomena. It is not obvious to me that there is a viable response arguing that this is not observational inadequacy, just a different interpretation, performance rather than competence, instrumentalist rather than realist, of the same data. Assuming a one-to-one mapping from the child's adult-like lexical representation to the instructions to the articulators would save the level of representation, and hence the viability of any theory assuming such a level, but would leave untouched the problem of correctly characterising the child's output. As Moira Yip (p.c.) suggests, it would be like claiming that the child has, as yet, no phonology: an unlikely claim in view of the fact that within this period he already had correct forms for plurals ([tɔt/tɔts] – *clock/clocks*; [ɛd/ɛdz] – *egg/eggs*), third person singular verb forms ([dəu/dəud] – *go/goes*), and so on.

d. The demarcation between phonetics and phonology becomes hazier – maybe non-existent (cf. the claims of 'emergent phonology' – e.g. Lindblom, 1992, 2000). If the child 'has no system', no output representation and no distinction between realisation rules and phonetic detail rules, that dichotomy also ceases to have any relevance in this domain.

e. If the hypothesis holds, it should generalise to the adult language. Regular morpho-phonemic and allophonic alternations need not be represented either, so that the pronunciations [sɔf tɔiz] for *soft toys* (where *soft* loses its final consonant) or [seim piːpəl] for *sane people* (with assimilation of /n/ to [m]) would have no representational status. It may also be possible to generalise

> even more widely: on the one hand to certain pathologies (see the remark about paraphasia above); on the other hand (as Anna Roussou suggested to me) to what the child represents in the acquisition of syntax.

I await refutation with interested anticipation.

5.2 Technical issues arising from the phonological development of A and Z

5.2.1 The units of phonological analysis

Throughout the analyses given in chapter 4 (see also chapter 1, section 1.6) I have presupposed the appropriateness of using syllables, distinctive features and 'phoneme-sized' units. The need for 'syllable' is clear *inter alia* from the treatment of unstressed syllables as formalised in R1 and R2. Similarly, the use of distinctive features repeatedly obviated the need to list arbitrary combinations of 'phonemic' segments, as can be seen in the treatment of (post-consonantal) sonorants, the neutralisation of coronals, and so on. Z did not provide such striking evidence for the definition of features as A did for [coronal], for instance, (see APh, especially section 5.1; or Smith, N.V., 1989: ch. 9, "Y", for discussion), probably because he had no harmony processes, but there were repeated cases where appropriate generalisations about his phonology could only be captured by using them. The case of the phoneme is complementary to that for distinctive features. The latter are advantageous when natural classes of segments are involved in some process, the former are superior when a single such segment (e.g. pre-consonantal /s/) exhausts the scope of some rule. Every theory seems to use them essentially without question.

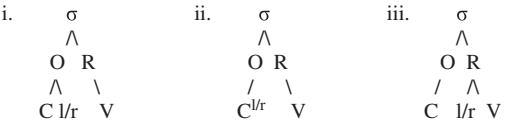
There is evidence for further structure. I have appealed repeatedly to the notion 'onset', and it is now worth making explicit that Z's performance, especially his metalinguistic judgements as described here, provides some evidence (implicitly *contra* Yip, 2003) for the 'Onset' analysis of the syllable and, by implication, against a moraic analysis (cf. the discussion of [tʃ] and [tr, kl] at stage 10 of chapter 4). Yip observes that models of the syllable fall into two basic classes: those that postulate a division between Onset and Rhyme and those which allow only the mora to intervene between a segment and its syllable node. She then argues persuasively that the simpler moraic alternative is to be preferred. Her discussion is restricted to glides but, *mutatis mutandis*, it should generalise in relevant respects to liquids,[14] which constitute the primary evidence with Z. She

14 As is implicit in her discussion (2003: 811) of the parallel between vowel epenthesis in Stop–Liquid and Stop–Glide sequences.

summarises three different kinds of theory: Onset–Rime theories, illustrated with three alternative versions as in (20); Mora theories, illustrated with four alternative versions as in (21); and Flat theories, illustrated by the single example in (22). I have substituted liquids for her glides throughout:

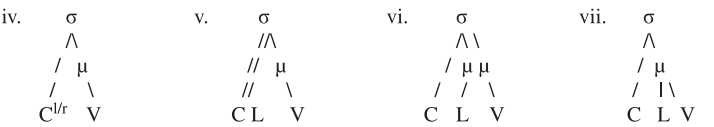
20. Onset–Rime theory:

(i) = Onset cluster; (ii) = secondary articulation; (iii) = part of Rime[15]

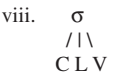


21. Mora theory:

(iv) = secondary articulation; (v) = non-moraic; (vi, vii) = moraic



22. Flat theories:



The issue is the status of the element, liquid or glide, following the initial consonant. As indicated, it may be either part of an onset cluster, a secondary articulation, or part of the rime; it may be moraic or non-moraic; or it may be part of no internal structure.

Recall that Z treated initial sequences such as /kl/and /tr/ (produced as [t^{s}]) or /sl/, /sm/ and /sw/ (produced as [ʃ]) as equivalent, but denied that examples like *farm* and *frog* or *spoon* and *soon* began the same. Only the analyses in (i), (ii) and (iv) ascribe constituent status to the sequences of elements involved. Two of these, (ii) and (iv), treat the post-consonantal item as a secondary articulation, so the question then arises whether such an analysis is plausible. If not, (ii) and (iv) are excluded, and only (i) is left: i.e. the notion 'onset' is necessary. Although it might be plausible for the glides [j, w] and perhaps

15 Yip emphasises (p.c.) that her analysis would not generalise to liquids in the manner indicated in (20iii), but the issue of the correct constituency of the post-consonantal liquid remains.

even for [r], nowhere in the literature is it ever suggested that the presence of a post-consonantal [l] should be treated as a secondary articulation. This is presumably because although the articulation of [l] may be anticipated during the articulation of e.g. [p] in *play* ([plei]), true simultaneity is excluded – the [l] is released after the [p].

Two points remain to be clarified. First, although the glides and /r/ might lend themselves to a treatment (viz. secondary articulation) different to that for /l/, it is appropriate to apply the same analysis to all of them, as it is clear that they were the same for Z. This is plain in that he substituted [r] not only for /l/ (e.g. in *black*) but also for /j/ and /w/ (e.g. *piano* pronounced [prænəu], *squash* pronounced [trɔʃ]); /sl/ and /sw/ were treated the same way (pronounced as [ʃ]), etc. Second, it appears that Z's onset substructure is different from that of the adult: whereas /fr/ consists of /f/ plus /r/ in the target language, some different analysis is correct for the child, for whom [fr] might perhaps be an unstructured entity not composed of [f] plus [r]. If correct, such an analysis would raise a question about the assumption of continuity (see above pp. 17f., 103f.). However, by the end of the investigation Z was beginning to give adult-like reactions to (some) initial sequences: for instance, his reaction to *spoon* changed from his saying it began with [p^{h}ə], at a time when he pronounced it [puːn], to saying it began with [sə] at a time when he pronounced it [sːpuːn]. This would imply a (pre-literacy) transition from one analysis to another or, more plausibly, a dawning change in the performance manipulation of already available competence categories as the neural network approximated the adult form.

In brief, the data are suggestive of the need for an onset constituent. The conclusion is not definitive because the moraic analysis in (21v) can accommodate Z's data by referring not to the constituent [CL] but to the pre-moraic sequence [C+L]. To exclude this possibility one would need, for instance, evidence of some process such as metathesis which moved the sequence as a unit. Sadly, Z provided no such data.

5.2.2 Explananda

It is clear that the phenomena listed as in need of explanation in APh – grammatical constraints; recidivism; 'across-the-board' change, and so on – are still with us and have indeed been supplemented by others, such as the need to account for the greater degree of variation found in Z, and the sporadic creation of 'templates'. These phenomena were previously (partly) explained by the postulation of an ordered set of realisation and phonetic detail

rules operating conspiratorially to characterise the child's competence. The interpretation has changed such that the rules characterise performance and can be replaced by (e.g.) a neural network with no representational output. It follows that there can in fact be no distinction between realisation and phonetic detail rules, no extrinsic ordering of (the replacement for) such rules, and the universal functional tendencies or 'conspiracies' must fall out as epiphenomena. Is this plausible?

I argued in chapter 4 (p. 66) that Z provided no evidence for rule ordering, whereas I had appealed repeatedly to that device in the analysis of A. Given the invidious implications of rule ordering for learnability it is necessary to determine whether A's data still require ordering or are amenable to reinterpretation. A typical example of the need for ordering is provided by the need to ensure that A's rules reducing nasal clusters (R1 and R2) must precede voicing neutralisation (R25) (see APh p. 22). There are several strategies one might apply to ensure the correct result. First, one might claim that rules apply whenever their structural description is met: this works in the case cited but faces problems with opaque rule interactions (see McCarthy, 2007, for discussion). Alternatively, one could argue for exploiting ordering but restricting it to manageable proportions. Specifically, I argued in APh that rules effecting (Consonant) Harmony and Cluster Reduction had to be implemented before rules of neutralisation ('systemic simplification'). Provided that the velarisation of /d/ to [g] in A's pronunciation of *puddle* as [pʌgəl] counts as harmonic, while the neutralisation of /z/ to [d] in *puzzle* ([pʌdəl] is 'simplification', then this stratagem accounts even for the most recalcitrant example. If all ordering relations can be reduced to this one statement, ordering provides no learnability problem.

Other explananda have either been discussed above (grammatical determinants of phonological development, the many–many relation between adult and child forms, exceptions, recidivism, across-the-board change, 'non-English' pronunciation, extensive variation both within and across lexical items) or are unproblematic. Thus grammatical conditioning can be accommodated by making morpho-syntactic information part of the context of particular rules (or part of the 'seeds' affecting the weighting on connections in a network). The across-the-board nature of (most) developmental change follows from the formulation of rules (or probabilities) rather than *ad hoc* statements. Non-English (or non-target) pronunciations resulting from coalescence or harmony are a simple function of rules (or weightings) and are problematic only for usage-based or emergentist theories. The high incidence of pronunciational variation (and the radical difference in the amount of such

variation produced by different children) is likewise a function of random factors and statistical properties of performance mechanisms without systematic import for the nascent phonology.

The phenomenon that is most challenging to account for is recidivism, as its U-shaped learning curve reflects non-monotonic development of a kind that sits uneasily with most theories; except, of course, SPE-type rule-based ones. The implication is that, whatever theory one ends up with, it will have to employ devices equivalent in power to generative rules. I turn finally to the nature of such a theory.

5.3 A smorgasbord?

There is a temptation to see virtue in a smorgasbord of theories, taking what is best from each of the competitors (Nevins and Vaux, 2008: 19): SPE-type derivations, preferably pruned of rule ordering; OT constraints (for functional explanations, especially of conspiracies); emergent phonology for the use of artificial neural networks to accommodate mechanisms of perception and production; usage-based phonology for the reduction of structural complexity. The temptation should be resisted if this eclecticism is pernicious. One principal objection is that technical terms in one theory don't translate coherently into alternative theories, but are 'incompatible' (Nevins and Vaux, 2008: 1). Many examples spring to mind: the notion 'lexical representation' has different implications in a theory that postulates an input and an output lexicon as opposed to a theory which allows only one neutral entity; the notion 'constraint' is different depending on the potential violability of the constraints involved; comparing distinctive features which may be unary, binary or n-ary is liable to misinterpretation, and features are anyway not directly comparable in theories where they are used to characterise length and stress as opposed to theories embodying e.g. skeletal and metrical structure to deal with such phenomena. The list can be extended indefinitely.

However, such purity may itself be a manifestation of undue pessimism. No theory has a monopoly on the truth, and progress requires assimilating insights from the opposition and defining the resultant terms with sufficient rigour to make testable predictions. With this in mind I suggest a revised model similar to figure 2 in chapter 2 incorporating all the components desired, as in figure 3. Suitably annotated this model then suffices to describe and in part explain all the phenomena mentioned.

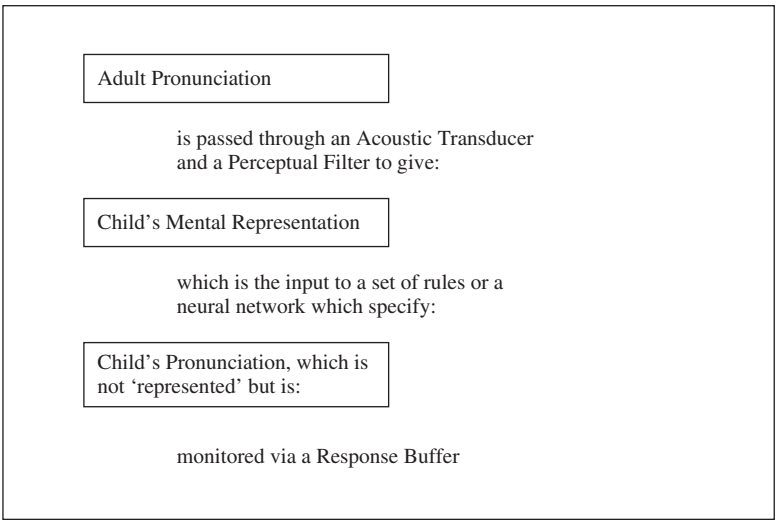


Figure 3 Final revised model of the child's lexical phonology

The representation of the adult form is as before and necessarily 'symbolic'. Importantly, it is necessary to assume that there is some transducer converting the acoustic signal of the adult pronunciation into auditory, more specifically phonetic, constructs which underlie the child's own representations. This transducer, amalgamated with the perceptual filter, is subject to frequency constraints though, in Z's case, these were not obviously of importance. As with the adult form the child's form, whether it differs from the adult's or not, is symbolic.

The set of (realisation) rules could be replaced by a neural network which could implement violable constraints, giving an output ('of the body') which is not mentally represented. That is, they specify instructions to aim at a set of articulatory targets, but the failed approximations to those (represented) targets are not themselves represented.[16] I would like to have my cake and eat it too. Although I have argued for a neural network, some of the metalinguistic data may be problematic for the 'no output representation' position that this entails. If it in fact proves untenable I suspect that a competence account with realisation rules having the same status as in APh could be resuscitated.

The network (or the set of rules) could also automatically implement the kind of structure reduction seen in (3) in chapter 4, whereby the specification for place of articulation is simplified, resulting in this instance in the pronunciation

16 If the child's output is not represented it would be more accurate to describe these as 'articulatorily realised auditory targets'.

of a glottal stop. More problematically, the output of the network can be monitored via the response buffer, thereby accounting for the child's apparent awareness of his own pronunciation and its difference from the stored form.

Continuing to assume a performance account, the network can be viewed as encapsulating the totality of performance limitations that are gradually overcome in development. This undercuts Gnanadesikan's (2004) objection that the child has unmotivated rules with no adult congeners, as the change in status of those rules means that they have not been 'learned' and are not mentally represented. What drives this development is the physiological maturation of the system interacting with the child's monitoring of its comprehensibility. If he fails to be understood the child is led to pay attention to the contents of his response buffer and to make iterated attempts to approximate more closely to his stored representations. That physiological maturation should be manifested in terms of what look like developments in the 'phonological system' is possible because natural classes of segments – e.g. fricatives – have their production facilitated by the same or overlapping advances of motor control. The extent to which such 'active monitoring' (as opposed to purely subconscious processing) plays a causal role in development is an open question.

Like the transducer, the network is also subject to frequency effects and all components are subject to individual idiosyncratic variation depending on the child. As presented here the model makes no provision for morpho-phonological alternation of the kind seen in the relation between *keep* and *kept*, or even that between the /s/, /z/ and /ɪz/ in *cats*, *dogs* and *horses*, but such refinements would be easy to incorporate.

A final consideration is that, if the parallel between adult and child language suggested above (p. 118) is correct, the model could also perhaps accommodate accent simulation in second language acquisition, whereby learners (subject to perceptual limitations) aim at reproducing the characteristics of one or more targets.

5.4 Conclusions and speculations

Despite some account of the role of perception, the preceding discussion has dealt overwhelmingly with the child's pronunciation. This gives a seriously distorted view of 'the acquisition of phonology'. In the first year of life, long before he is capable of any relevant production, the child establishes the inventory of contrastive segments characteristic of his native language, the elements of its prosodic system, its basic syllable structure and more (see especially Jusczyk, 1997). Using this knowledge the child then learns piecemeal the correct, adult-like, representation of items in his burgeoning vocabulary. Only then does he begin to produce his own

version of these words. In some sense then the acquisition of (segmental) phonology is complete before the kind of longitudinal documentation given here and in APh starts. If I am right that this stage is a matter of performance and the child's productions are not represented then neither monograph has much to say about the acquisition of phonology as such. Moreover, none of the literature looking exclusively at children's output *could* have much to say about this. Rather, it is an account of the various ways that children overcome the limitations of their performance systems during physiological maturation. That wasn't what I had thought I was doing, and I feel suitably chastened. The conclusions in (23) are none the less worth making explicit as they are not all obvious and some are certainly contentious. Demonstrating that these claims about the acquisition of phonology are wrong will be a sign of progress and, right or wrong, this account of productional development casts light on some aspects of the human faculty of language.

23a. The child's performance is rule-governed, hence largely predictable.
b. The child's lexical representations are adult-like, established on the basis of an acoustic transducer and subject to some perceptual filtering.
c. The child has no system of his own.
d. The child's output, produced by a set of realisation rules or, more plausibly, a neural network, is not 'represented'.
e. By parity of argument the child probably does not represent the adult input *prior to transduction* even though it forms the basis for the child to set up his own (lexical) representation.
f. The network (or set of realisation rules) is not represented but is emergent or 'architectural', and provides the basis for the idiosyncratic and partly random variation in different children's pronunciation.
g. The network (or set of realisation rules) implements one or more of a limited set of functional constraints or 'conspiracies': vowel and consonant harmony, cluster reduction, systemic simplification, grammatical simplification and template creation. As a corollary of (f) conspiracies are epiphenomenal and do not need to be explicitly catered for by the theory.
h. The child's developing phonology provides evidence for the units (e.g. distinctive features, syllable structure) and processes (e.g. syllable simplification, segment simplification) licensed by phonological theory, and how these interact (e.g. no rule ordering is necessary).
i. The child's metalinguistic judgements are a rich source of evidence for his competence and hence for the constructs of linguistic theory.
j. The conclusions pertaining to child phonology have suggestive implications for adult phonology – e.g. with regard to the representation of the output.
k. There is provision for taking account of (statistical) frequency effects in all of the acoustic transducer, the perceptual filter and the neural network.
l. If language is "a mirror of mind", language acquisition polishes that mirror.

6 *Diachronic lexicon of Z data*

Purely for convenience the data which form the basis of this study have been divided into a number of 'stages', each of which consists of a sequence of 'sessions'. A number in [square brackets] after a head word indicates the session at which the item was noted. There are no theoretical implications in the terms 'stage' and 'session': each session simply designates the date on which the data were recorded; each stage is marked by some intuitively salient development, e.g. the appearance of clusters. Stage [0] refers to a problematic period before phonological status was established. Each subsequent group of sessions constitutes a stage, used as a basis for the child's longitudinal development, as spelt out in the tables in 6.1 and 6.2.

6.1 Table of stages and ages

Stage 0: Babbling, up to first words: age 6½–13½ months.
Stage 1: Sessions 1–10: age 14½–22 months.
Stage 2: Sessions 11–17: age 22 months up to his second birthday (30 August 2003).
Stage 3: Sessions 18–31: age 24–26 months {the last 'pre-Amahl' stage}.[1]
Stage 4: Sessions 32–40: age 26–27 months.
Stage 5: Sessions 41–50: age 27–28 months.
Stage 6: Sessions 51–61: age 28–29½ months.
Stage 7: Sessions 62–75: age 29½–31 months.
Stage 8: Sessions 76–93: age 31–33½ months.
Stage 9: Sessions 94–108: age 33½–36½ months.
Stage 10: Sessions 109–16: age 36½–38 months.
Stage 11: Sessions 117–28: age 38–40 months.
Stage 12: Sessions 129–41: age 40–43 months.
Stage 13: Sessions 142–54: age 43 months up to his fourth birthday.

1 The analysis of A's data started at age 2 years 60 days: the precise beginning of Z's stage 4.

6.2 Table of sessions and ages

Ages are given as a triple such as 1/7/1 or 2/10/17. That is, the data for that session were collected when Z was 1 year 7 months and 1 day, or 2 years 10 months and 17 days old. Dates separated by a dash indicate that data were collected on more than one occasion between the ages specified.

Session 0	There were 10 occasions on which I collected data, from 0/6/17 to 1/1/8
Session 1	1/2/17–1/4/25 (data collected on 5 occasions)
Session 2	1/5/9, 1/6/14 (data collected on 2 occasions)
Session 3	1/7/1
Session 4	1/7/21
Session 5	1/8/3–1/8/12 (data collected on 3 occasions)
Session 6	1/8/18–1/8/19
Session 7	1/8/25
Session 8	1/9/15
Session 9	1/9/24
Session 10	1/10/2
Session 11	1/10/7–1/10/8
Session 12	1/10/13–1/10/14
Session 13	1/10/15
Session 14	1/11/3–1/11/5
Session 15	1/11/10–1/11/11
Session 16	1/11/19
Session 17	2/0/0
Session 18	2/0/2
Session 19	2/0/7
Session 20	2/0/13
Session 21	2/0/20
Session 22	2/0/21–2/0/22
Session 23	2/0/28–2/0/29
Session 24	2/0/30
Session 25	2/1/7
Session 26	2/1/12
Session 27	2/1/14
Session 28	2/1/17
Session 29	2/1/18
Session 30	2/1/21

Session 31	2/1/26
Session 32	2/2/1
Session 33	2/2/2
Session 34	2/2/4
Session 35	2/2/11
Session 36	2/2/17
Session 37	2/2/22
Session 38	2/2/23
Session 39	2/2/24
Session 40	2/2/25
Session 41	2/3/2
Session 42	2/3/4
Session 43	2/3/7
Session 44	2/3/8
Session 45	2/3/9
Session 46	2/3/16
Session 47	2/3/22
Session 48	2/3/23
Session 49	2/3/29
Session 50	2/3/30
Session 51	2/4/2
Session 52	2/4/3
Session 53	2/4/6
Session 54	2/4/10
Session 55	2/4/11
Session 56	2/4/19
Session 57	2/4/24
Session 58	2/4/26
Session 59	2/5/1
Session 60	2/5/3
Session 61	2/5/10
Session 62	2/5/15
Session 63	2/5/16
Session 64	2/5/17
Session 65	2/5/23
Session 66	2/5/29
Session 67	2/5/30
Session 68	2/6/8
Session 69	2/6/14

Session 70	2/6/15
Session 71	2/6/21
Session 72	2/6/28
Session 73	2/6/29
Session 74	2/6/30
Session 75	2/7/0
Session 76	2/7/4
Session 77	2/7/6
Session 78	2/7/7
Session 79	2/7/9
Session 80	2/7/10
Session 81	2/7/13
Session 82	2/7/16
Session 83	2/7/19
Session 84	2/7/25
Session 85	2/8/0
Session 86	2/8/3
Session 87	2/8/4
Session 88	2/8/9
Session 89	2/8/10
Session 90	2/8/17
Session 91	2/8/22
Session 92	2/9/6
Session 93	2/9/7
Session 94	2/9/13
Session 95	2/9/28
Session 96	2/9/29
Session 97	2/10/3
Session 98	2/10/4
Session 99	2/10/5
Session 100	2/11/1
Session 101	2/11/2
Session 102	2/11/3
Session 103	2/11/6
Session 104	2/11/18
Session 105	2/11/25
Session 106	2/11/30
Session 107	3/0/4
Session 108	3/0/11

Session 109 3/0/18
Session 110 3/0/19
Session 111 3/0/20
Session 112 3/0/25
Session 113 3/1/2
Session 114 3/1/16
Session 115 3/1/23
Session 116 3/1/30
Session 117 3/2/6
Session 118 3/2/7
Session 119 3/2/8
Session 120 3/2/13
Session 121 3/2/20
Session 122 3/2/21
Session 123 3/2/27
Session 124 3/3/4
Session 125 3/3/5
Session 126 3/3/11
Session 127 3/3/18
Session 128 3/3/19
Session 129 3/4/1
Session 130 3/4/2
Session 131 3/4/8
Session 132 3/4/15
Session 133 3/4/29
Session 134 3/5/0
Session 135 3/5/7
Session 136 3/5/12
Session 137 3/5/13
Session 138 3/5/19
Session 139 3/5/26
Session 140 3/6/5
Session 141 3/6/12
Session 142 3/6/19
Session 143 3/6/26
Session 144 3/7/2
Session 145 3/7/4
Session 146 3/7/9
Session 147 3/7/30

Session 148 3/8/0
Session 149 3/8/14
Session 150 3/8/28
Session 151 3/10/27
Session 152 3/11/7
Session 153 3/11/10
Session 154 3/11/27

6.3 The lexicon

I have indicated every session at which a particular item was recorded, with a comma separating sessions. A dash between two numbers indicates that the item was recorded at every session between, and including, those two sessions. That is [3, 6, 8] indicates that an item was recorded at those three sessions but not at sessions 4, 5 or 7, for instance; [3–6, 8] indicates that the item was recorded at each of sessions 3, 4, 5 and 6, also at session 8, but not at session 7. It may, of course, have been produced at session 7, but I have no evidence for that. If an item was recorded at some session in free variation with a different form, this is indicated in the lexical entry concerned. See, for instance, '*no*', which was recorded as [nəu] at every session from 11 to 23, but as both [nəu] and [næ] (hence the entry "nəu/næ") at session 24. Where more than one pronunciation is given, the ordering reflects frequency (where this is known) with the most frequent first; a pronunciation given (in parentheses) indicates that it was either elicited or immediately imitated. The inconsistency of the variation found is mildly surprising and in contrast with the type and amount of variation found in A's data.

The alphabet of the IPA is used, including the following conventions:

ˈ	indicates stress; hence the item concerned must be at least disyllabic
˜ and ⁿ	indicates a nasal offglide, the latter with some oral contact
˥	indicates an unreleased stop
’	indicates an ejective articulation

A subscript ̪ as in [s̪] indicates a dental(ised) articulation

A superscript letter, e.g. ᵗ or ᶻ, as in the entries for *shoes*, indicates a faintly articulated offglide or onglide to the adjacent segment.

A subscript ̥ or superscript ˚, as in [b̥], [d̥], [ʒ̊], indicates a voiceless lenis articulation.

Z's articulation was not as consistent as the entries here may indicate. Typically, he would produce an item like *bin* with a voiceless lenis initial consonant in isolation (e.g. in response to "What's this?"), but with a fully voiced consonant in his most usual (intervocalic) articulation of it: namely, [in ə 'bin] –"in the bin".

Caveats and explanations are provided in {curly brackets}. Where a head word appears with a parenthetical 's' or 'd', as in 'egg(s)', the implication is that Z's pronunciation was appropriate for the implicit singular/plural (or other) contrast. Where the usual adult pronunciation of an entry might be opaque I have indicated it below the head word in /phonemic/ transcription: see e.g. 'Janneke'.

Alphabetical list of entries

a	ə	[37, 40, 43–4, 47, 49–50, 54, 56–8, 60, 64–5, 69–70, 72, 76–8, 82, 85–6, 92, 94, 100, 107, 113, 117, 132] {actually much earlier}
	ə/æ	[42]
	ei	[153]
able	'eibu	[72]
about	ə'baut	[82, 92, 103]
acre	See 'hundred acre wood'	
across	ə'trɔs	[117, 132]
actually	'ækʃəliː	[139]
aeroplane	'hei	[13] {see also 'helicopter'}
	ɛ'bein	[31] {disyllabic}
	ɛːə'bein	[35] {trisyllabic}
	iːə'bein	[36]
	eːə'bein	[37]
	'ɛːrəpein	[56]
	pʳein	[99]
	'ɛːrəprein	[107]
	'ɛːrəplein	[120]
afraid	ə'feːd	[94]
	ə'freid	[124]
Africa	'æfritə	[112, 114, 121]
after	'aːtə	[68]
	'aːftə	[104]
	'æftə	[145]

afternoon	aːftəˈʔuːn	[106]
	əˈsæftənuːn	[146] {scil. ‘this afternoon’; see also ‘morning’}
again	dein	[37]
	əˈdɛn/ əˈdein	[43]
	əˈdɛn	[48, 50, 56, 62, 64, 84, 86, 92, 94, 97, 109, 115]
	əˈdein	[61, 66]
ages	ˈeidzʲiz[2]	[109]
ago	əˈdəu	[92, 105, 128, 132]
airport	ˈɛːpɔːʔ	[107]
all	ɔː	[31, 59, 71, 76, 78]
	uː	[38]
	ɔːl	[49, 87, 93, 100]
	ɔːl /ɔː	[106]
all gone	ˈuː dɔn	[44]
allowed	əˈlaud	[80, 89]
	laud	[88]
almost	ˈɔːməu	[81]
along	əˈlɔn	[62, 81, 85, 90, 136]
alongside	əlɔnˈsaid	[120]
already	ɔːˈwɛdiː	[48]
	ɔːˈrɛdiː	[74]
always	ˈɔːlwei	[65]
	ˈɔːwei	[81]
Amahl[3]	ˈæmə	[22]
	ˈæmaːᵘ	[43, 68]
	ˈæmaː	[53, 63]
	ˈæmaːᵘ/ ˈæmaːɬ	[80]
am	æm	[89, 100, 107, 113] {frequently [m] previously}
ambulance	ˈæmbins	[99]
	ˈæmbəjəns	[135]
America	əˈmɛritə	[89, 99, 105, 112, 116]
	əˈmɛritə / əˈmɛrikə	[137]
an	ə	[39] {see also ‘a’}
and	ə	[26]
	ə / ən	[37]
	æn	[46–7, 49, 66, 69, 71–2, 85, 88, 90, 100, 107, 113, 115, 119, 149]

2 The intervocalic consonant was a palatalised alveolar affricate.

3 Zachary’s father’s name: the correct adult pronunciation is [ˈæmaːɬ].

	ən	[50, 56–7, 61, 89, 109, 112, 116, 130,[4] 141]
	æn /ænd	[60]
	ænd	[70]
Angela	ˈænd^{z}ələ	[80]
animal	ˈæməl	[72]
ankle	ˈæntul	[132]
Annabel	ˈænəbɛl	[90]
	ˈænəmɛl	[91]
Anne[5]	æn	[22, 43, 56, 59, 80]
another	moː	[14] {see also ‘more’}
	ˈʌə	[33]
	ˈnʌdə	[39, 69]
	ˈnʌdə / əˈnʌdə	[43]
	əˈnʌdə	[44, 46, 48, 54, 56, 63, 89, 94]
	aˈnʌdə	[45]
any	ˈɛniː	[55, 58, 62, 73]
anybody	ˈɛniːbɔdiː	[85]
anyone	ˈɛniːwʌn	[82]
anything	ˈɛnisin	[114]
anyway	ˈɛniːwɒi	[136]
	ˈɛniːwei	[137]
apart	b̥aːʔ	[40]
	b̥aːt	[48]
apparatus	æpəˈreitəs	[144]
	æpəˈreitəs / əˈreiəs	[152]
apple	ˈæpu	[71]
	ˈæpu / ˈæpul	[121]
apricot	ˈeidɔʔ / dɔʔ	[37]
	ˈeib̥itɔt	[68]
	ˈeibriːtɔt	[81]
are	aː	[67, 70–2, 76, 78, 84, 86, 88, 90, 92, 94, 100, 104, 110, 118, 126, 132]
areas	ˈɛːriːəz	[128]
aren’t	aːnt	[80, 90, 106, 132 {with subject ‘I’}]
ark (Noah’s)	aːt	[69]
	(aː)	[78]
armbands	ˈaːm bænz	[88]

4 The form with [n] occurred before a velar – i.e. no assimilation.

5 Zachary’s mother’s name. Cf. from session 56: [æː mʌmiː tɔːd æn, ən həː ʌdə neim tɔːd ə wumən] – *My Mummy (is) called ‘Anne’ and her other name (is) called ‘a woman’.*

around	raund	[78]
arrived	waivd	[90]
as	æz	[74, 109]
	æ	[91]
	əz	[100, 138–9]
ask	aːt	[58]
asleep (or 'to sleep')	əˈsiːp	[86]
	əˈçiːp	[106]
	əˈʃiːp	[113, 115–17]
asphalt	ˈæsfəlt	[98]
as well	ə ˈwɛᵘ	[69]
	ə ˈwɛl	[85]
	əz ˈwɛl	[90]
at	æ	[43]
	ə	[48, 66]
	æʔ	[64]
	æt	[137]
at all	əˈtɔːl	[82]
ate	See 'eat'	
attach	tætʃ	[112, 119]
	tætʃ / əˈtætʃ	[116]
August	ˈɔːdəst	[100, 117]
auntie	ˈaːntiː	[95, 100, 104]
auriscope	ˈiə tɔːt	[81] {'ear torch'}
	ˈɔːritəup	[120]
avocado	ævəˈtaːdəu	[51, 81]
	ævəˈd̥aːdəu	[68]
away	həum[6]	[14]
	wei/ həum	[30]
	wei	[32, 37, 40, 46]
	wei /əˈwei	[39]
	əˈwei	[42, 48, 50–1, 54, 58, 61–2, 68, 73–4, 110, 120]
baby/babies	bæi	[37] {intended meaning dubious}
	ˈbeibiː	[43, 60, 81, 84, 86, 104, 110]
	ˈbeːbiː	[70]
	ˈbeʲbiː	[79]
	ˈbeibiz	[100]

6 He uses [həum] for putting something 'away' and for 'home', but understands 'home' and 'away' perfectly well. Presumably [həum] is his lexical item for both. That is, his phonological representation, phonologically the adult's 'home', maps onto two concepts in a way the adult form does not.

back	b̥æ	[15, 17, 23, 26, 35, 40]
	b̥æ / b̥æʔ	[34]
	bæ	[38, 43]
	bæʔ	[50, 54, 63–4, 69, 71, 73, 86, 97, 118, 132]
	bæt	[72, 133, 135]
back hoe loader	ˈbæʔ ˈhəu ˈləudə	[76]
back-pack	ˈbæʔpæʔ	[54, 77]
backwards	ˈbæʔwədz	[92]
bad	bæd	[71]
	ˈbædə	[136] {scil. ‘worse’}
badger	ˈbædə	[63]
bag	bæd	[53, 87, 92, 104] {see also ‘bean bag’}
baked beans	ˈbeiʔ ˈbiːnz	[121]
balance (V)	ˈbæləɴt	[70]
ball	b̥oː	[12] {see also ‘meat balls’}
	b̥oː/ b̥ɔː	[14]
	b̥ɔː	[22]
	bɔl	[84]
balloon	buːn	[90]
banana	b̥aː	[22]
	ˈb̥aːnə	[32]
	ˈbaːnə	[39, 44, 53, 60, 79, 90]
	ˈbɔːnə	[41]
band (rubber)	bʌn	[35]
bandage	ˈbændid	[81]
	ˈbændiz	[110]
	ˈbændiʒ̊	[121]
bandaged	ˈbændid	[90]
	ˈbændiz	[93]
bang	bæm	[16–20, 23, 34, 56]
	bæm / bʌm	[35]
	bæm / bæn	[50]
	bæn	[73, 84, 115, 122–3]
banging	ˈbænin	[73]
bangle(s)	ˈbændᵘ	[48]
	ˈbændu / ˈbænduz	[62–3]
	ˈbændu / ˈbændud	[78]
banisters	ˈbænistə	[110]
bank	bænt	[113]
Bank holiday	ˈbænt ˈhɔlidei	[87]
barn	baːn	[89]
barrier	ˈbæriːə	[100]
barrow	ˈb̥æʲiː	[31]

basin	'beisən	[131]
basket	'baːstit	[123]
bath	b̥a	[7]
	b̥aː	[8, 15, 23]
	baː	[42]
	baːt	[62, 69–70, 73]
	baːs	[85, 133]
	bæs / baːs	[92]
bathroom	'baːʔruːm	[39]
	'baːsrum	[112]
battery	'b̥æːtiː	[48]
	'bæʔriz	[95]
battle	'bædu	[54]
	'bæʔu	[56–7]
be	biː	[44, 49, 53, 58, 71–2, 78–9, 91, 103, 115, 125, 139, 141]
bean bag	'biːn bæ	[38]
beans	biːn	[31, 34,[7] 36]
	biːnz	[92]
bear	bɛ	[44]
	baː	[55–6, 62–3, 68, 70]
because	tɔʔ	[53]
	tɔd	[65–6, 68, 72]
	tɔd / tɔz	[69]
	tɔz	[73, 84, 90, 133, 136,140–2]
	tɔs	[100, 107]
	tɔz / kɔz	[146]
Becky	'b̥ɛtei	[43]
	'bɛtiː	[125]
bed	b̥ɛd̥	[37]
	bɛd̥	[42]
	bɛd	[49, 69, 72]
bee(s)	b̥iː	[26]
	biːz	[107]
been	biːn	[55, 65]
beetle(s)	'biːdu	[46, 50, 54, 57]
	'biːdəu	[48]
	'biːdu /'biːtu / 'biːdud / 'biːtud	[56]
before	ə'fɔː	[67–8, 113]
	fɔː	[69, 73, 82]
	bi'fɔː	[127]
begin(s)	bi'din(z)	[109, 113–14, 116–18]

7 Self-corrected from [bin] when I had failed to understand him.

behind	əˈhaind	[75]
being	ˈbiːin	[56]
	biːn	[79]
bell	bɛl	[94]
bench	See ‘work-bench’	
better[8]	ˈbɛdə	[43–4, 49, 68]
	ˈbɛdᵊ	[48]
	ˈbɛtə	[58, 80, 86, 92, 94]
	ˈgudə	[141]
between	biˈtriːn	[132]
bhujia	ˈbuːdʒilaː /ˈbuːdʒiːə/	[115] {a fried savoury vegetable}
bib	bi̥b	[39]
	bib	[44, 71]
big	bi	[35–6, 38, 42, 47] {see also ‘huge’}
	bi / bid	[37, 41 {usually [bid]}]
	b̥i	[40]
	bid	[44, 50, 56, 58, 62–3, 65, 68, 70–1, 73–4, 76–7, 85, 87–91, 94–5, 97, 100, 107, 114–15, 117, 122, 128]
	bid / bit	[46, 57]
	bi / bit	[48]
	biʔ	[49]
	big	[139]
	big / bid	[145]
bigger	ˈuːə /ˈb̥ijə	[32] {[ˈbijə] on imitation}
	ˈbidə	[37, 82, 90, 105, 107]
Billy	ˈb̥iliː	[49]
bin	bum	[19]
	bim	[22]
	bin	[23, 29, 32, 34–7, 48, 53, 92, 94]
	bim / bin	[27]
bird(s)	baːd	[59]
	bəːd	[64, 69, 91]
	bəːdz	[92, 112]
birthday	ˈbəːdei	[71]
	ˈbəːfdei / ˈbəːsdei	[85]
	ˈbəːsdei	[117]

8 Both a comparative adjective and an auxiliary.

birthday cake	ˈbəːʔdei teit / ˈbəːdei teit	[58]
biscuit	ˈbitit	[50]
	ˈbidiː	[56] {‘bicky’}
	ˈbiʔd̥it / ˈbiʔdiʔ / ˈbiʔtiʔ	[74]
	ˈbistit	[115]
bit(s)	biʔ	[35, 50–1, 61–3, 65, 72, 106, 109, 124]
	biʔ /bit	[37, 67–9, 71]
	b̥i / bi / bit	[46]
	biʔ / bi	[48]
	bit	[54, 56, 132, 138, 141]
bite	bait	[56, 89, 107]
black	bæʔ/ bækˀ	[36]
	bæʔ	[56, 64]
	bæʔ / bʳæʔ	[69]
	bˡæʔ	[72]
	bʳæʔ	[91]
	bræʔ	[104, 106, 115, 117, 120, 128, 131]
	blæʔ	[107]
	blæk	[136]
blanket	ˈbræntit	[133]
bleed	briːd	[124]
blinds	blainz	[94]
blocking	ˈbrɔʔin	[131]
	ˈblɔtin / ˈblɔkin	[138]
blocks	brɔʔs	[117, 120]
blood	bˡʌd	[79, 87[9]]
	brʌd	[101, 123, 126, 131]
blood pressure	ˈblʌd prɛsə	[92]
	ˈbʳʌd prɛsə	[97]
bloody	ˈbrʌdiː	[109]
blow	b̥əu	[34]
	bəu	[56, 82, 90]
	bˡəu / bʳəu	[100]
	brəu	[106]
blowing	ˈbrəuin	[104]
blue	b̥ʏm	[18]
	(ˈbuːa)	[19]
	buː	[57, 62]
	bʳuː	[95,[10] 109, 112]
	bruː	[101, 120, 132]

9 The post-consonantal sonorant was indeterminate, after several hearings, as between [l], [r] and [w].

10 Post-consonantal /l, r, w/ are neutralised: either phonetically indistinct or in free variation.

blue tack	'buː tæʔ	[88]
boat	b̥əu	[14, 16]
	bəut	[78]
Bob the Builder	b̥əu(m)[11]	[19]
	'b̥əu 'bijæ	[21–2]
	'b̥əu 'bijæ / 'b̥əu 'bilæ[12]	[23]
	'b̥əu 'bijə	[24]
	'b̥ə 'bijə	[25–6]
	'b̥o 'bijə	[27, 30–1, 33]
	'b̥o 'bijə /'b̥ə 'bijə /'b̥uː 'bijə	[29][13]
	'b̥o 'biljə/ 'b̥əu 'bijə	[32]
	'bɔ 'bijə	[35, 37]
	bɔb	[41–2]
	'bɔb ə 'biᵘdə	[58–9, 63, 68–9]
	'bɔb ə 'bildə	[117]
bog	bɔd	[61]
boiler	'bɔilə	[107]
bone	b̥əuⁿ	[19]
	bəun	[87]
bonfire	'bɔnfaiə	[115]
book	b̥u	[1, 12, 19, 22–3, 25–34, 36, 37]
	b̥oː	[11]
	b̥u / b̥uf	[13]
	b̥u/ b̥uh / b̥uɸ	[14]
	b̥uʰ	[15, 18]
	b̥u / b̥uʰ	[17]
	b̥uː	[21]
	bu	[39, 43, 45, 47, 49]
	buʔ/ bu	[43]
	bu / bɔt / buʔ	[46]
	buʔ/ bu / butˢ	[48]
	buʔ	[50, 54, 95, 102]
	but	[55, 66] {scil. 'books'}
	but / buk	[133]
book case	'bʊʔteis	[123]
boom	buːm	[140]
boot (of car)	b̥u	[14]
	b̥uː	[28]

11 Pointing to a picture of same; usually without [m].

12 The latter pronunciation occurred only once.

13 He identified with Bob the Builder, referring to himself and the toy in identical terms.

boots (shoes)	b̥uː	[24, 27, 32]
	b̥u	[35]
	buːt	[43, 65]
borrow	'bɔrəu	[54]
both	bəuf	[69]
	bəut	[71]
	bəus	[105]
bother	'bɔdə	[73]
bottle	bɔ	[37]
	'bɔdu	[62]
	'bɔtəl	[106, 109]
	'bɔkəl	[136, 152]
bottom	'bɔdəm	[71]
	'bɔtəm	[107]
bought	bɔː	[34] {maybe 'brought'}
	bɔːt	[44]
	bɔːʔ	[54, 105]
	baid	[81]
bow (as in tying a bow)	b̥oː / bɔː	[14]
	b̥əu	[15,[14] 36]
bowl	b̥əu	[13]
	bəuł	[97]
box	b̥u	[26]
	b̥ɔʔ	[31, 32]
	bɔʔ	[38, 49, 61, 67–70, 72]
	bɔʔ / pɔt	[46]
	b̥ɔt	[48]
	bɔʔ / bɔt	[54, 56, 74]
	bɔtˢ	[57]
	bɔt	[58, 71, 73, 78]
	bɔʔs	[92, 109, 116]
boy	bɔi	[37, 65]
	bɔᵉ	[63]
brake	beiʔ /beit	[36]
branches	'braːntʃiz	[116]
bread (dough)	d̥oː	[4, 6]
	d̥oː/ d̥əu	[10]
	d̥əu	[28, 29]
	bɛʔ / dəu	[37]
	dəu	[44, 69]
	bɛd	[55, 64]

14 In fact an instruction to tie his shoelaces.

	bʳɛd	[68]
	brɛd	[70, 74, 110, 140]
	bʷɛd	[71]
bread bin	ˈbɛd bin	[69]
break	beit	[62]
	breit	[68, 100]
breaker	ˈbreitə	[98]
breakfast	ˈbrɛdfəd	[70]
	ˈbrɛtfət	[79]
	ˈbʳɛtfəs	[95]
	ˈbrɛʔfəst	[133]
breathe	briːd	[133]
	briːð	[148]
breathing	ˈbriːzin	[134–5, 144]
	ˈbriːðin	[148]
	ˈbriːðin / ˈbriːzin	[152, 154]
brick(s)	bi	[37]
	bit	[58]
	brits	[73]
	briʔ	[74]
	bʳiʔ	[77]
	biʔ	[78]
	biʔs	[92]
	briʔs	[106, 109]
	brit	[135]
bridge	bʳid	[70]
	bʳidᶻ	[91]
	brid	[95]
	briz	[100, 106]
	bridʒ	[154]
brief-case	ˈbiːtteit/ ˈbiːdəteitə	[48]
	ˈbiːʔteit	[58]
bring	bin	[35, 38, 56, 61–2, 68–9]
	bʳin	[77]
	brin	[86, 91, 106]
bringing	ˈbinin	[63]
	ˈbʳinin	[97]
broccoli	ˈbɔʔəliː	[94]
broke (past tense of *break*)	bəut	[54]
	bəud	[56]
	brəuʔ	[68]
	brəuʔt	[87]
	brəut	[109]
broken	ˈbəutən	[62]
	ˈbrəutən	[75–6, 100, 106, 136]

	ˈbʳəutən	[81, 90]
	brəut	[128]
	ˈbrəukən	[137]
	ˈbreikən / brəukt	[145]
broom	b̥um	[22]
	buːm	[34, 40, 58, 62]
	bʳuːm	[92, 121]
brother	ˈbʌdə	[70]
	ˈbʳʌdə	[79]
	ˈbrʌdə	[84]
	ˈbʳʌzə	[86]
	ˈbrʌzə	[108, 112, 139]
	ˈbrʌðə	[137]
brought	bɔt	[54] {see also 'bought'}
	brin / bɔːt / bʳɔːt	[86]
	brind	[108]
brown	(baːuⁿ)	[19]
	bʳaun	[69–70, 72, 91]
bruised	buːd	[64]
brush	bʳʌt	[79]
	bʳʌs	[85, 97]
	brʌʃ	[131]
bucket	ˈbʌʔiː	[34]
	ˈbʌʔbiʔ	[37]
	ˈbʌʔiʔ / ˈbʌʔit	[65, 128]
	ˈbʌʔiʔ	[79, 81, 92, 95, 100, 107–8]
buggy	ˈbədiː /ˈbʌdiː	[36]
	ˈbʌdiː	[38, 46, 64, 72, 97]
build	b̥iː	[21][15]
	biᵘd	[58, 72]
	biᵘd / biɬd	[145]
building (V)	ˈbiᵘdin	[85]
buildings	ˈbiudinz	[108]
bulldozer	ˈbuldəudə	[76]
bum	bʌm	[37]
bump	b̥əm	[23]
	bʌp / bʌm	[32]
	bʌm / bʌmp˥	[34]
burglar	ˈbəːda	[38] {imitating me}
	ˈbəːdlə	[133]

15 As in [biː hæ] – build have {= "let's do some building"}. See the discussion of stage 3 in chapter 4.

burn	bəːn	[68]
bus	bʌt	[72, 81]
busy	ˈbidiː	[56, 67, 71]
butter	ˈbʌdə	[37, 56]
	ˈbətə	[92]
butterfly	ˈb̥ʌdəfai	[48]
	ˈbʌdəfai	[63]
	ˈbʌdəwai	[65]
	ˈbʌtəfʳai	[112]
button	ˈbʌdən	[66]
	ˈbʌʔən	[99, 113]
buy	bai	[56–7]
buying	ˈbaiin	[145]
by (hand)	b̥ei hæⁿ	[31]
	bai ˈhænd	[94]
	bai	[115, 139] {passive morpheme}
bye-bye	bah	[0]
	ˈb̥aba, ˈb̥æbæ, ˈb̥æ ˈbæ[16]	[1]
	ˈb̥æ ˈbæ, ˈb̥æbæ	[2]
	ˈb̥æ ˈbæ	[28]
cab	tæb	[122]
cable	ˈteibu	[95]
cake	d̥ei	[31]
	ˈd̥eiː	[32]
	d̥ei	[34]
	deit	[42]
	teit	[48, 57, 71, 82, 84, 97, 126, 132]
	teit /teiʔ	[70]
	keit	[133]
calf, calves	taːt	[59]
	taːvz	[110]
call	tɔːl / tɔː[17]	[74]
called	tɔːd	[53–4, 56, 58, 62, 68–9, 72, 82, 100]
	tɔːld	[81]
	tɔːld / tɔːd	[114, 120]
Cambridge	ˈteimbid	[59]
	ˈteimbʳiz	[100]

16 Used to indicate the end/disappearance of anything – both before and after – e.g. signalling that he is ready to get out of the bath; go to bed after listening to songs and stories; etc.

17 The alternation was in the context of a following *it*, giving: [tɔːl it/ tɔːwiʔ] – *call it*.

came	teim	[64, 113]
camel	ˈtæməɬ	[128]
camera	ˈd̥æmə	[26, 32]
	ˈtæmə	[51]
	ˈtˢæmə	[70]
	ˈtˢæmrə	[84]
	ˈtæmrə/ ˈtʳæmə	[88]
can (= be able)	tæn	[54, 56, 58–9, 61–2, 65, 67–9, 71–2, 74, 77–8, 81, 85, 87–92, 94–5, 97, 102, 105, 108, 140]
	tʰæn / tæn	[84]
	kən	[136]
	kæn	[141]
candle(s)	ˈdænə	[34]
	ˈtændu	[57, 82]
	ˈtændu / ˈtændəl	[84]
	ˈtænduz	[95]
	ˈtændəlz	[106]
candle lighter (match)	ˈtændəl laitə	[84]
candle-stick maker	ˈtændu tit meitə	[90]
can't	taːn	[56, 58, 61, 66]
	taːnt	[65, 74, 85, 115]
	taːnt / taːn	[62]
	taːnʔ	[89, 100, 123]
car	brm/ brrm	[8, 11, 13, 14, 19, 22, 23, 24, 25, 30, 36]
	d̥aː	[32]
	daː	[46]
	taː	[48, 50, 54–5, 58, 66, 71–2, 75, 78–9, 81, 86, 89, 97, 99–100, 104, 112, 114, 120, 130]
card	d̥aːd̥	[43]
	taːd	[58, 63]
cardboard	ˈtaːdbɔːd	[58]
	ˈtaːbɔːd	[94]
care (N)	tɛː	[78]
careful	ˈtɛːfu	[90, 95]
carol	ˈtæwəɬ	[48]
car park	ˈtaː paːʔ	[106]
carpet	ˈtaːbiː	[48]
	ˈtaːpiʔ	[50, 66]
	ˈtaːpit	[60, 73, 76, 79, 87, 99, 129]
	ˈtaːpiʔ / ˈtaːpit	[106]

carriage	ˈtæriz	[70]
carried	ˈtærid	[115]
carrot	ˈtæwəʔ	[63]
	ˈtærət	[72]
	ˈtæwət	[77, 80–1, 94]
	ˈkærət	[135]
carry	ˈtæiː	[43, 51, 78, 92, 95]
	ˈtɛiː	[57]
	ˈtæriː	[74, 116, 124, 135]
	ˈtæʳiː	[84]
	ˈtæwiː	[85, 91]
	ˈkæriː	[137, 145]
cart	taːʔ	[108]
carton	ˈtaːtən / ˈkaːtən	[133]
case	teit/ teiʔ	[62]
	teit	[64, 66, 78]
	teis/ teit	[69, 85]
	teis	[92, 114]
	keis	[149]
castle	ˈtaːsu	[100]
	ˈtaːsəl	[106, 117]
	ˈtaːsul	[120]
cat	ˈæːə[18]	[3, 6]
	æː /ˈmiːau	[23]
	ˈmiːau	[32]
	tæt	[50, 52, 62, 68, 76, 112, 122–4]
	tæʔ	[59, 79, 97]
	ˈmiːau tæt / ˈmiːau tæʔ	[66]
	tætˢ	[91]
	kæʔ	[133]
catch	tæt	[63]
	tæts	[105]
	tætʃ	[116]
	kætʃ	[139]
caterpillar	ˈtætəpiːjə	[69]
	ˈtætəpilə	[92, 120]
caught	tɔːt	[117, 124]
	kætʃt	[154]
caused	tɔːzd	[124]
cave	teiv	[113]

18 Up to and including session 23 Z used a consistent, but intonationally odd, gradual high to low fall for this item.

ceiling	'siːlin	[72, 86, 92, 102, 113–14, 136, 149]
cement mixer	brr	[3] {see 'mixer'}
	'mɛnt midə[19]	[59]
	'mɛnt midə / 'sɛnt midə	[64]
	sə'mɛnt midə	[71]
chair(s)	tɛː	[47]
	tɛ	[50]
	taː	[63]
	tʳɛː	[79, 87]
	trɛː	[101, 107–8, 117, 121, 133]
	tᶜɛː	[111]
	trɛːz	[120]
chance	træns	[132]
change	tʳeind	[84]
charge {as in "I'm in charge"}	traːz	[117]
check (V)	tˢɛʔ	[73]
	tʳɛt	[78]
	trɛʔ	[113]
cheese	d̥iː	[20, 32]
	tiːd	[58]
	tˢiːz	[66, 88–9, 100]
	tˢiːz / tˢiːdᶻ	[71]
	tˢiːz / tˢiːd	[74]
	triːz	[110, 119]
chemicals	'tɛmitəlz	[133]
cherry	'tˢɛiː	[82]
	'trɛriː	[124]
	'tʃɛriː	[139]
chew	tʃuː	[134]
chick	tiʔ	[63]
chicken	'tritinz	[106]
	'tʃiʔin	[114]
chicken pox	'tritin pɔʔs	[106]
child	tˢaiᵘd	[87]
	'trildrən	[112]
chimney	'tʃimniː / 'ʃimniː	[140]
chin	tin	[56]
	tˢin	[90]
	trin	[101]

19 [si'mɛnt midə] on being asked for his mother's pronunciation. A comparable reaction occurred in session 64.

china	ˈtʳainə	[114]
Chinese	tsaiˈniːz	[85]
chip(s)	tip	[57, 61, 65]
	tʳip	[82]
	tˢip	[94]
	trip	[128]
chlorine	ˈtɔːriːn / ˈtʳɔːriːn	[85]
chocolate	ˈtɔdit	[51]
	ˈtʳɔʔdit	[84]
	ˈtʳɔʔlit / ˈtʳɔʔliʔ	[91]
	ˈtrɔʔlit	[92, 94, 112, 121]
	ˈtʳɔʔlit	[95]
	ˈtʳɔʔliʔ	[100]
	ˈtrɔʔləʔ	[108]
	ˈtʃɔʔlit	[140]
	ˈʃɔklit	[141]
chomp	trɔmp	[80]
choose	tuːd	[71]
	truːz	[119]
chop (V)	tɔp	[65, 71]
	tʳɔp	[94]
chopping	ˈtɔpin	[65]
Christmas	ˈtrisməs	[103, 107, 110, 116, 129] {see also ‘Father Christmas’}
Christopher Robin	ˈtidəwə ˈrɔbin / ˈtidə ˈrɔbin	[58]
	ˈtʃistəfə ˈrɔbin	[109]
circle	ˈsəːtʊ	[56, 123]
	ˈsəːkəl	[137]
clamp	træmp	[120]
clap	træp	[86–7, 101]
clean	d̥iːn	[27, 29, 34, 39]
	tiːn	[48, 53, 58, 69–71, 76, 79]
	tiːn / tʰiːn	[64]
	tˢiːn	[73, 87, 109]
	tiːn / tˢiːn	[84]
	triːn	[100, 114, 125, 132]
cleaned	tiːnd	[79, 87, 90]
cleaning	ˈtriːnin	[108]
clear	triə	[110]
	kliːə	[138]
clever	ˈtrɛvə	[101, 130]
climb	deim	[38]
	tæːm	[50]
	taim	[62]
	traim	[85, 101, 107–8, 112–13, 120, 124, 130]

	tʳaim / traim	[87]
	tˢaim	[88]
	tʳaim	[106]
climbed	traimd	[115, 131]
climbing	ˈtˢaimin	[90]
	ˈtʳaimin	[93]
climbing frame	ˈtaimin feim	[90]
	ˈtʳaimin feim / ˈtʳaimin fʳeim	[95]
	ˈklaimin freim	[136]
cling film	ˈtin fim	[76]
clinic	ˈtriniʔ	[128]
clip	See ‘paper clip’	
clock(s)	tʰɔʔ	[56]
	tɔt / tɔts	[58]
	tɔʔ	[67]
	trɔʔ	[110, 131]
	trɔʔ / trɔt	[120]
close (V)	təud	[62]
	trəud	[78]
	tʳəud	[79]
	tʳəuz	[97]
	trəuz	[104, 120, 123, 128, 131]
close (Adj)	trəus	[92, 115, 121, 126]
closed (passive)	ˈtʳəuzən	[97]
	trəuzd	[111, 116]
closing	ˈtəudin	[74]
cloth	tɔt	[76]
	trɔs	[85, 100, 108, 110, 117]
	tʳɔs	[86, 95]
	trɔf	[89]
	trɔs / trɔs̟ / trɔθ	[90]
	trɔʃ	[115]
clothes	təud	[65]
	trəuz	[108, 110, 122, 128]
cloud	traud	[127]
coal	d̥əu	[36]
	dəu	[37]
coat	dəut	[43]
	təut	[86]
	təut / təuʔ	[97][20]
cobwebs	ˈtɔbwɛbz	[114]

20 Final [t] in careful speech, [t] or [ʔ] in normal speech.

coffee	'tɔdiː	[55, 63, 67]
	'tɔwiː	[68, 70]
	'tɔfiː	[71, 73, 79, 87, 90, 93, 95, 99, 101, 113, 117]
	'tɔfiː / 'kɔfiː[21]	[133]
cold	təud	[55, 67]
	təud / təul	[73]
	təuld	[74–5, 92, 109]
colour	'dʌbə	[43]
	'tʌlə	[66, 70, 72, 74, 111]
	'tʌləz	[113]
	'kʌləz	[136]
comb	dəum	[31] {reported by his father}
	təum	[63, 72, 118]
combine	dɔmə 'haːwə	[39]
harvester	'tɔm 'bain 'haːvidə	[82]
	'tɔmbain 'haːvidə	[83]
	'tɔmbain 'haːvistə	[122, 136]
come, comes	d̥ʌm	[28, 30, 35, 37]
	dʌm	[38, 42]
	tʌm	[48, 56, 60, 64, 68–9, 71–2, 76, 79, 84, 86, 89, 92, 97, 108, 121, 131]
	tʌmd	[58]
	tʌmz	[117]
coming	'dʌmin /'dʌmi	[56]
	'tʌmin	[61, 67, 90, 132]
completed	kɔm'pliːtid	[149]
compost bin	'tɔmpɔʔ bin	[58]
composter	'tɔmpɔdə	[51, 69]
	'tɔmpɔtə	[65]
	'tɔmpɔtə / 'tɔmpɔdə	[71]
	'tɔmpɔstə	[85]
computer	'buːdə/ 'buːd̥ə	[39]
	'puːdə	[48, 56, 62]
	'puːtə	[50–1, 87, 93, 100]
	təm'puːtə	[122]
	'pjuːtə	[141]
concrete	'tɔntriːt	[98, 122]
	'kɔnkriːt / 'kɔŋkriːt	[137]
concrete mixer	'tɔntiːt midə	[71]

21 He said ['tɔfiː] a few times, but once or twice self-corrected to ['kɔfiː].

concrete pump	ˈtɔntʳiːt ˈpʌmp	[93]
condensed milk	dɛnʔ ˈmiᵘt / dɛn ˈmiᵘt	[76]
condor	ˈtɔndɔː	[120]
Connector	təˈnɛʔtə	[117]
	təˈnɛktə / kəˈnɛktə	[135]
control	ənˈtʳəul / ənˈtəul	[76]
	ənˈtrəul	[98]
cook (V)	tuʔ	[70–1, 110, 121]
cooked	tuʔt	[72]
cooking	ˈtudin /ˈtuʔin	[71]
	ˈtuʔin	[87, 106]
	ˈkukin	[145]
cool	tuːl	[144]
cooler (Adj)	ˈtuːlə	[100, 128]
corner	ˈdɔːnə	[38]
	ˈtɔːnə	[58, 62, 65, 67, 71, 79, 94, 117]
Cornwall	ˈd̥ɔːnwə	[46]
	ˈtɔːnwɔːᵘ	[90]
cosy	ˈtəudiː	[58]
cot	d̥ɔʔ	[37]
cough	tɔd	[63]
	tɔf	[73–4, 78, 109, 124–5]
	tɔfs	[126]
could	tud	[71–2, 80–1, 104]
count (V)	taunt	[68]
countries	ˈtʌntriz	[128]
couple	ˈtʌbu	[62]
courgette	tuəˈzɛt	[94, 113]
	tuˈzɛt	[95]
cover	ˈtʌvə	[106]
covered	ˈtʌvəd	[86, 106]
covers (N)	ˈtʌvəz	[100]
cow(s)	muː[22]	[3, 4, 26]
	ˈmuː dau	[32]
	d̥au[23]	[34]
	tau	[52, 59, 79, 88, 105, 109, 113, 131]
	tauz	[100, 110]
	kau	[137]
cow catcher	ˈtau tæsə	[95]
crack	tæt	[49]

22 Used for *horse* and *cow* in the early sessions.

23 Response to "What says 'moo'?".

crackers	ˈtrætəz	[109]
crackle	ˈtræʔəl	[107]
cranberry juice	ˈtʳæmbʳiː duːt / ˈtʳæmbiː duːt / ˈtʳænbriː duːt	[74]
crane	tʳein	[69, 77, 83, 93] {cf. ‘train’}
	trein	[98, 102,[24] 112, 120]
	kʳein[25]	[129]
	krein	[137]
crash	tʳæs	[85]
	træs	[99]
	træʃ	[108, 114, 120, 122]
	kræʃ	[140]
crawl	tʳɔːl	[95, 100, 113]
	trɔːl	[124]
	krɔːld	[136]
crawling	ˈtrɔːlin	[127, 131]
crayon	ˈtreiɔn / ˈtreiən	[79]
	ˈtʳeiɔn	[87]
	ˈtreiɔn	[117]
cream	tiːm	[63, 69]
	triːm	[131–2]
	kriːm	[140]
cress	trɛs	[88]
	tʳɛs	[92]
Cridlington	ˈkridlintən / ˈtridlintən	[145]
	ˈkridlitən	[146]
croc(odile)	dɔʔ	[37]
	ˈtɔtudæᵘ	[57]
	ˈtɔtədaiᵘ	[63, 78]
	ˈtɔtudaiᵘ	[72, 80]
	ˈtʳɔtədaiᵘ	[92]
	ˈtrɔtudaiu	[112]
crocus	ˈtəutət	[64]
cross	tɔt	[67]
	tʳɔs	[100]
	krɔs	[137]
crossing (N)	ˈtrɔsin	[92, 107]
crow	təu	[58, 67]
	trəu	[116]
crowded	ˈtraudid	[114]
crumble (N)	ˈtʳʌmbu	[89]

24 As in [trein trein] – *train crane* – an appropriate compound for a crane carried on a train.

25 The velar articulated with visible effort.

crumbs	tʌmd	[78]
	trʌmz	[100, 110, 120, 147]
	krʌmz	[136]
	krʌmz / trʌmz	[148]
crunch	tʳʌnt	[73]
crunchy	ˈtʌntiː	[62, 67]
	ˈtʌnʔtiː	[63]
	ˈsʌziː / ˈtˢʌndiː	[70]
	ˈtʳʌntiː	[73]
	ˈtrʌnsiː	[86]
	ˈtrʌntʃiz	[120, 126]
crush	trʌs	[85]
crusher	ˈtʌtə	[46]
	ˈtʌsə	[48, 94]
	ˈtrʌsə	[92, 98]
	ˈtrʌʃə	[122]
crust	tʌt	[69]
	tsʳʌθ	[74]
cry	trai	[78, 123]
crying	ˈtʳaiin	[71, 97]
	ˈtaiin	[105]
cucumber	ˈtuːtʌmbə	[64, 74]
cuddle	ˈtʌdu	[76, 95, 128]
	ˈtʌdu / ˈtʌdul	[124]
cup	dʌʔ /dʌp˥	[37]
	tʌp / tʌb	[71]
	tʌp	[82, 92]
	kʌp	[138]
cupboard	ˈdʌbə	[42]
	ˈtaːbə	[48]
	ˈtʌbəd	[58, 61, 65, 68, 73, 85, 106, 109, 127]
	ˈkʌbəd	[136]
curtains	ˈdʌən	[38]
curvy	ˈtəːdiː	[58]
	ˈtəːviː	[120, 123]
	ˈkəːviː	[139]
cushion	ˈtuʃən	[111]
custard	ˈtʌstəd	[89]
cut	d̥ʌt̄	[32]
	tʌt	[56, 69, 85, 92, 95]
	tʌʔ	[59–61, 64, 80, 84, 106, 113]
	tʌʔ / tʌt	[66, 81]

cutting	'tʌtin	[90]
cutter	'tʌtə	[74, 116]
Daddy[26]	d̥a	[0]
	'd̥ada(da(da(d)))	[5, 6] {all possible combinations occurred}
	'd̥ada	[7] {possessive}
	'd̥æ (dæ)	[8]
	'd̥ædæ (dæ (dæ))	[9, 11]
	'd̥ædæ	[13, 14, 15, 17]
	dæd	[15] {as part of 'Mum Dad'}
	'd̥æ (daː)	[19]
	'd̥æda:	[20, 23]
	'd̥ædməm /'d̥æ 'məmiː	[23] {Mummy and Daddy}
	'd̥æda: /'d̥ædiː	[26]
	'd̥ædiː	[30, 32, 36]
	'd̥æd(iː)	[31]
	'dædiː	[38, 42, 50–1, 53–4, 56, 61–2, 65, 71, 79, 89–90, 94, 106]
	'dædəiː	[125]
damage	'dæmiʒ	[126]
damaged	'dæmiʒd	[124]
dandelion	'dændiːlæᵊn	[82]
	'dændiːlaiᵊn	[86]
dangerous	da, dæː[27]	[1]
	daː	[2, 3, 6, 13, 29[28]]
	'deinrəs / 'deindrəs	[89]
	'deinrəs	[90]
dark	daːʔ	[38, 56, 87, 108]
	dɔːʔ	[49]
	daːʔ / daː	[57]
	daːk	[141]
darling	'daːlin	[85]
dates	deit	[48]
day	diː	[31] {in 'old days'}
	dei	[43, 59, 71, 91]
dead	d̥ɛ	[31]
	dɛd	[91]
deal	diːl	[86]
dear	diə	[23] {see also 'oh dear'}
dear me	diə 'miː / tiə 'miː	[44]

26 Also used for *Grandpa*.

27 Typically, but not invariably, with a slow rise and slightly quicker fall.

28 Used for *knife* as well as *dangerous*.

decided	ˈsaidid	[106]
decorate	ˈdɛtəreit	[87]
deer	diə	[63]
den	dɛn	[86–7]
design	diˈzain	[138]
desk	dɛst	[133]
destroy	disˈtrɔi	[132
detach	ʌnˈtætʃ	[119]
diaphragm	(ˈdaiəfæm)	[85]
did	did	[56–7, 65–9, 73–5, 77–8, 89, 95, 106]
different	ˈdiwənt	[89]
	ˈdifrənt	[100]
difficult	ˈdifitəlt	[111]
dig	d̥i	[15, 17, 20–1, 26]
	did	[75, 91, 99, 106]
digger	d̥i	[19, 22]
	ˈd̥iːjə	[29]
	ˈd̥ijə	[30–1, 35]
	ˈd̥iːə	[36]
	ˈd̥iˠə	[37]
	ˈdiːjə	[45]
	ˈdidə	[57, 59, 69, 71, 76, 83, 88, 92–3, 129]
	ˈdidəz	[95]
digging	ˈdidin	[89–90, 92]
dilute	daiˈluːt	[82, 128]
ding-dong	ˈdinlin	[19]
	ˈd̥in dɔ	[34]
dining room	ˈdainin rum	[82, 91]
dinner	ˈd̥inə	[20–1, 23, 34]
	ˈdinə	[137]
dinosaur	ˈdæⁿsɔː	[46]
	ˈdainəsɔː	[84, 136]
dirt	dəːt	[41, 44, 48]
	daːt	[53]
dirty	ˈdəːdiː	[68]
	ˈd̥əːd̥iː	[70]
disaster	ˈzaːstə	[90]
Dizzy	ˈdidiː	[48, 56, 59, 65, 72]
	ˈdiziː	[97, 117]
do	duː	[23, 26, 28, 32, 34–5, 37, 39, 41–3, 46, 49–50, 55–6, 60–2, 64–5, 67–74, 77, 84 {= ‘do you’}, 85, 88, 90, 92, 99, 119, 139]

doctor	ˈdɔʔtə	[60, 64, 80, 85, 97, 111, 120, 127]
	ˈdɔk̚tə	[137, 145, 149]
does	dʌd	[71]
	dʌz	[72, 82, 89, 97, 100]
	dəz	[109]
	duːz	[116, 122, 139]
doesn't	dʌnt	[65]
	ˈdʌənʔ	[72]
	ˈdʌdᵊn	[73]
dog	ˈwowo	[1, 3] {virtually voiceless throughout}
	woː	[4]
	wuː/ ɸuː	[14]
	wu/ ɸu	[32]
	ɸː	[36]
	dɔʔ	[47]
	dɔd	[52, 59, 62, 86–8, 97, 110, 115, 122–3, 129]
doing	ˈduːin	[34, 70, 89–90, 94]
dolly	ˈdɔliː	[71]
dolphins	ˈdɔlfinz	[112]
dominoes	ˈd̥ɔmə /ˈd̥ɔm	[21]
done	dʌn	[48, 56, 70–1]
donkey	ˈdɔndiː	[43]
	ˈdɔntiz	[131]
don't	dəun	[48, 55, 57–8, 60, 64, 68–70, 74, 78–81, 85, 88, 109]
	dəunʔ	[71, 92, 95]
	dəun / dəunt	[73]
	dəunʔ / dəun	[84]
	dəunt	[125]
door	d̥u /d̥o	[14]
	d̥oː	[16, 18, 23]
	dɔː	[58, 62, 69, 72–4, 76–7, 140]
double	ˈdʌbəl	[137]
double decker (bus)	dʌbu dɛdə ˈbʌt	[81]
	dʌbəl ˈdɛtə	[109]
dough	See 'bread'	
down	d̥æ	[14] {inconsistent}
	d̥au	[34]
	daun /daum	[37]
	daun	[38–9, 42, 46, 51, 58, 69, 72, 76, 78–9, 84, 86, 90–2, 97, 106–7, 110, 131, 139]

downstairs	daun'tɛːd[29]	[84]
drag	dæd	[62]
	dræd	[73]
dragon(s)	'dʳædən	[70, 95]
	'dᶻædən / 'dʳædən	[71]
	'drædənz	[92]
	'drædən	[101, 112]
	'dʒægən	[140]
draw	d̥ɔː	[31, 34]
	dʳɔː	[38, 94]
drawing	'dʳɔːin	[71]
dream(s)	diːm	[57]
	driːmz	[133]
dressed	dɛt	[67]
	dʳɛs	[71]
	dʳɛt	[73]
	dʳɛst	[87]
drew	duː	[37]
dribble	dʳibu	[71]
dried	'dᶻaidiʔ	[71]
drill	dɨᵘ	[39]
	diu	[49–50]
	dʲiᵘ	[64]
	dʳil / dᶻil	[87]
drill bit	'dril bit	[74]
drink	d̥i	[34]
	dᶻint	[71]
	drint	[72]
	drint /dᶻint	[82]
	dʳint /dᶻinʔ	[84]
	dʳint /dʳinʔ	[87]
	dzint	[94]
	dʳint	[95]
	dʒiŋk	[140]
drinking	'drintin	[109]
	'driŋkin	[141]
drip	d̥ip	[29]
driver	'daidə	[63, 65]
	'daivə / 'dʳaivə	[70]
driving	'daidin	[64]
	'draivin	[81]

29 He contrasted: [wɔːʔ daun'tɛːd] – *walk downstairs* and [wɔːʔ daun ə 'tɛːd] – *walk down the stairs*.

drop (N/V)	dɔp	[62, 66]
dropped	dɔpʔ	[62]
drove	dəud	[49]
drum (stick)	ˈdrʌm tiʔ	[117]
drunk (pp)	dʳinʔt	[87]
duck	d̥æk˺ /d̥æʔ˺	[26]
	d̥ʌʔ	[32]
	dʌʔ	[37, 38, 59, 61, 69–70, 113, 119]
	dæʔ	[43]
	dʌt	[58, 82]
	dʌʔ / dʌt	[73]
	dʌkh / dʌkʼ / dʌt	[136]
	dʌk	[143]
duckling	ˈdʌʔlin	[101]
dummy	ˈdʌmiː	[69]
dump	dʌmp	[56, 87, 89–90, 98, 106]
dumper	ˈdʌmbə	[55]
	ˈdʌmpə	[97]
Duplo	ˈduːprəu	[91]
	ˈdruːpləu	[106, 132]
	ˈdruːprəu	[125]
duster	ˈdʌʔtə	[58]
dustbin	ˈdʌsbin	[113]
dustbin lorry	ˈb̥in ləuriː	[33]
	ˈbin lojiː	[54]
	ˈbin lɔriː	[77]
	ˈbin lɔwiː	[94]
duvet	ˈduːveⁱ	[64]
	ˈduːvei	[98]
each other	iːts ˈʌdə	[81]
ear(s)	ˈiːə	[33, 81]
	iəd	[69]
earthquake	ˈəːstreiʔ / ˈəːstreit	[117]
easily	ˈiːziliː	[108]
easy	ˈiːdiː	[56]
	ˈiːziː / ˈiːziː ˈpiːziː	[120]
	ˈiːziː	[126]
eat	iː	[26]
	iːt / iːd̥	[38]
	iːt	[44, 55–6, 86, 90]
eaten	ˈiːtən	[71, 73]
	ˈɛtən / ˈeitən	[149]
eater	ˈiːtə	[135]

echo	('ɛdəu)	[35]
Eeyore	'ʔiːʔɔː	[42]
	'iːʔɔː	[43]
egg(s)	ɛv /ɛd	[38]
	ɛd	[43–4, 48–9, 58, 69, 72, 100, 109, 124]
	ɛd / ɛdᶻ	[64]
	ɛd / ɛdz	[71]
	ɛgz	[137]
eight	eit	[48, 55, 60]
	eːt	[54]
elastic	'lædit	[78]
electric	'lɛtrit	[89]
elephant	ɛnː	[39]
	'ɛdin / 'ɛdən / 'ɛniː	[55]
	'ɛvənt	[78]
	'ɛfisint	[105]
	'ɛfəsint	[112]
	'ɛləfənt	[136]
eleven	'lɛdən	[60]
	ə'lɛvən	[71]
else	ɛlt	[69]
e-mail	'iːmeiu	[50]
empty	'ɛmtiː	[74]
end	ɛnd	[56, 72, 78, 80–1, 92]
	ɛndz	[138]
energy	'ɛnəʒiː	[108]
engine	'ɛndin	[62, 76]
	'ɛndᶻin	[86]
enormous	i'nɔːməs	[137]
enough	nʌt	[53]
	i'nʌt	[55]
	i'nʌf	[100, 123]
equipment	'tripmənt	[112]
	ə'tripmənt	[115]
	i'tripmənt / 'kwipmənt / i'kwipmənt	[145]
escalator	'ɛdəleitə	[43]
even	'iːvən	[123]
every	'ɛviː	[78]
everybody	'ɛviːbɔdiː	[46, 48, 84]
	'ɛwiːbɔdiː	[55]
	'ɛvʳiːbɔdiː	[95]
everything	'ɛvrin	[103]
	'ɛvrisin	[114]
excavator	'eidəweidə	[44]

excuse me	'tuːz 'miː	[118]
expert	'ɛʔpəːt	[76]
explode	prəud / is'prəud	[128]
face	feit	[50, 69]
fair (N)	faː	[81]
fall	fɔː	[46, 70]
	fɔːl	[88, 106]
falling	'fɔːi	[48]
far	faː	[102, 120]
farm(s)	faːm	[61, 70, 100]
	faːmz	[108]
farmer	'faːmə	[86–7, 120]
Farmer Pickles	'faːmə 'pidəld	[71]
fart	faːʔ	[117]
farting	'faːtin	[59]
fast	faːt	[81]
	fæst	[139, 141, 149]
fasten	'faːtən	[72–3]
fastened	'faːdənd	[84]
faster	'fæstə	[141]
Father Christmas	faːwə 'tˢimaː / faːwə 'timaː	[54]
favourite	'feivət	[76]
fawn	fɔːn	[63]
fear	fiə	[107]
fed up	'fɛd 'ʌp	[47]
feed	fiːd	[43, 56, 81]
feet	fiːt	[38, 89, 95, 107]
	fiːʔ	[65]
fell	fɔːd	[58, 69]
felt pen	'fəut 'pɛn	[82]
few	fuː	[77, 85]
field	fiːᵘd	[58, 89]
fifty	'fifiː	[115, 128]
figure (of eight)	'fidə ə 'eit	[55]
	'fidə	[57]
	'fidə əv 'eit / 'fidə 'eit / 'fidə ə 'heit	[70]
	'fidə əv 'eit	[72]
find	fainᵈ	[69]
	faind	[75, 80–1]
finding	'faindən	[76]
fine	fain	[39, 68]
	fæn	[47]
	fæᵉn	[57]

finger	'fində	[37, 43–4, 54, 57, 60, 65, 68, 70, 72, 78, 85–6, 92, 99–100, 113, 121, 131]
	'findəz	[95, 105, 107, 112, 120]
finish	'fini	[43]
	'finit	[69]
	'finis	[100]
finished	'fidiː	[56, 58]
	'finid	[64]
	'finit	[70, 74]
	'finist	[90]
	'finis	[104]
fire	'fæjə	[42, 44]
	fæː	[94, 100, 128]
	faiɬ	[141]
fire brigade	'fæː bi'deid	[105–6]
fire engine	'niːnə	[38] {imitative}
	'fai rɛndin (din(din))	[69]
	'fæː ɛndin	[71]
	'niːnaː	[76] {imitative}
	'fæː ɛndʑin	[109]
	'fæː rɛndʒin	[133, 144]
	'fæ rɛndʒin	[153]
fire extinguisher	fæː i'tinwisə	[105]
fireman	'fæᵉmən	[71]
	'fæːmən	[114]
fire station	'fæᵊ teisən	[104]
fireworks	'fæːwəːʔs	[117]
first	fəːt	[58, 60, 72]
	faːt	[71]
	fəːst	[131]
fish	fit	[56–7, 65, 71, 81]
	fis	[85, 90, 105]
fit	fiʔ	[56, 62, 70, 72]
five	fæ̰	[48]
	fæv	[54]
	faid	[58]
	fæid	[60]
	faiv	[71, 106]
fix (it)	'fid iʔ	[58]
	fit	[59]
	fiˀt it	[61]
	fiʔt	[63, 69]
	fiks	[154]
flames	seimz	[103]
	freimz	[126]

flannel	ˈfænu	[69]
flapjack	ˈsæmdæ/ ˈd̥æmdæ	[34]
	ˈsæmdæ/ ˈfæmdæ	[37]
	ˈsæpd̥æ	[44]
	ˈsæpdæʔ	[58, 62, 66, 68]
	ˈsæpdʳæʔ	[72, 89]
	ˈsæpdᶻæʔ	[74, 86, 105]
	ˈsæpzæʔ	[87]
	ˈsæpdæʔ / ˈsʳæpdæʔ / ˈdzæpdzæʔ	[100]
	ˈlæpdzæʔ[30]	[112]
	ˈʃæpdʒæʔ / ˈfʳæpdzæʔ	[115]
	ˈʃæpdʒæʔ	[117]
	ˈfʷæpdzæʔ	[121]
	ˈfræpdzæʔ	[124]
	ˈfræpdʒæʔ	[126, 131]
	ˈflæpdʒæk	[136, 144]
flat (N)	fæʔ	[87]
flat-bed (truck)	ˈfʷæt bɛd / ˈfʳæt bɛd	[95]
flea	fʳiː	[106]
fleece	fiːt	[56, 60, 63]
	fiːtˢ	[57]
flip-flops	ˈfripfrɔps	[132]
float	fəut	[86]
floor	fɔː	[43, 51, 60, 63, 69, 76, 79, 86, 128]
	flɔː	[72, 136, 149]
	frɔː	[130]
floppy	ˈfɔpiː	[87]
flounder (fish)	ˈfaundə	[63]
flour	ˈfɔːə	[37]
	ˈfæwə	[44]
flower(s)	ˈfæwə	[37, 38, 65–6, 69]
	ˈfræwə	[124]
flush	frʌʃ	[126]
fly/ flies (N)	ɸai	[34]
	fæᵉ	[59]
	fai / fʷai	[89]
	faiz	[92]
	fai / fʷai / fˡai	[99]
	fai	[113]
	frai	[120]

30 In both sessions 112 and 115 he claimed, despite his variant pronunciations, that *flapjack* begins with [ʃ].

fly (V)	fai	[56, 85, 113]
foam	fəum	[124]
fold	fəud	[59]
food	fuːḓ	[45]
	fuːd	[58, 85, 105, 136]
foot	fut	[43, 88, 136]
football	ˈfutbɔːl	[139]
for	ɸɔː	[49]
	fɔː	[50, 55–6, 61, 65, 67–8, 70–1, 73–4, 76, 81–2, 90, 95, 107, 117, 121, 138]
	fə	[58, 60, 109, 137, 139–41]
forget	fiːˈdɛt	[109]
	fiˈdɛt	[112]
fork	wɔː / fɔː	[29]
	ɸɔːʔ	[38]
	fɔːʔ	[39, 48, 55–6, 61, 67, 74–5, 86]
	fɔːʔ / fɔːt	[64]
	fɔːt	[126]
	fɔːt / (fɔːt^{h})	[131]
	fɔːk	[140]
formula	ˈfɔːmilə	[112]
forty	ˈfɔːtiː	[115, 132]
found	faund	[78]
foundation	faunˈdeiʃən / faunˈdeisən	[117]
four	o̬ɔːˤ/ o̬ɔː	[36]
	vɔː	[42]
	fɔː	[48, 54, 58, 60]
fox	fɔt	[48, 54, 58, 78]
	fɔʔ	[56]
	fɔks	[136]
frame	feim	[48, 63]
	feːm	[68]
France	fraːns	[119]
fridge	friḓ / fiḓ	[76]
	friz	[121]
friend	fɛnd	[94]
	frɛnd	[105]
	frɛnz	[137]
frog(s)	f^{w}ɔp / f^{w}ɔ	[38]
	ɸɔβ	[39]
	fɔd	[63]
	f^{r}ɔd	[72, 92]
	frɔd	[94, 118, 130]

	frɔdz / frɔgz	[140]
	frɔg	[141]
from	fɔm	[56, 60, 81]
	fˈɔm	[72, 86]
	frɔm	[106]
front	fʌnt	[70, 81]
	frʌnʔ	[131]
frost	fˈɔst	[121]
fruit	fuːʔ	[71]
	fuːt / fruːt	[141]
fruit salad	ˈfuːt ˈsæəd	[58]
full	fu / ful	[74]
fun	fʌn	[37, 39, 49]
funnel	ˈfʌnu	[108]
funny	ˈfʌniː	[37, 43, 48, 50, 56, 119]
	ˈfʌniː / ˈɣ̊ʌniː	[46]
further	ˈfəːdə	[72]
gallons	ˈdælənz	[128]
game(s)	deimd	[58, 60]
	deim	[62, 120]
	deimz	[92, 95]
gang	dæn	[131]
gannet	ˈdænit	[127]
	ˈdæniʔ	[131]
garage	d̥aː	[32, 34]
	ˈdæwa	[42]
	ˈdæraːd	[62]
	ˈdæwaːd	[66]
	ˈdæwaːz	[69, 91]
	ˈdzæwaːd	[74]
	ˈdᶻæwaːd	[75]
	ˈdæwaːdᶻ	[86]
	ˈdæraːz	[87–8]
	ˈdæraːʒ	[113]
garden	daː	[30, 32]
	ˈdaːhə	[31]
	ˈdaː / ˈdaːnə	[34]
	ˈdaːnə	[35, 40, 65, 68]
	ˈdaːnə / ˈdɔːnə	[48]
	ˈtaːdən	[64]
	ˈdaːdən	[75, 81–2, 84, 86, 89–92, 95, 100, 103–4, 109, 113, 117, 126]
gardening	ˈdaːnin / ˈdaːdnin	[74]
	ˈdaːdənin	[112]

garlic press	ˈdaːliʔ prɛsə	[125]
gate	d̥eiʔ	[35]
	deit	[83]
gave	divd	[120]
geese	diːs	[87]
gentle	ˈdrɛntul	[120]
Germany	ˈdrəːməniː	[116, 119]
get	dɛt	[37, 38, 44, 47, 58, 67, 70, 72–3, 78–9, 91–2, 120, 123, 126]
	d̥ɛt	[40]
	dɛʔ	[51, 61–2, 64]
	dɛt / dɛʔ	[71]
	dɛts	[94]
	gɛt	[132]
getting	ˈdɛtin	[88]
gigantic	draiˈdæntiʔ	[110]
ginger	ˈdᶻindᶻə / ˈdᶻində	[94]
giraffe	taːf / (ˈdiːraːf)	[69]
	draːf / dᶻraːf	[103]
	dᶻraːf	[112]
	draːf	[119]
	dʒiˈraːf	[136, 143]
	dʒiˈraːf / dʒiˈræf	[139]
girl	dəːl	[72]
	dəːɬ	[97]
give	di	[50]
	div	[82]
	div / (giv)	[131]
given	ˈgeivən	[154]
giving	ˈdivin	[71]
Glasgow	ˈdræzdəu	[107]
glass	daːt	[56]
	draːs	[90, 94, 100, 110, 127]
	ˈdraːsiz	[91] {plural of ‘glass’, not ‘spectacles’}
	draːs / dʒaːs	[128]
	glæs / glaːs[31]	[141]
glasses	ˈdaːdiː	[56]
	ˈdaːtid	[69]
	ˈdraːsiz	[87, 100, 108, 112, 126]
	gᵊˈlaːsiz	[140]
	ˈglæsiz / ˈglaːsiz	[141]

31 See the discussion of Z’s metalinguistic abilities in chapter 5.

Glenferrie (Road)	dɛnˈfɛiː rəud	[56]
	dɛnˈfɛiː	[59]
	dʷɛnˈfɛiː rəud	[74]
	drɛnˈfɛiː rəud	[106]
glove(s)	dʌʔ	[36]
	dæd /dʌb	[49]
	dʳʌv	[95, 97]
glue	duː	[48, 56, 58, 66]
	duː / dʳuː	[85]
go	d̥oː/ d̥əu	[10] {also for ‘gone’}
	d̥əu[32]	[11–12, 14, 15, 17–20, 22–7, 29–32, 34–6, 38]
	d̥əu / dəu	[37, 42]
	dəu	[39[33]–41, 44, 46–9, 53–6, 58, 60–2, 67–70, 72, 74, 77, 81–2, 84–5, 89, 92–3, 104, 127]
	gəu	[139]
goats	dəuts	[112]
gobble	ˈdʌbu	[56]
	ˈdɔbu	[57–8, 74, 105]
	ˈdɔbəlz	[92]
	ˈdɔbəl	[94, 113–14, 121]
	ˈgɔbu	[140]
God	dɔd	[76, 100, 106]
	gɔd	[133]
goes	dəud	[60, 62, 65]
	dəuz	[137]
goggles	ˈgɔgəlz	[142]
going	ˈdəuin	[19, 58, 69, 83, 86, 89, 91, 108]
	ˈgəuin	[139]
golden	ˈdəudən /ˈdəuldən	[66]
Goldilocks	ˈdəuldiːlɔʔs / ˈdəuldiːlɔks	[133]
gone	dɔn	[37, 48, 50–1, 54, 58, 68–9, 73–4, 88, 92, 108, 131]
goo	duː	[62, 67]
good	dud	[63, 74, 77, 86, 92, 113, 117, 123]
	gud / dud	[138]

32 This was part of his first two-word utterance *Go home* (session 11). See the discussion on p. 56.

33 ‘go’ both as in motion and as in ‘go roar’.

	gud	[139, 141]
goodness	ˈgudnis	[138]
goods (train)	ˈdudː tʳein	[85]
goof (V)	duːf	[74, 77]
goose	duːs	[87]
got	dɔʔ	[39–42, 44, 48, 53–5, 60–1, 63–5, 67, 71–2, 82, 117]
	dɔt/ dɔʔ	[43, 48, 56, 78, 84, 95]
	dɔt	[46–7, 49–50, 57, 70, 76, 92, 109]
	gɔt	[140]
grader	ˈdreidə	[93, 129]
Grandma	b̥æ	[8] {referent dubious}
(paternal)	məm	[14] {referent dubious}
	ˈmama	[18] {referent unequivocal}
	ˈməmaː	[20]
	ˈmamə / (ˈræmə)	[22]
	ˈræmə[34]	[23, 24]
	ˈræma	[26, 27, 28, 30]
	ˈᵍræmaː / ˈræmaː	[31, 32]
	ˈræmaː /ˈræmə	[34]
	ˈræmaː /ˈdæmaː	[35]
	ˈdæmaː	[36, 38, 63, 65]
	ˈræmaː	[37, 39, 46, 54, 56
	ˈræmaː /ˈrænmaː	[43, 61]
	ˈrænmaː	[44, 48, 50, 55, 81]
	ˈrænmaː / ˈdænmaː	[67]
	ˈdænmaː	[68]
	ˈræmaː /ˈdʳæmaː	[69]
	ˈræmaː /ˈdᶻæmaː	[71]
	ˈdzæmaː	[74]
	ˈdʳænmaː	[77, 94 (also plural: ˈdʳænmaːz)]
	ˈdrænmaː / ˈdræmaː	[84]
	ˈdzænmaː	[85]
	ˈdrænmaː	[87, 100, 106–7, 114, 123, 130]
	ˈdræmaː	[89]
	ˈdʳæmaː	[95]
	ˈdrænmaː / ˈgrænmaː	[131]
	ˈgrænmaː	[137, 149]
Grandpa	ˈbaba	[1] {referent dubious}
(paternal and	ˈd̥ada, ˈbaba	[5]
maternal)	ˈd̥ædæ (dæ (dæ))	[9]

34 Consistent but with some velarisation of the [r].

	ˈd̥ædæ	[13, 14, 15, 17, 18]
	ˈd̥æda:	[19, 20, 22, 23]
	ˈd̥ædi:	[25, 26]
	ˈd̥ædi	[28]
	dæm	[32, 34]
	ˈdæmba:	[35, 36, 38–9, 41–2, 44, 49–51, 54, 57]
	ˈdæmba: / ˈdæmpa: (*once*) / ˈbæmba: (*once*) / dæmˈba: (*when calling me*)	[37]
	ˈdæmba: / ˈdæmpa:/ ˈtæmba:/ ˈtæmpa:/ ˈd̥æmba:	[43]
	ˈtæmba:/ ˈt̥ʰæmba:/ ˈdæmba:/ ˈtæmpa:/ ˈtæmpʰa:/ ˈtʰæmba:/ tæmˈpa: / dæmˈpa:	[46]
	ˈdæmba: / ˈtæmba:	[47–8]
	ˈdæmba: / dæmˈpa:[35]	[55]
	ˈdæmba: / ˈdæmpa:	[56, 62]
	ˈdæmpa:	[60, 64–5]
	ˈdæmpa: / ˈdræmpa:	[68–9]
	ˈdæmpa: / ˈdʳæmpa: / ˈdᶻæmpa:	[71]
	ˈdræmpa:	[72, 76–9, 81, 83, 88–9, 95, 104–8, 112–13, 115–17, 120–1, 126–7]
	ˈdᶻæmpa:	[75, 90, 94]
	ˈdʳæmpa: / ˈdᶻæmpa:	[85, 92, 97]
	ˈdræmpa:pa:	[100] {playing}
	ˈdræmpa: / ˈgræmpa:	[129–32][36]
	ˈdræmpa: / ˈgræmpa: / ˈkæmpa:	[133]
	ˈgræmpa:	[134, 137, 140, 142, 149]
	ˈgræmpa: / græmps	[138]
Granny (maternal)	ˈdæni:	[49, 64]
	ˈdræni:	[88, 123]
grape(s)	deip˥	[39]
	deip	[43, 58]

35 Stress on the second syllable was when he was calling me – usually with a high head followed by a rise fall.

36 His inconsistency at this session is illustrated by his coordinate sequence: [ˈdrænma: ən ˈgræmpa:] – *Grandma and Grandpa* (with no assimilation of the /n/ before the velar).

	d̥eip	[46]
	deip / deːp	[51]
	dʳeip	[74]
	dᶻeip	[85]
	dreip	[115, 117, 121, 124]
	greip	[136]
grapefruit	ˈdeipfuːt	[55–6]
	ˈdeitfuːt / ˈdeitfuːp	[67]
	ˈdreipfuːt / ˈdreipfʳuːt / ˈdreipfuːʔ / ˈdreipfʳuːʔ	[70]
	ˈdʳeipfruːtid	[73]
	ˈdʳeipfʳuːt / ˈdʳeipfuːt	[99]
	ˈdreipfuːt	[130]
	ˈdreipfruːt / (ˈgreipfruːt)	[133]
grass	daː	[35]
	draːt /dʷraːθ	[74]
	draːt	[79]
	draːs	[84, 90, 92, 97, 100, 109]
	græs	[149]
great	dreit	[122]
greedy	ˈdʒriːdiː	[124]
green	ˈdinlin[37]	[18]
	(diːn)	[19]
	(ˈd̥inᵃᵉ)	[22]
	diːn	[51, 56]
	dᶻiːn	[74]
	dziːn	[97]
	dʒiːn	[100] {once only}
	driːn	[103, 120]
	dʳiːn	[107]
	dʒiːn / driːn	[113]
grey	drei	[112, 128]
groove	druːv	[126]
ground	dᶻaund	[90]
	draund	[92, 100, 133]
grow	dəu	[58]
	drəu	[82, 107, 127]
growing	ˈdʳəuin	[84]
grown-up (Adj)	ˈdəunʌp	[65]
grown-up (N)	ˈdrəun ʌp	[100, 104, 114, 116, 118, 124]
	ˈdrəun ʌps	[108–9]

37 His attempt to repeat both *green* and *key*.

	ˈdrəun ʌp / ˈdʒəun ʌp	[113, 117]
	ˈdʒəun ʌp	[125]
	ˈgrəun ʌp	[139]
grubby	ˈdʳʌbiː	[85]
Gruber	ˈduːbə	[48]
Gruff	dʌf	[67, 72]
	tʌf / dʌf	[68]
	dʳʌf	[73]
	ˈdrʌfiː	[86]
	drʌf /trɔf[38]	[99]
	drʌf	[111, 119]
Gruffalo	ˈdrʌfələu	[113, 123]
guard (V)	daːd	[106]
guide dog	ˈdaid dɔd	[115]
guinea pig	ˈdiniː pid	[81]
guitar	giˈtaː	[136]
gulp	gʌlp	[139]
gum(s)	dʌm(z)	[113]
hacksaw	ˈhæʔsɔː	[61, 65]
had	hæd	[41, 55, 58, 71, 81]
hair	hɛ	[33]
half	haːf	[141]
hallway	ˈhɔːwei	[46–7]
ham	hæⁿ	[16]
	hæm	[58, 124]
hammer(s)	ˈhæmə	[17–20, 22–3, 25, 32, 34–5, 38–41, 43, 55, 79, 90, 113]
	ˈhæməz	[101]
hand	hæn	[31, 36, 84]
	hænd	[64, 94]
handle	ˈhændl̩	[49] {[l] syllabic}
hanky(s)	ˈhændiː	[38, 42, 46, 50]
	ˈhæntiː	[61]
	ˈhæntid	[81]
happy	ˈhæpiː	[71, 78, 82]
hard	haːd	[48, 56]
hardly	ˈhaːdliː	[137]
Harpenden	ˈhaːpəndən	[68]
has	hæd	[60, 65, 73, 76, 88]
	hæ / hæd	[68]

38 The latter was when he was trying to remember the name; the former was consistent thereafter.

	hæd / hæz	[84]
	hæz	[86, 90, 92, 95, 107]
hat	hæt	[94]
have	hæ / æ	[21][39]
	hæ	[22, 37, 39, 42, 46, 63, 73, 78]
	hæ˜ / hæ	[23, 24, 29]
	hæ˜ / hæ /ha /hɛ	[25, 32]
	hæ˜ / hæ / hei˜/ ha	[26]
	hæ /hɛ/ ha	[27, 28]
	hæ / ha / hæ˜	[30]
	hæ / ha / hɛ	[31]
	hã	[34, 44]
	ha	[35]
	hã / hæ	[36]
	hæ^{i}	[69]
	hæd / hæ	[70]
	hæ / hæv	[71, 76][40]
	hæv	[72, 81–2, 84–6, 94, 100, 106–7, 141]
	hæ^{v}	[78]
	əv	[140]
having	'hæin	[37, 72]
	heː	[51]
	'hæ^{i}n	[58]
	'hæjin	[64]
	'hævin	[92, 94, 100]
hay	hei	[14]
he	hiː	[51, 56–8, 60, 62, 65, 67, 70, 72, 84, 88, 95, 105, 107]
	hiː / iː	[106]
	iː	[140]
head	hɛd	[47, 70, 84]

39 ([(h)æ] seems to be some kind of generalised auxiliary verb, corresponding to 'is', 'has', 'does'): e.g. in response to: "Shall Daddy do it?" he said: [hæ̃, G nəu] – *Yes, SELF no* {G was a gesture to himself}.

A wide range of examples occurred over many weeks: e.g. from session 23:

NS – "Shall I come too?"	Z	[nəu hæ]	– no (do)
NS – "What's Grandma got for you?"	Z	[naː hæ]	– it's milk
NS – "I'll throw this away"	Z	[bin hæ]	– yes, in the bin

It seems on occasions to mean 'yes' (the Hindi for 'yes' is [hã]) but his exposure to the language was minimal. For further examples, see stage 3 in chapter 4.

40 [hæ] was used consistently for *have (to)* {*must*}; both [hæ] and [hæv] were used for *possess*.

hear	hiə	[53, 105]
hearth	haːs	[90]
heavy	ˈhɛviː /ˈhɛβiː	[37]
	ˈhɛdiː	[44, 57]
	ˈhɛwiː	[66]
	ˈhɛviː	[137]
hedge-trimmer	ˈhei dimə / ˈhei diːmə	[26]
	ˈhɛz tʳimə	[95]
Helen	hei	[14]
	ˈhɛlən	[80]
helicopter	ˈhei	[13, 14]
	ˈheiː	[17, 19]
	ˈhɛi	[18, 29]
	ˈhɛjədɔʔə	[39]
	ˈhɛliːdɔtə	[48]
	ˈhɛjətɔptə /ˈhɛjətɔtə	[54]
	ˈhɛjətɔttə /ˈhɛljətɔttə[41]	[71]
	ˈhɛjətɔtə	[72]
	ˈhɛlitɔptə	[131]
	ˈhɛlikɔptə	[136]
hello	hɛˈjəu / hɛˈləu	[36]
	hɛˈjəu	[37]
	ˈhɛˈləu	[39]
	hɛˈloːː[42]	[80]
helmet	ˈhʌmit / hɛmːp	[62]
	ˈhɛlmit	[124]
help	həm(p)	[58]
	həmp / hʌmp	[62]
	həmp	[64, 71]
	hʌmp	[66]
	həmp / hɛup	[68]
	hɛᵘp	[73, 81]
	həᵘp	[76]
	həlp	[91]
	hɛlp	[106]
hen	hen	[32]
	hɛn	[52]
her (she)	həː	[56]
	siː	[77]
here	hiə	[15, 37, 38, 43, 47–8, 50, 53, 62, 65, 68–9, 71, 75, 79, 85, 92, 107]

41 Geminate [t], alternating with [pt], [p] unreleased.

42 This was a conscious imitation of a Scottish neighbour (see p. 115).

	iə	[21]
	hiː	[22]
hiccups	'hiʔʌp	[62, 94]
	'hitʌps	[131]
hid	hid	[48]
hidden (it)	'hindit	[53]
hide and seek	'haid æn siːt	[63]
hiding	'haidin	[68, 70, 74]
high	hai	[50]
higher	'haijə	[103]
hills	hiᵘz	[105]
him(self)	him	[47, 50, 58, 62, 68, 84, 89]
	im	[60]
	hiː	[90]
hippo	'hipəu	[71]
	hipəu'pɔtəməs	[119]
his	hi	[46, 87]
	hiz	[51]
	hid	[62, 85]
hiss	his	[100]
hoe	hoː	[4]
	həu	[8]
hoist	hɔis	[93]
	hɔist	[98]
hold	həu	[34, 36, 43]
	həud	[37, 50, 58]
	həuld	[89]
holding	'həudin	[85]
	'həuldin	[137]
hole	həu	[16, 19, 22, 26]
	əu	[30]
	həul	[87]
	həulz	[100]
holiday	'hɔlədei	[46]
home	hoːm / hoː	[5] {see 'away'}
	həum	[7, 9, 11–12, 14–16, 18–20, 22, 24–6, 28–30, 34–9, 41, 43–4, 48–50, 58, 62, 64, 66, 68]
hommous	'hɔməʊt	[58, 78]
honey	'heĩ	[9, 11, 13, 14, 17, 21]
	'heniː /'həniː	[22]
	'həniː	[23, 26, 28, 32]
	'hʌniː / hʌ'niː	[29]

	ˈhʌniː	[31, 34, 36, 37, 39, 43–4, 50–1, 54, 58, 64–5, 67, 69, 72, 74, 91, 120, 137]
Hong Kong	ˈhɔn ˈtɔn	[94]
hood	hud	[41]
hook	huʔ	[56]
hoover	ˈhuːwə / ˈhuːə / ˈhuːʊə	[9, 10, 13, 14]
	ˈhuwə	[16, 18–20, 21–6, 29, 31–2]
	ˈhuwə / ˈhumə	[17]
	ˈhuːwə	[27, 34, 37, 42, 50, 53, 62, 68, 78]
	ˈhuwə /ˈhuːvə	[41]
	ˈhuːvə	[46–8, 76, 88, 92, 100, 139]
	ˈhuːβə	[63]
hop	hɔp	[99, 149]
hope	həup	[64–5]
Horace	ˈhɔrit	[64]
horrible	ˈhɔrəbəl	[69]
horse (neigh)	muː	[3] {see ‘cow’}
	ˈniːhæ˜	[21]
	ˈniːniː	[32]
	hɔːt	[39, 52]
	hɔːs	[87, 105, 137]
	hɔːs / ˈhɔːsiː	[88]
	ˈhɔːsiː	[113]
horse-shoe	ˈhɔːt suː	[71]
hose	həuz	[131]
hose pipe	ˈhəud paip	[61, 67]
	ˈhəuz paip	[95]
hospital	ˈɔbətu	[79]
	ˈhɔʔbul / ˈhɔbul	[90]
	ˈhɔspitəᵘ	[116]
	ˈhɔspitəl / ˈhɔspikəl	[136]
	ˈhɔspikəl	[147]
hot	hhh[43]	[1]
	hɔʔ	[34, 37, 44]
	hɔt	[43, 46, 48, 141]
house	haus	[41, 88, 90–1, 107, 114]
	hau	[47]
	haut	[66, 68, 72, 78]
how	hau	[72–3, 107, 137]

43 A general egressive air stream (breathy voice).

how many	hau ˈmɛniː	[72]
hub-cap	ˈhʌb dæ	[38]
hug (N)	hʌd	[84, 107]
huge	ˈho: ˈho:	[1]
	ˈiːuː[44]	[3, 4, 10, 11, 12, 14, 18, 19, 24]
	ˈiːu	[17]
	ˈiuː /ˈiːuː	[20]
	ˈiːuː /ˈiːu	[22]
	ˈiːuː / uː	[23]
	uː	[27, 31, 32]
	huː/ uː	[30]
	ˈuːə / uː	[34]
	ˈuːə	[35, 36]
	huːdᶻ	[37]
	ˈuːwə /huː	[38]
	huːd	[56]
	huːʒ	[114, 123, 126]
	huːʒ̊	[124]
	huːz	[128]
human	ˈhuːmən	[117]
hundred acre wood	ˈhʌndət eidə ˈwud	[71]
	ˈhʌndət eitə ˈwud	[79]
hungry	ˈhʌndiː	[65, 68, 81, 85]
	ˈhʌndriː	[74, 99–100, 104, 107, 115–16]
	ˈhəndiː	[91]
hunt	hʌnʔ	[62]
hurt	həːʔ /həːt	[37]
	həːt	[54, 112]
I/me	æ	[19–21, 22, 24, 26–7, 29–35,[45] 38–44, 46–50, 53–5, 59]
	æː / æ	[23, 51]
	æm / æ	[25][46]
	miː /æ	[37][47]
	æ /ə	[48]
	æ / ai	[56, 58]

44 Consistent but intonationally odd: long high tone followed by a relatively short low fall.

45 In session 33 it was clear that he was using [æ] for both "I" and "you".

46 Clearly intending to convey "I want to use the hoover" he said alternately: [æ huwə] and [huwə æm].

47 It's not clear whether the use of [miː] was intended as subject or object.

	æ / a^{i} / ai	[57]
	æi/ ai	[60, 69]
	ai	[61, 64–6, 72–4, 77–2, 94–5, 98, 100, 102–5, 107–10, 113, 115, 117, 121, 123, 125, 131–2, 136–7, 141]
	ai / æː / æ	[62]
	æ^{e} / æ / ai	[63]
	ai / æː	[68, 70]
	ai /æ^{i}	[71]
	ai / æ^{i}/æ	[76]
ice	ait / (ais)	[55]
	ais	[139]
ice-cream	ˈæ^{i}ttiːm	[76]
	ˈaittiːm / ˈaitt^{s}iːm	[80]
	ˈaistiːm	[89]
	ˈaistriːm	[107, 109, 114, 121]
	ˈaiskriːm	[141]
idea	aiˈdiə	[39]
	æˈdiə	[43–4, 48, 141]
if	if	[95, 107]
Ilkley	ˈitliː	[63]
	ˈi^{u}ʔliː	[89]
	ˈiltliː[48]	[95]
in	iː^{n} /in	[17]
	in	[18–32, 34–9, 41–3, 47–9, 54–5, 58, 61, 65, 69–70, 73–5, 77–9, 81–2, 87, 90–2, 104, 106, 114, 116, 126]
indoors	ˈin ˈdoː	[23]
injection	inˈdɛʔtən	[81]
	inˈdɛʔsən	[97]
	inˈdrɛʔsiən / inˈdrɛʔsən	[127]
inside	inˈsaid	[46, 76, 81]
internet	ˈindənɛt	[78]
into	ˈintuː	[72]
is	z	[59] {appropriate reduction}
	id	[60, 67–8, 71–2, 74, 79]
	iz	[70, 73, 85, 89–90, 92, 94, 97, 106–7, 113, 117, 132, 139–40]
	id^{z}	[80]

48 First /l/ darker than the second, but not vocalised.

it	ə	[34]
	it	[41, 48, 50, 53–6, 60, 66, 75–9, 81–2, 84–5, 87, 89–92, 94, 97–8, 106, 109, 112, 121, 128, 139]
	ʔi / i	[43]
	ʔi / it	[57–8, 61, 65, 68]
	iʔ / it	[62, 69–70, 72, 74, 80, 86, 100]
	i	[63]
	iʔ	[64, 67, 105, 107, 133]
	iʔ / it / id	[71]
	iʔ / it / i	[73]
its	it	[56, 58]
Ivan	ˈædiː	[50]
	ˈaidiː	[51]
	ˈaidə	[56]
	ˈæᵉdən	[59]
	ˈaivən	[68, 79, 92, 100]
jacket	ˈdæʔiʔ	[58]
	ˈdræʔit	[112]
jam	dᶻæm	[71, 92]
	dræm	[104, 109]
Jane	drein	[104, 125]
Janneke	ˈlænitə	[68, 81, 95]
/ˈjænɪkə/	ˈlæninə / ˈlænin	[84]
	ˈlænində	[85]
	ˈjænitə	[91]
	ˈjænitə / ˈlænitə	[100][49]
jars	draːz	[104]
jeep	d̥iːp	[40]
jelly	ˈdɛiː	[64, 71]
	ˈdɛiː / ˈdɛliː	[68]
	ˈdʒɛliː	[141]
Jenny	ˈdrɛniː	[125]
Jerry	ˈdɛiː	[66]
	ˈdrɛriː	[124]
Jess	dɛtˢ / dɛt	[59]
jigsaw	d̥i	[21]
	ˈd̥idɔː	[31–4]
	sɔː /ˈdiʔsɔː	[37] {[s] velarised}
	ˈdisɔː	[41–3]

49 See p. 116.

	ˈdidsɔː	[48, 52, 54, 56, 58, 62, 69, 76, 91]
	ˈdidsɔː / ˈdᶻidsɔː	[64]
	ˈdᶻidsɔː/ ˈdidsɔːz	[71]
	ˈdzidsɔː	[92]
	ˈdzidsɔː / ˈdzidsɔːz	[99]
	ˈdʑidsɔː	[109]
	ˈdʒidsɔː	[131]
Jimmy	ˈdᶻimiː	[94]
	ˈdzimiː	[97]
	ˈdrimiː	[116]
jingle bells	ˈdindu ˈbɛu	[58]
Jo	d̥əu	[21]
job	dɔp	[48]
	dɔb	[55]
	dʳɔb	[86]
	drɔb	[121]
	drɔb / dzɔb / dʒɔb	[139]
jobs	dɔbᶻ	[67]
Joe	dəu	[58, 67]
John	drɔn	[120]
Johnny	ˈdɔniː	[100]
join, joined	dᶻɔin, dʳɔind	[72]
Joshua[50]	ˈdrɔduːə / ˈdrɔduːaː	[79]
	dʳɔs / ˈdʳɔduːə	[80]
	ˈdʳɔsuːaː	[81]
	ˈdrɔsuːə	[82, 104, 106]
	ˈdzɔsuːə	[83, 93–4]
	ˈdɔsuːə	[84]
	ˈdᶻɔsiː	[85]
	dᶻɔs	[86]
	ˈdɔsuːə / ˈdʳɔsuːə	[91]
	ˈdᶻɔsuːə	[95]
	dʳɔs	[97]
	dɔs	[100]
	drɔç	[107]
	drɔs	[108, 116, 124]
	ˈdrɔʃiː	[112, 117]
	drɔʃ	[113, 119–20, 123]
	ˈdrɔsuːaː	[114]
	dʒɔʃ	[115, 125, 127, 139, 145, 149]
	ˈdrɔsiː / ˈdʒɔsiː	[132]

50 Zachary's brother, also known as 'Josh'.

	ˈdʒɔʃiː	[136]
	dʒɔʃ / dʒɔsʲ	[140]
jug	dʳʌd	[72, 85, 98]
	drʌd	[118]
	dʒʌd	[129]
juice	duːt	[56, 58, 67, 73]
	duːt / dᶻuːt	[74]
	duːs	[81]
	dᶻuːs / dʳuːs	[82]
	dᶻuːs	[84]
	dzuːs	[92]
	druːs	[121]
	dʒuːs	[139]
jump	d̥ʌ	[28]
	dᶻʌmp	[69]
	dʳʌmp	[72]
	dʌmp	[98]
	drəmp	[104]
	drʌmp / (dʒʌmp)	[114]
	drʌmp	[122]
jumped	drʌmt	[105]
jumper	ˈlælæ	[17, 37] {see ‘teddy’}
	ˈdʌmpə	[62, 71]
jungle	ˈdrʌndəl	[128]
Jupiter	ˈdʒuːpitə / ˈdruːpitə	[121]
	ˈdruː ˈpʰi ˈtʰə[51]	[124]
just	dʌʔ	[46]
	dʌt	[69]
	dʌs	[88, 100]
	drʌst	[90, 124]
	dzʌs	[94]
	dʌs / dzʌs	[95]
	dʒʌs	[109, 141]
	dʒʌs / drʌs	[117]
	dʳʌs	[121]
kakaka	(tatata)[52]	[58, 78]
Kanga	ˈdændə	[43]
	ˈtændə	[59, 71]
kangaroo	dændəˈruː	[43]

51 An example (from many) of spontaneous segmentation (or perhaps just syllabification) of words.

52 His response to my attempt to get him to imitate velars.

keep	tiːp	[48, 58, 60, 68, 74, 87, 93, 100, 113, 116, 120, 132]
ketchup	ˈtɛtːʌp	[82]
	ˈtɛtˢʌp / ˈtɛtˢəp	[94]
kettle	ˈtɛtul	[109]
key	ˈdinlin	[18] {see ‘green’}
	d̥iː	[35]
	tiː	[67, 108]
	tiːz / (kiːz)	[131]
kicking	ˈtiʔin	[87]
kidney	ˈtidniː	[111]
kind (sort)	taind	[69, 85]
King’s Cross	ˈtinz ˈtrɔs	[118]
kitchen	ˈtitin	[56, 58]
	ˈtiɪ̯tin / ˈtiʔtin / ˈtitin	[76]
	ˈtiʔdin	[79]
	ˈtiʔtin	[82]
	ˈtiʔtsin	[94]
	ˈtiʔsin	[106]
	ˈtitsin / ˈtiˀtsin	[108]
	ˈtiʔtˢin	[112]
	ˈtiˀtʃin	[124]
kite	tait	[121]
	kait	[137]
kitten	ˈtitən	[56]
	ˈkitən	[133]
kiwi (fruit)	ˈtiːwiː	[51, 58, 71, 94]
	ˈtiːwiː /ˈpiːwiː[53]	[64]
knee	niː	[11, 12, 29, 31, 34, 50–1, 63, 131]
	niːz	[86]
kneel	ˈniːu	[37, 90]
knew	nuː	[140]
knife	na	[32] {see also ‘dangerous’}
	nai	[36]
	nait	[53, 58, 60–1]
	nait / naif[54]	[67]
	naif	[68, 74, 92, 140]
knock	nɔʔ	[38–9, 107, 114]
	nɔt	[46]

53 [ˈpiːwiː] was his spontaneous attempt to recall the word; all subsequent attempts were [ˈtiːwiː].

54 [nait] was his spontaneous production; when I asked him what I called it he said [naif] but reverted to [nait] himself.

knocked	nɔʔt	[67]
	nɔkt	[139]
knot	nɔʔ	[32, 36, 39]
know	nəu	[80, 95, 100, 109, 121, 137]
Knox	nɔt	[48]
label	leibəɬ	[48]
ladder	'lælæ / læ	[11]
	neiə	[32] {presumably an associative mistake}
	nei	[34]
	'lædə	[35–7, 40, 46, 50, 52, 56, 62, 71, 105, 108, 123, 128]
lake	leik	[135]
lambs	læmd	[78]
lame	leim	[62]
last	laːs	[89]
late	leit	[36]
later (on)	leidə 'ɔn	[42]
	leidə	[50]
	leitə	[81]
	leitə 'ʔɔn	[85]
laugh	laːf	[132]
	laːf / læf	[139]
laughing	'læfin	[106]
lawn	lɔːn	[74]
lawn-mower	'lɔːm məuə	[92]
lead (dog's lead)	liːd	[41]
leaf, leaves	liːf /liːv^{z} / liːv	[36]
leave (V)	liːd	[60, 62]
leek	liːʔ	[113]
left (V)	lɛt	[66]
left (Adj)	lɛft	[87, 98]
leg	lɛd	[98, 116, 120, 123, 131, 140]
	lɛg	[149]
Lego	'lɛdəu	[107]
lemon juicer	'lɛmən dʒuːsə	[115]
lemons	'lɛmənd	[84]
lentil	'lɛŋkəl / 'lɛŋtəl	[141]
leopard	'lɛpəd	[136]
let	lɛt	[41, 54, 71, 79, 139]
letter	'lɛdə	[64]
lettuce	'lɛtis	[90, 95]
level crossing	'lɛvəl 'trɔsin	[108]
	'lɛvəl 'krɔsin	[137]
library	'leidiː /'laibiː	[56]

lick	lik˺ /nik˺	[37]
	liʔ	[56, 62]
	lit	[66, 77, 121]
licking	'liʔin	[131]
lid	lid	[39, 54, 58, 60, 64, 68, 71, 88, 97]
lift (V)	lid	[58]
	lit	[62]
	lift	[87]
light (N)	leid	[37] {before a vowel}
	leit	[38] {before a vowel}
	læːt	[49]
	lait	[72]
	lait^{h}	[136]
light (V)	{see 'lit'}	
light (Adj) (not heavy)	lait	[66]
like (V)	lait	[46, 57–8, 60, 62, 65, 70–1, 73–4, 76, 78, 80, 84, 91–2, 105]
	laid / lait	[56]
	la^{e}ʔ	[61]
	laiʔ	[95, 100]
like (P)	laiʔ	[61, 69, 88, 100, 107, 110]
	lait / laiʔ	[109]
	lait	[116, 122, 130, 140]
	laik	[138]
lines	lainz	[139]
lion	lẽn	[34]
	laiən	[112]
listen	'lidən	[76, 81]
lit	lit / laitid	[106]
little	'lidu	[56, 72–3, 84] {see also 'small'}
	'litul	[87]
	'litəl	[118]
	'likəl[55]	[138]
lizard	'lidə	[39]
	'lidəd	[63]
load	ləud	[36, 106]
lock	lɔʔ	[35, 64, 73, 97]
Lofty	'lɔdiː	[50, 56, 58, 65]
	'lɔftiː	[72]

55 This occurred only in [likəl mʌntiː] – *little monkey* – referring to his brother.

London	'lʌndən	[55, 58]
	'ləndən	[56]
lonely	'ləuliː / 'ləuniː	[56]
long	lɔn	[39, 46, 59, 63, 71–2, 92, 95, 100–1, 105, 116, 126, 128, 132, 138, 141, 145]
	lɔn / lɔŋ	[149]
longer	'lɔŋgə	[140]
look	luʔ	[41, 64, 70–2, 74, 78, 80, 84–5, 87]
	lut	[46, 69, 132]
	luʔ / lut	[68, 93]
	lut / luk	[133]
looking	'luʔin	[67, 79]
	'lukin	[145]
lorry	'ləuriː	[33]
	'lɔriː /'lɔliː	[35]
	'lɔjiː	[38]
	'lɔwiː	[64, 94, 98, 106]
	'lɔrid	[84] {plural}
	'lɔriː	[92, 97]
	'lɔriː / 'lɔwiː	[95]
lost	lɔd	[78]
lots /a lot	lɔt	[43, 48, 53, 75, 140]
	lɔt ə 'lɔt	[55]
	lɔt ən 'lɔt	[71]
	lɔt æn 'lɔt	[77, 82]
	lɔʔt æn 'lɔʔt	[81]
	lɔt / lɔts	[85]
loud	laud	[73]
lounge (N)	læːnd	[58]
	laun	[68]
love	lʌv	[110, 116]
lovely	'lʌmiː	[48, 58, 77]
	'lʌdiː	[54, 62, 67]
Luke Luck	'luːt 'lʌt	[55]
lunch	lʌnt	[56, 58, 61, 68, 76]
	lʌnt^{s}	[84, 90]
	lʌns	[92, 113]
	lʌnts	[104]
	lʌntʃ	[108]
Luton	luːtən	[58, 107]
machine	miˈsiːn	[93]
	əˈsiːnz / (biˈsiːn)	[98]

made	meid	[43–4, 48, 51, 56, 60, 82, 109–10]
magazine	mædəˈziːn	[67, 69, 71]
magnet(s)	ˈmædniʔ	[69]
	ˈmædniʔs	[100]
mains	meinz	[132]
make	mei	[37]
	meid[56]	[43]
	meiʔ̊	[61–2, 80]
	meit	[73, 95, 131, 137]
	meiʔ / meit	[94, 120]
	meik	[133]
making	ˈmeidin	[71]
	ˈmeitin	[84]
man	mæn	[35, 55, 70]
manage	ˈmænid	[69]
mango(es)	ˈmændəu	[78, 85–6, 89–90]
	ˈmændəu / ˈmændəuz	[84]
march (V)	maːʔs	[123]
marker	ˈmaːtə	[92]
	ˈmaːʔə	[93]
market	ˈmaːʔiʔ	[92]
Marmite	ˈmɔːmait	[43]
marrow	ˈmærəu	[113]
mask	maːst	[108, 124]
	mæsk	[140]
	mæsk / maːsk	[144]
mat	mæ	[32]
match	See ‘candle lighter’	
Matthew	ˈmæsuː	[122]
may	mei	[63, 137, 141]
maybe	ˈmeibiː	[39, 41–2, 46]
	ˈmeːbiː	[97]
me	miː	[35, 43, 50–1, 57, 62, 64, 68, 71, 73, 75, 79, 81–2, 103, 109, 114, 117, 121, 139]
	æ	[56]
	ai	[70]
measure	ˈmɛdə	[43, 60] {see also ‘tape-measure’}
measuring	ˈmɛzrin	[83]
meat balls	ˈmiːt bɔːld	[88]

56 This occurred in an imperative, so presumably *make* not *made* was intended.

medicine	'mɛdin	[58]
	'mɛdən	[85]
	'mɛdsən	[92]
medium-size	'midiːsaid	[61]
meet	miːt	[42]
mend	mɛn	[43]
	mɛnd	[56, 74]
mended	mɛnd	[43]
	mɛndid	[81]
merry-go-round	'mɛriː dəu raun[d]	[69]
mess(es)	mɛt	[51, 60]
	mɛd	[68]
	mɛs / 'mɛtid	[90]
messing	'mɛdin	[78]
metal	'mɛkəl	[136]
mice	mæːs	[92]
	mais	[135]
Micky Mouse	mitiː 'maut	[48]
microwave	'mætəweidə	[49]
	'maitəweidə / 'maitəweiɖ[57]	[59]
	'maitəweidə / 'maitəweivə / 'maitəweiv[58]	[66]
	'maitəweivə	[71, 79]
	'maitəweiv	[133]
middle	'mi[d]ə / 'miə	[36]
	'midu	[58, 63]
	'migəl / 'midəl	[145]
midwife	'midwaif	[78, 81, 86]
might	mait	[57–8, 86, 112, 115]
	mait/ maiʔ	[61]
	meit / mait	[62]
	maiʔ	[65]
milk	na[59]	[3, 8, 10, 14, 26, 32]
	naː	[4, 7, 17, 22, 23, 34]
	muː[60]	[8, 12]
	'muː 'naː	[19, 27] {cow's milk (not formula milk)}
	'muː 'na	[30]
	næ	[31]
	mik˺ /mi[u]	[37]

57 The second pronunciation was his response to his mother saying "What does Mummy call it?"

58 The last pronunciation was his attempt at giving his mother's version.

59 Sometimes used for 'cow'. The etymology is obscure.

60 Probably not consistently distinct from [mu] – 'moon'.

	miu	[38]
	miʔ	[48]
	mid	[54, 56]
	mi^{u}t	[58, 64, 105]
	miʔ / mi^{u}ʔ	[63]
	milt	[66, 91]
	mi^{u}t	[69, 82]
	mi^{u}ʔ / mi^{u}t / mi^{u}	[71]
	miɬt / miut	[97]
	milt / miut / mi^{u}t	[104]
	miɬt	[122]
	milk	[136–7]
millions	ˈmilinz	[106]
mine	æ	[26] {see also 'I'}
	ˈænə	[34]
	main	[44, 72, 90, 132]
	mæ^{e}n	[61]
minute (60 seconds)	ˈminit	[77]
	ˈminiʔ	[84]
mirror	ˈmiwə	[51]
miss (V)	mit	[73]
missing	ˈmitin	[54]
	ˈmidin	[67]
Mister	ˈmitə	[55]
	ˈmistə	[98]
mix	miʔt	[81]
	miʔs	[94]
mixer	brr[61]	[3]
	ˈmiːjə	[27]
	ˈmijə	[32, 35]
	ˈmidə	[58]
	ˈmiʔdə	[71]
	ˈmiʔsə	[87, 126]
mole	məu	[34]
Monday	ˈmʌndiː	[46]
	ˈmʌndei	[57]
money	ˈmʌniː	[46, 54, 60]
monkey	ˈmʌʔniː	[34]
	ˈmʌndiː	[37, 39, 46, 69]
	ˈmʌntiː	[107, 138]
	ˈmʌŋkiː	[139, 145]

61 Bilabial trill (often accompanied by hand gestures as of two beaters; also used for 'cement-mixer').

monster	'mɔndə	[44,48]
	'mɔnʔə	[60]
	'mɔntə	[78]
	'mɔnstə	[93, 98, 140]
moo	See 'cow'	
moon	mu[62]	[12, 13, 19]
	muː	[14]
	muːn	[32, 73, 84]
	muːn/ muːm	[34] {[muːm] once only}
moor	muːə	[41]
mop	mɔp	[76]
more	məː	[1]
	mmoː / moː	[2]
	məː / moː	[3, 6]
	moː	[7, 13–16, 18–20, 22–4, 26–7]
	məː / moː	[10, 12]
	moː / məː	[17, 21, 28]
	mɔː	[29–31, 36–8, 41, 43–4, 48, 62, 73]
	mɔː / 'mɔːmɔː	[32]
	mɔ	[35]
morning / this morning	'mɔːnin	[56, 65, 131]
	ə'sɔːnin[63]	[97, 121]
	i'sɔːnin	[110]
moth	mɔt	[63]
mother	'mʌzə	[137]
motorbike	'məutəbait	[77]
motor car	'məutətaː	[95, 104]
motorway	'məutəwei	[104]
mouse	maut	[42, 66, 76]
	maus	[112]
mouth	maut	[47, 62, 68]
	mauf	[78, 85, 136]
move	muː	[27]
	muːd	[58, 60, 62–3]
	muːβ /muːv	[69]
	muːv	[88, 137]
mow (hay)	məu	[14] {actually used for 'hay'}

62 Probably not consistently distinct from [muː] – 'milk'.

63 This suggests the morphological analysis: 'the smorning', as /sm/ regularly becomes [s].

mow (V)	məu	[74]
mower	moː[64]	[3, 4]
	mo	[6, 7]
	moː	[10, 12, 17] {as earlier but no longer accompanied by a gesture}
	məu	[20]
	ˈməuə	[26, 29, 31]
much	mʌʔ	[37, 62]
	mʌtˢ	[100]
Muck	mækˀ /mæʔˀ	[26]
	mækˀ	[27, 32]
	mʌʔ	[36, 42, 48, 97, 117]
	mæʔ	[56, 58]
	mʌkᵊ	[135]
mud	mʌb̥	[38]
	mʌd̥	[46]
	mʌd	[99]
muddy	ˈmədiː	[35]
	ˈmʌdiː	[36, 77, 90]
mug	mʌd	[99]
	mʌg	[136]
Mummy	ma	[0]
	ˈmama(ma(ma(m)))	[5, 6] {all possible combinations occurred}
	ˈmama	[7] {possessive}
	məm	[8, 10, 11, 14, 16, 19]
	ˈməm ˈdæd	[15] {‘Mum and Dad’}
	ˈməm dæ	[16, 20, 21] {‘Mum and Dad’}
	ˈməmə	[17] {possessive}
	ˈməmiː	[26]
	ˈmʌmiː	[29, 31, 47, 50, 54, 56, 71, 76, 81, 86, 88, 92]
munch	mʌn / mʌnt	[56]
mushroom	ˈmʌsrum	[94]
music	ˈmoːmoː[65]	[2]
	məːm / məm	[3]
	ˈməːˈmə / ˈməˈmə	[4]

64 Auditorily indistinguishable from ‘more’; but accompanied by a gesture to indicate holding a lawn-mower – both arms stretched in front of him as though pushing one.

65 Consistently used for ‘music’, though usually an entreaty to play a CD. The segments are the same – with considerable variation – as for ‘more’ but the reduplication is consistent, and the stress pattern is [s w] and not two [s s] as it is when he repeats ‘more’.

	məː	[12]
	məi	[41]
	ˈmuːdit	[54, 56]
	ˈmuːdiʔ	[58, 62, 67]
	ˈmudiʔ	[61]
	ˈmuːziʔ	[111–12]
must	mʌt	[62]
mustn't	ˈmʌdᵊnt / ˈmʌdᵊn	[71]
	ˈmʌtən	[72]
my	æ	[26, 39, 46, 49, 53]
	a:	[32]
	æː	[36, 56]
	mæ / æ	[37]
	mæ	[43–4]
	mai	[58, 62, 64, 68, 74, 76, 84, 89–91, 94, 100, 106, 122, 138]
	mai/ mʌᵉ	[60]
	mi	[104, 107]
myself	maiˈsɛf[66]	[58]
	maiˈsɛᵘt	[69]
	maiˈsɛᵘ	[71]
	miˈsɛlf / miːˈsɛlf	[99]
	maiˈsɛɬf	[124]
nail(s)	neiə	[30, 32]
	nei / neiə	[34]
	neiᵘz	[85]
	neiu	[100]
nail-cutter	ˈneil tʌtə	[106]
name(s)	neⁱm	[38]
	neim	[56, 67, 72]
	neimz	[100]
napkin	ˈnæptin	[76]
nappy	ˈnæpiː	[64]
naughtiest	ˈnɔːtiːist	[126]
naughty	ˈnɔːdiː	[43, 56, 60, 69]
	ˈnɔːtiː	[77, 86, 114]
nearer	ˈniːə[67]	[113]
nearly	ˈniəliː	[81]
neck	nɛʔ	[37]
	nɛts	[104]
	nɛt	[126]

66 It was not clear whether the final consonant was [f] or [t]; most probably the latter.

67 Cf. the omission of intervocalic /r/ in e.g. *very*.

need	niːd	[47, 49–50, 53–4, 56, 60–4, 68, 71–4, 76, 81–5, 100, 105]
neigh	See 'horse'	
Neil	niːə	[54]
	niːu / niːɔ	[59]
	niːl	[68]
	niːu	[69]
nest	nɛt	[64]
nettles	ˈnɛtəlz	[107]
never	ˈnɛvə	[82, 107, 125]
new	nuː	[17,[68] 34, 38, 47, 57, 63, 67, 85, 90, 95, 107, 109, 112–13]
	njuː	[154]
newspaper	ˈnuːdpeipə	[64]
	ˈnuːspeipə	[109]
next	nɛts	[92]
	nɛʔs	[113]
nibble	ˈnibəl	[68]
nice	nait	[58, 61, 68]
nicely	ˈnaitiː	[71, 78]
night(s)	nait	[115]
	naits	[132]
nine	næn	[48, 54]
	næːn	[60]
no	nəu[69]	[11–23, 25, 27, 29–32, 34–7, 39, 41, 43–4, 47, 50, 54, 65, 68–9, 78, 87, 89, 110, 114, 117, 119, 137]
	nəu /næ	[24]
Noah	ˈnəuə	[32, 34]
noodle(s)	ˈnuːdu	[77]
	ˈnuːdəld	[80]
	ˈnuːdəl	[81]
normal	ˈnɔːmu	[72]
	ˈnɔːməl	[91]
normally	ˈnɔːmiː	[56, 58, 76, 78, 92]
nose	nəu	[33, 41]
	nəud	[56, 58, 70]
not	nəu	[39]

68 'new' has as its initial consonant a coarticulated bilabial/alveolar nasal; sometimes reduced to either of the two components.

69 Used both as the contrary of *yes*, and as a general marker of negation.

	nɔt	[40–1, 43, 46, 64–5, 69, 72–3, 76, 79, 85, 87, 92, 109, 113, 127, 137–41]
	nɔt / nəu	[42]
	nɔʔ	[44, 47, 67–8, 71, 74, 84, 86, 88–9, 106, 118]
	nɔʔ / nɔt	[57]
	nəu / nɔʔ	[58]
notepad	ˈnəuʔpæd	[85]
nothing	ˈnʌsin	[149]
notice board	ˈnəutid bɔːd	[66]
now	nau	[37, 38, 41, 43–4, 46, 48–51, 56–7, 61–2, 84, 88–9, 94, 97, 117, 128, 133]
nozzle	ˈnɔdu	[50, 56, 68]
	ˈnɔzəl	[116]
nurse	nəːs	[86–7, 113]
nursery	ˈnəːsəriː	[132]
nut	nʌʔ	[58]
nut crackers	ˈnʌt tæʔə	[62]
oak (tree)	əut / ˈəut triː	[124]
oats	əu	[22]
	əutˀ	[37]
o'clock	əˈtrɔʔ	[131]
	əˈtrɔt	[132]
	əˈklɔʔ	[133]
octopus	ˈɔttəpəs	[114]
	ˈɔʔtəpəs	[115]
of	ə	[49, 54–5, 62, 69, 77, 85, 91]
	ɔv	[100, 110]
	əv	[136, 138]
off	ʔɔ	[22]
	ɔ	[31]
	ɔɸ	[36]
	ɔf	[43, 69, 72, 76, 88, 106, 109, 120]
	ɔd̰	[50, 68]
	ɔd	[51, 56, 58, 60]
	ɔt	[66]
oh dear (me)	ˈoː diə	[14]
	ˈə diə	[15]
	ˈəu diə	[19, 25, 26,[70] 28, 30, 34, 36]

70 Part of a compound: [ˈəu diə bu] – *Oh dear book* (request for the book whose punch-line is 'Oh dear').

	ˈəu diə / ˈəu diə diə	[20, 21]
	ˈəu diə miː	[24]
oil	ˈiːu	[45]
	ˈiːɔː	[56]
oink	ɔint	[131]
OK	əuˈtei	[71]
	ˈəuˈtei	[74, 85, 92, 121]
old	əu	[17, 31, 42]
	əud	[48, 50, 68]
on	ɔn	[34–9, 41, 43–4, 46–51, 54, 56–8, 60, 63–5, 69, 73–4, 86, 91–2, 97, 100, 104, 108, 124, 137, 140]
	ʔɔn	[107]
one	wʌm	[34]
	wʌn/ wʌm/ bʌm	[36] {[wʌn] when counting, [wʌm] (usually) or [bʌm] otherwise}
	wʌn	[37, 39, 42–4, 46–9, 54, 60, 62, 67–9, 71–2, 74, 76, 81, 87, 89, 91, 103, 105, 131, 136, 139, 141] {pronominal and numeral}
	wʌnz	[85, 100]
onion(s)	ˈʌnin	[65, 72, 77, 80]
	ˈʌnind	[81]
only	ˈəuniː	[47–8, 58, 72, 76, 80, 87, 89, 108]
open (V)	ˈəubə	[53]
	ˈəubən	[62, 66, 71]
	ˈəupən	[74, 84, 92]
open (Adj)	ˈəupən	[58, 76]
opened	ˈəubənd	[60]
opener	ˈəupənə	[93]
opening (V)	ˈəubənin	[70]
operation	ɔpəˈreiʃən	[111, 120, 149]
or	ɔː	[65]
orange	ɔnd / ˈɔnidᶻ	[51]
organic	ɔːˈdæniʔ	[96]
organise	ˈɔːdənaiz	[95]
ostrich	ˈɔstridʒ	[141]
other	ˈʌdə	[37, 51, 56, 72, 92, 141] {see also ‘another’}
	ˈʌzə	[143]

otherwise	'ʌdəwei	[46]
	'ʌdəwai	[56, 70]
our	æ	[47]
	æː	[88]
out	au	[14–15, 17–26, 30–2, 34–5, 37]
	aut	[38, 40–1, 56, 58, 60, 70, 72, 76–7, 81, 86, 88, 106, 137]
	aut /auʔ	[39, 61–2, 66]
	au/aut	[44]
outdoors	'au 'doː	[26]
oven	'ʌdən	[58]
	'ʌvən	[68, 70, 80, 124, 128, 133, 140]
over	'əuə /'əudə	[36]
	'əuwə / 'əudə	[37]
	'əuwə	[38–9, 58, 60, 67]
	'əudə	[46, 48, 53]
	'əuvə	[114, 124, 133]
owl	au / hau	[5]
	au	[27, 30, 44, 52]
own	əun	[37, 41, 49, 53, 106]
oxygen	'ɔʔsidʒən	[120]
	'ɔˀksidʒən	[134]
	'ɔksidʒən	[140]
packet	'pæʔiʔ	[62, 74, 99]
	pæt	[67]
	'pæʔi	[73]
page	b̥ei	[34]
	peid	[76, 89]
paint	pein	[48]
paint-brush	'peinʔbʌt	[65]
	'peintbʳʌs	[85]
painting	'peintin	[84]
panda	'b̥ændə	[39]
pansy	'pændiː	[58]
paper	'peipə	[55, 91]
	'paipə	[58]
	'pʰeib̥ə	[59]
paper clip	'peipə tip	[52]
parcel	'paːtᵘ	[71]
	'paːsu / 'paːsə	[81]
	'paːsul	[86]
park	b̥aː	[26]
	paːʔ	[95, 108]

parking	ˈpaːʔin	[65]
parsnip	ˈpaːʔnip / ˈpaːnip	[65]
	ˈpaːnip	[78]
	ˈpaːsnip	[139]
pass	pæd	[68]
past	pæst / paːst	[141]
pasta	ˈpætə	[65]
	ˈpætə / ˈpæstə	[84]
	ˈpæstə	[88, 92]
patchwork	ˈpætwəːt	[55]
paté	ˈpæʔe^{i}	[58]
	ˈpæʔəi	[73]
path	pæs / paːs	[144]
patio	ˈpætiːəu	[84, 99]
patting	ˈpætin	[128]
paver	ˈpeivə	[92]
pear	pɛː	[56]
	paː	[58, 71]
pedal	ˈpɛdəl	[104]
peel (N/V)	piː^{u}l /piːl	[65]
	piːɬ	[71]
peeler	ˈpiːlə	[94]
peeling	ˈpiːlin	[94]
pen(s)	pɛn	[82]
	pɛnz	[91]
penguin	ˈb̥ɛmiː	[28]
	ˈb̥ɛnhə	[39]
	ˈpɛnin	[56]
	ˈpɛndin	[63]
	ˈpɛnd^{w}ind	[78]
	ˈpɛndwin	[86, 92]
	ˈpɛnwin	[140]
penny	ˈpɛniː	[54]
people	ˈpiːpəl	[80, 103]
pepper	ˈpɛbə	[69]
petrol	ˈpɛtrəl	[81]
Phillips (screwdriver)	ˈfilips	[90]
phone	vəum	[32]
	fəun	[34, 39, 54, 92]
photo	ˈfəutəu	[47]
piano	ˈdinlin[71]	[18, 20]
	ˈbænəu / ˈbæməu / bæm	[37]

71 Used for his toy piano, the burglar alarm, and also when asked to say ‘key’ and ‘green’.

	ˈb̥ænəu[72]	[45]
	ˈpʰænəu	[46]
	ˈbænəu	[48]
	ˈpænəu	[56, 60, 109]
	ˈprænəu	[113, 128]
	ˈpjænəu / ˈprænəu[73]	[133]
	ˈpjænəu / piːˈænəu	[134]
	ˈpjænəu	[138, 141]
pick (up)	piʔ (ˈʌp)	[46, 84]
	pit ˈʌp	[81]
	pit	[88, 90]
picking	ˈpiʔin	[71]
picnic	ˈpiʔniʔ	[93, 122]
picture(s)	ˈpidə	[50–1, 58]
	ˈpʰiʔdə	[62]
	ˈpiʔtə	[67]
	ˈpiʔdəz	[73]
piece(s)	b̥iː	[32]
	piːt	[55, 71]
	piːd[74]	[58]
	ˈpiːtid	[65]
pig	b̥iʔ	[26]
	pik̚	[30]
	b̥i	[32]
	pid	[52, 59, 81, 88, 108]
pigeon	ˈpizin	[86]
Piglet	ˈbihɛ	[42]
	ˈpidit/ ˈpidiʔ	[58]
	ˈpidiʔ	[78]
	ˈpidləʔ / ˈpidlət	[109]
	ˈpidlət	[121]
Pilchard	ˈmiːau	[26] {name of the cat in *Bob the Builder*}
	ˈb̥ijə	[30]
	ˈmiːjəu	[43]
	ˈpiltə	[50]
	ˈpildə	[61]
	ˈpildəd	[62]
	ˈpildəd / ˈpilʔdəd	[68]
	ˈpiltʃəd	[131]

72 On seeing printed music.

73 His pronunciation alternates but, when asked, says explicitly that the former is correct.

74 As in: [piːdə ˈpaipə] – *piece of paper.*

pile	pæ^{u}	[89]
pillow	ˈb̥ijəu	[35]
pinch (steal)	pint	[76]
pink	pinʔ	[108]
	piŋk	[133]
	piŋk’	[149]
pins	pinz	[68]
pip(s)	pip/ pit	[50]
	pip	[73]
	pips	[87]
Pippa	ˈpipə	[72]
place	peit	[69, 74]
	preis	[113, 124]
plane	See ‘aeroplane’	
plant (V)	paːnt	[91]
plant(s) (N)	pænts	[90]
	plænt^{s}	[91]
	plaːnt	[92]
	praːnt	[103]
	plænts	[109, 144]
	praːnt / p^{r}ænt	[113]
	prænts	[131]
plaster	ˈb̥aːdə	[38]
(elastoplast)	ˈpaːtə	[54, 57]
	ˈpaːtə / ˈplaːtə / ˈpaːstə / ˈplaːstə	[81]
	ˈpaːstə	[87]
	ˈp^{r}aːstə	[97]
	ˈpraːstə	[120, 127]
plate	b̥ei	[32]
	beiʔ	[37]
	beit	[50]
	pleit	[82]
	preit	[106]
platform	ˈprætfɔːm	[122, 128]
play	b̥ei	[32, 35, 48]
	bei	[37, 38, 40, 42]
	pei	[46, 56–8, 61, 71]
	p^{w}ei	[78]
	prei	[109, 111, 113–17, 121, 123–4, 131, 134]
	prei / plei	[133]
	plei	[140–1]

playgroup	'pei duːp	[69]
	'pˡei druːp	[87]
	'pei druːp	[88, 94]
	'plei druːp	[108]
	'pʳei druːp	[113]
playing (N)	'pʳeiin / 'preiin	[92]
	'preiin	[112, 116]
playschool	'pleituː	[123]
playtime	'preitaim	[132]
please	piːz	[50, 54]
	piːd/ piːdz	[56]
	piːz	[58]
	piːd	[62, 64]
	priːz	[120, 132]
	pliːz	[148]
pliers	'b̥eiə	[28]
	'pæᵉəd	[58]
	'pʷaiəz	[90]
	'pʳaiəz	[113]
plug (V/N)	bʌʔ	[47]
	pʌd	[54, 58, 68]
	pʌʔ	[56]
	pʌd / plʌd	[73]
	pˡʌd	[95]
	pʳʌd / plʌd	[98]
	prʌd	[132]
	plʌd	[133]
plugged	pʌd	[69]
plum	prʌm	[109]
plumber	'prʌmə	[120, 122]
pocket	'pɔʔiʔ	[54]
	'pɔʔit	[70]
poke	pəuʔ	[54]
polar (bear)	'bəuwə	[39]
	pəuwə 'baː	[63]
pole	pəul	[112]
police	piːs	[90]
	pʳiːs	[97][75]
polish	'pɔliʃ	[114]
polishing	'pɔlisin	[103]
poo	b̥uː	[22, 23]

75 Post-consonantal l/r/w seem to be merged: either phonetically indistinct or in free variation.

Pooh (bear)	b̥uː	[14, 17, 21] {see also 'Winnie'}
	buː	[39, 41, 43]
	puː	[42, 44, 49, 54, 72, 86]
	b̥uː/ buː	[43]
	b̥uː / pʰuː	[46]
	puː / ˈpuː ˈbaː	[58]
	puː / ˈbuː ˈbaː	[62]
poorly	ˈpuːliː	[49, 57]
	ˈpuəliː	[50, 76, 84–5, 137]
pop	pɔp	[107]
poppy	ˈpɔpiː	[116]
pork	pɔːʔ	[58]
porridge	ˈpɔriʒ	[128]
Portobello	bɔːdəˈbɛwə	[48]
Port Salut (cheese)	ˈpɔːʔ læˈluː	[69]
possum	b̥əu	[16]
	ˈpɔmiː	[52]
pot(s)	b̥ɔʔ	[31]
	b̥ɔ	[37]
	pɔt	[56, 58, 61, 116]
	pɔʔ	[68, 114]
	pɔtˢ	[91]
	pɔts	[145]
potato	ˈpeitəu	[101]
	pəˈteitəu	[113]
pour (it)	ˈpɔːriʔ/ ˈpɔː ə tiː	[71] {'pour the tea'}
	ˈpɔːr it	[82]
pralines	ˈpreiliːnz	[140]
pray	prei	[116]
prefer	fəː	[109]
present (gift)	ˈpɛdənt	[79]
	ˈprɛzənt / ˈprɛzən	[84]
presumably	ˈzuːməliː	[109]
pretend	əˈtɛnd	[105]
	tɛnd	[110]
	piˈtɛnd	[111]
	priˈtɛnd	[123]
pretending	piˈtɛnin	[71]
	piˈtɛndin	[112]
prickles	ˈprikəlz	[141]
print	pint	[50, 56]
probably	ˈpɔbliː	[56]

problem	ˈpɔbləm	[85]
	ˈprɔbləm	[123]
professor	ˈfɛdə	[60]
programme	ˈpəudræm	[90]
proper	ˈpɔbə	[61]
	ˈprɔpə	[112]
properly	ˈprɔpliː	[149]
pudding	ˈpudin	[76]
puff	pʌf	[90]
pull	pu	[70]
purse	pəːs	[54]
	pəːt	[60, 64]
push	pud	[77]
pussy cat	ˈpudiː tæʔ	[79]
	ˈpusiː tæt	[91, 112]
put	bu	[37]
	b̥u	[40]
	put	[42, 47–8, 50, 56, 72, 77, 86, 92]
	puʔ	[46, 54, 61–2, 107]
	puʔ / pu	[73]
	pu	[133]
putting	ˈputin	[73]
puzzle(s)	ˈpʌdu	[64, 69, 75]
	ˈpʌdəl / ˈpʌzəl / ˈpʌdəld	[85]
pyjamas	ˈdimdæm	[43–4] {referred to as ‘jimjams’ by his parents}
	ˈdimdæmz	[68]
quack	xwæ	[26]
	tʳæʔ	[97]
quarter	ˈtɔːtə	[120, 141]
quick	tiʔ	[67]
	triʔ	[123]
	triʔ / (krit)	[133]
	krik	[140]
quicker	ˈritə	[102, 120]
quickly	ˈriʔliː	[99, 126]
	ˈkwiʔliː	[141]
quiet	tʳaiət	[83, 90]
	traiᵊt	[87]
	træᵊt	[121]
quince	tint	[64]
	tins	[68]
	tinʔ	[71]
	trins	[120, 141]

quite	trait	[90, 120–1, 127, 140–1]
	traiʔ	[106, 108–9, 113, 117–18, 131]
	kwait	[145]
rabbit	ˈræna	[32]
	ˈwæbiʔ	[59]
radio	ˈreidiːəu	[140]
rain	wein	[32]
	rein /wein	[37, 112]
	rein	[39–40]
	wein	[50]
rainbow	ˈreinbəu	[70]
raining	ˈreinin	[34, 56]
	ˈweinin	[88]
rainy	ˈreiniː	[43, 45, 70]
raisins	ˈweidənd	[77]
	ˈweizən	[94]
rang	ræn	[106]
raspberries	ˈraːzbriz	[104]
razor	ˈreidə	[48, 59, 67, 73]
reach	riːd	[62]
	riːt	[72]
read	riː	[29]
	wiːd/ riːd	[43]
	riːd	[44–6, 48–50, 54]
	wiːt	[87]
	wiːd	[89, 126]
ready	ˈrɛdiː	[44, 72, 74, 127, 139]
	ˈwɛdiː	[48, 92]
real	iːuː[76]	[6, 12, 14] {cf. ‘huge’}
	riːu	[100]
really	ˈriliː	[73]
	ˈriːliː	[82, 110]
rebuild(ing)	ˈriːˈbiᵘd(in)	[57]
	ˈriːˈbiudin	[118]
recipe(s)	ˈwɛsipiz	[91]
	ˈrɛsəpiː	[145]
rectangle(s)	ˈrɛttændəlz	[114]
	ˈrɛttændəl	[117]
recycling	riːˈsaitin	[94]
red	(ʊɛ)	[19]

76 This ‘word’ seems to have generalised from ‘big’ (‘huge’) to ‘grown-up’ to ‘real’. Z used it to refer to my ‘real’ tools as opposed to his toy ones.

	rɛd	[43, 51, 56–7, 61–2, 69–70, 73]
	wɛd	[77, 90, 92]
regular	('wɛdidə)	[91]
relax	ri'læt^{s} / i'læts	[85]
remember	ə'mɛmbə	[69, 79]
	'mɛmbə	[74]
	ə'mɛmbə / i'mɛmbə	[81]
	ri'mɛmbə	[115, 138]
remote (control)	'məuməu	[15, 27, 28]
	məu'məu	[22]
replace	riː'preis	[126]
rescue(d)	'rɛstuːd	[108]
	'rɛskuː / 'rɛskjuː	[137]
rest	rɛst	[137]
resting	'rɛdin	[72]
rhinoceroses	rai'nɔsərəsiz	[119]
rhyme	raim	[112]
rice	raiʔ	[58]
Rice Crispies	'rais 'tripsiz	[107]
	'wais 'trispiz	[109]
Richard	'd̥ijə	[25]
	'wiʔdəd	[78, 85]
ridiculous	'ditliːəs	[126]
riding	'raidin	[65]
right	raiʔ	[56–7]
	wait	[72, 90]
ring (a bell)	win	[94]
river	'ridə	[56]
	'rivə	[113]
road	rəud	[58, 93, 138]
roar	rɔː	[39]
robot	'rəubɔt	[136]
rock	rɔk̚ /rɔʔ	[31]
	rɔk	[139]
rocket	'rɔʔiʔ	[54]
	'wɔʔiʔ	[69]
	'wɔʔit	[91]
	'rɔtit	[133]
rocket plane	'rɔk̚ bein	[32]
roll	rəu	[36, 37]
roller/Rolly	'rəuwi	[27, 29]
	'rəuwə/ 'rəuwiː	[32]
	'rəuliː	[58, 72, 97, 117]
	'rəulə	[92]

roly-poly	ˈrəuliː pəuliː	[42, 86]
Roo	(beibiː) ˈruː	[43]
	ruː	[59]
roof	ruːf / ruː	[32]
	ruːf	[34, 73, 76, 90, 117]
	ruːt / ruː	[37]
	ruːt	[46, 62, 64, 66]
	ruːf / wuːf	[74]
	wuːf	[92–3, 100]
room	rum	[29, 32, 34, 42, 48, 50, 57, 82]
	ruːm /rum	[37]
	wuːm	[78]
round	ræː	[18]
	rau	[26]
	raun / raund	[37]
	raun	[56, 68]
	raund	[65, 72]
	waund	[71]
rubber(-band)	ˈrʌbə	[58]
	ˈrʌbə ˈbæn/ ˈrʌbə ˈbænd	[61]
	ˈrʌbə ˈbænd	[68]
	ˈrɔbə ˈbæn	[69]
rubbish	ˈwʌbis	[89]
	ˈwʌbid̥	[90]
	ˈrʌbis	[97]
	ˈrʌbis / ˈrʌbiʃ	[106]
ruler	ˈruːə/ ruː	[30]
	ˈruːlʷə	[60]
run	rʌn	[39, 42–3, 106]
	wʌn	[48, 61]
rung	rʌn	[113]
runner bean	rʌnə ˈbiːn	[72]
running	ˈrʌnin	[39]
rural	ˈruːrəl	[128]
rush (V)	rʌs	[104]
Russia	ˈrʌsə	[116]
Safeway	ˈseɪfweː	[56]
said	sɛd	[131]
Saint Albans	s̥ɛnt ˈɔːlbənz	[112]
salad	{See ‘fruit salad’}	
salmon	ˈsæmən	[85, 105]
salt	sɔʷt	[84]
Sam	sæm	[59, 71, 77, 108, 132]
same	seːm	[39, 84]
	d̥eim	[44]
	seim	[67, 74, 94, 124]

Sammy	ˈsæmiː	[55]
sand	çɛn / sɛn / hɛn / dʲɛ	[26]
	(çænᵈ)	[30, 31]
sandals	ˈsændə	[48]
sandwich	ˈsænit /ˈsæmiʔ /ˈsæniʔ	[58]
	ˈsæmit	[72]
Santa (Claus)	ˈsæntə / ˈsændə	[48]
	ˈsæntə trɔːz	[107]
Sarah	ˈsæwə	[77, 79]
Saras[77]	ˈsæwət	[59]
	ˈsʌrət	[64]
	ˈsərət	[68]
	ˈsærət	[81]
	ˈsərəs	[85]
satsuma	seiˈsuːmə	[51]
sausage	ˈsɔzid	[82]
	ˈsɔsiz	[94]
saw	sɔː /θɔː	[34] {[θɔː] once only}
	sɔ	[35] {[s] blade not apical}
	sɔː	[40] {[s] blade not apical}
	sɔː	[41, 46, 49, 53, 79, 89, 116, 118, 136, 143]
saw-dust	ˈsɔːdʌ	[40]
say	sei	[76, 89, 91, 123, 141]
scales	teild	[68]
	steiᵘz	[126]
scarecrow	ˈtɛːtəu	[91]
	ˈstɛːkrəu / ˈskɛːkrəu	[143]
school	tuːl	[109]
	stuːl	[132]
scissors	sɨs̬[78]	[3]
	θɨz̬	[5, 6]
	sɨz	[7, 48]
	sɨs[79]	[14]
	çiː	[30]
	siz	[38, 47]
	ˈsidəd	[56, 59–60, 64, 69, 74, 78–9]
	ˈsizə	[105] {compound – singular appropriate}
	ˈsizəz	[108]
scone	təun	[121]

77 His grandmother's given name: /sərəs/ in Hindi, /ˈsʌrəs/ in English.

78 The [i] is voiceless, occasionally with a hint of a voiced offglide before the final fricative.

79 The barred [ɨ] was voiceless at sessions 7 and 14.

	stɔnz	[126]
	stɔn	[138]
Scoop	tuːp	[50, 61–2, 68, 74, 87, 89–90, 92, 97]
	tʰuːp	[59]
	stuːp	[128]
	stuːp / skuːp	[135]
	skuːp	[138–9]
Scotland	ˈtɔʔlənd	[105, 114]
	ˈtɔtlənd	[107]
scrambled	dəmb	[43] {see also ‘egg’}
	ˈtæmbu ˈɛd	[49, 69]
	ˈtʳæmbəld ˈɛd	[92]
	ˈtræmbəld ˈɛd / ˈsæmbəl ˈɛd	[109][80]
	ˈstræmbəl ˈɛd / ˈtræmbəl ˈɛd	[128]
	ˈskræmbəld ˈɛgz	[137]
scrape	treip	[77, 114]
scraper	ˈteipə	[46]
	ˈtʳeipə	[93]
scream(s)	tiːm	[57]
	tʰiːm	[90]
	tˢiːm/ tˢiːmz	[92]
screw	tuː	[67]
	tˢuː	[69]
	skruːz	[136]
screwdriver	ˈd̥idə/ ˈd̥idɔ/ ˈd̥uːdaː	[30]
	ˈd̥uːdaː	[31, 34]
	ˈd̥idaː / ˈd̥uːdaː	[32, 35]
	ˈduːdeijə	[39–41]
	ˈtuːdeidə	[56]
	ˈtuːdeidə /ˈtuːdaidə	[60]
	ˈtuːdaidə	[61]
	ˈtʳuːdraivə	[90]
	ˈstruːdraivə	[134, 136, 143]
seaside	ˈsiːsaid	[87, 136]
seat	siːt	[106]
secateurs	ˈsɛtəz	[77]
	ˈsɛtətəz	[86]
	sɛtəˈtəːz	[92]
second (moment)	ˈsɛtənd	[71, 127, 133]
second (after ‘first’)	ˈsɛtənd	[131]

80 In both sessions 109 and 128, the first pronunciation was a self-correction of the second.

secret	ˈsiːʔrət	[121]
see	siː	[39, 44, 50, 54, 58, 60, 66, 68, 75, 79, 81, 139]
seen	sin	[46]
	siːn	[53]
see-saw	ˈçiːdiː	[26]
Sellotape	ˈsɛteip/ˈsɛəuteip/ ˈsɛəteip	[48]
	ˈsɛləteip	[54]
	ˈsɛᵘteip	[63]
	ˈsɛəteip	[67–8]
	ˈsɛoteip	[74, 79]
	ˈsɛuteip	[92]
send	sɛn	[50]
setting	ˈsɛtin	[100]
seven	ˈsɛdən	[58, 60]
	ˈsɛwən	[66]
shall	sæᵘ	[61–2, 80]
	sæl	[66, 69, 82, 87, 99, 103]
	sæɬ	[108]
shampoo	ˈsæm ˈpuː	[49]
shape	seip	[107]
share	sɛː	[71]
	ʃɛː	[131]
sharing	ˈsɛːwin	[90]
	ˈsɛːrin	[99]
shark	ʃaːt	[131]
sharp	saːp˺	[35] {see also ‘dangerous’}
	d̥aː	[36]
	sɔp	[41]
	saːp	[46–47, 49, 59,[81] 90, 145]
	sɪaːp	[55]
	saːp / ʃaːp	[108]
shave	seid	[59, 63, 67]
	seiv / ʃeiv	[126]
she	siː	[56–7, 59, 64, 68, 70–2, 74, 82, 84, 92, 95]
shears	ʃʉ̟ʊ̟[82]	[7]

81 The initial [s] was blade not apical.

82 C_1 is a fairly regular voiceless palato-alveolar fricative, but V is high, back, unrounded, usually voiceless, and C_2 is a voiceless bilabial trill or fricative. The whole is sometimes articulated on an ingressive air-stream mechanism. It sounds weird, but is quite definitely both distinct from his word for ‘scissors’ (now [siz] where the vowel is voiceless [i̥]) and, aside from the variation mentioned, consistent.

shed	sːɛd	[48]
	sɛd	[82]
sheep	baː	[4]
	ʃiːp	[37, 113, 115, 137]
	siːp	[52, 70, 72, 88]
	ɕiːp	[106, 111]
shine	sain	[93]
shirt	səːt	[95]
Shivas	ˈsidəd	[58]
/ˈʃɪvəz/	ˈɕivəz	[106]
shoe	s̻uː /d̻uː	[34]
	ʃʷuː	[36]
	suː	[46]
shoes	suːᶻ	[48]
	suːd	[74, 76, 81]
	suːz	[92]
	suːz / ᵗsuːz	[95]
shoot	suːt	[105]
shop	sɔp	[54, 56, 71, 92]
	ʃɔp	[136]
shopping	ˈsɔpin	[94]
short	sɔːt	[121]
should	sud	[48, 58, 62, 67, 71, 76, 91]
	sud / ʃud	[117]
shoulder	ˈsəudə	[44]
show	d̻əu	[36]
	səu	[42, 62, 73]
shower	ˈsæwə	[46, 48–9, 51]
	sauə	[87]
shut	sʌʔ	[35, 56, 58]
	sʌt	[44, 69, 71–3, 76–7, 89]
sick	sit	[49–50]
	siʔ	[80]
side	said	[62]
silly	si / ˈsidiː	[57]
	ˈsiiː	[58]
	ˈsiliː	[74, 85, 92, 107, 127, 132]
silver	ˈsilβə	[66]
	ˈsiᵘvə	[69, 74, 79, 81]
	ˈsilvə	[132]
sing	sin	[37, 84]
	siŋ	[154]
singing	si[83]	[42]

83 [si] was part of a compound [si bɔb] – *Singing Bob (the Builder)*.

	'sinin	[60, 87]
sink	sint	[126]
siren	'sæʒən / sairən	[106]
	'sæːʒən	[108–9]
sister	'sidə / 'sidːə	[80]
sit	d̥in	[14] {inconsistent (and followed by 'down')}
	sit	[37, 47, 88, 97, 106]
	ᵗsit /siʔ	[39]
	sːit	[51]
	siʔ	[71, 79, 84]
sitting	'sitin	[44, 63]
	'sitin / 'siʔin	[111]
sitting room	'sit rum /'sitin rum /'sitæn rum	[37] {see also 'room'}
	'sitᵊⁿ rum	[42]
	'sitᵊ rum	[43]
	'sidin rum	[48]
	'sit rum	[49]
six	sit	[60, 62, 66, 71, 73]
	sits	[101]
	siks	[145]
size	saiz	[90]
skin	tin	[78, 85–6]
skinny	'tiniː	[71]
skip (builders' skip)	tip	[121]
Skip	tip	[91]
sky	tai	[92, 95, 100, 104–5, 119–20, 124]
	tai / sːtai	[127]
	stai	[131, 137]
	stai / skʰai	[139]
sky-scraper	'tai treipə	[108]
slap	sæp	[56]
sleep	d̥iːp	[39]
	siːp	[73, 100, 104, 110]
	çiːp / siːp	[111]
	ʃiːp	[112, 130]
	ʃiːp / (ʃliːp)	[123]
	ʃiːp / ʃliːp	[126]
	ʃiːp / sᵊliːp	[131]
	ʃiːp / sliːp	[133]
sleeping	'siːpin	[56]
	'ʃiːpin	[120, 122]
sleepy	'siːpiː	[72, 74]

sleeve	siːv	[81]
	siːv / stiːv[84]	[95]
	ʃiːvz	[108]
	siːvz	[109]
	ʃriːvz	[112]
	ʃiːv	[127]
slid	srid	[106]
	sid	[113]
slide (V)	sraid	[106, 110]
slide (N)	sʳaid	[105]
	ʃaid	[111, 122, 130]
	said / ʃaid / ʃlaid	[112]
	said / ʃaid / ʃəˈnaid	[116]
	slaid	[133, 136]
sliding	ˈʃaidin / ˈsaidin	[108]
	ˈʃaidin	[131]
slightly	ˈsaiʔliː	[89]
slip	ʃip	[123, 127]
slipper(s)	ˈlibə	[50]
	ˈsipə	[71, 82]
	ˈsibəz	[76]
	ˈʃipəz	[128]
slow	səu	[58, 67]
slowly	ˈʃəuliː	[37]
	ˈsəuliː	[38, 64, 86, 108]
slug(s)	s̪ʌd	[95]
	sʌdz	[114–15]
	ʃʌd	[116]
	ʃʌdz	[130]
small	iː	[23, 27] {see also ‘little’}
	iə	[26]
	sɔːl	[102, 106, 108, 110]
	ʃɔːl	[116]
	sɔːl / ʃɔːl / smɔːl	[123]
smaller	ˈsɔːlə	[121]
Smarties	ˈsaːtiz	[95]
smell(s)	fil	[87]
	sɛl	[100, 106]
	sɛu / sɛɬ	[105]
	sɛɬ	[108]
	sɛlz	[109]
	sᵊˈmɛɬ	[125]
	sːmɛɬ	[128]

84 [stiːv] occurred once only.

smile	saiu	[106]
	smaiəlz	[132]
Smith	(siθ)	[85]
	sis / (siθ / smiθ / miθ)	[116]
	smis	[132, 135]
	smiθ	[149]
smoke	səuʔ	[115]
	sːməut	[124]
smoked mackerel	ˈsəuʔ ˈmæʔrəl	[105]
smoky	ˈsməukiː	[141, 145]
snack	snæt	[131]
	snæk	[141]
snail(s)	seiᵘz	[114–15]
	neiᵘ / səˈneiᵘ	[116]
snake[85]	sː	[10, 13, 18, 23]
	ʂɨ	[14]
	çː	[16]
	çː/ sː	[32]
	seit / seiʔ	[56, 92]
	seːt	[71]
	seit	[72, 100, 112, 114]
	neit	[78]
	seit / sneit	[116]
snap	sæp	[107]
sneeze	siːz / (siːnz)	[107]
	siːz	[109]
snoring	ˈsɔːrin	[87, 92]
snow (N)	səu	[54–5, 101, 113]
snows (V)	səuz	[54]
snowballs	ˈsəubɔːd	[55]
snowdrop	ˈsəudɔp	[64]
snowman	ˈsəumən	[56]
	ˈsəumæn	[59]
	snəu, ˈsəumən	[120] {self-correction – *sic*}
snow plough	ˈsnəu plau	[139]
snowy	ˈsəuiː	[67, 110]
so	səu	[54, 58, 68, 105–6, 136–7]
soap	sʲəup˥	[38]
	ʂəup	[43, 54, 66]
soapy	ˈsəubiː	[54]

85 Also ‘attachment for a vacuum cleaner’.

socks	sɔt	[48, 54, 58, 129]
	sɔʔ	[56, 121]
	sɔʔ / sɔt	[67, 71]
sofa	ˈsəudə	[52]
	ˈsəudə / ˈtəudə	[64]
solid	ˈsɔlid	[139]
some	səm	[37, 99, 109]
	sʌm	[48, 53–4, 56–7, 62, 70, 91, 95, 154]
somebody	ˈsʌmbɔdiː	[81, 92]
somehow	ˈsʌmhau	[117]
something	ˈsʌmtin	[72]
	ˈsʌmsin	[100]
sometimes	ˈsəm̥ɗeim	[43]
	ˈsʌmtaim	[46]
	ˈsʌmtaimz	[89]
somewhere	ˈsʌmwɛ	[50, 67]
song(s)	sɔn	[58, 60, 105, 112, 139]
	sɔnz	[111, 113]
soon	suːn	[73, 109]
sooner	ˈsuːnə	[50]
sorry	ˈsɔwiː	[94]
	ˈsɔriː	[139]
sorts (all sorts)	sɔːs	[49]
	sɔːts	[100]
soup	suːp	[81]
space	speis / sːpeis	[125]
spade	ɗi	[20] {scil. ‘dig’}
	b̥ei	[27]
	peid	[90]
	speid / peid	[133]
	speid	[136]
spaghetti	pəˈdɛtiː	[119]
	spəˈdɛtiː / spəˈgɛtiː	[136]
spanner	(ˈbæmə)	[18]
	ˈpænə	[79, 106]
spare (room)	ˈpəu rum / ˈpaː rum	[57]
	ˈpaː ˈrum	[68]
sparkler	ˈpaːtlə	[118]
spatula	ˈpæʔtlə	[66]
	ˈpætlitə	[121]
special	ˈpədu	[56]
	ˈpɛdu	[61, 65, 74]
	ˈpɛdəl	[81–2]

	ˈpɛsu	[95]
	ˈpɛsəl	[103, 105]
	ˈpɛʃəl	[108]
	ˈspɛʃəl	[127]
	ˈspɛsəl	[145]
spend	pɛnd	[115–16]
	spɛnd	[132]
sphygmo- (manometer)	ˈfigməu	[145]
spider	ˈbaidə	[37]
	ˈpæᵉdə	[59]
	ˈpaidə	[92, 105, 112–13, 115]
	ˈspaidə	[127, 131, 135]
spin	pin	[120]
spiny anteater	ˈpainiː ˈæntiːtə	[120]
spirit level	ˈpirit lɛwəl	[66]
spit	piʔ	[98]
splash(ed)	pæt	[64]
	spræʃt	[125]
splint	sprint	[126]
spoil	pɔil	[111]
	spɔil	[137]
sponge(s)	pʌnz(iz)	[100]
spoon	b̥uːn / b̥uː	[29]
	buːn / buː	[37]
	pʰuːn	[48, 56, 60, 76, 112, 114]
	puːn	[94, 115]
	sːpuːn	[127]
	spuːn	[133, 140]
spout	paut	[112–13, 120]
	spaut	[131]
spray	prei	[126]
spring (in a watch)	prin	[127]
sprinkler	ˈprinʔlə	[100]
sprouts	paut	[65]
Spud	pʌd	[59, 107, 127]
square	trɛː	[121, 126]
	trɛː / strɛː	[127]
squash (drink)	tɔt	[48, 61]
	tɔt/ (tɔs)	[58]
	sɔt / tɔt	[68]
	tʳɔt	[73]
	trɔs	[80, 92, 100, 117]

	tʳɔs	[87]
	trɔʃ	[109, 114–15]
	trɔs / trɔʃ	[110]
	tʳɔʃ	[113]
	stʃɔʃ	[136]
	skwɔʃ	[142]
squeak	skwiːk	[144]
squid	strid	[131]
squirrel	ˈtrirəl	[119]
	(ˈskwirəl)	[136]
stack	tæʔ	[67]
stairs	tɛːd	[92]
	tɛːz	[115–16]
	tɛ	[129]
stand	d̥æn	[37]
	tæn / tænd	[71]
	tæn	[72]
	tænd	[97, 117]
standing	ˈtændin	[85]
	ˈstændin	[131]
stapler	ˈsteipləraizə	[146]
star	d̥aː	[45]
	taː	[112, 118]
	staː	[127, 131]
start	taːt	[94, 114, 117]
starting	ˈsaːtin	[93]
starving	ˈtaːvin	[104, 106, 108, 113–14]
station	ˈteisən	[85, 100–1]
	ˈteiʃən	[124]
	ˈsteiʃən	[133, 138, 154]
stay	d̥ei	[32, 34–5, 37]
	dei	[38, 41]
	tei	[47, 50, 62, 73–4, 107, 116]
staying	ˈteiin	[85, 116]
steady	ˈtɛdiː	[72, 74]
	ˈstɛdiː	[127, 139]
steal	tiːᵘ	[60]
	tiːɬ	[125]
steam (train)	tiːm	[88, 100]
	stiːm	[137]
steep	tiːp	[105]
step ladder	ˈtɛp lædə	[68, 92, 100, 113]
	tɛp	[71]
stethoscope	ˈstɛsəskəup	[137, 145]
	ˈstɛθəskəup	[149]

stick (V)	tit	[58]
	tiʔ	[64, 85]
	stit / stik	[139]
stick (N)	tit	[48]
	tiʔ	[92]
sticker(s)	ˈtidəd	[58]
	ˈtidəz	[60]
	ˈtidə	[79]
	ˈtitə	[94, 97]
	ˈtiʔə	[113]
sticky	ˈdidiː	[44]
	ˈtitiː	[48, 121]
	ˈtidiː	[66]
stiff	tif	[114]
still	ti^{u}	[62–3, 68, 71, 85, 90]
	til	[92, 113]
sting	tin	[107]
	tinz	[122]
stinging	ˈtinin / ˈstinin	[132]
stole	tə^{u}	[60]
stool	tuː	[71]
	t^{h}uːl	[87]
	tuːl	[104, 113–14, 120]
stop	dɔp$^{\neg}$ / dɔɔɔɔp$^{\neg}$	[38]
	dɔp	[39–40, 69]
	tɔp	[105]
	tɔp / (sːt^{h}ɔp)	[125]
stopped	tɔp	[86]
	tɔpt	[100]
storeys	ˈtɔːriz	[108]
story/ stories	ˈtɔːriː	[63, 73, 115, 117]
	ˈtɔːriz	[95]
stove	təuv	[124]
	stəuv	[128, 133]
straight	teit	[60]
	sreit/ treit	[107]
	treiʔ	[110]
	treit	[120]
	streit	[138]
straight away	teitəˈwei	[56]
strainer	(ˈreinə)	[22]
strap	træp	[124, 126]
straw	trɔː	[122]
strawberry/ies	ˈtɔːbiː	[58, 78]
	ˈt^{r}ɔːbriː / ˈt^{s}ɔːbriː	[71]

	ˈtʳɔːbiː / ˈtʳɔːbid	[76]
	ˈtʳɔːbʳiz	[92, 100]
	ˈtrɔːbriː	[104]
	ˈtrɔːbriː / ˈsrɔːbriː	[108]
	ˈtrɔːbriz	[121]
	ˈsrɔːbriː	[141]
stream	tʰiːm / siːm	[90]
string	trin	[101]
stripes	traips	[107]
stroke	tʳəut	[82]
	tʳəuʔ	[95]
	trəuʔ	[105]
stroking	ˈtʳəuʔin	[106]
strong	sɔn	[71]
	tʳɔn	[73, 81]
	trɔn	[98, 110, 114, 124]
	trɔn /srɔn	[117]
	trɔn /strɔn	[127]
	strɔn	[145]
	strɔn / strɔŋ	[149]
stuck	tʌʔ	[103]
student	ˈtruːdənt	[118]
study (N)	ˈtʌdiː	[58, 74, 77, 100, 114, 123]
stupid	ˈstjuːpid / ˈstruːpid / ˈstuːpid	[131]
	ˈʃuːpid / (ˈʃtuːpid)	[136]
	ˈstruːpid	[139]
submarine	sʌbməˈiːn	[69]
suck	sʌʔ	[85, 106]
Sue	suː	[67]
sugar	ˈsuʸə	[34]
	ˈfuʸə /ˈsudə	[37]
	ˈsudə	[44, 62, 66, 80, 94, 117]
	ˈʃudə	[121, 124, 126, 131, 133]
	ˈʃugə	[138, 141]
suitcase	ˈsuːʔteis	[108]
summer	ˈsʌmə	[48]
sunflower	ˈsʌnfauə	[87]
sun-glasses	ˈsʌn draːsiz	[100, 104]
sunny	ˈsʌniː	[56, 61, 70, 110]
sunshine	ˈsʌnsain	[78]
	ˈsʌnʃain	[131]
super-fast	ˈsuːpəfaːt	[81]
super-glue	ˈsuːpədruː	[117]
supervise	ˈsuːpəvaiz	[95]
supper	ˈsʌpə / ˈsæpə	[56, 58]

supposed	əˈpəud	[71]
	pəud	[79]
	pəud / səˈpəud	[90]
sure	ʃuə	[138]
surface	ˈsəːfis	[110]
swallow(ed) (V)	ˈsɔləu	[105, 115]
	ˈsɔləud	[106]
swan	sɔn / sɔm	[100]
	ʃɔnz	[119]
	ʃɔnz / sːwɔnz	[136]
sweep	siːp	[84]
	ɕiːp / siːp	[111]
	ʃiːp	[123]
sweeper	ˈʃiːpə	[120]
sweeping	ˈsiːpin	[92]
	ˈʃiːpin	[120]
sweet	siːʔ	[58]
	siːt	[90, 92]
	ʃiːt	[124, 128, 131, 133]
	swiːt / səwiːt	[141]
swim	sim	[58, 72, 86, 88, 113]
	sim / ʃimz	[117]
	ʃim	[136]
swimming	ˈsimin	[85]
	ˈsʷimin	[116]
	ʃimin	[117, 119]
swimming pool	ˈsimin pəːᵘ	[72]
swing(s)	dᶻum	[26]
	sɯm	[44]
	sʷin	[112]
	ʃin / ʃinz	[116]
	ʃin	[128]
	ʃinz	[136]
switch (N/V)	sit	[50]
	siʔt	[62]
	sitˢ	[115]
	switʃ / ʃitʃ	[131]
switching	ˈsiˀtin	[73]
syringe	səˈrind	[79]
syrup	ˈsirəpˀ	[37] {[s] velarised}
	ˈsirəʔ	[58]
	ˈsiwəp	[68]
	ˈsirəp	[141]
table	ˈteibu	[87, 95]
	ˈteibul	[118]

Tagger	ˈtædə	[69]
take	d̥ei	[31]
	deit/ teit	[43]
	teit {actually for ‘took’} /d̥ei	[44]
	teiʔ	[47, 65, 100]
	teit	[51, 56, 68, 72, 74, 76, 78, 82, 90]
	teiʔ / teit	[58, 87]
	teij[86]	[62]
	teit / teik	[133
taking	ˈteitən	[74]
talk	tɔːʔ	[69, 89, 100, 123–4]
talking	ˈtɔːʔin / tɔːin	[89]
	ˈtɔːʔin	[92]
tall	tɔːl	[109]
taller	ˈtɔːlə	[109]
tap (faucet)	d̥æp˥	[45]
	tæp	[76]
tape	teip	[57]
tape-measure	ˈd̥æ meijə	[30]
	ˈd̥eⁱ meijə	[31]
	ˈmædæ	[37]
	ˈteipmɛdə	[48–9]
	ˈteipmɛdᶻə	[83]
tape-recorder	ˈteipitɔːdə	[70]
	teipriˈtɔːdə	[90]
tarmac	ˈtaːmæʔ	[98]
tarn	taːn	[61]
taste	teit	[58, 68]
tasty	ˈteistiː	[121]
tea	tiː	[26, 71, 138]
	diː	[37]
tea-bag	ˈdiːbæ	[37]
	ˈtiːbæd	[82]
team	tiːm	[71]
tea-time	ˈdiːdeim	[43]
teddy	ˈlælæ	[14] {inconsistent}
	ˈlælæ	[17, 18, 37] {also ‘jumper’[87]}
	ˈlælæl	[19, 35]

86 The glide at the end of ‘take’ was clear and consistent, but only in this one session and always prevocalically, in ‘take it’.

87 His favourite jumper had a picture of a teddy bear and the word was extended to all jumpers.

	ˈlælæl / ˈlælæ	[21, 32–3]
	ˈlælæ / ˈlælælæ	[29]
teeth	d̥iː	[29]
	tiːs	[82, 84, 107]
telephone[88]		
Tele-tubbies	ˈtɛ tʌbid	[60]
	ˈtɛiː tʌbid	[63]
television	ˈtɛlivizən	[87, 113]
	ˈtɛləviʒən	[126]
tell	tɛ^{u}	[69]
	tɛl	[95 {= ‘ask’, see p. 88}, 103]
telling	ˈtɛlin	[79]
temperature	ˈtɛmpitʃə	[112]
ten	d̥ɛn	[48]
	teːn	[54]
	t^{h}ɛn	[58, 60]
	tɛn	[71]
tent	d̥ɛ^{n}	[29]
than	æz	[90]
	ən	[103, 149]
	æn	[109, 121]
thanks	sænts	[105, 121, 123, 136]
	sæns / sæŋks	[139]
thank you	ˈsæntuː	[47, 56, 62, 80, 120]
	ˈsænt^{s}uː	[50, 75]
that	æː	[17, 56]
	æ / dæ	[26]
	æ	[27, 29, 30, 31, 32, 36, 39, 41–2, 44, 48–51, 54, 57]
	d̥æ	[28]
	æ /dæ	[37]
	æ/ ʔæ	[43]
	æ /dæ / dæʔ	[46]
	æ /aː	[47]
	dæʔ / æʔ	[61–2]
	æʔ / æt	[64–5, 74, 106, 115, 140, 149, 154]
	æʔ	[67–8, 72, 79, 84, 91, 102, 109, 118, 121, 123]
	dæʔ / dæt / æʔ	[71]

88 In session 23, when asked if he could say ‘telephone’, he produced an indecipherable but undoubtedly trisyllabic response.

	æt	[73, 76, 85,[89] 98, 105, 107, 114, 129, 138–9, 142–4, 146, 151]
	æʔ / æt / ət[90]	[92]
	dæt[91]	[94]
	ət	[141] {complementiser}
	æt / zæt	[150]
the	d̥ə	[27]
	ə	[29–31, 35, 37, 38–9, 46–51, 54, 56–8, 60, 62–3, 65–6, 69–70, 72–4, 76–8, 80–2, 84, 86–7, 89–94, 99–100, 104–6, 110, 113, 117, 121, 126, 132, 137–9, 141–5, 150, 153]
	də / ə	[32, 34, 36, 42, 64, 68]
	iː	[141]
	ə / ðə	[154]
their	ɛː	[116]
them	ɛm /əm	[58]
	əm	[60, 65, 70, 94, 137]
	ɛm	[128, 138]
	ðɛm / ɛm	[154]
then	dɛn	[70]
	ɛn	[95, 97, 126, 135, 154]
there	d̥ɛ	[21, 23]
	aː	[73]
	dɛː	[77, 88]
	ɛː	[89–91, 106, 108, 113–14, 120–1, 124, 126, 129, 133, 136, 138–40, 143–4, 149, 154]
	ɛː / zɛː	[92]
these	iːd	[69, 72]
	iːz	[90, 92, 113, 121]
they	ei / eː	[70]
	ei	[71, 88, 100, 103, 106, 118–19, 126, 132, 136, 150]
	eː	[97]

89 In his version of *do that*, there was a clear bilabial transition between the words: [duː ʷæt].
90 This last was a relative pronoun.
91 As in: [huː iz dætiz hæt] – *Whose hat is that?* {*Who is that's hat?*}.

they're	ɛːə	[137]
	ɛə	[149]
thing(s)	fin	[49]
	sinz	[51, 64, 71, 85, 88, 90, 92, 100, 126, 137, 149]
	sind	[58, 75, 77]
	sin	[97, 122, 132]
	sin / fin	[106]
	sin / θiŋ	[154]
think	sinʔ	[61, 71, 100, 123]
	sinʔ / sint	[64, 108]
	sint	[66, 69, 74, 76, 90, 92, 98, 105–7, 109–10, 113, 126]
	siŋk	[137, 140–2, 145, 149]
thinking	ˈsiŋkin	[142]
thirsty	ˈsəːstiː	[100, 107]
thirty	ˈsəːtiː	[115, 136]
	ˈfəːtiː / ˈsəːtiː	[132]
thirty-one	fəːtiː ˈwʌn	[56]
this	ʔiʔ	[61]
	ʔid	[62]
	is	[64, 85–6, 88, 100, 103, 109, 113–15, 121, 128, 130, 133, 136, 138–41, 143–4, 149–51]
	id	[65, 67–9, 71, 74, 76]
	dis / is	[92]
	dis	[97]
Thomas	tɔm	[66]
	ˈtɔmət	[79]
those	əu	[78]
	əuz	[121, 146]
thought	sɔːt	[104, 149]
three	d̥iː	[36]
	ɣ̥iː	[37, 39]
	diː	[42]
	fiː	[44, 48, 54, 58, 60]
	friː	[115, 123, 132, 139, 141]
through	fuː	[40–1, 56, 70–1, 93]
throw	rəu	[29]
	dəu	[32]
	θəu	[34]
	wəu	[35]
	ɣ̥əu	[39]
	fəu	[42, 48, 89]

	fəu / fʳəu	[85]
	fʳəu	[113]
throw-ball	ˈfrəubɔːl	[139]
thrown	fəun	[60]
	fəun / fʳəun	[92]
“thub” [ðʌb]	zʌb[92]	[121]
thumb	fʌm	[55]
	s̪ʌm	[95]
	sʌm	[112–13]
	sʌmz	[137]
tickle	di	[38]
	ˈtitu	[56]
tickling	ˈtiʔlin	[94–5, 104, 132]
ticklish	ˈtiʔliːiʃ	[132]
tidying	ˈtæⁱdin	[54]
tiger	ˈtaidə	[55, 63, 72, 105, 110, 112, 141]
	ˈtaigə	[136, 140, 144]
Tigger	ˈd̥ijə	[26]
	ˈd̥iːjə	[31] {cf. ‘digger’ – length and voicing random}
	ˈdiə	[42]
	ˈtidə /ˈtiʔə	[48]
	ˈtidə	[58–9, 67–8, 82]
till (until)	til	[145]
time	teim	[43] {see also ‘tea-time’}
	taim	[69, 89, 92, 105–6]
tin (for cakes)	d̥iⁿ	[16]
	d̥i(n)	[19]
tiny	dein	[38]
	ˈteiniː	[46]
	ˈtæniː	[47–8, 50]
	ˈtainiː	[87]
tip	d̥ip	[36]
	tip	[76, 81]
tip-up truck	ˈtip ʌp trʌʔ	[106]
to	tə	[49, 61, 69, 78, 80, 82–3, 113, 126, 139]
	tuː	[50, 60–1, 70, 72–4, 76, 84–6, 88–90, 115]
	ti	[54]

92 Zak (and other children) typically omit the initial [ð] in ‘function words’. Accordingly we invented new names for things – i.e. for lexical categories – and I called something a [ðʌb]. Z’s response was (consistently) to call it a [zʌb].

	tu / ə	[55, 71]
	tu	[56, 91–2]
	tə / ə	[57]
	tuː/ tu /tə	[58]
	ə	[63]
	tuː / ə	[64–5]
	tuː / tə	68, 79, 81]
toast	dəut	[43]
toasted	ˈtəusᵗːid	[49]
	ˈtəudid	[55]
today	dei	[38, 46–7]
toes	təu	[43]
	təud	[73]
	təuz	[104]
toffee	ˈtɔfiː	[133]
together	tuːˈgɛdə[93]	[58]
	tuːˈdɛdə	[71]
	tuːˈdɛzə	[86, 89]
	təˈgɛzə	[137]
Tom	tɔm	[124]
tomato(es)	ˈmaːtəu	[58, 66, 68, 72, 74, 77, 80]
	ˈmaːtəuz	[92]
	ˈmaːtəu / təˈmaːtəu	[117]
	təˈmaːtəu	[140]
tomorrow	ˈmɔrəu	[44, 46, 48–9, 81]
	ˈmɔrəu / tuːˈmɔrəu	[54]
	tuːˈmɔrəu	[55]
	tuːˈmɔwəu	[59, 65]
	əˈmɔrəu	[77]
	tuˈmɔwəu	[94]
tongue	tʌn	[105, 122, 132]
tongue twister	ˈtʌn tistə /ˈtʌn titə	[62]
too	(duː)	[37]
	d̥uː	[43]
	tuː	[44, 47, 50, 58, 68, 89, 114, 120, 137]
toolbox	ˈtuːbɔʔ	[65]
	ˈtuːbɔt	[78]
tools	tuːd	[58]
	tuᵘd / tuᵘz	[90]
	tuːlz	[100]
tooth	tuːs	[104, 113]

93 This is in my notes but it is most probably a transcription error.

top	tɔp	[67, 90, 92, 107]
torch	dɔː	[39]
	tɔːtˢ	[49]
	tɔːt	[55–6, 81]
	tɔːs	[113]
torn	tɔːn	[46]
tortoise	dɔː	[39]
	ˈtɔːtəs	[91, 132]
(in) total	in ˈtəukəl	[151]
touch	tʌt	[71]
tower(s)	ˈdæwə	[38]
	ˈd̥æwə/ˈdæwə	[39]
	ˈtæwəd	[78]
	ˈtauə	[98]
toy(s)	tɔid	[74]
	tɔi	[94]
toyshop	ˈtɔiʃɔp	[136]
track (N)	tæʔ	[54, 56–7, 63–4]
	tæt	[58]
	tæʔ / tʳæʔ	[70]
	tæʔ / tæt	[71]
	træt	[72]
	træʔ	[74, 87, 107–8, 123–4]
	træk	[137–8, 140]
tractor	brrm	[14] {cf. ‘car’}
	ˈd̥æʔa	[27]
	ˈdʌʔə	[38]
	ˈd̥æʔə	[39]
	ˈtæʔtə	[48, 58, 65, 68]
	ˈtæʔtə / ˈtætə	[56]
	ˈtʳæʔtə	[69, 100]
	ˈtræʔtə	[76, 85]
	ˈtræktə	[140]
train	oo–oo	[24, 25, 32] {imitative – high low high}
	tein	[54]
	tʰein/ tein	[56]
	teːn / tein	[57]
	tein	[58, 63, 65]
	tʰein	[60]
	tʳein / təˈrein	[69]
	trein	[72–4, 87, 100, 102, 107–9, 112, 120, 137]
	tʳein	[77, 85, 93, 95, 129] {cf. ‘crane’}

	tʳein / tᵊˈrein	[88]
	trein / tʃein	[154]
training	ˈteinin	[65]
transplant (N)	ˈtraːnzpraːnt	[120]
trapped	tæpt	[58]
Travis	ˈtrævis	[139]
tree	d̥iː	[30, 32, 34, 48]
	tiː	[46, 58]
	tˢiː	[88]
	tʳiːz	[93]
	triː	[113, 116]
triangles	ˈtraiænduz	[95]
trick	tiʔ	[67, 69]
	tʳit̚	[71]
tricycle	ˈtraisitəl	[117]
tried	taid	[58]
	traid	[112]
trolley	ˈtrɔliː	[74]
trousers	ˈtaudəd	[65]
trowel	trauᵊl	[86]
truck	brrm	[23] {see also ‘car’}
	(tæʰ)	[43]
	tʌʔ	[65]
	tʳʌʔ / trɔʔ	[74]
	tʳʌʔ	[77, 97]
	trʌʔ	[106]
try	tai	[65]
	trai	[123]
trying	ˈtʳaiin	[72]
T-shirt	ˈtiː səːʔ	[72]
Tuesday	ˈtruːzdiː	[125, 131]
tummy	ˈdʌmiː	[37, 39]
	ˈd̥ʌmiː	[43]
	ˈtʌmiː	[63, 81, 86]
tummy ache	ˈtʌmiː eit	[90]
tuna	ˈtˢuːnə	[105]
tunnel	ˈtʌnu	[57, 70]
	ˈtʌnul	[120]
turmeric	ˈtəː məˈrit	[54]
turn	dəːn	[38]
	təːn	[50–1, 56, 60, 69, 72, 86, 94]
turned	təːnd	[76]
turning	ˈtanin	[65]
tweetle	ˈtiːdu	[54, 57] {from *Fox in Socks*}

twelve	d̥ɛᵘd	[60]
	trɛlv	[118, 128, 136]
twenty	ˈtɛntiːn	[71]
	ˈtʳɛntiː	[106]
	trɛnˈtiːn	[115]
	ˈtrɛntiː	[121, 132, 136]
twinkle	ˈtrintəl	[112, 118, 131]
two	d̥uː	[36, 37, 39, 48]
	duː	[42]
	tuː	[54, 60, 69, 78, 87, 95]
ugly	ˈʌdliː	[101]
uncle	ˈʌndə	[50–1, 56, 58, 68, 79]
	ˈʌntəl	[100]
	ˈʌntəl / ˈʌntu	[108]
	ˈʌntu	[125]
under	ˈʌnə	[34]
	ˈʌndə	[64, 79]
undone	ʌnˈdʌn	[32, 34, 36]
unlock	ʌnˈlɔʔ	[108]
unplug	ʌn ˈpʌd	[62]
unscrew	ʌnˈtruː	[106, 117]
untangled	ʌnˈtændəld	[114]
until	ʌnˈtil	[94]
up	ʌ	[22]
	æp˥ /ʌp	[32]
	ʌp	[33, 37, 38, 41–4, 48–50, 53–6, 58–9, 62, 72–4, 83–6, 88, 92–3, 99, 139]
	ʌp˥/ ʌp	[34]
	ʌp / ʌ	[36]
	ʌp / ʌʔ	[71]
	ʌp˥	[76]
upstairs	ʌpˈtɛːd	[82]
us	əs	[62]
use (V)	luːz	[84]
	uːz̥	[91]
	uːz	[98, 100]
	juːz	[127]
use (N) {as in ‘no use’}	luːs	[117]
used	(ˈiːuː)	[64]
used to	ˈuːstə	[91, 103]
using	ˈuːzin	[113]

usually	'uːziː / 'uːzəliː / ('luːzəliː)	[103]
	'juːzəliː / 'luːzəliː	[109]
	'uːziː	[113]
	'uːzəliː	[117]
	'uːʒəliː	[120]
	'uːzəliː / 'luːzəliː	[126]
	'juːʒəliː	[137, 141]
utility room	uː'tilitiː rum	[108]
van	væn	[74, 78, 83, 98]
vanilla	və'nilə	[114]
vanished	'vænist	[145]
vegetable	'vɛbəl	[91]
vehicle	'viətəl	[111]
	'viəkəlz	[154]
Verulamium	vɛruː'leimiːəm	[133]
very	'veiː	[46, 48, 50]
	'vɛiː	[56, 71, 90, 92, 100, 113, 128, 139]
vest	vɛs / vɛst	[72]
	vɛd	[73]
video(-player)	'riːəu peiə	[56]
	'viːdəu	[60]
	'vijəu	[61]
	'vidəu	[65, 68]
vinegar	'vidinə	[82]
violin	væː'lin	[109]
voluntary	('pɔdəntiː)	[76]
Voyne	vɔin	[108]
wacky	'wæʔtiː	[46]
	'wækiː	[149]
wait	weiʔ	[68]
	weit	[77, 84]
waiting	'weitin	[55]
wake up	'weit ʌp	[75]
walk	wɔːt	[42–3, 90]
	wɔːʔ	[84, 100, 102, 113]
	wɔːʔ / wɔːt	[124]
walking	'wɔːʔin	[85, 93]
	'wɔːin	[104]
	'wɔːtin	[131]
wall	wɔː	[34, 38, 50]
Walligator	'wɔlideitə	[91]
wallop	'wɔləp	[140]
want	wɔʔ / wɔn	[37]
	wɔn	[41–4, 50–1, 53–8, 63, 68, 71, 76]

	wɔn / wɔm (once) / wɔnt	[46]
	wɔ /wɔn	[47]
	wɔnt /wɔn	[48, 60]
	wɔnt	[65, 107]
	wɔnʔ	[72, 82]
	ˈwɔnə	[74] {= ‘want to’}
	ˈwɔntuː	[75] {= ‘want to’}
	wɔnʔ / wɔnt	[87]
wanted	ˈwɔntid	[68]
wants	wɔt	[46]
	wɔnt	[86]
	wɔnts	[95, 115]
wardrobe	ˈwɔːdəub	[63]
	ˈwɔːdəub / ˈwɔːdʳəub	[71]
warm	wɔːm	[43, 63, 71, 74]
warming	ˈwɔːmin	[71]
was	wɔd	[60]
	wɔd / wɔz	[70]
	wɔz	[91]
	wəː[94]	[110]
	wəz / wɔz	[140]
wash	wɔt	[50, 71]
	wɔd	[81, 83]
	wɔd / wɔs	[82]
	wɔs	[84, 86, 100]
washing	ˈwɔdin	[80]
	ˈwɔʃin	[123]
washing up	wɔdin ˈʌp	[78]
watch (V)	wɔt	[40]
	wɔt/ wɔʔ	[58]
	wɔʔ	[61]
	wɔd	[63]
	wɔʔʃ	[109]
watch (N)	wɔtˢ	[79]
	wɔʔs	[92]
watching	ˈwɔdin	[63]
water	wɔː	[28]
	ˈwɔːə	[31]
	ˈwɔːdə	[36, 37, 46, 48, 54–5, 61, 63–4]
	ˈwɔːdə / ˈwɔːtə	[71, 84]
	ˈwɔːtə	[76]

94 Now regularly uses [ai wəː] for I was.

water butt(s)	ˈwɔːdə bʌt	[65]
	ˈwɔːʔə bʌt	[84]
	ˈwɔːtə bʌts	[91]
watering	ˈwɔːdrin	[84]
	ˈwɔːʔəlin / ˈwɔːʔlin / ˈwɔːrin	[100]
watering can	ˈwɔːtərin tæn	[133]
way	wei	[33, 39–40, 46, 56, 60, 63, 68, 72, 74, 88, 106–7, 137, 139–40]
we	wiː	[53, 59, 62, 67–9, 71–2, 77–8, 81–7, 89, 92–5, 99–100, 104, 109]
	wi / wiː	[61]
wear	wɛː	[122]
wedge	wɛd	[84]
Wednesday	ˈwɛndei	[72]
weed	wiːd	[126]
week	wiːt	[47]
Weetabix	ˈwiːdəbiə/ ˈwiːdəbit/ ˈwiːtəbit	[44]
	ˈwiːtəbit	[50]
	ˈwiː dəbit^{s}	[54]
	ˈwiː dəbiʔ	[60]
	ˈwiː təbiʔ	[68, 94]
	ˈwiːdəbit	[79]
wee-wee	ˈwiːwiː	[34]
weigh	wei	[58]
well	wɛl	[70, 79, 90]
Wendy	ˈwɛndiː	[59]
went	wɛn	[56]
were	wəː	[89]
weren't	wəːn	[79]
wet	wɛt	[45, 73]
what (Non-Q)	wɔt	[50, 68, 72, 80, 91, 131, 139]
what(?)	wɔt	[37, 81–2, 86, 92, 109]
	wɔt / wɔʔ	[64, 68, 70]
	wɔt / wɔ / wɔʔ	[71]
	wɔʔ /wɔt	[72][95]
whatever	wɔʔˈɛvə	[72]
wheel(s)	wiː	[36]
	ˈwiːu	[54, 56]
	wiː^{u}(d)	[74]
wheelbarrow	ˈwiːlbæwəu	[90, 106]

95 Z had [wɔʔ] and [wɔt] for interrogative 'what?' and only [wɔt] for pseudo-cleft 'what', but it is not clear if this is significant.

wheelie bin	'wiːliː bin	[97]
wheeling	wiːlin	[69]
when	wɛn	[43, 46, 58, 61, 69–70, 79, 113]
when?	wɛn	[83, 87, 115]
where	wɛ	[62]
	wɛː	[87, 92–3, 100]
where?	waː	[64, 67, 71, 73, 85]
	wɛː	[87, 108]
where's	wɛːd	[69]
which?	wit	[60, 76, 81]
	wid̥	[67]
	wit^{s}	[71, 92]
	wis / wits	[115]
while	wæ	[43]
	wai^{u}	[62, 77]
	wæː	[68]
	wæ^{u}	[72]
whisky	'witiː	[82]
	'wistiː / 'vistiː	[84]
white	wait	[76, 103, 110, 139]
	waid	[83]
who?	huː	[83, 89, 94]
whole	həu	[47]
why	wai	[84–5, 89, 95]
wife	waif	[87]
will (future)	wil	[58, 61, 65, 68, 85, 91]
	wi^{u}	[60, 70, 73]
	wiu	[61]
	wi^{u} / wiɬ / wil	[62]
	ail	[71] {= 'I will'}
William	'wiləm	[122]
Willy	wi	[41]
wind (up the yoyo)	wæː	[16]
window	'wində	[45]
	'windəu	[57, 72, 141]
	'windəuz	[110]
windy	'windiː	[61]
wine	wa^{i}n	[65]
	wain	[136]
wing(s)	wind	[56, 69]
	winz	[103, 120]
	win / wiŋ	[148]
wing mirror	'vin mirə	[66]

Winnie (the Pooh)	'winiː 'buː	[35, 36, 39] {see also 'Pooh'}
	'winiː 'puː	[49, 56, 68]
	'winiː	[50]
	'winiː ə 'puː	[60, 70, 77, 95, 121]
winter(-time)	'vindəteim	[46]
	'wintə	[89]
wipe	waip	[65]
wire	waiᵊ	[62]
	'wajə	[94]
	waiɬ	[142]
wise	waid	[82]
wish	wis	[109]
with	wid / wit	[48]
	wid	[51, 57, 58, 64, 72, 78, 88, 92, 106]
	wi	[61, 71]
	wið	[109, 113–14, 116–18]
	wiv	[138]
	wið / wiz	[149]
without	au	[36]
	wid'aut	[55, 70, 94]
wobble	'wɔbu	[62]
woke	wəuʔ	[56]
	wəut	[59]
woken	'wəutən	[100]
wolf/wolves	wut	[53, 63]
	wut / wult	[64]
	wuf	[72, 78]
	wuᵘf / wulf	[90]
	wulf	[92, 100, 112, 121, 145]
	wulvz	[116]
woman	'wumən	[56, 59]
wombat	'wɔmbæʔ	[46]
Wombles	'wɔmbə	[48]
won't	wəunʔ	[62, 64]
	wəun	[70]
wood (material)	wud	[56]
wood (forest)	wud	[77]
word	wəːd	[123]
work	wəː	[34, 36, 79]
	wɔːʔ	[37]
	wəːt	[48, 54–5, 99]
	wəːʔ/ wəːt	[58]
	wəːʔ	[60–1, 78, 110, 123]

work-bench	ˈwɔːʔbɛnt / ˈwəːʔbɛnt	[65]
	ˈwəːʔbɛnt	[78]
working	ˈwəːkin	[138]
worm(s)	wəːm(d)	[75]
	wəːm	[136]
worry	ˈwʌriː	[70–1, 73, 78]
worse	wəːs / ˈbædə	[136]
would	wud	[58, 68, 70, 91, 110]
wouldn't	wudən	[68]
wrapped	wæpt	[76]
wrapping paper	ˈræpin peipə	[79]
wrench	rɛnt^{s} / wɛnt^{s}	[90]
wriggle	ˈwidu	[90]
wriggly	ˈridliː	[104]
wrist	rist	[85]
write	ræ	[31]
	wæʔ	[38]
	raiʔ	[76, 131]
	wait	[78, 90–1]
writing	raitin	[86, 92]
wrong	rɔn	[33, 51, 66, 106–7, 112]
	rɔn / rɔm	[48]
	wɔn	[56]
xylophone	ˈzailəfəun	[91]
Yamuna /jemnə/	ˈlɛminə	[80]
yap	læp	[64]
yapping	ˈlæpin	[64]
yard	jaːd / iˈjaːd	[128]
yawn	lɔːn	[59, 102, 123]
	jɔːn / iˈjɔːn	[128]
year(s)	liəz	[106]
	liə	[113]
yeast	liːst	[119]
yellow	ˈlɛu	[18]
	(lɛn)	[19]
	ˈjɛləu	[22 {imitated}, 136, 138]
	ˈlɛjəu	[56, 61, 63–4]
	ˈjɛjəu	[57]
	ˈlɛləu	[66, 69, 71, 73, 79, 81, 95, 97, 100, 106, 109, 113, 120, 127]
yes	aː[96]	[4]

96 Breathy, nasalised, falling tone.

	hã	[7, 56, 60, 62]
	ãː / hãː	[14]
	æ / hæ / æ˜ / hæ˜	[17]
	hæ˜	[19, 20]
	hæ	[22] {status vexed – see 'have'}
	lɛt	[59]
	lɛd	[61, 63, 79]
	lɛs	[110, 112–13, 115, 119–20, 126, 129]
	lɛs / lɛː	[114, 121, 123] {= 'yeah'/ 'yes'}
	lɛs / lɛ	[116, 128]
	lɛ	[117] {scil.= 'yeah'}
	lɛː	[124]
	lɛs / (jɛs)	[131]
yesterday	'lɛdədei	[65, 69, 72]
	'lɛstədei	[99, 110]
yet	lɛt	[69–70, 72, 85–6, 88, 90, 92, 109, 123, 125, 127]
	lɛt / lɛʔ	[98]
	lɛ	[118]
	jɛt	[138]
yew (tree)	luː / 'luː triː	[124]
yoghourt	'lɔdət	[79, 113]
	'jɔdət	[132]
Yorkshire	'lɔːʔsə	[89]
you	æ[97]	[32–3]
	miː	[50]
	uː	[54–5, 62–5, 67–82, 84–92, 94–5, 97–8, 103–9, 112–5, 117, 121, 123–7, 131–2]
	juː	[61, 134, 137, 140–1]
	uː / juː	[129]
young	lʌn	[110]
younger	'jʌnə	[139]
	'jʌŋgə	[149]
your	æ	[32] {probably pronoun reversal: see 'you'}
	ə	[43]

97 This is probably pronoun reversal: in session 33 I sneezed repeatedly as part of a story then asked: "Who keeps sneezing?" Z responded [æ] pointing to me. That is, he uses [æ] for both *I* and *you*. Similarly, his use of [miː] for *you* in session 50 occurred when he pointed to me in response to: 'Who'll drive the car, you or me?'

	aː	[51]
	ɔː	[62, 67, 79, 84, 88, 90–1, 95, 100, 105–6, 114, 120, 125, 128–9, 131]
	uː	[85]
	jɔː	[137–8]
yours	ɔːz	[85, 90, 92, 95]
yourself	ɔːˈsɛlf	[112]
yoyo	ˈləuləu	[59, 87]
yum	lʌm	[63]
yummy	ˈlʌmiː	[112]
Zachary (Zak)	ʒ̥æk̚ / ʒ̥æ / ˈʒ̥æk̚diː / ˈʒ̥æk̚riː	[37]
	zæk̚ / zæʔ	[38]
	ʒ̥æʔ	[39]
	sæʔ	[42]
	sːæʔ	[48]
	zæʔ	[50, 54, 104]
	zæʔ /ˈzæʔəriː	[55–6]
	ˈzæʔəriː	[62–3, 66, 68, 70, 72, 79, 85, 95, 100, 106–8, 112, 115, 124]
	ˈzæʔəriː / zæʔ	[114, 117]
zebra(s)	ˈziːbə	[36, 38, 69]
	ˈziːbə / ziː	[37]
	ˈzɛbʳə	[72]
	ˈzɛbəz / ˈzɛbəd	[78]
	ˈzɛbrə	[107]
zigzag	ˈzitzæt / ˈziʔzæʔ	[45, 48]
zip	zip	[41] {[z] blade alveolar, slightly palatalised}
	zip	[43, 46]
zoo	zuː	[119]

6.4 Z's repertoire of gestures

As well as simply pointing to what he wanted (e.g. the television), Z also had a wide repertoire of gestures including the following, all from stages 1 and 2. All these gestures were sufficiently frequent and consistent for his family to be able easily to identify what he intended to communicate (cf. p. 108 above). A question mark by the entry indicates that it was only marginally transparent.

BACK-PACK (pointing over his shoulder at his own back)
BYE-BYE (standard hand-wave)
CAR (brrm – imitative)

CATERPILLAR (hand with fingers pointing down and wiggling)
DOMINOES (a point to his nose!)
DUCK (pac-man handshape with undulation)
EAT (fingers in mouth)
FATHER (a point to sore eyes – his father suffers from hay fever)
FISH (weaving motion of his right hand)
FROG (jumping motion with his hands)
GRANDMA {paternal} (a pat on the ground where she cut his nails)
GRANDPA {paternal} (the mixer sign with a point to me as he associates me with making cakes)
IVAN (wringing hands – his uncle suffered from damaged hands)
JO (indicating a pony-tail)
LAWN-MOWER (holding hands as though pushing a mower)
LIFT (PICK-UP) (raising arms to be picked up)
MIXER (FOOD) (both hands dipping into an imaginary bowl)
MORE THAN ONE (both hands raised beside his cheeks)
NO (a shake of the head)
PAINTING (imitative)
RABBIT (indicates ears?)
SCREWDRIVER (imitative of tool use)
SECATEURS (cutting motion?)
SELF (a point to himself)
SIT (a pat on the floor)
SNAIL (points round the side to his own back – indicating a house)
SPINNING ROUND (holding hands horizontally for his father to spin him round)
TIPPING (imitative)
UP(STAIRS) (points up)
WATERING (imitating using a watering can)
WORM (wiggling finger)
YES (a nod of the head)

7 *Appendices*

7.1 Z's cluster production

This appendix documents the 'clusters' produced by Z. This simple observation hides a multiplicity of problems, hence the scare quotes. First is the question of systematicity: in the first six stages Z sporadically produced a number of complex articulations (such as [xw]) without these becoming in any way predictable. I have therefore gathered these together in appendix 7.1.1 as 'sporadic clusters'. Others, of course, may be able to see patterns where I have failed to do so. The second problem is raised by the contrast between clusters and secondary articulations, a problem which becomes particularly acute when these are on a continuum, as in the difference between [ts] and [t^{s}]. Third, the adult target may be either one phoneme or two and it seems slightly odd to characterise the child's realisation of /z/ by [-dz] in *please*, or of /dʒ-/ by [dr-] in *giraffe*, as a cluster on a par with his realisation of /dz/ and /dr/ by [dz] and [dr]. None the less, I have generally included here all digraphs even where these are used for a single adult phoneme, except that heavy aspiration (represented by [C^{h}]) is not treated as instantiating a cluster. Apart from this a superscript typically indicates that the sequence is a secondary articulation rather than a cluster, though this is problematic with e.g. Z's first initial 'cluster' [b^{r}]. This leads to the fourth problem: given his later metalinguistic judgements (see section 5.1.6 and appendices 7.3 and 7.4) he may anyway be treating some adult clusters such as [fl] as unitary, whether as single segments or onsets. Finally, I have excluded clusters occurring across syllable boundaries – e.g. the [-mb-] in ['dæmbaː].

For A's cluster development see APh: 169.

7.1.1 Sporadic clusters

xw	for /kw-/	26	(onomatopoeic imitation for *quack*)
d^{z}	for /sw-/	26;	for /-dʒ/ 37, 51
n^{d}	for /-nd/	31	

^{g}r	for /gr-/	31	
ʃ^{w}	for /ʃ-/	36	
v^{z}	for /-vz/	36	
f^{w}	for /fr-/	38	
^{t}s	for /s-/	39	
nt^{s}	for /-ŋk-/	50	
t^{s}	for /–ks/, /kr-/	54;	for /-s/, /-ks/ 57
t^{h}	for /kl-/	56	
th	for /tr-/	56	
dz	for /-z/	56	
p^{h}	for /sp-/	56	
l^{w}	for /-l-/	60	
mːp	for /-lmɪt/	62	
ʔt	for /-tʃ/	62	

7.1.2 Final clusters

The clusters are listed in order of first appearance. 'nd' was the first cluster to appear – for adult /-nd/, 'mb' was the second to appear – for adult /-mbəld/, 'nt' the third – for adult /-nt/, and so on. However, I have then listed, again in order of appearance, the other adult sequence for which Z produced the same cluster. Thus 'nd' appeared (in session 43) for adult /-ndɪd/, (in session 56) for adult /-ŋz/, etc.

nd	for /-nd/	37, 56, 60, 61, 64	
	for /-ndɪd/	43	
	for /-ŋz/	56, 58, 69, 75	{plural}
	for /-ndʒ/	58, 79	
	for /-nz/	77, 78	
n^{d}	for /-nd/	69	
mb	for /-mbəld/	43	{scrambled (egg)}
nt	for /-nt/	48, 60, 62, 65, 68, 70, 78	
	for /-ntʃ/	56, 58, 61, 65, 76	
	for /-ns/	64	
	for /-ŋk/	64, 69, 71, 74, 76	
nz	for /-ŋz/	51, 64, 71, 118	{plural}
	for /-nz/	68, 91, 92	
mp	for /-mp/	56, 69, 80	

	for /-lp/	58, 62, 64, 71	{*help*}
md	for /-mz/	58, 60, 75, 78	{plural and third person sg}
ts	for /-ks/	58, 73	{plural}
	for /-kst/	92	
pt	for /-pt/	58, 76	{past participle}
nʔ	for /-ŋk/	61, 64, 71, 87	
	for /-nt/	64, 71	
	for /-ns/	71	
pʔ	for /-pt/	62	
ʔt	for /-ks/	63, 69, 81	
	for /-kt/	72, 87	
lt	for /-lf/	64	
	for /-ls/	69	
	for /-lk/	91	
	for /-lt/	98	
b^z	for /-bz/	67	
ns	for /-ns/	68	
	for /-ntʃ/	92	
ld	for /-lz/	68, 71, 80	{plural}
	for /-ld/	74, 75, 81, 92, 109	
mz	for /-mz/	68, 89	{plural}
dz	for /-gz/	71, 130	{plural}
	for /-dz/	92	
d^z	for /-z/	71	
st	for /-st/	72, 85	
	for /-ʃt/	90	
	for /-sk/	108	
nt^s	for /-ntʃ/	84, 90	
ft	for /-ft/	87	
nʔt	for /-ŋkt/	87	
lf	for /-lf/	90, 92, 124	
ps	for /-ps/	90, 107	
vd	for /-vd/	90	
nts	for /-nts/	90, 95	
	for /-ŋks/	105	
t^s	for /-ts/	91	{plural}
ʔs	for /-ks/	92, 117	

	for /-tʃ/	92, 123
lz	for /-lz/	92, 100
mt	for /-mpt/	105
lp	for /-lp/	106
ntʃ	for /-ntʃ/	108
vz	for /-vz/	108
bz	for /-bz/	114
lvz	for /-lvz/	116
ʒd	for /-dʒd/	124
ŋk	for /-ŋk/	133
ks	for /-ks/	133, 136
kt	for /-kt/	139
ŋks	for /-ŋks/	139
gz	for /-gz/	140
sk	for /-sk/	140

7.1.3 Initial clusters

b^r	for /br-/	68, 69, 70, 72, 77, 79, 91
	for /bl-/	69, 87, 91, 95
d^r	for /gr-/	69, 70, 71, 73, 74, 85
	for /dr-/	70, 71, 73, 84
	for /dʒ-/	72, 80, 81, 82, 86, 91
t^s	for /skr-/	69
	for /k-/	70
	for /str-/	71
	for /tʃ-/	71, 73, 74
	for /kl-/	73, 84, 88
	for /tr-/	88
	for /tj-/	105
d^z	for /dʒ-/	69, 71, 72, 74, 82, 84
	for /dr-/	71, 82, 84
	for /gr-/	71, 74, 85, 94
	for /g-/	75
dr	for /gr-/	69, 72, 74, 76, 84, 129
	for /dr-/	72, 73, 81, 82
	for /dʒ-/	79, 82, 121
	for /gl-/	94, 106

	for /dj-/	106, 125
t^r	for /tr-/	69, 70, 71, 77
	for /kr-/	69, 71, 73, 74, 77, 79, 83
	for /str-/	71, 73, 76, 81, 82
	for /skw-/	73
	for /tʃ-/	78, 79, 82, 84
	for /kl-/	79, 85
	for /kw-/	83
	for /skr-/	92, 93
f^r	for/fr-/	70, 72, 76, 121
	for /θr-/	92, 113
	for /fl-/	95, 106
br	for /br-/	70, 71, 74, 75, 84
	for /bl-/	101, 117, 124
b^w	for /br-/	71
	for /bl-/	87
b^l	for /bl-/	72, 79, 87
tr	for /tr-/	72, 73, 74
	for /skr-/	77
	for /kl-/	78, 85, 86, 87, 100
	for /kr-/	78, 92, 129
	for /skw-/	80, 100, 119
	for /kw-/	87, 99, 102
	for /tʃ-/	92, 101, 124
	for /str-/	101, 107
	for /tw-/	112, 118
	for /stj-/	118
	for /tj-/	131
fl	for /fl-/	72
pl	for /pl-/	73, 81, 82, 92
fr	for /fr-/	73, 94, 124
	for /fl-/	120, 124
	for /θr-/	123
d^w	for /gl-/	74
dz	for /gr-/	74, 85, 97
	for /g-/	74
	for /dʒ-/	83
$d^w r$	for /gr-/	74

ts^r	for /kr-/	74
p^w	for /pl-/	78
p^l	for /pl-/	87, 95
pr	for /pl-/	91, 92, 120
	for /pr-/	92, 97
	for /pj-/	113, 128
	for /spr-/	126
bl	for /bl-/	92, 94
p^r	for /pl-/	92
f^w	for /fl-/	95, 99, 121
dʒ	for /gr-/	100
s^r	for /fl-/	100
	for /sl-/	105
sr	for /sl-/	106
	for /str-/	107, 108
ʃl	for /sl-/	112, 126
ʃr	for /sl-/	112
s^w	for /sw-/	112
sn	for /sn-/	116, 120, 131
sm	for /sm-/	116, 123
sːm	for /sm-/	124, 128
$d^ʒr$	for /gr-/	124
sp	for /sp-/	125, 127
sːp	for /sp-/	125, 127
$sːt^h$	for /st-/	125
spr	for /spl-/	125, 126
st	for /sk-/	126, 128, 135
	for /st-/	127
	for /stj-/	131
str	for /str-/	127
	for /skw-/	127, 131
	for /skr-/	128, 134
	for /stj-/	131, 139
gr	for /gr-/	129, 133
kr	for /kr-/	129, 136
	for /kw-/	133, 140
sw	for /sw-/	131
stj	for /stj-/	131

sl	for /sl-/	133
pj	for /pj-/	133
kl	for /kl-/	133
sk	for /sk-/	135
stʃ	for /skw-/	136
skr	for /skr-/	136
kl	for /kl-/	136
sːw	for /sw-/	136
skw	for /skw-/	136, 142
skj	for /skj-/	137
sk^h	for /sk-/	139
kw	for /kw-/	141
gl	for /gl-/	141

7.2 Adult English initial clusters and their realisation by Z

Clusters of adult English and the successive realisations with which Z produced them:

bl-	b̥, b, b^l, b^r, br, bl	
br-	b̥, b, b^r, br	
kl-	d̥, d, t, t^h, t^r, t^s, tʃ, tr, kl	
kr-	d, t, t^s, ts^r, t^r, tr, kr	
kj-	t	
kw-	t, t^r, tr, kr, kw	
dr-	d̥, d, d^j, d^r, d^z, dr, dʒ, dr	
dj-	d, dr	
fj-	f	
fl-	ɸ, f, f^w, f^r, f^l, s, fl, fr, fl	{*flapjack* was special}
fr-	f, f^w, ɸ, f^r, fr	
gl-	d, d^w, d^r, dr, dʒ, gl	
gr-	r,[1] d̥, d, d^r, d^z, dʒ, dr, dz, gr	
hj-	h	{see 'huge' in alphabetical list of entires, ch. 6, section 6.3}
mj-	m	
nj-	n, nj	
pj-	b, b̥, p^h, p, pr, pj	
pl-	b̥, b, p, p^w, p^r, p^l, pl, pr, pl	

1 *Grandma* only.

pr-	p, pr
sk-	t, t^h, sːt, st, sk
skr-	d, t, t^s, t^r, t^h, tr, s, str, skr
sl-	d, s, ʃ, ʃl, ʃr, sr, sl
sm-	s, sːm, sm
sn-	s, n, sːn, sn
sp-	b, b̥, p, p^h, sːp, sp
spr-	p, pr
skw-	t, s, t^r, tr, str, skw
st-	d̥, d, t, sːt, st
str-	t, t^r, tr, s, sr, str
stj-	tr, str, stj
sj-	s
sw-	s, s^w, ʃ, sw
θr-	d̥, y̥, d, f, f^r, fr
tr-	d̥, d, t, t^h, t^r, t^s, tr
tj-	t^s, tr
tw-	d̥, t, t^r, tr

There are no examples of the remaining adult clusters.

7.3 Metalinguistic data

Because of their importance in the discussion of levels of representation I have assembled Z's various metalinguistic judgements chronologically by session. Examples which have been discussed in the text are identified by page reference.

22 In this session Z practised all sorts of sounds, including on an ingressive air-stream mechanism, and attempted to imitate individual words in a way he used not to.

29 He now (systematically) used alternate pronunciations – either in play or in practice, as in: ˈhʌniː / hʌˈniː – *honey*; ˈbo ˈbijə/ ˈbə ˈbijə/ ˈbuː ˈbijə – *Bob the Builder*.

31 Metalinguistic use of 'no' (see p. 58)

43 Putative first echoic use:

NS: "Me too"

Z: nɔt miː tuː, ˈræma – Not 'me too', Grandma [does].

58 First systematic use of contrastive stress (see p. 72)

59 Z became aware of his own and others' differing pronunciations for some words (see p. 74 and the dialogue below):

Anne: What's that?
Z: ˈmaitəweidə (microwave)
Anne: What does Mummy call it?
Z: ˈmaitəweiḍ̥

63 Z corrected the term 'fawn' in a book I was reading to him to 'deer'.

67 He spontaneously said [nait] for *knife*; when I said: "What do I call it?" he responded [naif] (twice) and then reverted to calling it [nait].

70 He resisted correction of his pronunciation, probably because the correction was the same as his intention. He said [ˈwiniː ˈə ˈpuː ˈbaːt] – *Winnie the Pooh Bear* – very carefully and deliberately with stress on each element. When he was corrected from [ə] to 'the', he responded vehemently: [ˈwiniː ˈə ˈpuːt].

80 Imitating a (Scottish) accent (see p. 115).

81 Changing his choice of lexical item.

He said [it ˈɔːməu mɛndid] – *It's almost mended*. When I tried to get him to repeat 'almost mended', he came back with 'nearly mended' [niəliː mɛndid], presumably because he realised we often had trouble understanding him, so changed the word.

82 He corrected me very firmly and clearly when I pronounced the flower 'Daddylions' instead of 'dandelions' – [ˈdændiːlæᵊn].

92 Commenting on the use of different terms for the same item (the lawn-mower box) (see pp. 82–3)

100 Sub-vocal rehearsal in a whisper to himself, alternating between pronunciations (see p. 116).

Playing with my name: "[ˈdræmpaːpaː] is what I call you".

106 Commenting on my pronunciation (and grammar): *afternoon* (see p. 87).

The first clear examples of 'repairs' also occurred in this session (see p. 116) and: [ei did ˈsraid daun, ˈsrid daun] – "They did slide down, slid down."

Comparable examples occurred in several of the following sessions.

107 He said [siːz] for ‘sneeze’; when asked to repeat it, he said [siːnz].

109 For ‘scrambled egg’, see p. 117. Comparable self-correction occurred in session 128.

110 For ‘glass’ and ‘grass’, see p. 116.

113 Describing a picture of a hospital ward, he spontaneously self-corrected ‘lady’ to ‘nurse’ [nəːs].

115 For ‘sleep’ and ‘sheep’, ‘squash’ and ‘cloth’, see p. 117.

116 He said that ‘play’ and ‘pray’ (both of which he pronounced [prei]) are the same for him but different for me.

118 For what ‘frog’ and ‘farm’ begin with, see p. 117.

120 He volunteered the accurate information that he says ‘sleeping’ and ‘sweeping’ the same, [ʃiːpin], and I say them differently.

121 After saying I was really ‘Grandpa Neil’ he said he calls me [ˈdræmpaː fɔː sɔːt] – “‘Grandpa’ for short”.

After repeating ‘square’ and ‘chair’ to himself a few times, both [trɛːː] for him, he explicitly described them as the same for him but different for me.

124 He was adamant that ‘sugar’ ([ʃudə]) and ‘sweet’ ([ʃiːt]) begin the same (with [ʃ]) both for him and for me.

For ‘foam’ and ‘fireman’, see p. 117.

126 For ‘usually’, see pp. 116, 117.

133 For ‘piano’, see p. 117. He alternated between [pjænəu] and [prænəu] in his pronunciation but, when asked, said explicitly that the former was correct.

137 He corrected my usage of “at the double” by saying: [nəu ˈgræmpaː – ˈɔn ə dʌbəl, nɔt ˈæt ə dʌbəl] – “No, Grandpa: ‘on the double’, not ‘at the double’.”

138 For ‘yellow’ and his awareness of syllable structure, see p. 117.

139 Vocabulary correction:

[its nɔt ə ˈfutbɔːl, its ə ˈfrəubɔːl] – “it’s not a football, it’s a ball for throwing”.

140 Playing games with words, see p. 115.

141 On ‘glass’ as [glæs] or [glaːs], see p. 116.

148 Intermittently over several months he called me ‘Dad’ and then self-corrected to ‘Grandpa’. This self-correction seemed to be comparable to that he made with changing [trʌmz] to [krʌmz] for *crumbs*, for instance. That is, it was marked by the same sort of delay and intonation, indicating the same kind of monitoring.

7.4 Inventory of Zachary's judgements of what various words begin with, reproduced (with copious additions) from Smith, N. V. (2005)

The most striking, and problematic, of Z's metalinguistic judgements were his identifications of what words 'begin with', so I have collated an alphabetical list of all the relevant examples together here.

The left-hand column is either the stimulus I gave him or what he spontaneously volunteered; the middle column is his response or continuation: what the item in the first column "begins with"; and the right-hand column is his normal pronunciation of the word at the time. Some of the phonetic detail has been simplified. Where several entries occur for the same word this simply records different utterances of the same item (in chronological order). Some of the very late examples (e.g. *design* or the second instance of *spoon*) show a significant change in his ability but are included for the sake of completeness.

Amahl	- [ə]	ˈæmɑːl
Anne	- [ə]	æn

He volunteered that "*Amahl* and *Anne* begin the same with [ə]." These are the names of his parents.

before	- [fə]	əˈfɔː
begin	- [də]	biˈdin
bottle	- [bɔʔ]	bɔtəl *or* bɔʔəl
box	- [bə]	bɔʔs
bread	- [dʳə]	brɛd

When I contradicted him he gave: [bʳə].

chair	- [tr]	trɛː
climb	- [trˤ]	traim
cloth	- [tʳə]	trɔʃ
cow	- [pʰə]	tau

When asked again, he managed [thə], and then volunteered: [thə] fə tau ən tʌbəd i.e.- [thə] for *cow* and *cupboard* (his pronunciation was [tʌbəd]).

crane	- [tʳə]	trein	
cupboard	- [thə]	tʌbəd	See 'cow'
Daddy	- [də]	dædiː	
design	- [də]	diˈzain	
drum	- [dr]	drʌm	

When asked: "Is that the same as 'duck'?", he replied: "No."

egg	- [ə]	ɛd
equipment	- [trˤ]	tripmənt

farm	- [fə]	faːm
fire	- [fə]	fæː
fireman	- [fə]	fæːmən
flapjack	- [ʃ]	læpdzæʔ *or* ʃæpdʒæʔ *or* fʳæpdzæʔ
flapjack	- [fʷ]	fʷæpdzæʔ
flapjack	- [fr]	fræpdzæʔ
flower	- [fr]	fræwə
foam	- [fə]	fəum
foot	- [fə]	fut
fork	- [fə]	fɔːʔ
forty	- [fə]	fɔːtiː
frame	- [frə]	freim
France	- [frə]	fraːns
frog	- [frə]	frɔd

Explicitly not the same as 'farm'. Much later (session 142) he said spontaneously: [its fʳə fə frɔg, nɔt fə] – "It's 'fr' for 'frog' not 'f'."

funny	– [fə]	fʌniː

Explicitly not the same as 'France'.

giraffe	- [dr]	draːf
girl	- [də]	dəːl
Grandma	- [drə]	drænmaː
Grandma	- [də]	drænmaː
Grandpa	- [drə]	dræmpaː
Gruff	- [drə]	drʌf
grape	- [dr]	dreip
hand	- [fə]	hænd

When asked again, he managed [hə].

honey	- [hə]	hʌniː	
horse	- [hə]	hɔːs	
ice-cream	- [ais]	'aistriːm	
Jimmy	- [drə]	drimiː	
John	- [drə]	drɔn	
Josh	- [drə]	drɔs *or* dʒɔʃ	
Josh	- [dʒə]	drɔs *or* dʒɔʃ	
Josh	- [dʒrˠ]	drɔs *or* dʒɔʃ	
Joshua	- drɔsuːaːbi'dinz wið ə dʒə[2]		
Jupiter	- [dʒə]	druːpitə *or* dʒuːpitə	
kettle	- [tə]	tɛtul	See 'tomato'
lion	- [lə]	laiən	
Mummy	- [mə]	mʌmiː	

2 This was a striking example of a mismatch between use and mention.

nose	- [nᵊ]	nəuz
piano	- [pʳə]	prænəu
piece	- [pʰə]	piːs
plant	- [pr]	praːnt
play	- [pr]	prei
poppy	- [p]	pɔpiː
pot	- [p]	pɔt
potato	- [tə]	teitəu
pray	- [pr]	prei
pretend	- [bʳ]	priˈtɛnd

After much thought he said: 'pri' begins with [bʳ], just like 'Brussels', and 'tɛnd' begins with [tᵊ].

room	- [rᵊ]	rum
Scoop	- [tʰə]	tuːp
Scoop	- [sə]	stuːp
scrambled	- [tr]	træmbəld
sheep	- [ʃ]	siːp *or* ʃiːp
sky	- [sə]	tai *or* sːtai
sleep	- [ʃ]	ʃiːp
sleep	- [ə ʃə]	ʃiːp

He prefixed several of his answers with a schwa that I interpreted as an indefinite article.

sleeve	- [ʃ]	siːv *or* ʃiːv
sleeve	- [ʃᵊ]	ʃiːv
sneeze	- [ə siː]	siːz
sorry	- [sᵊ]	ˈsɔiː
spoon	- [pʰə]	puːn
spoon	- [sə]	sːpuːn
Spud	- [sə]	pʌd
squash	- [tʳə]	trɔʃ
star	- [sə]	staː
stool	- [tʰə]	tuːl
strong	- [trᵊ]	trɔn *or* (once) srɔn
swans	- [ʃ]	ʃɔnz
sweet	- [ʃ]	ʃiːt
swimming	- [ʃ]	ʃimin
swing	- [s]	sʷin
thanks	- [s]	sænts
think	- [ə sᵊ]	sint
think	- [sᵊ]	sinʔ

He volunteered: “Just like ‘sorry’.”

thirty	- [sə]	fəːtiː *or* səːtiː
three	- [frə]	friː

He volunteered: “Just like ‘frame’.”

tomato	- [tə]	maːtəu

Repeated [tə] when questioned. He then volunteered: ə tɛtul biˈdinz wið ə ‘tə’ – “A *kettle* begins with a [tə].”

NS (holding up a tomato) “What does this begin with?”			Z:	[maː]
NS “And when I say it?”			Z: (*sotto voce*)	[təˈmaːtəu] pause: [təˈmaː]
torch	- [tʰ]	tɔːs		
train	- [tʳə]	trein		
usually	- [lə]	uːzəliː *or* luːzəliː		
yawn	- “don’t know”	lɔːn		
yawn	- [lə]	lɔːn		
yellow	- [lə]	lɛləu		
yellow	- [jə]	jɛləu		

He actually said: “[jə] and [lə]”. He had begun (session 138) to sound out non-initial consonants, often saying that the word ends in the non-word-initial but syllable-initial consonant. Similarly: [ʃugə ɛndz wiv ə gə] – “‘Sugar’ ends with a [g].”

your	- “don’t know”	ɔː
Zachary	- [zə]	ˈzæʔəriː

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