The price of a perfect system: learnability and the distribution of errors in the speech of children learning English as a first language

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The Price of a Perfect System:

Learnability and the Distribution of Errors in the Speech of Children Learning English as a First Language

by

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Abstract

This study reports on a strictly-cognitive and symptomatic approach to the treatment of phonological disorders, by an effect which can also be reproduced in most normally-developing children. To explain how this works, it is necessary to address certain asymmetries and singularities in the distribution of children's speech errors over the whole range of development. Particular words occasion particular errors. In early phonology there is 'fronting' with Coronal displacing Dorsal, and harmonies where Coronal is lost. In the middle of phonological acquisition, the harmonic pattern changes with coronal harmony coming to prevail over other forms. As well as these asymmetries, there is also the case of harmonic or migratory errors involving the property of affrication, but not the affricate as a whole, i.e. ignoring the property of voicing. Many of these asymmetries and singularities and the harmony or movement of affrication are described here for the first time. They are all difficult to explain in current theoretical models, especially in 'bottom-up' models. On the basis of the 'top-down' notion of 'parameters' from recent work in phonology, I shall assume that: A) finite learnability has to be ensured; B) there can be no privileged information about the learnability target; and C) phonological theory and the study of speech development (normal and otherwise) have an object in common.

I shall propose: A) a Parameter Setting Function, as part of the human genome, possibly a defining part; B) 'Phonological Parapraxis', as a way of characterising the generalisations here about incompetent phonology by the general mechanisms of 'floating' and 'non-association'; C) a Stage$_{n-1}$ as a necessary construct in the theory of acquisition, typically not reached before 8;6; D) a 'Representability Inspection' relating normal competence to Chomsky's 'Articulatory/Perceptual interface', sensitive to a relation between featural properties such as roundness or labiality and prosodic properties such as the foot and syllable; E) a syndrome, Specific Speech and Language Impairment, SSLI, extending the notion of Specific Language Impairment, SLI.

I shall hypothesise that: A) segmental and suprasegmental representations interact; B) the phonological learnability space is uniform and consistent; C) it is the very minimality of the learnability system which makes it vulnerable to SSLI.

This: A) side-steps the implausible inference that development proceeds by the loss of 'processes'; B) accounts for at least some of the asymmetries noted above; C) lets parameters 'set' a degree of abstract exponence; D) makes it possible to abolish 'processes' such as fronting, lisping, consonant harmony, in favour of successive degrees of imprecision in the parameterisation; E) provides a conceptual mechanism for the cognitive and symptomatic therapy, mentioned above: the therapy effects an increase in the set of phonological structures which are 'representable' by the child.

Acknowledgements

This study is inspired by the thousand or so children and their parents with whom it has been my pleasure to work as a therapist. Hopefully, this study will help in a small way to address the needs of those who are told, as the author once was, to 'stop mumbling'.

I am endebted to those parents who agreed to let their children take part in this research, and to the staff, parents, and governors of a school in Southwest London where in 1997 I was allowed to collect most of the data here. In an act of consummate generosity, the head teacher, asked the staff for a volunteer to act as my co-worker. JW, a classroom assistant, volunteered. She is a most gifted phonetician and scientist. She deepened and sharpened my thinking about many of the issues here.

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Standard acronyms

AP	Articulatory Phonology
A/P	Articulatory/Perceptual (Interface) (Chomsky, 1995 a p. 2)
C_{HL}	Computation for Human Language (Chomsky, 1995a a p. 221, ff)
DER	Default Exponence Rule
DP	Dependency Phonology (see Anderson and Owen, 1987, Durand, 1990)
EAT	Edinburgh Articulation Test
GP	Government Phonology (see Kaye, Lowenstamm and Vergaud, 1985 and 1990, Charette, 1991, Harris, 1994, and Chapter 5.1)
IPA	International Phonetic Alphabet
L1	First language
L2	Second Language
LP	Lexical Phonology
MNAR	Marked Node Association Rule
NP	Natural Phonology
NCC	No Crossing Condition
OT	Optimality Theory (see Smolensky, 1997).
PAC	Phonological Association Convention (see Goldmith, 1976)
PP	Phonological Parapraxis
PSF	Parameter Setting Function
PPT	Principles and Parameters Theory (see Atkinson, 1992, Roca, 1991 and 1994)
RP	Received Pronunciation
RAPT	Renfrew Action Picture Test
R-Inspection	Representability Inspection
RR	Redundancy Rule (see Archangeli, 1984)
RU	Radical Underspecification (see Archangeli, 1984)
SOT	Slip of the Tongue
SPE	*The Sound Pattern of English* (Chomsky and Halle, 1968)
SLI	Specific Language Impairment
SSLI	Specific Speech and Language Impairment
UG	Universal Grammar
UR	Underlying Representation

Introduction

This study seeks to bring into a common focus: A) a particular therapeutic practice, B) the results of an experimental investigation of this, C) current phonological theory, and D) the appearance of order in phonological disorder, an anomaly in physics. By the physical law of entropy, errors should represent the loss of organisation, tending towards randomness. But on the evidence here, this is not so. The error distribution shows a degree of organisation. One example of this is the contrast between harmony in *hippopotamus* as [hɪtəˈpɒtəməs] and metathesis in *hospital* as [ˈhɒstəpəl] with the same segments canonically in the same order in both cases, but with characteristically different processes in each one. It is hard to see how this apparent organisation could be learned. The anomaly of organised errors demands an explanation. Leaving open the psycho-linguistically all important question of whether children's speech errors are at the perceptual or production stage, the challenge here is to explain both the asymmetry (problematic from all points of view) and a degree of variability (problematic from the perspective of generative linguistics).

Core task

My task is to bring together therapeutic and theoretical ideas. The therapeutic thinking is from ten years as a speech and language therapist in National Health Service or NHS clinics in Southwest London. The thinking concerns a specifically symptomatic approach to phonetic/phonological disorders. On this thinking, while the surface expression of such disorders varies widely, they have a common core. This should be assumed unless there are independent reasons for thinking otherwise. So my concern is not with all problems with speech or with phenomena such as those associated with: A) cerebral palsy and other disorders of the central nervous system, B) clefts of the lip and palate, C) independently defined conditions such as Downs syndrome, D) mental handicap with a non-specific diagnosis, E) hearing loss, F) the effects of social deprivation. Nor is my concern with the artificial triggering of speech errors, as by 'tongue twisters', or slips of the tongue, SOT's. There may be a connection between children's speech errors and tongue twisters or SOT's, but it does not need to be assumed. On this thinking, the appearance of a phonological disorder may be, and indeed is likely to be, just this. In any one case, one or more other factors may be relevant. But in the process of assessment and remediation it may be possible to ignore them. The evidence for this is from the successful application of a procedure, originally developed and carried out over a number of years in clinical practice, to most members of a normally developing sample (see Chapter 4). The procedure cannot be devolved to parents. But it is still economical in terms of clinical time.

The core theoretical idea concerns phonological learnability. I take it to be axiomatic: A) that no principles should be invoked other than those which are necessary for the description of adult competence; and B) that the learning process is both demonstrably finite and such that it does not require privileged information about the target – for instance, whether tone is or is not part of a lexical representation.

The theoretical focus has only emerged in the course of this study. At the beginning of this study, its focus was almost exclusively therapeutic, i.e. practical. From this starting point, I shall argue that a particular pattern of therapeutic response among speech-disordered children (demonstrated in this study) is inconceivable other than on the basis of a highly specific, cognitively defined, defect. This, I shall argue, is explicable in terms of 'parameters' (see Halle and Idsardi, 1995), but not easily explicable in terms of the currently favoured Optimality Theory (see Bernhardt and Stemberger, 1998, and references therein). A key element of the thinking here is given by Chomsky's (1995 a) 'articulatory / perceptual interface', as one of the defining elements in what I shall characterise as the phonological 'learnability space'.

Here I shall assume and seek to justify the notion of 'incompetent phonology', i.e. phonology which is incompetent for any reason, either as an aspect of normal development or as a manifestation of disorder. In the framework here, the main manifestation of phonological incompetence is that parameters are incompletely set. The sets of categories on which they should properly be defined are not yet fully specified. One consequence is the 'floating' or 'non-association' of elements which 'associate' (or don't) in particular parts of the phonological structure. Both effects can seem to apply over a long range. By a set of hypotheses to be presented in the final Chapter, the parameters are defined in a highly abstract, but generalised way. It is this which leads to the bias, or appearance of organisation, in the error distribution.

The core task in treating a phonological disorder is thus to help the child to a fuller and more correct setting of the relevant parameters. The task is a subtle one.

Literature

Here, in capitals 'Child Phonology' denotes an area of research, and expresses the idea (not accepted here) that there is such a field of study, with principles separate from those of linguistics. Uncapitalised, child phonology denotes the corresponding data. In the study of child phonology, as opposed to Child Phonology, a broadly generative, specifically linguistic, approach is emerging. In the phonology of van der Hulst and van de Weijer (1995) and Dresher (1999), attention is paid to developmental data. But in phonology generally, little attention has been paid to developmental data since the work of Jakobson (1941). Clinically oriented researchers, such as Law

(1992) and Martin and Miller (1996) tend to favour various combinations of interactionist, socio-linguistic, neuro-psychological, psycho-linguistic, computational, and what we shall call 'bottom-up' approaches, but not linguistic ones.

Working towards a generative model, Chin and Dinnsen (1992) write, "Our previous work with functional disorders ... has concentrated on system internal phenomena, and .. assumed the uniqueness of the children's underlying representations.. However, we do acknowledge that in many cases, there seems to be a generalized, non-accidental relationship between adult representations and children's phonetic forms.." (p.283). (See also Dinnsen, 1992, 1993, 1996, Dinnsen and Chin, 1995, Chin and Dinnsen, 1996). Other proponents of this cognitive/generative approach include Waterson (1976), Chiat, (1983 and 1989) Spencer (1984, 1986), Ingram (1985, 1988, 1989, 1990, 1992, 1993, 1995), Iverson and Wheeler (1987), Fikkert (1994), Bernhardt (1992), Bernhardt and Gilbert (1992), Berhardt and Stoel-Gammon (1994), Archibald (1993, 1995, a, b, c, 1997), Barry (1993), Dresher and van der Hulst (1995), Ball (1995), Rice and Avery (1995), Fee (1995), Demuth (1995), Brown and Matthews (1997), Kehoe and Stoel-Gammon (1997), Goad (1998), Stemberger and Stoel-Gammon (1998).

In the framework here, as in Chomsky and Halle (1968), henceforth SPE, there is reference to both representations and derivations. Here 'derivation' is used in a sense, largely due to Smith (1973), that child phonology should be defined on a set of relations between the surface phonetic form and underlying representations, UR's (see Chapter 1 for more discussion). Without adopting Smith's 1973 conclusion that the child's UR's are no less abstract than those of adults, here I shall nevertheless assume that they involve both a degree of abstraction and ordering in the building of phonological structure. I shall also appeal to some ideas from Lexical Phonology (see Kiparsky 1993 and 1995), an area of research barely noticed in Child Phonology other than in the work of Dinnsen and Chin (see references above).

Background

This study began with the approach to therapy mentioned above and of which more below and with the observation of what seemed like a number of unaccountable patterns in the error distribution. The pattern only came into view because of the my attempt to focus my therapy as precisely and symptomatically as possible.

Here I shall take a sample from the 16 children having the most intensive treatment over a given period. A fragment of the data from these children is given in Appendix 3. Going beyond this sample, at any one time there were typically about 150 children registered in three clinics with various disorders, mainly phonological or articulatory. Over the 10 years about 1000 children, aged between 3 and 18, mostly in the younger part of this age range, would have passed through these clinics.

In many parts of Britain today, this age-range would be disallowed. Part of the purpose of this study is to justify a clinical practice, more flexible with regard to age.

The theoretical background of the clinical observations here was, at the time they were made, from SPE. The patterns involved both context-free and context-sensitive processes, the latter similar to the speech errors of some adults, such as the Reverend Spooner.[1] A relation between developmental disorder and the 'Spooner syndrome' is given by clinical observation. One child, HI, produced the following errors, as repetitions of the words as spoken.

Consonantal processes in the phonology of HI at 9;0 in long term speech therapy

archeopterix	a:pɩ'ɒptrɩks
Burlington[2]	'bɜnɩtəm
diplodocus	dɩplə'dəukləs
ecstasy	'ɛkstəɩ
fascination	fæʃə'nɛɩʃən
gobbledigook	'gɒbədɩgup
mahogany	mən'hɒgəlɩ
slipshod	ʃɩp ʃɒd

Given that we are dealing with disorder, the status of the elements in the paradigm above is not obvious. The data is complex because of the apparent singularity of the contexts. The errors occurred in a long, detailed assessment of single words. There were no other errors noted, other than those listed above. HI repeated without error many other words of similar length and apparently similar complexity, as listed in Appendix 2. It was not, therefore, the case that HI had a difficulty with particular segments, but rather with particular structures. But which aspects of which structures? Call this the context-sensitivity issue in speech pathology.

Anticipating more detailed discussion below, looking at realisations of *archeopterix* by children with phonological disorders, [a:tɩ'ɒptərɩks] seemed to be common, and HI's [a:pɩ'ɒptrɩks] seemed to be less common, but how much so? In Appendix 3, there are 6 cases with [t] or [d] surfacing and just the one with [p]. But there is not

[1] Potter (1980) tries to reconstruct the pathology in this case from various sources. These include the writing of the late Reverend. Bearing in mind the obvious student humour of an eminent and senior academic with a speech disorder, many of the reported errors may have been 'improved' in the process of reporting. But of the disorder, Potter is in no doubt.

[2] The word occurs as a name where this data was collected.

a single case of the phonotactically permissible inverse of the harmony – as [a:kɩ'ɒktərɩks] or, in a way similar to HI's [a:pɩ'ɒptrɩks], as [a:kɩ'ɒktrɩks].

Using the term 'polarity' to characterise a relation between two phonological elements, α and β, we shall characterise an asymmetry with respect to polarity as $\alpha \Rightarrow \beta$, in contrast to ◆ $\beta \Rightarrow \alpha$, where the diamond bullet ◆ denotes a low rate of attestation. The bullet notation does not imply absolute non-attestation. As the sample increases, at least one case of any 'logically possible' error is predicted. The issue is just one of sample size. To express the fact that in *archeopterix* we do not find harmony in respect of the /k/, we shall say ◆[a:kɩ'ɒktərɩks]. This is not to say that this never occurs, just that it does not do so often. Another asymmetry concerns the 'process/domain' relation. In HI's idiolect, as in many others, there is lateral copying in *diplodocus* as [dɩplə'dəukləs]. But the deletion of the lateral is rare.

Such asymmetries cannot easily be construed just in terms of hearing or articulation. *A fortiori* the deletion in HI's *ecstasy* as ['ɛkstəɩ] cannot be construed as 'making the word easy to say'. It is not a 'natural' phonological process (see Section 1.1.6.2 for a more theoretical discussion of the notion of 'naturalness').

The significance of these long words suggested itself in the course of assessing children between 6;0 and 9;0, re-referred for speech and language therapy after a previous discharge (see Joffe, Penn, and Doyle,1996, and Davison and Howlin, 1997). The list of words only emerged in the course of practice. Children were only asked to repeat words if there seemed to be some possible clinical benefit in their doing so. So for a mixture of practical and ethical reasons the clinical data is not quantified.

In relation to an area such as phonology, the quantification of clinical data is difficult because of at least two interacting variables, the fact of referral and the diagnosis by the clinician. The significance of the former is shown by the 2 to 1 variation in the proportion of boys and girls in the clinics of the author's colleagues. This variation may indicate different expectations of speech and language skills in boys and girls in those making the referrals for speech and language therapy.

No standardisation was (or is) available concerning children's articulation of words such as *mahogany* and *diplodocus*. And little is known about the natural history of idiolectal properties such as those which characterised the speech of HI. But at a point when children's phonemic inventories were either complete or very nearly so, particular errors were triggered in particular environments. A five-year old in the 1997 experiment made the point nicely. After saying *archeopterix* syllable by syllable, but correctly, he noted, "I can only do a bit of it at a time", seemingly aware that at a normal tempo, part of the structure would be lost, as in the idiolect of HI.

One account for the effect in HI's sample might seem to be by the fact that at least some of the words are complex and unfamiliar. Not so. Taking account of idiolects other than HI's, *cardigan* causes more errors than *crocodile*, where the former is more familiar than the latter. It is also simpler in not containing a cluster. Looking at the number of syllables, *caterpillar* and *mahogany*, for example, both have 4 open syllables; but the latter occasions many more errors than the former. In *mahogany* as [mən'hɒgəlɩ], in a derivational model, first nasality seems to be copied into the first syllable. Then the 'source' of the copying seems to disharmonise, surfacing as /l/. It is not obvious how this can be construed as any sort of 'simplification'.

Here we need to consider two points. FIRST, real word environments for testing the criterial properties with respect to a particular process do not always exist. There are numerous gaps in the lexicon, growing more numerous as structures get more complex. In relation to any asymmetry in the error distribution, any aspect of the environment may be criterial. There is no *a priori* method of determining this. In relation to the apparent difficulty of *mahogany*, it is not obvious whether the criterial factor is the difference between the nasals in the first and the last syllable or something else. To determine which property is criterial, each needs to be varied separately. In principle it might seem that one way of doing this, would be to look at the distribution of the errors in the real word environment X__Y and in a series of nonsense words, differing from X__Y in minimal, controlled steps. By this technique, described by Chiat and her colleagues (see Chiat, 1983 and 1989, and Brett, Chiat, and Pilcher, 1987), it is possible to control the phonological environment with some precision (see Chapter 4). A 'regular' process should be immune to some change to the phonological structure. If it applies in respect of both X__Y$_i$ and a nonsense congener, X__Y$_j$, necessarily without previous lexical representation, we can speak of some sort of *process*, not just an error. SECOND, although words like *mahogany* and *diplodocus* are long, unfamiliar and not in everyday use, it is the conclusion of this study, as well as that of Chiat and her colleagues, that these factors are less relevant than structure (See Chapter 4).

A cautionary note. Given the real-world knowledge that words are sometimes misheard or mis-spoken (indeed by clinicians!), nonsense forms are open to re-analysis. By folk-etymology the listener looks for the closest phonological 'fit' in his or her lexicon. There is afterall no reasonable, Gricean-type expectation of an invitation to repeat nonsense. In some of the data-sets considered here, a child says *soldier* as ['ʃəʊɫdə]. It is, of course, the case that *shoulder* reflects a less uncommon phonological structure. But in a situation where there are contextual clues to the effect that the adult is talking about a soldier, etymological re-analysis as *shoulder* is simply not plausible. In such cases, it is clear that there is a phonological process.

Obviously, in the case of a polysyllabic word there is a large number of possible words arising from minimal changes in respect of each segment. The total is equal to the product of the minimal contrasts. Take *diplodocus*. The combinatorix of possible variations is at least 3,600, obviously beyond any conceivable investigation with a child in the clinic or elsewhere. Making full records, and taking account of the need to interact socially with the child, I found it possible to investigate between 50 and 150 such environments in one half-hour session. I asked children to repeat a sequence of minimally different nonsense forms presented as a naturally-stressed, prosodic words. Starting with a form which I expected the child to say correctly, each new form differed marginally from the last. After one such investigation, I asked the child to repeat the original word. He did so correctly. With no consultation with the parents, a week later with presumably no rehearsal in between, he said the word again without error. The therapeutic implications were obvious. The result was the symptomatic approach to therapy mentioned above. I describe it in more detail in Chapter 4. I discuss its theoretical implications in Chapter 7.

By this technique, in a single session, it was often possible to inhibit a particular error permanently. One six-year old progressed from a two year delay, as measured by the EAT (see Anthony, Bogle, Ingram, and McIsaac, 1971), to an age appropriate score in the course of 11 sessions each lasting half an hour, spread over 3 months.[3] Children who had failed to respond to an approach, focused conventionally on segments or processes, made progress with this approach.

But the data is not quantified or capable of being quantified. The present study was not anticipated. Only a small fragment of the data has been preserved, that is to say some of the data from a sample of 16 children, as set out in Appendix 4.

Goals

I shall argue the case for a learnability system capable of resolving both the phonemic inventory, and the principles according to which its elements are categorised, e.g. whether /r/ is a liquid or a glide, what van der Hulst (1995) calls 'abstract exponence'. This extends the 'logical problem of language acquisition' (see Horstein and Lightfoot, 1981, Roca, 1990, Atkinson, 1990 and 1992) to speech. To address this problem, I shall develop the idea that speech is organised around the system which makes it learnable, with phonological universals defined on learnability, rather than the other way round.

[3] This rather uncommonly mature six-year old referred himself to the author. So far as he was concerned the main problem was the response of other children in the class when he said *twenty* as [kwɛntɩ]. His phonological problems went rather further than this. But his response to the therapy here no doubt had something to do with the degree of commitment implicit in the fact that the child had referred himself. This was (by far) the youngest self-referral ever encountered by this author.

Many authors, most recently van der Hulst (1993) and Durand (1995), have drawn attention to the case where the auditory aspect of the interface is inaccessible – in deafness. This allows a cognitive architecture, genomically adapted for spoken language, to be used for signed language. But (contra Durand, 1995), this does not imply that the speech/language relation should be treated as an accident of neuro-anatomy. The fact that a fully developed language is possible without access to a key part of the interface does not, by the reasoning below, justify the inference that vocal speech is an accidental facet of it. To make the point here, it is necessary to look at the convergence between linguistics and evolutionary biology (see, for instance, Lieberman, 1975 and 1998, Bickerton, 1990, Glynn, 1999). These authors and many others are agreed that the evolution of the vocal tract in modern human history is maladaptive other than for speech. The only justification for such an evolutionary sacrifice has to be a non-accidental relation between speech and language. This conclusion is underpinned by evidence suggesting that speech is optimised for auditory phenomena. The evidence concerns a degree of hemi-spherical specialisation for the discrimination of [±Voice]. A similar specialisation is found in both mammals and man (see Morse and Snowdon, 1974, Waters and Wilson, 1975, and Vihman, 1996, for a summary of recent research on this point). Whatever the adaptive significance of this character (it obviously wasn't speech perception), we can assume that this is by common inheritance of the specialisation before the point of divergence (tens of millions of years ago), and not by convergence. By contrast, it is now widely assumed that the development of modern articulate speech in homo sapiens has taken place over the past 150,000 years (see the authors mentioned above). Given the key role of on-line feedback in speech production (see Nunes 1994), it is implausible that the phylogenetically ancient auditory perception did not play some part in the evolution of speech. If, as assumed here, the speech/language relation is not accidental but by a specific, recent genomic adaptation, the development of speech and language is likely to be unstable and vulnerable, as it observably is.

Chapter 7 asks whether a dedicated learnability function might address what is characterised here as the 'articulatory/perceptual interface' as one of the irreducible minima from the Minimalist Program (see Chomsky 1995a). I pose this as a hypothesis for further research. From the data here, I can only consider this interface, as it is addressed in the acquisition of speech. I hypothesise that this learnability function is defined in terms of variables. This allows it to address any equivalent interface, including the face, hands, and vision. On this hypothesis, the interface provides the raw materials for language learning, materials which are independently heritable. Many of the biological characters involved in human identity are also involved, directly or indirectly, in the vocal tract and the face (as part of the sign language interface). Relatives may not just look, but sound, and possibly sign, like each other too. The learnability issue is then what phonology *does* with the articulatory / perceptual interface, as provided by the genome. On this hypothesis, the interface is not the phonological system. It just provides the alphabet for the expression of that system in the form of a grammar.

Generative linguistics has long viewed the acquisition of speech and language as a process which is reliable, and universal. Here I take stock of the fact, noted above, that even in normal development, errors seem to be organised. I shall claim that learnability is an issue in Phonology (see van der Hulst and Dresher, 1995). In human development there seems to be a point, typically around 1;6, when the rate of lexical development starts to grow and syntactic complexity appears. On the idea that this represents a qualitative change, there is agreement between non-generativists, such as Grunwell (1987), and generativists, such as van der Hulst and Dresher (1995).

The role of learnability in this study reflects the shift in this direction in syntax. I shall claim that 'finite learnability' imposes equally strong conditions on phonology.

Data

The data here reflects speech which is incompetent to different degrees and in different ways, reflecting disorder, delay and immaturity within normal limits. But all of this speech is incompetent. I shall use the notion of incompetence to generalise across all of the different sorts of case where it is appropriate to do so.

I shall distinguish between 'phonemic errors' in which, impressionistically at least, one phoneme is replaced by another and 'non-phonemic errors' in which the change is partial or unclear. Of course, it remains an open question whether the first category is well-defined. But in much of the relevant literature, there is an implicit assumption that it is possible to speak of a 'substitution'. Without this assumption, the notion of transcription becomes impossible.

The data is of three sorts, from my own clinical observation, from the literature, and from two experimental investigations carried out for this study, a pilot study in 1991 with 22 children and a fuller study with 97 children in 1997, in both cases with no prior knowledge as far as I was concerned of whether there had been any previous question about any given child's speech. (The methodological issues at stake here are discussed in Chapter 3). As far as the clinical data is concerned, in a way that reflects what is still everyday clinical practice, the observations were made on-line with no recording and no opportunity of rechecking. In the case of any observation, there is always the possibility of observational error. But other than in the case of single case studies, the observations here are all in respect of more than one child, and in most cases, of many more than one. At the time of the clinical observations, the motivation was purely one of assessment. There was no hypothesis, and thus no observational bias emanating from this. The collation of the data was carried out without the benefit of a computer in the author's own time and subject to the obvious limitations which this imposes. Most of the clinical data cited here is from the author's observation. Most of this is from a sample of the data from 16 children, this itself representing only a small part of the data originally stored about each child. This data on these 16 children is set out in Appendix 3. A small part of the clinical data referred to here is from the literature. In each case it is made clear where the observation is from. The only major difference between the observations by the author and those from the literature is that the latter are restricted to environments no more than three syllables in length.

To test for organisation within complexity, as mentioned above, the data set should be as large and representative as possible. To achieve this, the experiment has to go to the subjects. So the study here was carried out in a school. This limited the facilities for recording, forcibly not those of a phonetics laboratory.

The experimental data was recorded on tape, transcribed by myself on-line and annotated by my co-worker, JW, both later rechecked by myself. The recording conditions in a school are not ideal. This influenced the transcription approach here. In contrast to the approach here, one obvious alternative would be to do the observation and recording in a laboratory, with fine transcription by two phonetically-trained transcribers, each checking the other's transcription. In the circumstances of the study here, no such option was available. It would also have been impossible to recruit more than a very small number of subjects. So one advantage of the approach here was that it was possible to recruit a relatively large and sociologically representative sample of children – but only thanks to the generosity of the school.

The clinical and experimental data both throw light on the process of phonological development in real time. All of this data reveals a series of asymmetries in the distribution of errors involving place of articulation. Cruttenden (1978) notes the asymmetry between 'fronting' with coronal or alveolar segments being replaced by dorsals or velars, with harmony or assimilation in bisyllabic words typically at the expense of what I shall call coronals. As noted above, data collected by myself both in the clinic and in the experimental investigation here shows that in some longer words harmony or assimilation favours coronality, e.g. *hippopotamus* with the first /p/ going to /t/, *archeopterix* with the /k/ in the same prosodic position also going to /t/, and the final /g/ onset in *cardigan* going to /d/. But this coronal harmony seems to be quite selective. At least in the clinical data, it did not seem to happen so frequently in the /k/ following the stressed vowel in *cricketer* or *crocodile*. But while clinical data can point to certain hypotheses, it does not provide a good basis for linguistic claims. FIRST, the only clinically justifiable reason for collecting the data is to guide the process of abolishing it. SECOND, the clinical population is independently defined as abnormal by the mere fact of referral – so standard conditions of statistical normalisation cannot be met. Although, as we have seen, clinical errors pattern in ways which do not seem to have any obvious explanation in auditory/perceptual terms, on independent grounds we might expect interface defects of various sorts to be over-represented in the population, effectively compromising the data. Dysfunction-to-function arguments have an obvious built-in flaw: the asymmetry may be a defining aspect of the dysfunction. So asymmetries in the clinical population, abnormal by definition, can be misleading. Reliability is undefinable. And statistical control is impossible or ethically impermissible. THIRD, there is the danger of mis-perception by the clinician (in all the cases cited here, without the benefit of either a tape-recorder or an expert second listener).

But in relation to the last point, on all the main lines of argument in this study, the same observation was made in respect of a number of different children. Any observational errors are likely to be factored out by the numbers involved.

The experimental investigation was designed to test the asymmetry in a way is impossible in the clinical context. But there is a statistical problem here. Looking for points of central tendency, words are selected on the basis of the very property which is being tested. It is highly non-random.

Consider a quite different case where the sample is such that we expect a perfect distribution unconditionally. Take a number of individuals tossing coins in unison, each with their own personal coin. After a given number of throws, some individuals have thrown widely differing numbers of heads and tails. A degree of asymmetry in the scores of some individuals is predicted on standard grounds. Whether this is likely to be by chance is something which can be estimated. But a suspicious mind might still insist on a study of the most asymmetric throwers' coins and techniques. Their throwing, their eye-movements, and the initial state of the coin in relation to a particular outcome might be related. Their coins might be compared with those of throwers with scores closer to the mean. Independently of statistical probability, it might be noted that some of these coins displayed various extreme and uneven patterns of wear and other damage. In such a case it would be appropriate to try and measure the effect of the apparent uniqueness of each coin, with the degree of wear controlled as far as possible. In a sense, this study is at such a level. Here a set of previously-observed asymmetries are being checked. In some cases there is no *a priori* or independent basis for expecting them, from phonological theory, from the sensori-motor consisedrations, etc.. But the structure of each word may be unique in the way the properties under consideration interact with the prosody. The data here is treated accordingly.

Ethics

In line with standard professional practice in speech and language therapy, the children in the study are not identifiable in any way. No information is given about exactly where any part of this study was carried out, other than that it was in Southwest London. Whether the purpose of the contact was for therapy or for experimental investigation, the permission of the parents was obtained. In some cases the experimental investigation led to referral for therapy. Where this rerral was to myself, I carried the therapy out.

The 1997 experiment was organised into three Phases, the first a simple assessment, the second an attempt to reproduce the effect to the therapy described above, the third an attempt to measure the effect of this. To minimise the amount of out-of-class-time, Phase One was designed to be completed in 17 minutes. In the event, it took between 30 and 50 minutes. Participation was seen by most subjects as fun and treated as a reward for good behaviour by the teachers. If there was any sign of the child tiring, the session was terminated and re-continued after a break. Phase Two took between 15 and 30 minutes. Phase Three took less than 5 minutes. In Chapter 4, I show that typically there was evidence of, a small, but seemingly permanent positive change, to the effect that a word previously wrong was now canonical.

Dialectal input

All the children in this study were regularly exposed to different forms of what I shall refer to as 'Greater London English', using this as a cover-term to include forms of RP, Estuary English, and Cockney. I shall treat these as distinct dialects which nevertheless seem to pattern the same way with respect to /r/, morpheme final /ŋ/, an epenthetic sub-phonemic 'gesture' between the nasal and the fricative in *prince*, and the perception that *tune* and *spoon* do not rhyme. Regarding /r/, there may be an on-going change, at least in RP with *sawing* as [ˈsɔːɩŋ] in conservative forms, an alternation with [ˈsɔːrɩŋ] in more innovative forms, and what may be an emerging dialect in younger speakers for whom [ˈsɔːɩŋ] is impossible.[4]

[4] If the speech of this author is anything to go by, the change may concern the speakers of

Differences between these forms involve vowel reduction, vowel features, the non-release of stops, and glottalisation, in *monkey* as [ˈmʌŋkɩ] (RP and Cockney) or [ˈmʌŋki] (Estuary), in *ketchup* as [ˈkɛtʃəp] (RP) or [ˈkɛtʃʌp] (Estuary and Cockney), *asbestos* as [æzˈbɛstəs] (RP) or [æzˈbɛstɒs] (Estuary and Cockney), *little* as [ˈlɩt˺l̩] (RP), [ˈlɩtʊ] (Estuary) or [ˈlɩʔʊ] (Cockney).

Using the umlaut diacritic suggested by Gimson to denote a slightly centralised, round articulation, not collapsing with any member of the vowel series, and following a suggestion to this effect by JW, some syllabic laterals might be transcribed more narrowly as [ö] rather than as [ʊ]. But such narrow transcription seems inappropriate in an essentially observational and impressionistic study.

Regarding the notation, following a line of thinking from Abberton (1978 – in class), I encode a degree of indeterminacy by enclosing a segment in pointed brackets, as a computer-readable equivalent of Abberton's circle (see Appendix 8 for more details).

Outline

Taking account of: A) the wide divergence between Phonology and Child Phonology; and B) the number of Phonological issues raised, theory and data are interleaved.

Chapter 1 outlines the asymmetry of clinical data and other issues, proposes a new way of characterising much clinical data, suggests a possible learnability issue in phonology, and lays the basis for the novel construct, a 'Parameter Setting Function'.

Chapter 2 introduces the notions of a 'Representability Inspection' and 'Phonological Parapraxis' against the background of the clinical data, asks whether the data here might be considered as slips of the tongue, and concludes that it should not.

Chapter 3 presents some real word data from normally developing children, and shows that clinically observable asymmetries hold generally.

Chapter 4 presents intervention data from two contexts, the clinical, therapeutic context and an experimental context with the normally developing children discussed in Chapter 3, and shows that the same effect can be found in both groups.

Chapter 5 outlines the now well-established 'geometrical' approach to features, and explains one aspect of child phonology by a new proposal in this framework.

Chapter 6 integrates aspects of feature geometry with what Kiparsky (1995) calls 'extrinsic under-specification', and explains one long-range harmony in this way.

Chapter 7 concludes, and sets out directions for future research.

what is referred to by Gimson (1970) as 'common usage' probably describing his students at the time of writing, now likely to be between 50 and 60 years of age.

1 Hard words

Chapter 1 presents empirical and theoretical issues in the description of clinical data, particularly the 'asymmetries' noted in the Introduction, adopts the notion of a 'leanability space' from current work, adds a new term in the expression 'Specific *Speech and* Language Impairment', and with reference to a learnability issue in phonology, introduces the new idea of a 'Parameter Setting Function' or PSF.

Section 1.1 notes a a psycho-linguistic issue, considers two methodological approaches to phonological acquisition, characterised here as 'bottom-up' and 'top-down', and plumps strongly for the latter. Section 1.2 sets out some asymmetries in the distribution of children's speech errors in cases of pathology, and relates these to cross-linguistic research. Section 1.3 sets out the new idea of 'Specific *Speech and* Language Impairment', SSLI, as a 'syndrome'. Section 1.4 sets out some learnability issues, and relates these to the notion of a Parameter Setting Function. Section 1.5 proposes a strong version of what might be called the 'parametric hypothesis'.

There is one obvious alternative to any of these approaches, and that is to view the data here as performance errors or slips of the tongue, SOT's. I shall set this issue aside until Chapter 2, where I shall consider it in the light of the empirical evidence.

1.1 Methodology

Section 1.1 is concerned with methodology. Section 1.1.1 sets out the psycho-linguistic issue mentioned above. Section 1.1.2 discusses the bottom-up approach in general terms and how it might or might not bear on the data here. Section 1.1.3 presents one particular example of the bottom-up approach. Section 1.1.4 presents the idea of marginal incompetence at 'Stage $_{n-1}$'. Section 1.1.5 considers an arbitrary dictomomy in Child Phonology. Section 1.1.6 considers a number of key points in the literature. Section 1.1.7 considers two current top-down approaches, Optimality Theory, OT, and Principles and Parameters Theory, PPT.

1.1.1 A psycho-linguistic issue

Consider the issue in (1.1).

(1.1) *A psycho-linguistic issue – input or output?*

a) Input $[\alpha]$ $\alpha \Rightarrow \beta$ / (X) __ Mental representation $/\beta/$
b) Representation $/\gamma/$ $\gamma \Rightarrow \delta$ / (X) __ Output $[\delta]$

By (1.1.a) a word, heard for the first time, may be wrongly encoded, leading to a lexicalisation different from the canonical form. If so, the output is bound to reflect the input error. There is no basis for self-correction. By (1.1.b), a word may be mispronounced, with the possibility of self-correction. Taking the lead from Chomsky and Halle (1968), or SPE, in this study it is assumed that the organisation of the grammar is neutral with respect to (1.1). A given child's error may express either a misanalysis of the adult input or an error in the course of production. Variability in child phonology is easy to find and obvious. This may occur either in the immediate input to the child's grammar, i.e. the output of the lexicon, or in the process of speech production. But it is difficult, more so than sometimes believed, to distinguish between these two things (on this point see in particular the discussion of Smith, 1973, in Sections 1.1.6.1 and 1.1.6.3). There is, in (1.1), an obvious psycho-linguistic issue. But on the strength of SPE, I shall assume here it is possible to study the speech error data without taking a decision on it.

1.1.2 Bottom-up or top-down?

Section 1.1.2 considers two directions in speech research, one motivated by the end-state, what I shall call 'top-down', the other, with the (plausible) aim of avoiding teleology and prescription, 'bottom-up'.

For top-down approaches, the end-state is competence in what Chomsky (1995 a, p. 221 ff) calls 'Computation for Human Language' or C_{HL}. On this basis, acquisition theory should be 'driven' by: A) the full expression of C_{HL}; B) a set of criterial inputs, necessarily available to the L1 learner in some form.

The bottom-up approach starts from the evidence of the child's verbalisations. It has the consequence of making questions about competence (in the Chomsky sense) either meaningless or illegitimate. This approach is reductionist in the sense that it tends to focus on: A) the smallest category which can be induced in the end-state (however this is characterised) and which might be conceived as part of some initial state, and B) the earliest point at which this can be identified, going back in developmental time towards birth, developments after 2;0 being considered 'late'. Theoretical issues such as the definition of words and their constituents do not arise. And the child's 'between words' phonology is ruled out of consideration. It is consistent with the bottom-up approach to relate deficits in speech and/or language to any one or more of a diverse set of concomitant sensori-motor deficits. These include the auditory system. (See Hill, 2001, for a recent summary). In work such as that of Bradford and Dodd (1994) and Dodd (1995), summarised by Hill, phonetic variability is taken to be a diagnostic of disorder. But this makes it impossible to address any evidence of organisation in speech-error data. I shall argue that this is a general characteristic of the bottom-up approach.

In bottom-up studies such as that of Jusczyk (1997) and Vihman (1996), the infant is shown to be learning language-specific featural contrasts in the first year, e.g. laryngeal contrasts in stops, distinguishing 'English-type' languages from those of the Indian sub-continent. Harrison (1996) shows that part of phonological development consists in learning to *disregard* acoustically discriminable information. Here the criterial evidence does not need to be sensitive to the form/meaning relation. The input can be interpreted stochastically. A learner of this sort could start learning the phonemic inventory on the basis of frequency. The end-state is modeled in terms of consistency or inventorial completeness. Mastery of such an inventory can then be tested with respect to a set of phonemes. On this basis it is often suggested, as by Anthony, Bogle, Ingram, and McIsaac (1971), that normally developing L1 English children reach this state by 6;0. But these authors do not explain why at this age few of their subjects can say all the words in their assessment. Not at all a bottom-up theorist, Smith (1973) ends his study even earlier, with his subject aged 4;0. In the same vein, Macken (1995, p. 689) suggests that acquisition is normally complete at five or six.

In 'Greater London English' including Cockney, Estuary English, and RP, the segments /r/, /l/, /t/ and /d/ all vary allophonically in complex ways. Taking account of the allophony as a whole, a bottom-up determination of the end-state would require the assessment of several hundred items at least – longer than most standardised tests, but not inconceivable. Significantly Edwards and Shriberg (1983) note that there is a wide disparity between studies in the age at which a given segment is said to be 'acquired'. For /r/ the range is from 3;0 to 7;6. Part of the problem may lie in the fact that human phonetic judgements are ultimately subjective and impressionistic. In relation to dark /l/ in dialects which have this, what degree of laterality as opposed to vocalisation is criterial? It is not obvious where to draw the phonetic line.

Here, at variance with exclusively bottom-up accounts, I shall deny the idea of *phonological* discrimination, other than in the context of semantic reference. I shall thus assume that the work of the stochastic learner is exclusively phonetic. Where the target is English, this early phonetic learning may include some properties of the vowel space, but not the way that vowel-length interacts with post-vocalic consonants; the latter presupposes that both the elements belong to the same syllable.

As a compromise between 'top-down' and 'bottom-up' perspectives, to explain language-specific variations in acquisition and pathology, Macken (1995) proposes a 'constrained hypothesis formation or cognitive model' which "incorporates the general acquisition patterns and universal structure envisioned by Jakobson and Chomsky, while recognising the freedom the system must have to allow individual learners the creative flexibility they show in forming generalisations and inventing rules" (p.679). Her model recognises variations such as those in (1.2).

(1.2) *Language specific variations in acquisition and pathology*

a) Arabic, Yucatec /l/ alternates (context-freely?) with /n/.
b) French — Nasal and oral stops alternate.
c) Spanish — /ʧ/ is acquired early.
d) Spanish, Greek — Spirant [ð], allophone of /d/, is replaced by [l].
e) K'iche' — Affricates, laterals, and /x/ are acquired early.
f) Greek — /l/ alternates (harmonically?) with /r/, /nɛˈro/ as [nɛˈlo].
g) Welsh — /s/ is replaced by /s̪/ and /θ/, but not by /ɬ/.
h) English — Affricates acquired late, /s/ as [s̪], [θ], [ɬ], [ʃ], /r/ as [w].

NB: (1.2.a) to d) are from Macken (1995); (1.2.e) is due to Ingram (1993); (1.2.f) is due to Aleka Georgakopoulou and Katerina Hilari; (1.2.g) to Olwen Rees, (1.2.h) from Edwards and Shriberg (1983) and common clinical observation.

While both babbling and early phonology conform to a broad pattern – along with stopping and other processes, as described by Jakobson (1941), the scale of the variation in (1.2) is non-trivial. Macken's account is as follows:

(1.3) Language-specific variations in child phonology are due to:

a) Typological differences in phonetic structure and phonological organisation;
b) Variable frequencies of forms in the different target languages;
c) Skews in the representation of elements in speech addressed to children.

Macken's point in (1.3.a) is both well-motivated and sufficient to account for the issue at stake. But there are problems with (1.3.b) and c). The variables of type- and token-frequency cannot be collapsed without arbitrariness. If English learners glide their rhotics and Greek learners lateralise theirs on grounds of phonetic distance and phonemic availability, lateral lisps should be common in Welsh speaking areas. But by (1.2.f) such lisps are rarer in children learning Welsh than in those learning English. If Greek rhotics are not glided due to the lack of a /w/, why are English rhotics seldom replaced context-freely by /l/ when the model is evident?

In bottom-up thinking, little attention is paid to allophony and prosodic factors such as stress and syllabification. Both issues tend to be put on one side in favour of measuring the completeness of the phonemic inventory. Here I shall assume that the inventory is only one measure of phonological development, that to prioritise it is both arbitrary and misleading, and that the devil is in the phonetic detail.

This study seeks to reconcile the obvious criterion of accounting for the end-state, with the evidence of concomitant sensori-motor disorders. Here, I shall consider the phonology of the first word-combinations, at say 1;9, as an instance of early phonology.

Vihman (1995) would consider it already late. Here, I shall look at evidence that phonological acquisition is still going on at 8;6. This evidence is of a sort that is likely to be hard to explain in bottom-up terms.

1.1.3 The auditory hypothesis

It is obvious that hearing is essential to speech acquisition. It is often held that a key variable in phonetic/phonological development is the level of auditory skill or skills. Such skills are sometimes taken to be one exclusive and irreducible datum. We might call this the 'auditory hypothesis'. On this point, see Kronvall and Diehl (1954), Sherman and Geith (1967), Marquardt and Saxman (1972), Dodd (1975), Tallal, Stark and Curtiss (1976), Tallal and Stark (1980), Locke (1980 and 1983), Mathews and Seymour (1981), Broen, Strange, Doyle and Heller (1983), Morgan (1984), Raaymakers and Crul (1988), Ohde and Sharf (1988), Chiat (1989), and Bird and Bishop (1992).

Bird and Bishop (1992) reason that the auditory hypothesis predicts diagnostically significant variations between individuals. They compare a group of 'phonologically impaired' children with individually matched controls. The subjects' ages range from 5.0 to 6.4. In the case of the impaired children, each had at least 5 losses of phonemic contrast by processes such as fronting, stopping, coda deletion, etc.. Each impaired subject was given discrimination tasks corresponding to 5 losses of phonemic contrast in the individual's production. One of these was carried out with pairs of nonsense words. Here the task was to decide whether the pair was the same or different. Another task – with real words – required the subject to decide whether they had been correctly repeated. Only in the nonsense words, however, was there a significant difference between the rate of false responses in respect of neutralised contrasts and in respect of contrasts which were part of the subject's productive repertoire. Whereas the controls made an average of 1 mistake out of 30 trials, the experimental subjects made an average of 6. In relation to their own production difficulties, the experimental subjects still produced correct auditory responses 4 times out of 5. Bird and Bishop note, "All children showed some ability to discriminate contrasts that they could not produce" (p.289). All subjects were relatively competent 'perceivers'.

Bird and Bishop contrast their tests of auditory discrimination with tests of rhyme generation and phoneme matching. The mean score (out of 10) for the experimental subjects was 4.79, while for the controls it was 7.57. The authors conclude that in respect of the clinically impaired children, "the underlying problem is neither sensory nor motor....[but rather].. in recognising that words can be analysed at the level of phonemic segments" (p.307). Bird and Bishop's results raise a question about the proportion of cases of phonological disorder where an auditory defect is etiologically crucial. It seems that such cases are likely to be rare.

By the results of Bird and Bishop, 'strong' interpretations of the auditory hypothesis, all strongly reductionist, are false. But what about weaker interpretations? Obviously, there may be a correlation between phonetic/phonological incompetence and a defect in respect of auditory attention or listening.[1] But such a defect is not easily defined or operationalised. I return to the issue here in Chapter 7.

The extreme case is represented by profound deafness. Brown and Goldberg (1990) summarise the findings of numerous studies over 40 years, showing that deaf speech is marked by errors with respect to stress, rhythm, transitions between articulatory targets, problems with clusters and diphthongs, and the phonetic implementation of the voice/voiceless contrast. All of these properties involve timing – in the case of the voice/voiceless contrast as a matter of definition. For our purposes here the point about Brown and Goldberg's conclusion is simply the specificity of the effect. If phonological disorders typically involved an auditory deficit, why is it that in the one case where such a deficit is plain, the effect is both specific and quite different from those which commonly characterise disorders?

In relation to the acquisition of what they regard as phonological perception Watson and Hewlett (1997) emphasise the 'transitional' properties of the syllable rather than 'steady state' properties of traditional phonological description. It may be on a relatively subtle level, such as this, that the (common) clinical observation of 'poor listening' is best expressed. In the light of new research directions of this sort, there is a weaker version of the auditory hypothesis according to which a key variable is the L1 learner's ability to *interpret* the input data. I shall develop this as a hypothesis in Chapter 7.

1.1.4 Marginal incompetence at Stage $_{n-1}$

From a top-down perspective, let us characterise full competence as Stage $_n$. Now take the case, characteristic of early phonology or disorder, when the identification or interpretation of a word is uncertain. Suppose the assumed target is *soldier* and the realisation is as [ˈɦəuwʊv]. This has been observed once by the author and also by Grunwell (1987) in two children with generally similar phonologies. With lesser degrees of incompetence, the problem is reduced, but the issue remains. Conversely,

[1] The investigation of phonological perception is a routine aspect of all speech therapy assessment. Obviously, the treatment of a distinction which cannot be perceived needs to be done in a special way, and quite differently from the case where the distinction is perceptible. But the clinical investigation of auditory perception is not straightforward. In some cases, where there is a systematic failure of auditory discrimination, at the top end of the acoustic spectrum, between /s/ and /ʃ/ or /f/ and /θ/ or, at the bottom end, between /n/ and /ŋ/, there may be a corresponding, audiometrically confirmed, hearing loss. But this not always the case.

as we approach any notional beginning of phonological acquisition the issue increases. On such reasoning, a Stage $_1$ is not definable other than in relation to the conditions for Stage $_n$ – a top-down perspective, in other words.

On any account of phonological acquisition, there are representational elements which have to be learnt. Here I shall assume that these include a set of 'features', used in ways which are, to some degree, language-specific.

Following a line suggested by Ingram (1976), I shall assume that phonology is not definable other than in relation to the lexicon, from the middle of the second year when the lexicon starts to grow by one or two items per waking hour. At this point the acquisition device effectively 'changes gear' as soon as the learnability space includes the syntax and phonological rules. This point is marked by: A) a sudden increase in the rate of vocabulary growth; and B) the use of words in meaningful, productive combinations. I shall propose here that this point is defined by the 'switching on' of a 'Parameter Setting Function' (see Section 1.4.4), with a linguistic analysis of the input by the learner. In this framework, phonological and syntactic acquisition proceed in tandem. The psychological mechanisms are switched on, most typically some time between 1;6 and 2;0, and are still visibly functioning in most children around 8;6 – contra many of the views mentioned above. In the framework adopted here, the issue is not the phonemic inventory but the way the 'melody' or the segmental structure interacts with the prosody. The accquisition of phonology is thus similar to that of syntax – on criteria of the sort assumed by Carol Chomsky (1969) and many researchers since. My focus here is towards the end of the acquisition process, when phonetic/phonological competence is almost complete. I shall characterise the very end of this process as Stage $_{n-1}$. Some individuals may not get beyond it. Looking at normal, disordered and delayed development, there is a case, for proceeding from Stage $_n$ to Stage $_{n-1}$, and so on – in the reverse of developmental sequence.[2] I shall follow such a methodology here. But even before Stage $_{n-1}$, there is unmistakeable evidence of organisation in the way children's speech errors are distributed. I shall return to this issue in Section 1.2.

1.1.5 An unhelpful dichotomy

One result of the long-standing predominance of bottom-up approaches has been an arbitrary dichotomy in research perspectives, as tabulated in (1.4).

[2] See Frith (1989) for a similar point about research into autism – that it should focus on the least-affected individuals to yield the clearest data bearing on a 'single common pathway.'

(1.4) *Dichotomous research perspectives, as dictated by a 'bottom-up' approach*

Errors by children	**Errors by adults**
Incompetence – variable consistency	Malperformance (slips of the tongue)
Context-free errors	Context-sensitive errors
Simple phonemic and syllabic structures	Polysyllabic environments
Articulatory, perceptual, metalinguistic factors	
Non-awareness of error	Timescale of self-correction – measured in milliseconds.

This tabulation reflects the fact that although much work has been done on harmony in children's speech, little of this has been in relation to polysyllables, other than in a programme of work initiated by Chiat (1983). Conversely, the assumption that all errors in the speech of 'competent speakers' are 'slips of the tongue', SOT's, and thus due to performance, has hardly been questioned. The asymmetry in the distribution of children's speech errors has been largely (but not completely) overlooked at the expense of the (large) issue of variability and the (closely-connected) issue of developmental change which cannot be characterised as 'across the board'.

From a bottom-up perspective, the tabulation in (1.4) has little meaning. The left and the right hand sides are different sorts of enquiry.

Here, by contrast, I am aiming for an internally consistent account of phonological development, as a process normally starting before 2;0 and, by the claims of this study, normally continuing after 8;6, but ruling out: A) enrichment of the phonogical mechanisms for full competence – at Stage$_n$; and B) privileged information about the learnability target.

1.1.6 SPE and its critics

To set the scene, I shall set out A) key features of what is characterised here as the 'linear' model of SPE, as assumed by Smith (1973), and B) some responses to it.

Section 1.1.6.1 sets out the idea of derivation by ordered rules. In 1.1.6.2 I turn to the question of 'naturalness'. Section 1.1.6.3 looks at phonological development, other than across-the-board.

1.1.6.1 Linearity and derivation by ordered rules

SPE provides a derivational account of English phonology. The first application of this model to child phonology is in Smith (1973).

One key aspect of the SPE framework is the notion of markedness, according to which voiceless is unmarked in obstruents and marked in sonorants, stridency is unmarked in sibillants, and so on. The key evidence here is cross-linguistic. Many languages have only voicing in sonorants and voicing in sonorants. The opposite is almost unattested.

Smith (1973) assumes that the input to the child's system is the 'adult surface form' (p.13), and that the underlying representation of simple monosyllables is essentially the same in both children's and competent phonology. Here I shall challenge both of these ideas. For the moment, let us review Smith's model. He points to various phenomena, seemingly best-explained derivationally. A key argument concerns the four rules in (1.5), using binary values of [+Coronal, +Anterior], to define what, in previous discussion here, I have referred to as 'Coronal' or 'coronality', the values [–Coronal, –Anterior] to define dorsality, and correspondingly binary values – positive or negative – with respect to [Strident], [Lateral], [Voice], [Consonantal], [Continuant], [Sonorant], [High], [Back], and [Stress]. The term V denotes a vowel. In (1.5), Smith's own numbering of the rules is shown in brackets on the left. Both the data and the rule formulation are slightly simplified here; voicing, for example, is ignored.

(1.5)	*Four ordered rules*			data from Smith (1973): A at 2;2
	puddle	*puzzle*	*pistol*	
(3)	pʌgl			[+Cor, +Ant] ⇒ [–Cor, –Ant] / __[–Cont] [V, –Str] [+Lat]
(4)	'pʌgu	pʌzu	pɪstu	[V] ⇒ [+High, +Back, –Tense] / __ , –Str [+Lat]
(7)			'pɪtu	[+Cor, +Ant, +Cont, +Stri, –Voi] ⇒ Ø / __ [+Cons]
(24)		'pʌdu		[–Son] ⇒ [–Cont]

Smith's Rule 3 dorsalises a coronal stop before a lateral in an unstressed syllable. Rule 4 vocalises the lateral. Rule 7 deletes a 'pre-consonantal' /s/. Rule 24 stops fricatives, neutralising the Continuant/Non-continuant contrast.

Essentially the model by (1.5) posits a significant abstractness in child phonology. And this, as we shall see, has been the focus of much criticism. Although, as noted by Smith (1973), there are many aspects of child phonology which the SPE notions of derivation and markedness do not explain, both of these notions are themselves in the process of development (see Chapters 5 and 6). It is a measure of the power of the SPE formalism that it can describe many aspects of children's speech, considered segmentally. But the SPE framework has been generally supplanted in phonology. Relevant problems in the context of this study include the following.

(1.6) *SPE and child phonology*

a) If the phonology of the mature speaker is defined on an abstract set of UR's, when and how does the UR come to be related to the 'surface form'?

b) Incompetence is not perspicuously captured by complexity in the rule system used to describe it. Smith postulated 30 or so rules, and defined the extrinsic ordering of 26 of them. Where does the order come from?

c) The SPE formalism misses key generalisations concerning syllabification, the commonality between laterality and roundness, the notion of stress as being essentially rhythmic, and the interaction between stress and the melody, all issues to which I turn in Chapters 5 and 6. One example of this arises in (1.5). Smith considers (p.23) the possibility of defining the lateral as 'dark', but notes that this is not properly expressible in the SPE framework.

d) SPE gives no easy account of the fact that glottalisation is both common in child phonology (see Grunwell, 1987) and cross-linguistically common as a form of lenition with a glottal surface expressing underlying coronality and voicelessness.

e) In L1 learners of English, the seemingly universal process of gliding, i.e. the replacement of /r/ by /w/, differing by 5 features, is not easily described in SPE terms. The issue has been noted by Walsh (1974), who treats it as evidence against distinctive feature theory.

f) In the SPE framework, a context-free rule reversing the values of [±Consonantal] is as highly valued as one changing one of those of [±Continuant], as in stopping or spirantisation. Context-sensitive changes with respect to [±Consonantal] are postulated by Kaisse (1992). But as a rule in child phonology, [α Cons] $\Rightarrow$[$-\alpha$ Cons] should be prohibited in theory. A child with a such a rule would be not so much incomprehensible, as not understood to be speaking.

g) As noted by Smith (1973), patterns in the acquisition of /s/ and /f/ are not adequately captured in terms of markedness. The least marked fricative, namely /s/, is the most developmentally problematic, hence the term 'lisp', and the occasional persistence of this in adult speech. The most typical replacements – as [s̪] and [θ] – are more marked than what they are replacing, contradicting the obvious prediction by markedness theory that the incompetent speaker should replace marked elements by less marked ones.

1.1.6.2 'Naturalness' and alternatives to ordered rules

Section 1.1.6.2 turns to an outright challenge to abstract UR's and derivation, as offered by Natural Phonology, NP (see Stampe, 1969 and 1973, Donegan and Stampe, 1979). Based on the 'child's own system', NP has had an enduring influence among speech and language pathologists, such as Edwards and Shriberg (1983) and Grunwell

(1987). Distinguishing between universal *processes* and language-specific *rules,* NP sees the child's errors in terms of an over-simplified conception (on the part of the child) of possible morphemes, expressed as Morpheme Structure Conditions, MSC's.

(1.7) *Under-developed syllabic templates in children's speech errors*

Loss of contrast	Stopping	*zoo*	du:
Context-sensitive loss of coronality	Harmony	*dark*	ga:k
Context-sensitive loss of contrast	De-voicing	*bead*	bi:t
Constituent (coda) deletion	Deletion	*ball*	bɔ:
Constituent (cluster) reduction	Deletion	*string*	dɪŋ

NP amounts to an enriched theory of phonotactics. Errors, such as those in (1.7), are seen as attempts to satisfy a reduced phonological 'template' – where the reduction follows a series of universal, asymmetric implications. The effects are mostly defined on the interaction between features and syllable structure. On typological grounds, NP proposes that the asymmetry of these implications reflects a difference in 'naturalness'. The language-learner re-interprets the structure of lexical entries according to a greatly-simplified model. Phonological acquisition proceeds by the *inhibition* or *suppression* of natural settings. NP claims to account for the distribution of children's errors on the basis that phonological contrasts are lost in favour of whatever is the less marked member of the pair in a particular context.

But applying the point in (1.6.f) to NP, it, like SPE, fails to throw light on the case of most lisps.

As noted in a critique of NP by Dinnsen (1980), based largely on child-phonology, NP fails to distinguish between the "NEED for SOME rule" and the prediction that it "would have a specific structural description" (p.176). Also focusing on child-phonology, Harris (1990) notes that NP tends to underestimate what the child is getting right. As shown in Chapter 2, a templatic approach does not provide a descriptively adequate account of parapraxis at its most extreme.

Broadly, there are patterns in child-phonology, not readily accountable in NP terms. In (1.8), the clinical data is from observations by the author in NHS clinical practice before this study started, the experimental data is from the 1991 pilot study or from the fuller study in 1997, and marked as such.

(1.8) *Non-naturalness in child phonology*

a) Copy/reduplication	*potato*	pəpəˈtɛɪləʊ	(Clinical data)
	Lucinda	ˈduːdənɪndə	(Smith, 1973)
b) Non-natural contrasts in adjacent segments			
	number	ˈnʌmdə	(Smith, 1973)
	pencil	ˈbɛmʔdʊ	(Clinical data)
	'porridge' (Finnish)	ptɪruptru	(Vihman, 1978)
	Jerusalem	dʒəˈuːsələm	(1991 pilot study)
c) Dorsal nasal onsets	*snake*	ŋɛɪk	(Smith, 1973)
	grandpa	ˈŋaŋa	(Leopold, 1947)
d) Onset metathesis	*icicle*	ˈaɪkətəl	(Smith, 1973)
	difficult	ˈgɪpətəl	(Smith, 1973)
	hospital	ˈhɒstəpʊ	(1991 and 1997 data)
	Jerusalem	dʒəˈluːsərəm	(Experiment here)
e) Other metathesis	*bulb*	bʌbl	(Smith, 1973)
	delve	ˈdɛvl	(Smith, 1973)
	milk	ˈmlɪk	(Smith, 1973)

In (1.8), there is no sense in which the ouput is more 'natural' than the canonical realisation. MSC's cannot account for the copying or reduplication in (1.8.a) or for the breach of the typologically common constraint on nasals on the left of another stop in (1.8.b). Dorsal nasals in the onset are typologically uncommon, not part of the target in English, and not attested in genetically related languages/dialects. And metathesis, as exampled in (1.8.d) and e), is unaccountable.

Rejecting derivation and underlying representations, Grunwell (1987) seeks to integrate NP with 'contrastive analysis'. Her argument is summarised in (1.9).

(1.9) Grunwell's view

a) There is a psycho-linguistic implausibility in the claim that "the child begins his phonological development with a complex set of pronunciation rules, many more than adults have, and eventually loses these rules" (p. 142).

b) Simple discrimination tasks establish that a difference has been detected, rather than that it has been correctly analysed phonologically.

c) There are "developmental factors in the control and mastery of pronunciation patterns particularly for complex articulatory sequences" (p. 139). A 'natural phonological process' consists in the loss of a contrast in favour of the 'easier member', and ".... since the effects of phonological processes are to simplify speech production, the analysis of disordered speech in this framework characterises the differences from normal pronunciation as simplifications" (p. 184). There is also 'systemic simplification', including context-free coronalisation, gliding, and context-sensitive voicing.

Grunwell's point in (1.9.a), characterised here as 'Grunwell's problem', is one of the starting points of this study. Her point in (1.9.b) is also accepted here. But it raises another issue: how do the child's powers of phonological analysis develop? As regards the thinking in (1.9.c), there are three problems. FIRST, it is not clear what the (unspecified) 'developmental factors in the control and mastery of .... patterns .... for complex articulatory sequences' are. SECOND, on Grunwell's point that context-sensitive voicing is both a 'systemic simplification' and a 'natural process', there is an ambiguity concerning the relation between phonetic production and phonological categorisation. If a system is simplified, in what sense can this be treated as a 'process' other than at the moment when the system is defined? How does ease of production relate to the loss of a category? THIRD, on Grunwell's analysis, disorder and simplification co-vary as a matter of definition. In the phonology of Paul (p.189), stressed syllables are closed by a glottal stop, and rightmost, unstressed syllables have a voiceless fricative in the onset. *Water*, for example, is said as ['wɔʔsə]. Grunwell describes the 'archi-phonemic' [ʔs] as 'a favourite articulation'. But given a voiceless coronal stop as the input, the surface form can hardly be treated as a simplification. Grunwell's framework does not facilitate precise, clinical description.

The clinical thrust of Grunwell's approach – in favour of a more integrated notion of assessment, diagnosis and treatment – is precisely that of the present study. But because her starting point is a 'child's own system' (phonemically defined), generalisations across children are unstatable in principle.

To conclude Section 1.1.6.2, in relation to child phonology, as in phonology generally, it is not clear what light the naturalness idea throws on the data. But it is accepted here that Grunwell's problem sets a tough challenge for generative models. This challenge is addressed here, in Chapters 5 and 6: A) by giving Coronal a special status; and B) by the notion of language-specific, i.e. learned, sequences of association.

1.1.6.3 A flaw in the puddle/puzzle argument?

In Section 1.1.6.3, I look at work by Macken (1980 and 1982), in which she criticises Smith's 1973 claim that the child has adult type UR's, developing phonologically by 'across-the-board' changes in rule-structure. Macken has two main points: A) Some changes are mis-categorised by Smith as applying across-the-board. She shows that they have exceptions over the whole period of the study. B) In addition to rules operating 'downstream', there are also rules operating 'upstream' from the lexicon, what she calls 'Perceptual-Encoding Rules'. On Macken's model, every coronal, originally misperceived as a dorsal, has to be separately re-categorised.

In Smith's data, what Macken takes to be the exceptional cases from 2.2;29 to 2,8;7 include the following (the relevant data is set out in full in Appendix 6):

(1.10) *Exceptions to A's dorsalisation (using current terminology)*

Data from Smith and Macken

Age		Word realisations				
2;2.29	*little*	ˈdɪdiː	*troddler*	ˈlɒlə		
2;4.24	*troddler*	ˈgɒgə				
2;6.28	*little*	ˈlɪdiː/ˈlɪtəl	*beetle*	ˈbiːtəl	*tiddly pom*	ˈdɪdəliː pɔm
2;8.7	*little*	ˈlɪtəl				

But in a way which Macken's model does not explain, there seem to be two factors here. Until 2.4.24, liquidity in the stressed onset triggers a root harmony. And over the whole of this period, coronality in the final onset is preserved where the stressed vowel is high and front.

What about Macken's 'perceptual/encoding rules', effectively a filter, operating 'upstream', making words easier to say before the 'downstream' task of phonetic implementation? If a potential difficulty is detected in the planning, the execution is adjusted accordingly. Let us call this the 'Upstream/Downstream Model'. It is not adopted here for the following reasons.

FIRST, the case of 'mixed speech and language disorders' is not easy to explain unless there is a common underlying factor.

SECOND, while children with phonological disorders are not usually aware of their speech errors on-line, for the rare child who is aware of most of his or her errors, the problem is exclusive to the output system. (Such as child was PR part of whose symptomatology is given in Appendix 3.) Such a case is unaccountable by the Upstream/Downstream Model.

THIRD, 'slips of the ear' as reported by Fromkin (1971) and Celce-Mucia, 1980) must necessarily occur 'downstream' in Macken's terminology. They would thus have to be treated separately. The UDM would need to be supplemented to account for such data. If slips of the ear occur, the Upstream/Downstream Model is ontologically insufficient.

FOURTH, the Upstream/Downstream Modelhas nothing to say about *Jerusalem* as [dʒəˈuːsələm] amounting, as I shall show, to about 10 percent of all errors, violating typologically common phonotactic constraints on sequences of vowels, not making the structure 'easier' to say in any obvious sense.

FIFTH, it is bizarre that the Upstream/Downstream Model should apply to UR's such as those of *little* and *muddle* but not to metathesised outputs such as *difficult* and *icicle* as [ˈgɪpətəl] and [ˈaɪkɪtəl], with coronals surfacing in the very environments to which the 'perceptual encoding rules' are said to be sensitive.

I accept Macken's 1982 argument against Smith's 1973 assumption of the child having adult-type UR's. But from this it does not follow that there is no derivation in child-phonology. All we need to assume is there is a point in phonological acquisition at which all language-specific aspects of derivation are completely unknown. There is a Stage $_0$. It is not unworthy of study. Obviously. It has been the primary focus of innumerable studies of phonological development. But its investigation requires a methodology quite different from the one I shall be adopting here.

1.1.7 Two top-down approaches

Currently there is competition between two top-down models of linguistic learnability. The first of these arose in syntax. It is the claim of Chomsky (1995 a) that all grammatically definable variation – and thus acquisition – is reducible to the interaction between: A) 'principles', B) 'parameters', each of the latter helping to define the way a principle is intepreted in a particular instantiation of C_{HL}, each representing a finite set of values. This approach is widely characterised as 'Principles and Parameters Theory' or PPT. Both in Chomsky's recent work in syntax and in Halle and Idsardi's 1995 phonological application of this thinking, each parameter is binary-valued, an assumption I shall stick to here. The main syntactic expression of PPT is the Minimalist Program (see Chomsky, 1995 a).

A key idea in Minimalist syntax is the distinction between two interfaces, both forced on grounds of conceptual necessity, an Articulatory / Perceptual (A / P) interface and a Conceptual/Intensional interface.[3] The A/P interface relates exclusively to phonetics and phonology.

The second top-down model I shall consider is Optimality Theory, OT. This rejects any sort of derivation more complex than a direct relation between underlying and surface forms (see Smolensky, 1997).

Despite the competition, PPT and OT are at one on four points: A) the learner has no knowledge of what his or her 'target language' is; B) the evidence of any language can help to define the 'leanability space'; C) there is a formal difference between universals and the terms of the variation; D) in current syntactic versions of PPT, i.e. the 'Minimalist program', and in all versions of OT, rules are eliminated.

Taking PPT first, Chomsky (1995 b) follows a long line of linguists in observing that it is in phonetic and phonological respects that languages differ most sharply. Here I explore the learnability implications of this. Parameters are taken to determine patterns of word stress (see Hayes, 1993, and Halle and Idsardi, 1995, for two different ways of doing this) syllable structure (see Blevins, 1995), and the organisation of vowel systems (see Archangeli and Pulleyblank, 1994).

The acquisition of speech and language is thus by the 'setting' of parameters by the learner in a 'learnability space'. A grammar is 'selected'. This contrasts with an earlier model of generative grammar, whereby acquisition was by 'theory construction', fortuitously implying that incompetence could be characterised in terms of rules more complex or more numerous than those associated with competence. While the issue is circumvented to a degree by the notion of 'theory selection' (see Chomsky, 1995 a), it is still necessary to identify the steps of this process of selection. The explanatory force of PPT has been tested mainly in relation to syntax (reflecting a more general bias in this direction in linguistic research). It can be characterised in either of two ways, in terms of the number of parameters (the fewer the better) or in terms of their internal consistency. In the 1980's the emphasis was on reducing the number of parameters. Recently it has shifted to internal consistency.

[3] It seems possible in principle that Chomsky's 'conceptual necessity' is not the only possible criterion, that another criterion might favour not two interfaces, but three, an A / P Interface of the sort assumed here plus two more, by splitting the Conceptual / Intensional, or C / I, Interface into two parts, one bearing the main burden of literal interpretation, the other pragmatic defining the interaction between 'literal meaning' and reference. One justification for such a distinction hinges on the interpretabily of sentences such as "the hamburger in the corner wants another milk shake" in the context where speaker and addressee are both waiters or waitresses in a restaurant. The issue at stake here goes (far) beyond this study. It cannot be discussed any further here beyond the suggestion that one possible area of investigation is the clinical study of autism, where the seemingly genetic damage may be specific to the 'pragmatic' interface.

In the phonological interpretation of PPT, there has been little consideration of the number of parameters involved, of the interaction between them, or the internal consistency of the acquisition system which they imply. Is it necessary to envisage a parametrical treatment of segmental representation, harmonic scope, word, phrase and sentence stress, and other rules? What, if anything, can be swept under the rug of phonetics? The questions are hard in two ways. FIRST, by phonological parameters as characterised so far (concerning stress, weight, etc..), all variation is categorial, in contrast to what seems to be the quantal or analogical variation, characteristic of phonetics. SECOND, if the parameterisation includes both the definitions of domains, such as the word and phrase, and of the categories within them, it is necessary to avoid a learnability regress. In a more general way, as will be shown in detail in Section 1.4, we seem to need parameters doing different sorts of thing. Putting this a different way, the theory of phonological parameterisation needs to be constrained.

Seeking to avoid the apparent abstractness of derivation, OT proposes that a 'grammar' is entirely by the ranking of 'constraints', one prohibiting codas, another prohibiting syllables with an empty onset, and so on. Where two constraints are incompatible, one 'outranks' the other. The number of grammars is the sum of the orderings of incompatible constraints. Phonological learning has to be from surface evidence. The surface is all that exists.

Goad (1998) proposes an OT explanation of consonant harmony in early child phonology, using some of Smith's 1973 data. But Goad's account A) considers only word *edge* phenomena, thus throwing no light on word-internal cases; and B) postulates a constraint involving the 'edge alignment' of articulator features without justifying this in relation to competent phonology, raising a general issue about the status of constraints which are universally demoted in the course of development.

In the context of what they take to be a fully developed OT account theory of child phonology, Bernhardt and Stemberger (1998) propose a separate constraint for every process in child phonology. One of them is fronting. This leads to a combinatorial increase in the number of constraints and consequently in the size of the learnability space. And it entails the existence of constraints which are universally down-ranked. Bernhardt et al do not discuss what this means for the theory of phonological learnability or for OT. Without reference to any of Bernhardt et al's constraints applying specifically to child-phonology, Tesar (1998) argues that a system of 20 ranked constraints is learnable in principle. But as shown in Section 1.4 below, it is hard to see how 20 constraints are sufficient to define either child phonology or the known cross-linguistic variation. Bernhardt et al's account of long-distance consonant harmony is less than complete. They ignore epenthesis, metathesis, and articulator harmony other than on the word edge. They give neither a complete description of children's errors, nor an account of the learnability implications of the mechanisms that they propose. In relation to the more subtle incompetence of HI, featured in the Introduction, we might ask: What constraints have yet to be ranked in relation to each other? The answer is not obvious.

OT takes the abolition of both rules and derivation to be necessary and desirable as a research goal. But there is a down-side. Derivation reconciles representational parsimony with redundancy at the phonetic surface – an obvious plus in terms of functional communication. (See Davenport and Hannahs, 1997, Honeybone (1997, McMahon, 1999, for critical dicussion of other issues concerning OT).

It is not a solution to any of these questions just to enrich the conceptual armoury, either of UG or of the system of constraints. Here I shall seek to combine different versions of the PPT framework with the aim of developing a parameterisation which: A) describes the data here; and B) is internally consistent.

1.2 Clinical asymmetry and variability

Section 1.2 identifies asymmetries in the distribution of children's speech errors in clinical data collected by the author, characterising one aspect of this by the formula $\alpha \Rightarrow \beta$ and ◆ $\beta \Rightarrow \alpha$, as suggested in the Introduction. Each asymmetry is exampled in Appendix 3 from a group of children each of whom was at some point being treated on his or her own for at least half an hour at least once a week. (These numbers are amplified in Chapter 3, reporting on a larger cross-section of normally developing children.)

The idea of *processes*, context-sensitive and context-free, informs generative approaches to the analysis of early and/or disordered phonology, currently and in the past (as in the work of Chin and Dinnsen, 1992). Grunwell's problem, noted above, reveals a flaw in the generative approach: if the difference between 'incompetence' and 'competence' is defined entirely on 'processes' exclusive to the former: where do the 'processes' come from? Grunwell's point is echoed by Mohanan (1992) who notes that incompetence/disorder is not well-defined unless it is expressed notationally by the loss of organisation, and that the idea of organisation of an ontologically different sort is incoherent. I shall argue A) that Grunwell's problem should not be lightly dismissed; B) that there is, for linguistic theory, a rich source of data in the distribution of speech errors; C) that there is simply no coherence in the notion of a 'process/ domain', as implied by the restriction of a process to one or more domains.

Common, context-free errors in incompetent phonology of all sorts, both normal and impaired, include 'stopping', i.e. neutralisation in favour of non-continuance in obstruents, e.g. /s/ $\Rightarrow$ /t/, and 'gliding', collapsing the liquid, /r/, into some approximation of the semi-vowel, /w/.[4] In disordered phonology, there is also 'fronting', as /k/ ⇒ /t/ and /g/ ⇒ /d/. But these processes are common only in this polarity. Hence, ◆/w/ ⇒ /r/.[5] Fronting is characteristic of the speech and language therapy population. In a way which has become standard since the work of Halle and Ladefoged (1983), articulations are defined here by the articulators, Coronal, Labial, and Dorsal, rather than by the site of the primary obstruction (See Chapter 5 for more discussion). With three contrastive places of articulation between the stops (one respect in which English is typologically typical), there are thus six logical possibilities of substitution. But it is only Dorsal which loses out to Coronal as a general rule. The asymmetry is noted both by Cruttenden (1979) and by Jakobson (1941 – p. 22 in the 1968 translation). The incidence of fronting can be (loosely) surmised from the clinical data sets provided by Grunwell (1987), describing the phonologies of 45 children with varying degrees of phonological disorder. Of the 45, there were 20 who fronted consistently, 12 with stopping, and 1 with an extreme degree of articulatory neutralisation, with /t/ and /d/ as the only stops. 'Backing' is not unattested, but uncommon, hence the diamond bullet in ◆ /t/ ⇒ /k/. The inverse polarity of stopping is spirantisation. But while commonly attested in the competent phonology of many languages including English, spirantisation is rare in child phonology (never having been observed, at least context-freely, by this author).[6] Broadly speaking, stopping, fronting, and gliding are all unipolar – in one polarity.

A context-sensitive error re-writes α as β in a context, i.e. $\alpha \Rightarrow \beta$ / X__Y, as in *little* as ['lɪkʊ].[7] In the acquisition of English (and other languages), there are more clearly harmonic errors between non-contiguous, word-internal consonants. (1.11.a) shows one from Smith's A at 2;2 (see Smith, 1973), where the harmonic source is seemingly /w/. (1.11.b) is attested clinically, as shown in Appendix 3, seemingly beyond the developmental point in (1.11.a), where the source is /d/ and/or /n/.

(1.11) *Word internal harmony*

a) *squeaky* 'gi:pɪ

b) *cardigan* 'ka:dɪdən

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[4] As is obvious, this process is not universally overcome in the process of acquisition.

[5] But we shall discuss the case of one child with an evident speech disorder who 'rhoticised' the /w/ in *question*.

[6] Two rare cases of seemingly context-free spirantisation are described by Dent and Letts (1994). Less rare is context-sensitive spirantisation on the right and stopping on the left, leading to *sea* as [ti:] *eat* as [i:s], and *sit* as [tɪs], observed by the author once and by Grunwell (1987).

[7] Echoing discussion in Section1.1.4, in response to a question by the author in plenary discussion at the 1997 GALA conference in Edinburgh (Generative Approaches to Language Acquisition), Smolensky noted that this was unaccountable in OT.

In both (1.11.a) and (1.11.b), Dorsal on the left edge of the final syllable is targeted by a different articulator, one with a source or possible source in the previous onset, Labial in (1.4.a), Coronal in (1.11.b). In (1.11.a), the trigger does not surface.

As noted above, disorder is expected to entail a loss of organisation, tending to chaos. In some environments, in some words, the null hypothesis of randomness in the error distribution is met. But across the clinical population as a whole, in some words, such as *cardigan,* there are asymmetries – [ˈkaːdɪdən] commonly, but ◆[ˈkaːgɪgən] and ◆[ˈtaːdɪgən], and so on.

Smith (1973) makes the claim in (1.12).

(1.12) "Examples of consonant harmony are frequent and exemplify most of the logical possibilities." (Smith, 1973, p. 163).

Smith's framework includes what is referred to here as a 'process-domain' (not a term used by Smith). Here I am concerned about the extent to which Smith's 'logical possibilities' are not always attested, at least not typically. In (1.13) below, I contrast clinically common and unattested errors in *hippopotamus* with harmony and *hospital* with metathesis. Here I ignore rare cases such as *hospital* as [ˈhɒʔbəbʊ] from the child with *soldier* as [ˈhəʊwʊv]. In (1.13) the phonetic detail in the final syllable of *hospital* bears on the point under discussion. It may have a role as one of the triggering conditions. But the data as recorded do not allow this point to be taken any further. Relevant examples of some attested cases are given in Appendix 3.

(1.13) *Asymmetry in the distribution of context-sensitive errors*

Word	Common errors	Unattested errors
hospital	ˈhɒstɪpʊ	◆ˈhɒstɪtəɫ/ˈhɒstətʊ
hippopotamus	hɪtəˈpɒtəməs	◆ hɪpəˈtɒpəməs

Between the two cases, there is an asymmetry. The idea that processes occur in domains is implicit in the 'qualitative' aspect of the Edinburgh Articulation Test, henceforth the EAT, of Anthony, Bogle, Ingram, and McIsaac, (1971) who distinguish between 'atypical' and other 'substitutions'. 'Atypicality' points towards asymmetry.

In a way similar to the cases in (1.13), in *yellow* lateral harmony as [ˈlɛləʊ] appears to be by far the commonest error. Much less often, it is realised with a 'glide harmony' as [ˈjɛjəʊ].[8]

[8] In learners of Scottish English, Anthony et al (1971) observe patterns which seem to be

Traditionally, harmonic or assimilatory errors in speech are treated in terms of left-to-right directionality, as 'progessive' or 'regressive'. Cruttenden (1979) notes the predominance of *doggy* with a regressive harmony as ['gɒgɪ] rather than ['dɒdɪ]. Smith (1973) describes both progressive and regressive forms of harmony. But, as we shall see, significant generalisations are lost if we take the directionality of harmony as a primary classification.

In the clinical population, in *spoon* and *smoke,* each with a contrast in respect of sonorance as well as articulators, there are significant asymmetries in the error pattern. Anthony et al (1971) include these words in the EAT. They discriminate statistically. (1.14) shows an asymmetry in these words. The non-attestation is with respect to the clinical observation of both the author and Chin and Dinnsen (1992).

(1.14) *Coalescence/mutual harmony*

a) *spoon*

fu:n	◆ tu:n
Coalescence (Labial, Continuant)	Coalescence (Coronal, Stop)

b) *smoke*

fəʊk	◆ nəʊk
Coalescence (Labial, Continuant)	Coalescence (Coronal, Stop)

The diamond bulleted cases in (1.14) are each the mirror-image of an attested case. In each word, there is an asymmetry in favour of both both Labial and continuance.

(1.15) contrasts attested and unattested errrors in respect of *cardigan,* listed by frequency of attestation, from frequent to infrequent. This corresponds, in each case, to the derivational complexity. In each case, as the scale of the problem increases, there is an unattested, but logically possible form which is simpler than the attested case. The terms 'onset' and 'coda' are used, shown as 'On' and 'C', to denote the right and left edges of the syllable. (See Chapter 5 for more discussion). An element in the rightmost or final syllable is characterised as Rmost. Examples of symptomatologies involving such forms are given in Appendix 3.

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different from those in learners of Greater London English. Anthony et al treat /l /, /r / and /w / as all equivalently immature in the first syllable of *yellow,* and [p] and [h] as atypical. This does not reflect the experience of this author, but the discrpancy may be due to sampling.

(1.15) *Derivationally unique harmony and other processes in* ***cardigan***

a)	ˈkaːdɪdən Coronal harmony, Rmost On	◆ˈlaːdɪgən Coronal harmony, Lmost On ◆ˈkaːgɪgən Dorsal harmony
b)	ˈkaːdɪlən (i) Coronal harmony, Rmost On (ii) Devoicing, Rmost On	◆ ˈkaːdɪkən Devoicing, Rmost On
c)	ˈkaːdɪntən (i) Coronal harmony, Rmost On (ii) Devoicing, Rmost On (iii) Nasal copying, C	◆ ˈkaːdɪndən (i) Coronal harmony, Rmost On (ii) Nasal copying, C

The data in (1.15) suggests the possibility of an exclusive, derivational order on the basis that for each step in the derivation there is an independently attested surface form. In relation to the realisation as [ˈkaːdɪntən], we might postulate two successive intermediate forms, both independently attested – as [ˈkaːdɪdən] and as [ˈkaːdɪlən]. Putting on one side the question of how to define the three attested processes so as to exclude the unattested, diamond bulleted forms in (1.15), recalling a suggestion by Smith (1973 p.189), one way of blocking the unwanted derivations is by (1.16).

(1.16) *Ordering convention*

Within a corpus of realisations from a given sample of speakers, given two alternative derivations, D_1 and D_2, of a form, where these differ in terms of the intermediate representations, IR's, which they entail, IR (D_1) and IR (D_2), if there is an attested instance of IR (D_1) as a surface realisation, but no corresponding instance of IR (D_2), derivation D_2 should be rejected in favour of D_1.

Assuming that phonological processes 'do one thing at a time' (see Goldsmith 1995), (1.16) is neutral between the learner's experience and linguistic analysis.

Consider now the data in (1.17), representing two other sorts of error with respect to *cardigan*, the first clearly a one-step process, the third seemingly derived from the second.

(1.17) *Metathesis and deletion* ***in cardigan***

a)	ˈkaːdɩən	Deletion, Rmost On
b)	ˈkaːgɩdən	Metathesis
c)	ˈkaːgɩən	(i) Metathesis
		(ii) Deletion

In the Appendix 3 data, one surface form of the b) form was as [ˈkaːgɩdɛn] and of the c) form as [ˈkaːgæŋ] – with metathesis, deletion, and two additional harmonies, one involving the vowels. Given the attestation of the metathesis in [ˈkaːgɩdən] and, conversely, ◆[ˈkaːgɩgən], the analysis and ordering in (1.17.c) follows directly and naturally. But to account for what is observed – by (1.17.c) – and what is not observed, it seems necessary to say that the deletion is conditioned, or preceded, by metathesis. Even in pathology, we need to postulate at least the effect of derivational sequence.

In simpler environments, the harmonic asymmetry is easier to state.

(1.18) In bi-syllabic words, harmony involving just the articulator was, in clinical cases observed by the author, typically unipolar, at the expense of Coronal, in *button* as [ˈbʌpən] and ◆[ˈdʌtən], *fussy* as [ˈfʌfɩ] and ◆[ˈsʌsɩ], *Sophie* as [ˈfəufɩ] and ◆[ˈsəusɩ], *ticket* as [ˈkɩkɩʔ] and ◆[ˈtɩtɩt], *donkey* as [ˈgɒŋkɩ] and ◆[ˈdɒntɩ].

In more complex environments, the asymmetry is more subtle. Take *diplodocus*. Here I shall adopt from Liberman and Prince (1977) the idea of the 'strong foot', essentially the stressed syllable and the unstressed syllable to its right (see Chapter 6 for more discussion). The data in Appendix 3 is consistent with the claim in (1.19).

(1.19) In *diplodocus*, 'one-step' errors not involving deletion consisted in copying or harmony at least in the strong foot. Hence [glɩpləˈgləukəd], [dɩpəˈgəusəs], [plɩkəˈgəutəs], [dɩpləˈgləutəs], [dɩpləˈdəukləs], [dɛbləˈkəuʃəs], [dɩpləˈkləukləs], [dɩpləˈdəukləs], but ◆[dɩkləˈdəukəs], ◆[dɩtləˈdəukəs], ◆[bɩpləˈdəukəs], ◆[gɩpləˈdəukəs], ◆[dɩpləˈbəukəs].

In another case, that of *asbestos*, the domain of vulnerability seems to be quite different.

(1.20) In *asbestos,* the codas harmonised in various combinations, but in 3 cases in Appendix 3 in favour of Labial in the most distant target position from the only consonantal source, as [æz'bɛstɒf]. In no case was the other onset or the coda of the stressed syllable selected as a single harmonic target; i.e. ◆[æz'bɛspɒs], ◆[æz'bɛftɒs], and ◆[æv'bɛfpɒf]. And there was no coronal harmony, i.e. ◆[æz'dɛstɒs].

Different again were the error patterns in *archeopterix*, like *diplodocus* in having all three articulators.

(1.21) In *archeopterix,* coronal harmony in the onset /k/ and stop deletion in the final coda were common. But there was no /s/ deletion, or a single harmony in either coda, or polarity reversal, or labial harmony, as an isolated process. Labial harmony in either /k/ involved other processes as well. Hence [a:ki'ɒptərɪs], [a:ti'ɒptərɪks], ◆[a:ki'ɒptərɪk], ◆[a:ki'ɒktərɪks] ◆[a:pi'ɒptərɪks], ◆[a:ki'ɒptərɪts], ◆[a:ki'ɒptərɪps].

Asymmetric error patterns, as listed above, involving a co-variance between processes and featural/prosodic domains, have not attracted much attention. I shall test this asymmetry in Chapter 3, and then consider how to explain it.

(1.22) summarises and extends the data so far, listing both comparable cases and non-attestations. Here I introduce these terms: A) the 'root' as a category comprising the melodic aspects of the segment (see Chapter 5); B) 'migration' from Shriberg and Williams, (1983), where a root surfaces in the wrong position; C) 'degenerate foot' (from Liberman and Prince (1977), where the stressed syllable is preceded by a single syllable (see Chapter 6); D) 'rime', as that part of the syllable comprising the vowel and any following consonants (see Chapter 5); E) 'ambi-syllabicity; as a way of defining the role of a singleton onset on the right of a lax stressed vowel, as a coda in relation to the syllable on its left and an onset in relation to the syllable on its right; F) 'realignment', where as a result of deletion, the onset of an unstressed syllable becomes the onset of the stressed syllable.[9] Descriptive statements in (1.22) are given here, not to mimic phonological rules (an idea it would be desirable to eliminate), but to define the *singularity* of certain environments. The data is clinical, i.e. non-quantitative. The definitions are tentative. In *hippopotamus* in (1.22.a), the coronalisation is treated as harmonic, not disharmonic, on the grounds that the singularity is most easily stated in this way. Justification for this will be given in due course. In the case of *diplodocus* a square bullet ▪ denotes that a form is relatively uncommon.

[9] This is using the notion with no implict commitment to Optimality Theory, OT, in which the notion is often appealed to. By the reasoning in Section 1.1.4 above, OT is rejected here.

(1.22) *Asymmetries in the distribution of one-step, context-sensitive errors*

a) Coronal harmony occurred between oral stops in unstressed onsets differing only in articulator, both ami-syllabic or neither ami-syllabic, by definition neither of them in the onset of the stressed syllable, where there is another case of the vulnerable articulator (not subject to harmony) in another stop, and the rightmost consonant is a coronal.

hippopotamus	hɪtəˈpɒtəməs	◆ hɪpəˈtɒtəməs
archeopterix	aːtɪˈɒptərɪks	◆ aːkɪˈɒktərɪks
cardigan	ˈkaːdɪdən	◆ ˈkaːgɪgən, ˈtaːdɪgən
calculator	ˈkæltəlɛɪtə	◆ ˈkælkəlɛɪkə, ˈtælkəlɛɪtə

b) Dorsal harmony, triggered by one such element, occurred in a coronal focus between stops, separated by a single vowel, in two heavy, rightmost syllables, one in the stressed syllable, necessarily in the same foot, with the same exclusive constituency, either onsets or codas, with a voicing contrast such that voicing is in the stressed syllable, where the specified contrasts are immediately preceded by labiality and sonorance (necesssarily in the adjacent onset), where all onsets contain either oral or nasal stops.

magnet	ˈmægnɪk	◆ ˈmædnɪt, ˈmægnɪp
diplodocus	dɪpləˈgəʊkəs	◆ dɪkləˈdəʊkəs

c) Labial harmony was between consonants, matching in obstruence/sonorance, one in the stressed syllable, with a voiced trigger with an onset role, in a target with a coda role, one of these in the final syllable, where there was, in addition to the target non-labial, another matching it in sonorance, continuance, and articulator, and backness/roundness on the right edge of the final syllable, underlyingly or by derivation in the case of /l/.

asbestos	æzˈbɛstɒɾ	◆ æzˈdɛstɒs, æzˈbɛspɒs
animal	ˈæmɪmʊ	◆ ˈænɪnʊ

d) In a word of at least three syllables, with labiality or surface roundness on the right edge or in the stressed syllable, one feature metathesised between the onset of the final syllable and an onset in the foot, one a Coronal.

hospital	ˈhɒstɪpʊ	◆ ˈhɒstɪtʊ
animal	ˈæmɪnʊ	◆ ˈænɪnʊ
pentagon	ˈpɛŋkədən	◆ ˈpɛndəkən

e) Strong foot elements were targeted at the root by /s/ and /m/, with surface gemination in the case of the former.

escalator	ˈɛssəlɛɪtə	◆ ˈɛkkəlɛɪtə
eskimo	ˈɛssɪməu	◆ ˈɛkkɪməu
Geronimo	dʒəˈmɒnɪməu	◆ dʒəˈrɒnɪrəu
diplodocus	dɪpləˈdəusəs	◆ dɪpləˈdəudəs

f) Reduplication involved coronality, copied from elsewhere, both positions having the same syllabic constituency.

diplodocus	dɪpləˈdəukləs	▪ dɪpəˈdəukəs
	dɪpləˈgləukəs	
budgerigar	ˈbʌdʒərɪgaːd	◆ ˈbʌʒərɪgaː, ˈbʌdərɪgaː
Manchester	ˈmæntʃɪnstə	◆ ˈmætʃɪstə, ˈmæntʃɪstəm
skeleton	ˈskɛlɪntən	◆ ˈskɛlɪən, ˈskɛlɪtə

g) Migration (or movement) of a feature or segment involved sibilant features surfacing in the onset of the stressed syllable.

spaghetti	b̥əˈskɛtɪ	◆ səˈbɛtɪ
soldier	ˈʃəuɫdə	◆ ˈdəuɫdʒə

h) Affricate movement and harmony affected only the affrication, not the voicing.

digital ˈdɪdʒɪtʃʊ, ˈdɪdɪtʃʊ ◆ ˈdɪdʒɪdʒʊ

i) The sonorant onset of a stressed syllable with a round vowel and the vowel of a degenerate foot were lost, leaving friction in the surviving onset.

thermometer	ˈfɒmɪtə
Jerusalem	ˈdʒuːsələm
Geronimo	ˈdʒɒnɪməu

j) What might be regarded as a form of compensatory lengthening affected the coronal fricative in the degenerate foot in *asbestos*.

asbestos æːˈbɛstɒs ◆ æˈbɛstɒs

k) Disharmony occurred in the /p/ in *monopoly*.

monopoly məˈnɒkəlɪ ◆ məˈmɒpəlɪ, məˈnɒtəlɪ

l) In the final coda of the word *archeopterix*, deletion affected only the /k/.

archeopterix aːkɪˈɒptərɪs ◆ aːkɪˈɒptərɪk

m) Between /l/, /r/, and /j/, /l/ was harmonically favoured

yellow	ˈlɛləʊ	◆ ˈjɛjəʊ (with 1 exception)
lorry	ˈlɒlɪ	◆ ˈrɒrɪ
ruler	ˈlu:lə	◆ ˈru:rə

n) Between two onset elements differing in two respects (the domain), where the stressed syllable is round, mutual harmony or coalescence preserved criterial labiality and continuance in the domain elements.

spoon	ˈfu:n	◆ ˈtu:n
smoke	ˈfəʊk	◆ ˈnəʊk

The environments in (1.22) are characterised in terms of their 'singularity'. The harmonic behaviour of each articulator is distinctive. In all the cases of 'long range' coronal harmony and metathesis, the singularity consists in a minimally trisyllabic domain. Outside the terms of the singularity by (1.22.a), there is *crocodile* with a mismatch with respect to voicing between the /k/ and the /d/, *doggy* and *diplodocus*, where the harmony was dorsal rather than coronal, with a mismatch with respect to stress, *magnet* with a mismatch respect to stress and voicing, and *asbestos* with mismatches with respect to stress, voicing, continuance, and syllabic constituency. In relation to the two labial harmony cases in (1.22.c), although *Melanie, monopoly* and *aluminium* occasioned lateral and nasal harmonies, none occasioned simple articulator harmony in the stressed syllable. In relation to dorsal harmony, in the cases of *cardigan* and *crocodile,* one or more of the terms of (1.22) is not met. In *cardigan,* with respect to the /d/ and the /g/, they are not in the same foot, and there is no voicing contrast. In *crocodile,* by virtue of the shortness of the preceding stressed vowel, the syllabic constituency of the singleton /k/ is shared, i.e. non-exclusive. Between the /k/ and the /d/, the voicing contrast is not as specified. And there are two dorsals.

(1.23) defines some aspects of the singularities where particular processes seemed to occur. In all, there are five common source/focus relations in articulator harmony in the speech errors occurring in phonological disorder.

(1.23) *Articulator harmony in phonological disorder*

Harmony	Focus	Word	Realisation	Domain
Coronal	Labial	*hippopotamus*	hɪtəˈpɒtəməs	Voiceless oral stops
Labial	Coronal	*asbestos*	æzˈbɛstɒf	Obstruents
Dorsal	Coronal	*magnet*	ˈmægnɪk	Oral stops
Coronal	Dorsal	*cardigan*	ˈkɑ:dɪdən	Voiced oral stops
Labial	Dorsal	*archeopterix*	ɑ:pɪˈɒptərɪks	Voiceless oral stops

For a set of relations between elements (ranging over features, phonemes, syllables, feet, and the null element) achieving the effects of harmony, disharmony, coalescence, metathesis, epenthesis, deletion, migration, and compensatory lengthening, the set of logical possibilities which are not attested seem non-trivial. I am led to these generalisations.

(1.24) In a particular cohort of phonological disorders of various degrees,

a) In words with at least one closed syllable, articulator harmony had a stop as a trigger, and in an onset was not triggered by a coda.

b) Harmony is typically by one step in one element – unlike many harmonies in competent phonology, which are often unbounded (see Piggott, 1996).

c) Harmonies involving Dorsal, Labial and Coronal went all ways but one; there is key data in the words *archeopterix, gobbledigook* and *diplodocus*. Dorsal did not harmonise in a Labial focus.[10]

The asymmetry, the context-sensitivity of the error distribution, is best described by a model which relates both prosody – with respect to stress – and melody – in a way not attributable to the properties of articulators.

To summarise, I have demonstrated what seem like some significant asymmetries in the distribution of errors in children with speech disorders. Some 'processes' that have been listed here do not need to be named other than in the context of child phonology. If we are not going to enrich the descriptive framework, it will be necessary to say that these are not 'processes'. This is an issue to which I shall return.

1.3 A common factor

If, as shown in Section 1.2, there are systematic asymmetries in phonological disorder, it is plausible to suppose that there is a common factor, leading to the introduction of a novel term, Specific *Speech* and Language Impairment, SSLI. Section 1.3 outlines three sorts of evidence in support of this. Section 1.3.1 reviews conclusions from the literature about 'Specific Language Impairment', SLI, (see Hewitt, 1996) or 'Specific Expressive Language Disorder', SELD, (see Paul. 1996). Section 1.3.2 looks at some cross-linguistic data. Section 1.3.3 notes one aspect of what is referred to here as 'the extended natural history of speech disorders'.

[10] The case of *monopoly* disharmonically as [mə'nɒkəlɩ] does not contradict this claim.

1.3.1 A syndrome with an epidemiology

In Section 1.3.1 I note the breadth of the agreement between researchers on points consistent with the claim that the acquisition of speech and language is a single process with a biological basis – hence the term, Specific Speech and Language Impairment, SSLI.

Ward (1999) took what she presented as the evidence of a particular (general and non-specific) approach to treatment to rebut the notion of SLI. But her methodology has been criticised (See Yoder, 1999, Letts and Edwards, 1999, and Hall 1999). Ward's argument does not bear sharply on the issue of specificity. Law (1992) emphasises the role of deprivation and other sociological factors. Hill (2001), reviewing the evidence of concomitant sensori-motor disorders, shows that these are common. She takes this to contradict the very notion of a specific disorder. In Chapter 7, I shall seek to resolve the apparent contradiction between the notions of SLI, SELD and SSLI, and the evidence of concomitant, sensori-motor disorders.

SLI and SELD have the problem of a negative definition – as problems which cannot be reduced to deprivation, medical trauma, hearing loss, intellectual defect, and so on. But negative definitions are weak. In this study, I am aiming for a non-negative characterisation. My point of departure is the substantial agreement in the literature on the points in (1.25.a), (1.25.b) and (1.25.c).

(1.25) *Syndromic/epidemiological aspects of speech and language impairment – SSLI*

a) There is a genetic factor in about 30% of cases.

Lucksinger (1970) found that out of 127 children with a diagnosed pathology, 35.5% had a parent who had previously had a related condition. Tomblin (1989) found that out of 97 second grade children in therapy, 23% had a first degree relative with a positive history of a related disorder whilst out of 255 controls, only 3% had a similarly affected relative. Parlour and Broen (1989) found individuals in their 30's, previously the subjects of a study of phonological disorder in children, now often the parents of children with similar disorders. Neils and Aram (1986) concluded that genetic transmission provided the only plausible account of such data. Gopnik (1990) reports on a case study of 3 generations with divergent levels of what appears to be a common morpho-phonological deficit.

b) SSLI is typically multi-factorial – with a highly significant co-variance with respect to problems in speech and in language.

SSLI tends to affect any one or more of a set of skills including phonetics, phonology, morphology, syntax, metalinguistics and literacy, but not what Chomsky (1995) refers to as the Conceptual/Intensional, C/I, interface, where the grammar intersects with properties such as logical scope. There is a corresponding distinction between the cluster of syntactic, morphological, and phonological problems characteristic of 'Broca's aphasia', and the C/I effects of 'Wernicke's aphasia'.[11] Lieberman (1984) addresses the question: why do speech and language disorders tend to co-vary? His explanation is in terms of frequency of occurrence: syntactic and phonological problems co-vary because of the lack of rehearsal in both areas. But the notion of rehearsing syntax is not convincing. For the multi-factorial linguistic and educational issues in L1 development, see Hall and Tomblin (1978), Leonard (1982), Lieberman (1984), Tunmer, Pratt, and Herriman (1984), Kahmi, Lee, and Nelson (1985), Tomes and Shelton (1989), Bishop and Adams (1990), Klein, Lederer and Cortese (1991), Ruscello, St Louis and Mason (1991), Whitehurst, Smith, Fischel, Arnold and Lonigan (1991), Paul and Jennings (1992), Weston and Shriberg (1992), Leonard, McGregor and Allen (1992), Catts (1993), Magnusson and Naucler (1993), Stackhouse and Wells (1993), Weismer and Hesketh (1993), Hewitt (1996), Singleton (1996).

c) SSLI has an extended 'natural history' (in the medical sense).

Lewis and Freebairn (1992), find that "remnants of a preschool phonology disorder may be detected at school age, adolescence and even adulthood" (p. 827). Hall and Tomblin (1978) re-investigated a number of the phonologically disordered subjects from Templin's original (1966) study. Using parental report, they found that 50% of these young adults were viewed by the parents as still having a degree of disorder. See also Paul (1996) and Joffe, Penn, and Doyle (1996), looking at the issue over a typical clinical time-span – within childhood.

The idea in (1.25.c) is reflected in the histories of two unrelated children, PR referred at the age of 3;10 (see Appendix 3) and one other child of a similar age, both fronting, and both producing scores on the EAT more than 2 Standard Deviations below the norm.[12] In both cases, the fronting and other context-free processes were successfuly treated in the first phase of therapy. For different reasons, both children were kept under review for a number of years. Both were subsequently found to have a number of context-sensitive processes including the [ˈkaːdɪntən] realisation of *cardigan* in (1.15) One way of describing this is to say that the coronalisation is initially context-free and later on context-sensitive in a particular 'derivational' sequence. This aspect of the data will be referred to in this study as 'developmental continuity'. On the most parsimonious account, there is a single phenomenon which is expressed in different ways at different points in development.

[11] In discussion at the 1997 GALA conference, Scobbie noted that in children with early phonetic problems, typically the phonology is involved as well.

[12] With a small approximation, EAT scores can be converted from 'standard scores' into Standard Deviations. The EAT was in commoner clinical use at the time of these observations in the 1980's than it is today. But for all its defects, it still provides a rough index of pathology.

The ideas in (1.25.a) and (1.25.c) are both consistent with the family history of HI mentioned in the Introduction and the occasion when a child's grandparent deliberately drew the author's attention to the fact that "his uncle sounded just like he does at the same age", decisively confirming a diagnosis of phonological disorder (when the case-history information had seemed, up to then, to point in a different direction).

Summarising this Section, I have introduced and justified the idea of Specific Speech and Language Impairment, or SSLI, as a syndrome. Foreshadowing more discussion, I shall seek to explain the properties of SSLI in terms of the learning process, what I shall call the 'learnability space', and the way these interact with the A/P interface. In this way, I shall address Hill's 2001 co-morbidity thesis.

1.3.2 Cross-linguistic evidence

In Section 1.3.2, I turn to cross-linguistic data on children's consonant harmony.

Vihman (1978) surveys a number of observational and diary studies, covering the phonological acquisition of Chinese, Estonian, Czech, Slovenian, Spanish, and English, including data from Smith (1973). Except for two of the Chinese subjects, they were all under 2.6. She notes that the rate of consonant harmony ranges from 32% in the case of A, the subject of Smith (1973), down to 5%, 3%, and 1% in the three Chinese subjects. The variation was thus over idiolects as well as target languages. Vihman notes that, "the children divide fairly evenly into those using harmony and those preferring to omit troublesome consonants" (p. 300). She finds that:A) of the harmonies that occurred, most were regressive; and B) the greater the amount of consonant harmony in any particular case, the greater this skew became. She rejects Smith's claim that consonant harmony is universal in child phonology, partly on account of the variability, and partly because it does not always apply to the earliest forms. She claims that the variable rates of consonant harmony reflect strategies in relation to lexical growth, 'fast mapping', as it is now known, from the activation of the acquisition device, postulated here (see Section 1.4.5). But Vihman's claim fails to capture the relation between immaturity and pathology. If the latter is defined, as it usually is in the clinical literature, on the distribution of 'processes' involving consonants, including consonant harmony, it is counter-intuitive to describe such harmony as an adaptive strategy. The most startling aspect of Vihman's data, noted by Vihman herself, concerns the exceptionality of harmony in Chinese acquisition. Given the characteristic poverty of coda representation in Chinese languages, (see Duanmu, 1994, and references therein), Vihman's data is consistent with the claim in (1.26).

(1.26) Long distance, harmonic, relations between consonants are characteristic of the speech of children learning languages like English with richly contrasting melodic contrasts in the syllabic coda.

1.3.3 Extended natural history

I turn in Section 1.3.3 to some consquences of the point in (1.25.c), according to which SSLI has an extended natural history.

As is easily observed, difficulties with /r/ and /s/ commonly persist into adulthood. It might be said that both must entail complex neuro-muscular co-ordinations. The problem with this intuitive 'interface account' is that it does not square with the cross-linguistic evidence. While a voiceless, coronal fricative is part of the phonemic inventory of most languages, many languages have no phonological contrast between liquids. English /r/ is typologically uncommon in terms of its phonetic retroflexion. So English /r/ and /s/ are at opposite ends of the scale of cross-linguistic attestation. Now contrast both of these segments to /θ/, also typologically uncommon, as a non-strident fricative of a particular sort. In the acquisition of English, where the target dialect has such a form, /θ/ tends to be late. In terms of social psychology, the non-acquisition of /θ/ is stigmatised. But despite the lateness of /θ/ acquisition, its replacement by /f/ is not commonly found by clinicians to be a developmental problem, requiring treatment. Nor is it commonly found as a speech defect in teenagers and adults.[13] It is not easy to provide a consistent interface-based account of the typological distribution and acquisition facts regarding /θ/, /s/, and /r/.

To varying degrees, some adults (like the mother of HI, mentioned in the Introduction) find some words 'hard to say'. The problem does not seem to be directly related, if at all, to whether the words are in common use by the speaker. It is as though they were 'easier to hear or say' with an alteration of their phonological structure. Such errors are often not noticed by the speaker and are resistant to correction – unlike 'slips of the tongue'. Some errors in adult speech can be characterised as either prevalent within a community (at least at some point in time) or consistent within an idiolect. In some cases, such as *etcetera* as [ək'sɛtrə], *anemone* as [ə'nɛnəmɪ], *trilobite* as ['traɪbəlaɪt], there is an obvious analogue – in *exception, an enemy, tribal,* etc.. But in one case, namely *phenomenon* as [fə'nɒmənəm], there is no

[13] Exceptionally this author has encountered an eighteen year old, self-referrred for therapy, with difficulties with both /r/ and /θ/. The latter was dorsalised. The effect was magnified in *three*. Apparently a similar disorder affected many members of the family, one half living in Eastern Europe, the other half in Britain, in a way that seemed to take no account of geography or separation over many years. This and other similar case with dorsalised coronalis do not contradict the main point being made here. Such cases may involve a funcamental misanalysis of coronality.

available analogue. Here, in an environment similar to the one defined in (1.22.c), there is harmony between an ambi-syllabic Labial and a target in the rightmost coda.

(1.27) *The error distribution in realisations of* ***phenomenon***

fə'nɒmənəm	Progressive harmonic labialisation, rightmost nasal coda
◆ fə'nɒməmən	Progressive harmonic labialisation, adjacent syllable onset
◆ fə'mɒmənən	Regressive harmonic labialisation, adjacent syllable onset
◆ fə'mɒməmən	Harmonic labialisation, adjacent syllable onsets
◆ fə'mɒməməm	Harmonic labialisation
◆ fə'nɒnənən	Harmonic coronalisation in nasals.

As is well known, children's speech errors aren't usually stopped by overt correction. For [fə'nɒmənəm] speakers, as this author once was, the difference between the canonical and the idiolectal form tends to pass unnoticed. Even after correction, care may be needed to inhibit such an error. It is not a slip of the tongue. With reference to a familiar term for reluctance to take correction, let us refer to these hard-to-correct errors in adult speech as 'cloth ear errors'. [14] Here I shall make this assumption.

(1.28) To the extent that cloth ear errors are consistent over time and across individuals, they seem to be the residue of developmental incompetence and diagnostic of the case where the individual has failed to pass from Stage $_{n-1}$ to Stage $_{n}$.

Given the anecdotal nature of the evidence, cloth ear errors are peripheral to this study. But the idea in (1.28) will allow us, in Chapter 2, to simplify our general typology of speech errors.

In Section 1.3, I have noted three pointers to the idea that the systematic asymmetries in phonological disorder may have a phonological basis. FIRST, phonological disorder seems to be part of SSLI. SECOND, there is cross-linguistic variation with respect to harmony in child phonology. THIRD, there are cloth ear errors.

[14] This term is due to Clare Gallaway in private conversation. They seem to what Berg (1991) is referring to when he talks about 'true malapropisms', on the basis of 'a wrong permanent link between sound and meaning... in the speaker's mind' (p.270). The parent of one child then being treated by the author drew attention to a corresponding problem in her own speech. Offered a session of treatment by the author, she readily accepted, and responded in the manner described in the Introduction.

1.4 Learnability in phonology

Section 1.4 turns to phonological learnability, picking up points by Ingram (1992) and Dresher and van der Hulst (1995), and adopting the Dependency view (see Anderson, 1987) that generalisations should be sought across syntax and phonology, rather than the opposite view – from Halle and Bromberger (1988) and Chomsky (1995b). Here I assume obviously and non-controversially that the theory of phonological acquisition must guarantee finite learnability. From this it follows that the acquisition of a particular, target instantiation of C_{HL} cannot be a matter of accident. But given some aspects of representation, there is a learnability issue which may be reflected in the child's learning process.

Section 1.4.1 considers aspects of the input, i.e. *competent* phonologyπ. Section 1.4.2 considers one assumption about learnability. Section 1.4.3 outlines a general problem for parameterisation, and makes a proposal.

1.4.1 Some issues in English phonology

In relation to the asymmetries described in Section 1.2 above, is there any learnability justification for a separate treatment of each articulator? One such justification can be found in the morphology.[15]

(1.29) Where the structure contains a nasal and an oral stop coda, only coronality is phonetically realised in all cases, dorsality being realised only in the case of *long, strong,* and *young,* in derived forms.

Root	*Comparative*	*Superlative*	*Participial*	*Past*	*Agentive*
bomb			*bombing*	*bombed*	*bomber*
ring			*ringing*	*ringed*	*ringer*
long	*longer*	*longest*			
blond	*blonder*	*blondest*			
mind			*minding*	*minded*	*minder*

The derivational productivity of the **/nd/** forms contrasts with what – in dialects like those of Greater London – is a special case arising in *young, long* and *strong,* as [ˈjʌŋ], [lɒŋ], and [strɒŋ] in their root forms and as [ˈlɒŋgə], [ˈjʌŋgə], etc. in the comparative (and similarly in the superlative), contrasting with *sing, ring, wing,* etc.,

[15] In *limber* and *clamber*, a voiced stop is phonetically realised as an onset next to a homorganic nasal. If *limber* is etymologically related to *limb, and clamber* to *climb,* the voiced labials in the spelling testify to an oral stop in the monosyllabic forms at some historical point. But while the semantic connection is detectable, it is no longer recoverable. Synchronically, *limb* and *limber*, and *climb* and *clamber*, are separate items.

where in neither the root nor in the derived forms as *singer, singing, ringer,* etc., is there any surface evidence of an oral stop. The issue seems to be whether the stop element is required to play the role of an onset in a syntactic head position within the same maximal category, something which seems not to happen in *thingy* as [ˈθɪŋɪ]. In a derivational framework, in 'g-drop' dialects the surface dorsality is by harmony preceding deletion, where the second process does not always apply in 'g-preserving' dialects of the English North-West, where the roots may surface as [sɪŋg], [rɪŋg], etc.. Hence (1.30).

(1.30) Productive, structure-preserving word-internal harmony/assimilation in English involves adjacent elements including Dorsal – not Coronal or Labial.

A similar case arises in what may be regarded as a gestural aspect of Southern British English dialects like the author's, in *prince* as [prin^{t}s] and *lymph* as [lɪm^{p}f], but not in derived *princes or lymphatic,* where the fricative is not in the coda. By the superscription, the epenthesis is not equivalent to a segment, but a gesture.[16] So there is a sub-phonemic contrast between *prince* and *prints.* As shown by the b) cases in (1.31), the criterial features of the environment are syllabic constituency, nasality and edgemost voicelessness.

(1.31) *Epenthesis in South-East varieties of English*

a)	*prince*	prɪn^{t}s	* prɪns	*princes*	* prɪn^{t}sɪz	prɪnsɪz
	length	lɛŋ^{k}θ	* lɛŋθ	*lengthen*	* ˈlɛŋ^{k}θən	ˈlɛŋθən
	warmth	wɔːm^{p}θ	* wɔːmθ			
b)	*filth*	*fɪɫ^{t}θ	fɪɫθ	*filthy*	* fɪɫ^{t}θ	fɪɫθɪ
	Heinz	*haɪn^{d}z	haɪnz			

But there are no cases of this in a monomorphemic root involving dorsality. Given this and (1.29), the L1 learner of English can infer that each articulator has a unique status. But how are gaps detected if this can only be determined when the lexicon is complete? In (1.32) two learnability conditions are proposed, one defining gaps as something the learner is on the lookout for.

[16] The special cases of *glimpse* and *tempt* may thus arise by virtue of the orthography wrongly encoding information which is, for the speakers concerned, predictable. We shall in Section 6 provide the basis for a derivational, but non-epenthetic treatment of the dialectal epenthesis.

(1.32) *Two conditions on finite learnability*

a) The probability of the L1 learner's experience of a given set of (criterial) inputs approaches certainty.

   Phonological acquisition cannot depend critically on the learner happening to encounter positive exemplars embodying particular contrasts, such as those between *sing* and *singer*, *long* and *longer*, *non-native* and *innate*, *unknowing* and *innovative*.

b) All paradigmatic systems are expected to be complete. Any gap, as perceived by the learner at any stage of the acquisition process, is significant.

   A gap is never more visible than in child phonology. By the disconfirmation of the expectation of perfection, the acquisition process can be driven forward by the evidence of gaps, as this emerges.

In the light of these considerations, let us turn now to the liquids, significant here because of their interactions with adjacent coronal stops. Regarding dark /l/, Sproat and Fujimora (1993) argue that the darkening is a gradient artifact of phonetic implementation (see Huffman, 1997, for comments on this claim). Clearly the phonetics are relevant. Even in those dialects with all laterals said to be light, there may still be some darkening. And while there are dialects with all laterals dark, there are none with darkening just in the onset. Here I shall uphold the view of phonological conditioning – but on the basis that onset darkening and coda lightening is impossible. Non-categorial, non-structure-preserving variations with respect to darkening might be treated as examples of what Kiparsky (1985) calls 'gradience'. One seemingly categorial property is 'intrusive /r/' – tending to co-vary with 'r-drop' (see McMahon, Foulkes and Tollfree, 1994). But many properties interacting with intrusive-r may be non-categorial. In (1.33), where the spaces in the transcription are just for easier reading, I set out some forms in which liquidity is involved in what might be characterised as 'r-drop dialects', including the RP described by Gimson (1970). As noted above, the term 'r-drop dialect' assumes the possibility of an abstract /r/ on the right edge, an abstraction not sanctioned by Gimson, who categorises /r/ as as a "frictionless continuant" with "more phonetic variants ... than... any other English consonant" (p.208). (1.33) lists some of the grammatical properties which, one way or another, have to be defined.

(1.33) Liquidity in the competent phonology of 'r-drop' English (see Gimson, 1970, Kiparsky, 1985, Nespor and Vogel, 1986, Giegerich, 1992, Kenstowicz, 1994, McMahon et al, 1994), viewing phonetics as 'late phonology':

a) [r] 'intrudes' after a non-high vowel before another vowel, in *hosannah in excelsis...* as [hɛʊˈzænə r ɪn ...], *the media are wrong* as [ðə miːdɪə r ə rɒŋ], *It's the law. Even you know...* as [ɪts ðə lɔ r ˈiːvən juː nəʊ...], etc..

b) [r] 'links' in *hearing, bearing, jarring, pouring, whirring* as [ˈhɪərɪŋ], [ˈbɛərɪŋ], [ˈdʒaːrɪŋ], [ˈpɔːrɪŋ], [ˈwɜːrɪŋ], with minimal pairs – in *pouring* as [pɔːrɪŋ], *pawing* as [pɔːɪŋ], and similarly *sawing* and *soaring, cawing* and *coring.*

c) In the onset

  a) /r/ and coronal continuance coalesce in *shred, shroud,* etc..

  b) A liquid in an onset cluster next to a voiceless obstruent is variably devoiced (adding some new environments to those listed by Gimson, p. 205, ff):

    a) completely devoiced:

      a) in a stressed syllable after a stop, not specifically voiced, on the left edge in *try, cry, pry, play, clay;*

      b) in a stressed syllable after an obstruent where the preceding vowel is schwa in *supply, appraise, asleep, afloat;*

      c) in the phrase, compound, or complex NP, in an initial unstressed syllable preceded by a voiceless obstruent, in *mass-renewal, Nuff-Respect, chief reporter, top reporter, base recorder, kit removal, wet linoleum, like LeSaux;*

    b) otherwise,

      a) partially or slightly devoiced:

        a) in a syllable with non-primary stress after a single stop in *Gertrude, subtly, quickly, upright, nitrate;*

        b) in a syllable with primary stress after a fricative (no matter whether there is a stop) in *spring, string, screw, fry, three, shrink;*

        c) (tentatively, by the author's observation) in the onset of the right branch in a left-headed compound – in *horse-race, surf-rider, base-line, cuff-link;*

        d) in the onset of an unstressed syllables after a fricative, in *belfry, saffron, mushroom, iceland;*

      c) minimally devoiced before a stresssed vowel, after a vowel other than schwa:

        a) after /s/ in the word in *dislike, dislodge, misrule, icelandic;*

        b) (again tentatively) in the head onset of a phonologically right-headed compound, in *pet-lunatic, pot-luck, pot-roast, Miss Russia, spoof reasoning.*

c) A liquid interacts with coronality in an adjacent oral stop:

   a) in the case of /r/ in the same onset, apart from being devoiced, affricating or palatalising the stop – *train, drain, strain, vestry, astride;*

   b) next to an underlyingly syllabic lateral – in *little, middle, kettle, meddle* – the coronality of the lateral effectively blocking the release of the /t/, but not its coronality, so the release is not apical, but lateral – as [lɩt̚ l̩] – like the velopharyngeal release of /t/ in *button* as [bʌt̚ n̩];

d) Otherwise – necessarily in the rime:

   a) a liquid, as a coronal sonorant, is potentially syllabic in an un-stressed syllable;

   b) /r/ is either :

      a) blocked (in some dialects/idiolects – see discussion in Chapter 6); or

      b) exclusively underlying, not surfacing as such; either

         a) with a lengthening effect, in some cases, in some dialects, triggering a schwa vowel in others, in *sailor, plaster, fear, fair, fire, sewer, dour, sour,* only surfacing phonetically by virtue of another step of word formation in *sailorish, plastery, fiery, fairer;* or

         b) with a long vowel in monosyllabic *her, cur, fir, fur, soar, core, pour;*

   c) Otherwise, necessarily as /l/ (on the observations of Gimson, 1970):

      a) lowering and centering a tautosyllabic schwa, especially in cases where the onset is labial, and the syllable is word-final – in *beautiful, careful, people, table,* as ['bju:tɩfo], ['kɛəfo], and so on;

      b) is 'darkened' to a variable degree subject to factors noted in (1.33.c). (see also Gimson, 1970, Giegerich, 1992).[17]

By (1.33), whatever the analysis of ['bju:tɩfo], ['kɛəfo] in (1.33.d.c.a), all interactions can be defined on strict adjacency. Harmonic/assimilatory interactions in the onset between sonorants and obstruents go both ways. In (1.33.d.c.a), the non-apicality of the sonorant harmonises with the obstruence of the stop. This is characterised as 'coalescence'. But the effect is not categorial. In the case of the lateral coda, the lowering (and centering) affects both the nucleus and the lateral itself – as darkening. In (1.33.d.c), there are various contributory factors. The most important of these seems to be stress. But the effect of this works in opposite ways in words and compounds, increasing the devoicing in words by (133.c.b.a.c), diminishing it in compounds by (133.c.b.b.c).

In (1.33), as noted above, an abstract /r/ is assumed, reflecting a surface /r/ in the

[17] This reinterprets Gimson's pre-generative observations in the light of generative research by Nespor and Vogel (1986). Basing himself on previous remarks by Abercrombie, Gimson notes that the phenomenon seems to be sensitive to the 'rhythmic group', and he distinguishes between *feeling* and *feel il..* But it seems clear that the phenomenon may be conditioned by phonological level in the Nespor and Vogel sense, possibly over a range of levels.

same position in more conservative dialects, such as those of the West Country.

For speakers with no r-drop, with *sawing* and *soaring* both as [ˈsɔːrɪŋ], the only contrast underlyingly and on the surface between /l/ and /r/ is in the onset. But the effect of this is not just one of where /r/ is allowed to appear. If /r/ is restricted to the onset, underlyingly and on the surface, it is at least open for re-categorisation and/or re-analysis in terms of roundness rather than stricture and/or sonorance. R-drop contrasts with the dialect of younger speakers for whom [sɔːɪŋ] is impossible.

The non-release of a coronal stop before a syllabic lateral (or nasal) in (1.33.c.c.b) is characteristic of RP. In the derivational pairs, *bottle* and *bottling, middle* and *middling,* this gives an alternation between surface forms where the property of non-release is more or less consistent in [ˈbɒt˺ɫ̩] and [ˈbɒt˺lɪŋ], [ˈmɪd˺ɫ̩] and [ˈmɪd˺lɪŋ] – where the lateral is alternately syllabic and an onset.

(1.34) contrasts the surface forms of *bottle* and *button* in three dialects, Gimson-type RP, Estuary, and Cockney. Each form is defined by particular features. Coronal is shown as Cor, non-continuance as –Cnt, lowness and roundness, as Lo and Rnd. This sets out the idea that these are three closely-related dialects.

(1.34) ***bottle*** and ***button*** – *underlyingly* /bɒtl̩/, /bʌtn̩/ (on assumptions here)

Gimson-type RP				Estuary				Cockney			
/bɒț	l̩/	/bʌț	n̩/	/bɒț	l̩/	/bʌț	n̩/	/bɒt	l̩/	/bʌț	n̩/
Cor	Cor	Cor	Cor	Cor		Cor	Cor				Cor
		–Cnt	–Cnt	–Cnt		–Cnt	–Cnt	–Cnt		–Cnt	–Cnt
	Lo				Lo						
					Rnd				Rnd		
[ˈbɒt˺	ɫ̩]	[ˈbʌt˺	n̩]	[ˈbɒt	ɤ]	[ˈbʌt	n̩]	[ˈbɒʔ	ö]	[ˈbʌʔ	n̩]

The outputs in (1.34) are reconstructed from Gimson's 1970 transcriptions. To different degrees, in each of these dialects vocalic features are added to the lateral, but in no case is there a surface collapse with a vowel. In each case, in both words, the stop is released. But in RP the release is lateral or velo-pharyngeal, rather than coronal. The variation in (1.34) is with respect to: A) the release of the /t/– coronal in [t] or non-existent in [t˺]; B) the coronality of the /t/– as [t] or lost to glottalisation in [ʔ]; C) the coronality of the lateral – as [ɫ] or (vocalised) as [ɤ] or [ö]; D) the rounding of the vocalised, non-coronal lateral – slightly as [ɤ] or rather more so as [ö].

While the transcription of the outputs understates the commonality and recoverability, the feature stacks encode the specifics and the generalisations across the three dialects.

Coronality is implemented in all four segments only in RP, in Cockney only in the nasal, in Estuary in all cases, other than next to the lateral. The non-continuance is not implemented in the oral stops in RP, other than as a release gesture. Darkening is expressed by lowness in RP and Estuary and by Roundness in Estuary and Cockney. In Cockney and RP, the nasal contrastively preserves one of the underlying features, coronality in Cockney, and non-continuance in RP. Conversely, in each of these dialects, in the distinctive environments in (1.34), one aspect of the plosive is omitted. In RP, the omission of the release gesture is reversed in a special register, when a word is used either in citation form, subject to heavy emphasis, as an insult, for clarification, and so on.

The contexts in (1.34) are similar to that of one case of lexicon-internal glottalisation in RP, in *ointment* as ['ɒɪnˀm n̩t], consistent with previously considered evidence available to the L1 learner pointing to the distinctive treatment of coronality.

(1.34) does not do justice to the phonetic complexity. But the interactions between stress, liquidity, coronality, voicing, word or phrasal category, and the mid-foot prosodic juncture, all fall within one learnability space.

In (1.33) and (1.34), I have been concerned with the interface between the phonetics and the phonology. In Chapter 7, I shall consider the possibility of reducing this interface to a point at which the quantal and categorial properties of phonology merge into the analogically defined gestures of phonetic implementation.

Let us now turn from what I am characterising here as the 'word-internal' cases to the evidence of articulator harmony between adjacent, voiced stops – at least in speech at a certain tempo – (see Kaisse, 1985). The alternation between harmonic and non-harmonic cases may be significant for learnability. The harmonic properties are Labial and Dorsal and the target is a voiced coda Coronal on the immediate left of the trigger. Jun (1996), using an experimental technique involving both production and subjective perception, argues that the harmony is partial, defined on a reduction in the 'degree' of coronality. Attested and unattested forms of this are shown in (1.35.a) and (1.35.b).

(1.35) *Articulator harmony in allegretto English speech (variable or optional)*

a) *Coronal target, Labial or dorsal trigger*		b) *Labial or dorsal target, Coronal trigger*	
good morning	gʊb 'mɔnɪŋ	*cheap nightie*	* tʃi:t 'naɪtɪ
ten girls	tɛŋ 'gə:lz	*black knight*	* blæt 'naɪt
ten brownies	tɛm 'braunɪz	*cream doughnut*	* kri:n 'dəunʌt

In this harmony, there is asymmetry with respect to coronality. The pattern in (1.35) matches that of the error data with Labial and Dorsal targeting a coda. This is only in allegretto speech. But Kiparsky (1992) notes that phonological acquisition may be helped, rather than hindered, by optionality or variability in the way processes apply.

In the case of nasals in the coda, in ways which are sometimes dialect-specific, the articulators may be treated differently.

(1.36) *Processes involving coda nasals, dialectally variable in some cases*

a) In some dialects surface realisation of final oral stop in the coda in a dialect-specific way in root morphemes, depending on voicing and articulator – in *sing, long, pong, hang, young,* and in others colescence, but in *sink, sank, sunk,* with just the dorsal harmony in the nasal, with overt labiality just where the stop is voiceless, in *lump, lamp,* etc., with unconditioned bi-segmental coronality in *paint, find.*

b) In some dialects, coalescence in superficially ambi-syllabic environments in derived *thingy, singer, singing, pongy, pongier, hanging, hanger,* etc..

c) In all dialects surface realisation of final oral stop in the onset in all monomorphemic cases including *hunger, finger, anger,* etc..

d) In a dialect-specific way surface realisation of the final oral stop in the onset, seemingly where maximal projection is involved – in comparative *younger* and superlative *youngest,* etc..

d) In all dialects, allegretto articulator harmony in a coronal coda, regressively in [tɛŋ 'gəːlz], [tɛm 'braʊnɪz] etc., and progressively in syllabic coronal nasals, in ['rɪbəm], triggered by Labial, and (perhaps less so), in *organ* as ['ɔːgəŋ], triggered by Dorsal (see Gimson, 1970).

To summarise, in Section 1.4.1 I have looked at cases where the articulators interact with each other and with other features and also at cases where the articulators are acted upon. Phonotactic, harmonic, and allophonic phenomena all demand the special treatment of coronality, the topic of Paradis and Prunet (1991), and one to which I return in Chapter 5.

1.4.2 Surface cues and the 'Continuity Criterion'

In Section 1.4.2 I consider the relation between the input – competent speech – and the learnability output – grammatical competence. In any conceivable framework, the learner has to learn the phonemic inventory, the phonotactics, and syllabic and prosodic structure (to the extent that these can be characterised as properly separate from each other). But what is the nature of the input/output relation. Is it direct? Most versions of both OT and PPT assume a strong version of what Pinker (1984) calls the 'Continuity Criterion'. Pinker explains the Continuity Criterion as follows:

> "In the absence of compelling evidence to the contrary, the child's grammatical rules should be drawn from the same basic rule types and be composed of primitive symbols from the same class as the grammatical rules attributed to adults in standard linguistic observations" (Pinker, 1984, p. 7).

Borer and Dresher (1990) argue that the Continuity Criterion should be set aside in favour of maturation. Here I shall retain the Continuity Criterion on the basis that the process of parametric settings have internal structure (developing an idea from Blevins, 1995). By this idea, the learner may be unable to set one parameter before setting another, so that at a given (early) stage, a particular sort of input evidence may be uninterpretable by the acquisition device.

On one widely held view, phonological learning proceeds by direct induction from the phonetic surface. On this view, there is a one-to-one – or 'cued'– relation between the learnability 'input', what the learner hears, and the output (what the learner concludes), i.e. the grammar. The phonemic inventory, the phonotactics, the syllabic template, the branchedness of syllabic constituents, the form and directionality of stress-contours, might all seem to be learnable in similar ways. Dresher (1999) develops this idea in relation to the stress system. A learner infers the existence of a property from the mere fact that it is attested. Each property is necessarily treated in isolation.

In the case of the syllable, to arrive at the correct settings, the learner has to make a series of adjustments to a default CV structure, each time prompted by the cue that such and such a word is undefined by the current setting, until eventually there are no more such cues, because the correct settings have in fact been reached (see Blevins 1995, and Tesar and Smolensky, 1998, for two very different accounts of this, but both taking the syllable to be a category which is learnable in isolation). Obviously, since the surface is all there is in OT, Tesar and Smolensky are committed by the logical constraints of their OT model to the notion of direct cueing from the phonetic surface. But this assumption is also made quite explicitly by Smith (1973. p. 13) and implicitly by Macken (1995), like Blevins, both working in frameworks quite different from each other's and from OT.

Here I shall refer to this idea, involving the direct cueing of parameters, as the 'Cue Based Learner Hypothesis'. According to Dresher (1999), for every parameter there is a 'correct cue' which A) reflects one of its fundamental properties; and B) is either given by UG (in Dresher's model) or is derivable from the input. But cue-based learning is problematic in six ways.

FIRST, it seems obvious that the notion of parameterisation has been invoked in a number of ways, not all compatible either with each other, where for cue-based learning to occur there is a clear entailment that the cueing is formally consistent. As an example of the problem, Backley and Takahashi (1996) suggest that melodic elements "... are arranged according to a language-specific melodic template, established according to parametric choice." This is said to define the possibilities of certain forms of vowel harmony. But the number of possibilities which this entails is not easy to compute. In what sense is such variation properly parametric? Consider the variation descriptively. The listing in (1.37) shows 22 *areas* of variation, some explicitly claimed to be parametric, the rest implicit in the literature, set out in various terminologies, reflecting various theoretical traditions. These are not parameters. The formulations just describe what the parameters (minimally) have to express. I look beyond the stress models of Halle and Vergnaud (1987), Halle and Idsardi (1994), Hayes (1995), the feature/segment model of Archangeli and Pulleyblank (1994), and the syllable model of Blevins (1994), all presented as separate and to some degree mutually incompatible exemplifications of the parametric hypothesis. In (1.37), I show in curly brackets just some of the apparent variables.

(1.37) *Some hypothetically parametric cross-linguistic phonological variations*

a) The phonetic exponence of a phonological property is defined with respect to laryngeal variation as {voicing/ aspiration/voicing and aspiration} (see Iverson and Salmon, 1995, Rice, 1995), or in voiced stops {with/without} redundant nasality, in rhotics as {uvularity/coronality}, if the latter as {retroflex/tapped}, {with/without} co-articulation, by {vocalic/consonantal} properties (see Crothers, 1973).

b) A prosodic category, word (perhaps of a given category, as in English) or foot, {is/isn't} permissibly unbranched, degenerate, or conversely, ternary or dactyllic (see Hayes, 1995), or forcibly branched.

c) Prosody is {tonal/pitch-accentual/by stress} (see Haulde, 1991, Hayes, 1995).

d) Word stress is {accentual/derivational}, and to the extent that it is derivational, based on {bounded/unbounded} constituents {of two elements/allowing three} counting from the {right/left}, {discounting/not discounting a particular rime element}, {allowing/disallowing} secondary stresses (see Kaye and Dresher, 1990, Halle and Idsardi, 1995, Harris, 1995, Kager, 1995, Hayes, 1995).

e) Heavy edgemost elements are {allowed/disallowed}.

f) Phonological association is from the {left/right/both edges} (see Marantz, 1982, Yip, 1990, Roca, 1994), with edgemost elements {contoured/associated on an adjacent bearer} (see Hyman and Ngunga, 1994).

g) The syllable {is/is not} optionally closed; the onset {is/is not} optionally null; the rime minimally consists of {one/two} elements (see Blevins, 1994, Tesar and Smolensky, 1998); a particular feature/features {occur/do not occur} in a given syllabic/prosodic constituent (see Goldsmith, 1991, Piggot, 1996, adopting different notions of 'licensing'); a syllabic category is {branched/unbranched} (see Levin, 1985, Blevins, 1994); in the case of a glide between an onset obstruent and the vowel, it clusters with the {onset/vowel}; the syllable structure is scanned from the {left/right} (see Noske, 1993).

h) The vowel {is/is not}, variably {vocalic/sonorant/free} and/or contrastively {long/tense/diphthongal}, where a diphthong {is/is not} invariably long.

i) A given {root/skeletal} element is {co-articulated/compounded/contoured/in groups of more than two} (Sagey, 1986), or, in a partial restatement of this, two sets of features are {in sequence/unordered in a single syllabic constituent}.

j) Sonority sequencing {is/is not} observed in the {onset/coda} (see Selkirk,1984).

k) All surfacing values of a feature {are/are not} underlyingly specified (see Archangeli, 1984, for an unqualified statement of underspecifiation, Archangeli and Pulleyblank, 1994, for a more qualified statement, or as a markedness condition on a lexical stratum, see Kiparsky, 1985, 1993).

l) An alternation between a vowel and zero is treated by a rule or principle effecting {epenthesis/deletion} (see Charette, 1991) or, in the case of a dialect variation, by gestural {loss/addition} (see McMahon, et al, 1994).

m) A given set of featural properties is {segmental/autosegmental/segmentally complex} (see Evans, 1995).

n) The presence of a coda {is/is not} equal to a long nucleus in the computation of syllabic weight (see Hyman, 1985, and Roca, 1994); compensatory lengthening {is/is not} triggered by elision (see Bickmore, 1995).

o) Within a given domain, a substring of the featural geometry harmonises as {a trigger/target} on the {right/left/both}, {opaquely/transparently/as a blocker}, {changing/not changing} underlying properties (see van der Hulst and van de Weijer, 1995), {locally/over a long distance} (see Gafos, 1998).

p) Consonants and vowels {are/are not} on separate planes (see Macken, 1995), permitting long distance harmony (see Archangeli, 1984) or involve co-occurrence restrictions or the derivational morphology (see McCarthy, 1989, McCarthy and Prince, 1995).[18]

q) The morpho-phonology {permits/prohibits} the copying/reduplication of segmental sequences (see Gafos, 1998).

r) The Obligatory Contour Principle {is/is not} violated with respect to a set of melodic featural contrasts F (see Hume and Odden, 1995).

[18] This work, on Semitic languages in particular, most recently reported in McCarthy and Prince (1995) is now recast in the OT framework of ranked constraints, not parametric alternation.

s) A rule or process effecting {deletion/insertion/lenition/fortition/harmony} is defined on one or more members of a continuous series of lexical strata (see Mohanan, 1993) or levels on the prosodic hierarchy (see Nespor and Vogel, 1986, p.182).[19]

t) A prosodic clash or conflict arising in the course of derivation {occasions adjustment/is ignored}, if the former by {lengthening/shortening/redefinition or revocation of more general principles} (see Harris, 1995).

u) A set of one or more elements have more than one categorial or representatonal analysis, e.g. /r/ as {glide/liquid} (see Kahn, 1976), or a glide in a prevocalic cluster with dialect-specific analysis as part of the {onset/vowel} (see Davis and Hammond, 1995).

v) The formation of phonological constituents {follows/precedes} affixation (see Inkelas, 1993).

All cases in (1.37) have to be learnable.[20] The fact that only some of these have been treated parametrically is not the issue. The issue is the sheer diversity of (1.37). Plainly the listing in (1.37) underestimates the variation. But (1.37) does not seem plausible as a description of what the learner has to attend to in order to reach a given learnability target.[21] As Kiparsky (1995) notes, it may not be immediately obvious, in respect of a given variation, which parameters are involved.

SECOND, there is an issue (noted by Ingram, 1995) in relation to Macken's (1992 and 1995) application to phonology of the Subset Principle (see Manzini and Wexler, 1987) – that the learner seeks to disconfirm too inclusive a grammar. Macken suggests that before the input data has been evaluated, i.e. in the default condition, the realisation of articulators should be defined in terms of some universally available maximum domain, such as the word or morpheme. Such a state is reflected by the case of A (Smith, 1973) who for a period at the age of 2;4 said *snake* as [ˈŋɛɪk]. By the evidence of both coronality and continuance in the /sn/ onset, the learner is forced to retreat to a more restricted domain where the target is an adjacent coda element. But what is the status of the default? A postulated developmental default should have cross-linguistic justification. Mohanan (1993) shows that many languages harmonise what we might for the moment call 'non-coronality' in a nasal to an immediately adjacent oral stop. Coronal harmony is almost unattested, as in English. But there are two problems in the case of Russian. Barry (1993) shows that in two loans, neither in

[19] Nespor and Vogel assert that this hierarchy is universal. From this it does not follow that this universality is always exploited. (See Section 6 for more discussion).

[20] Macken's discussion refers implicitly both to the work of Archangeli (1984) on the root morphology relations in Yokuts dialects and to the (early) work of McCarthy (see note above).

[21] The point at issue is similar to Webelhuth's (1995) list of distinct functional projections each with a supposedly parametric variability – including both negation and gender agreement.

common usage, *function* and *point* there is surface coronality in [ˈfunktsɪa] and [punkt] – contrasting with surface dorsality in *bank* as [baŋk]. Russian would thus seem to spread dorsality only where it is not the case that there is a coronal immediately to the right of the dorsal. By what seems like a typologically marked condition, the dorsal harmony is then blocked. But how does the learner learn this? In the framework here, this is not finitely learnable unless it is expressed elsewhere in the phonology. For the learner of Russian, there is another learnability issue in respect of voicing harmony where the domain is *larger* than the word. Putting the two cases together, harmony in respect of voicing and articulation, it is not obvious what sort of evidence would force the learner to retreat from two defaults in opposite directions. It is possible that the L1 learner progressively narrows the scope of one harmony and extends that of another. But this seems arbitrary and unconvincing. It is clearly preferable to define the learnability space in such a way that we do not have to stipulate defaults with respect to the harmonic scope of particular features.

THIRD, there is an issue about syllable structure. In English, apart from *a* and *the*, the minimal word has either a closed syllable, a long vowel, or two syllables, i.e. as 'bi-moraic'. But given the frequency of *a* and *the*, how does the native speaker of English determine that they are exceptional? Alternatively, given the evidence of the non-lexical phonology, how does the learner determine that a mono-moraic lexical item would fall outside the permitted phonotactics? On set-theoretic prinicples, there is no hypothesis from which a cue-based learner can be forced to retreat so as to define learning on this point. The evidence of type- and token-frequency seems to point in opposite directions. One way to ensure learnability in such cases is to invoke labeling under the categories, 'functional projection' and 'lexical item'. But this is not allowed within the Cue-based Leaner Hypothesis.

FOURTH, by (1.37.u) there is an issue with regard to abstract exponence with respect to /j/, /w/, /l/ and /r/.[22] In the case of /r/, there is reason for doubt about its categorisation as a liquid. The problem is compounded when there is an independent variation with respect to syllabicity. In the American English of Davis and Hammond (1995) and the British English of this author, it is necesssary to differentiate between /j/ as a singleton onset, in *yew*, and where it occurs between a consonant and the nucleus, in *dew*, *new*, etc.. On Davis et al's analysis of the two glides /j/ and /w/, only /w/ clusters in the onset in *twin*, *queen*, *quite*, etc., while /j/ in *tune*, *few*, *mite*, etc., is said to form a 'co-moraic' element with the nucleus. In the idiolect of this author, there is an intuitive argument in support of this: *squire*, *choir*, *wire*, *higher* all

[22] The evidence of this study does not seem to bear in any direct way on the question of whether the glides constitute a distinct category or whether they are suffiiciently defined by their featural representation and by their 'consonantal role' in the syllable.

rhyme; but while *skew, stew, due* and *queue* rhyme with each other, neither rhymes with *Sue* or *do.* (This intuition is not shared by all British English speakers). There is a learnability question here. How/why do learners like Davis et al and this author discount the obvious idea of a simple symmetry of /Cw/ and /Cj/ onsets, settling instead for the less obvious analysis of asymmetric syllabification? In order to distinguish between /CwV/ and /CjV/ structures, hypothetically 'co-moraic' in /CjV/, not in /CwV/, the syllabification has to be encoded separately from the phonetic melody. In a way more or less represented by the orthographic representation, the [+high, –back] values in the /CjV/ environment must be finitely determinable as vocalic in dialects like that of Davis et al. Chapter 7 considers a hypothesis according to which there is a surface cue defining both vocalic and non-vocalic analyses of the /j/ element in /CjV/ structures, but this involves reference to the derivation of the element in a way not permitted by the Cue-based Leaner Hypothesis.

A similar issue arises in the Canadian French of Charette (1991) and the American English of Kaisse (1985). In the case of Canadian French, the learner's experience of common, utterance initial *demande moi, reprends la,* as [dmɑ̃dmʷɑ] and [rprɑ̃lɑ] is open to mis-interpretation as syllable initial /dm/ and /rpr/ unless these and other cases with a pre-tonic schwa are correctly syllabified. In Kaisses's dialect, the same process occurs in *Toledo* as [ˈtlɛɩdəʊ]. In relation to such dialects of English and French, the learnability system has to ensure that these superficially empty vowel slots are recognised by the learner as such.

FIFTH, there is an issue concerning the lexicon-internal/post-lexical distinction. Here the term 'lexicon-internal' is introduced for the sake of clarity, in contrast to rule domains characterised as 'post-lexical' (see Rubach, 1992, Kiparsky, 1995). A cue-based learner depends on finding minimal pairs such as *nitrate/night-rate*. Here the interpretability of the input evidence depends on the labeling of the relevant boundaries, involving the elements in a compound in one case and word-internal in the other. This is exactly the case ruled out by the learnability condition in (1.32.a). Conversely, a learnability algorithm with the power to resolve the issue of lexical level entails a procedure of evaluation which is both top-down and bottom-up. This cannot be cue-based.

SIXTH, there is a problem from the results of Bertolo, Brohier, Gibson, and Wexler (1997): given two weakly equivalent grammars, finite learnability cannot be ensured by the Cue-based Leaner Hypothesis. Weak equivalence arises wherever it is possible to give more than one account of the same data. Bertolo et al construe their point in relation to syntax. But it applies no less sharply in phonology. Consider the case of autosegments, templates, complex segments, epenthesis, and deletion, in some instances more than one of these being available to describe a set of data. Consider the following cases. A) In some Australian languages there is a choice between autosegmental and complex-segment analyses (see Evans 1995). B) In French and Portuguese the contrast between nasal and non-nasal vowels can be treated autosegmentally or by virtue of an underlying property. C) In English, to characterise a number of Greater London dialects including RP, it is necessary to postulate deletion in *long, sing,* etc., and epenthesis in *prince, length, lymph,* etc., in the lexicon-internal phonology. So both devices must be available to the L1 learner. The learnability issue is with respect to /s, z/ in plurals and third person singulars. The alternation between cases where the root has a sibilant on the right edge, surfacing as [ɪz], and all others, surfacing as [s] or [z], is open to analysis either by deletion or by epenthesis.[23] On one analysis, the vowel is epenthetic in *edges, catches, wheezes, misses, wishes,* and now *rouges.* On another analysis, it is deleted in all other cases. If so, we have a case of weakly equivalent analyses of the number morphology. On the results of Bertolo et al (1997), this is unlearnable by the Cue-based Leaner Hypothesis.

This Section has provided six reasons to reject the Cue-based Leaner Hypothesis. In relation to the sixth we can: A) abolish weak equivalence by prohibiting one or more of the mechanisms bringing it about; or B) characterise acquisition in a different way. In Chapter 7, I consider some possible ways of addressing both of these objectives.

1.4.3 A 'Parameter Setting Function'

In Section 1.4.3, addressing emerging concerns about phonological learnability (see Ingram, 1992, and Dresher and van der Hulst, 1995), foreshadowing further discussion in Chapter 7, I shall assume that the input/output relation cannot be determined *a priori.* I shall allow the possibility of an abstract relation between the form of the parameters and the nature of the criterial learnability evidence. This will entail a correspondingly subtle evaluation of the input by the L1 learner. In Chapter 7, I shall advance some hypotheses concerning a learnability device capable of 'crunching' indirect evidence, as a way of addressing the problem of phonological learnability.

Recall the cases of *squeaky* as [ˈgiːpɪ] and *calculator* as [ˈkæɫtəlɛɪtə], at different levels of development, but both reflecting grammars in which long-distance articulator harmony is not disallowed. The problem is that no parameter defining such a grammar is justifiable by any form of competent phonology, since no natural language permits any such harmony. It appears that idiolects with [ˈgiːpɪ] or [ˈkæɫtəlɛɪtə] involve a parametric selection outside the set of those made available by UG. Call this the 'No Proper Subset Problem'.

[23] The fact that an under-specification approach is adopted in Chapter 6 does not affect the point at issue here.

Before the activation of a specific learnability device, the decisive input evidence may be both inductive and stochastic – on the basis of distributional asymmetries or absolute definitional properties of the inventory. A stochastic learner is sensitive to features relevant to the target language, breathy voice in South-East Asian languages, diphthongs in English, the evidence of paradigms – *sat, pat, spat, sprat,* and more. But as the learner becomes sensitive to meaning, and relates this to the categories of grammar, a stochastic approach to phonetic and phonological learning is likely to be quite misleading. The learning device has to be re-organised so that it is not misled by data such as *a* and *the*. From this perspective, the idea of a genomic adaptation for speech should be considered in two parts, the representational principles, and the input-output relation in speech/language acquisition. Consider the claim in (1.38).

(1.38) By an interpretive Parameter Setting Function , or PSF, categorial aspects of phonological variation (as featured in the input) are mapped onto linguistic properties. The PSF is species-specific. It is distinctively, and perhaps definitionally, part of the human genome. The developmental activation of this funtion is revealed by a simultaneous increase in the lexicon, phrasal complexity, phonological analysis (and possibly in metalinguistic awareness). Without a generalised function of this sort, the simultaneity and multi-factoriality of language development is just coincidence.

(1.38) postulates a function of some power.[24] Evidence for (1.38) is from the data here. It is a consequence of (1.38) that all aspects of the learnability space are subsumed within one set of variations. All aspects of phonologically variable information are encoded in the same way. The mapping referred to in (1.38) is repeated over and over again for all aspects of phonetic/phonological competence. Necessarily the mapping is indirect, hence the term 'function'. There is thus no reason to expect the criterial aspects of the input to be of a particular form. In fact, the inputs and the outputs of the system may be non-isomorphic. But the key idea is that the function is uniform. Learnable variations are *entirely* expressed in terms of a small set of finitely variable properties, defined as parameters in terms which go beyond an inventory of elements, conditions on their co-occurence, and allophonic rules. To address all of the questions implicitly raised by (1.38), it would be necessary to specify, not just the parameters, but the relations between them, the learnability space, and the input

[24]Such functions are not uncommon in psychology. At a relatively low level of phylogenetic development, there is significant computational power in stereo-scopic vision and the plotting of direction from binaural hearing. In both cases, the function seems to be both top-down and bottom-up. In hearing, for example, it is top-down in the sense of identifying a sound source of a particular kind and the characteristics of its modulations, and bottom-up in the sense of plotting the time-relation between the stimulus of a given modulation in the two ears respectively. The case of stereo-scopic vision is similar. Both of these faculties are shared by human beings and mice. A function mapping the input evidence of competent speech onto a grammar is obviously human-specific.

variables. In this study, I shall focus mainly on the form of these parameters. Given A) the asymmetric error distribution; B) SSLI as a syndrome; C) the learnability argument from weak generative capacity, I propose that:

(1.39) The PSF is a 'parameter independent general algorithm for parameter setting' to use a phrase from Dresher (1999). (Dresher denies that there can be any such thing). On the 6 grounds in Section 1.4.2, the PSF is not cue-based. It is:

a) such that it permits an indirect relation between learning inputs and outputs;

b) like other aspects of psychology / biology, variable across the population with respect to the speed and absolute completeness of its operation;

c) open for a finite period (as a necessary condition of finite learnability).

Unlike the capacities available during the first year, the PSF maps a set of inputs indirectly, i.e. non-inductively, onto parametric decisions. A defect with respect to the PSF (often genetic) may have correspondingly long-term consequences. The idea of a PSF addresses Grunwell's problem by implying a set of states in which one or more mappings is incomplete. The disordered state, characterised by a PSF defect, leads to a general inability to compute the necessary mappings.

The PSF is consistent with Lenneberg's 1967 theory, according to which there is a finite window for what is now referred to as 'parameter setting', maximally 'on line' during a finite period, opening between 1;6 and 2;0, as noted above, and not normally closing (by the evidence of the study reported in Chapter 3 below) before 8;6. This notion of a finite window for parameter-setting is not uncontroversial (see Archibald, 1995, Schwartz, 1997).[25] The phonological case is complicated by the evidence of loan phonology. The author has observed monoglot speakers of Greek with the English loans, *sex* and *sportsman* as [sɛks] and [spɔːrtsman], with the surface forms violating in different ways the standard phonotactics of the Greek coda. But such toleration is not universal. Blevins (1995) observes Chinese speakers, with some knowledge of English, unable to pronounce *Nixon* and *Juliet* – re-analysing them as [nɩkɛsun] and [dʒulɩjɛ] or [dʒulɩjɛdɛ] (adapting the transcription for the sake of consistency).

[25] There seem to be at least two ways of defending the 'finite-window-hypothesis' against evidence of the sort adduced by L2 theorists like Archibald. One is to say that there is variability across the normal population with regard to the closure of the window; that in some individuals it does not close completely, resulting in an 'ear for languages'. The other, from Tsimpli and Roussou (1991), is to say that L2 learners mimic the effects of parameter setting by a different set of psychological resources. Taking this conclusion from syntax, and adapting it to phonology, some L2 learners may mimic the effects of normal L1 parameter setting by an extreme form of what might be characterised as 'late phonetic adjustment'. In the framework here, the former approach is more parsimonious, and thus preferred.

Here, on the evidence of this study, the idea of a finite time window is assumed. It is a consequence of the PSF and the time-window idea that the rate of phonetic/ phonological acquisition may itself be not constant. There is evidence for this in a plot of this rate across social class. Anthony et al (1971) show that the rate of development doubles, in their social class 1 between 3;6 to 4;0, in classes 2, 3 and 4 between 3;0 to 4;6 and in class 5 between 5;0 to 6;6 (table V. p.16).

To conclude Section 1.4 I have argued that parameter-setting is: A) not cue based; B) fully functional only during a finite period; C) selectively vulnerable; D) mediated by a Parameter Setting Function.

1.5 Summary: the strong parametric hypothesis

In Chapter 1, I have demonstrated some asymmetries in the distribution of some consonantal errors in some children with phonological disorders. Some aspects of this asymmetry, like the prevalence of the dorsal or velar form of articulator harmony in *doggy*, are observable in early child phonology. Other aspects of the asymmetry like the special distribution of coronal harmony are only visible at a point closer to Stage $_n$. At this point the errors may be only observable in a small number of words. In the limit, these environments may represent singularities. But it does not follow from this that the environments are marginal. A generalisation over phenomena with a low rate of attestation is not diminished, in terms of its significance, by the rate of attestation. Rather the significance is enhanced.

Some environments, like the one for coronal harmony, seem to have a lowermost threshold. It is not obvious how this could be expressed in any sort of bottom-up model, whether based on articulation, perception, or both.

Are the asymmetries set out in (1.22) specific to the clinical population? If they are, this may say something interesting or significant about the condition. But this would have no necessary or general significance in relation to phonology. But if the asymmetries in (1.22) are not specific to the clinical population, but a reflection of phonological in general, this may tell us something about the nature of the process, one that is not easily explained by a bottom-up approach. I shall turn to the empirical question here in Chapter on the basis of evidence from normally developing children.

By any theory, phonological competence is reached at Stage $_n$. But what guarantees the completeness of this process? What sort of input evidence is criterial? Do exceptionless, structure-preserving processes like those of regular English inflection provide more easily interpretable evidence than those which are a function of speech rate and so on? Or the other way round? Do allophonic alternations provide useful clues or cause confusion? Do learners vary in what evidence they find easiest to interpret? If there is evidence for the learner in gaps in paradigms, how is this evidence interpreted and understood? Why, at a stage of incomplete competence, is there evidence of organisation in the distribution of children's speech errors? What is the reason for the asymmetry and apparent singularities?

Here I shall lead towards the idea that these questions are best addressed in the framework of Principles and Parameters Theory, or PPT. This raises the question of phonological learnability and what I shall refer to here as the 'learnability space'. PPT is interesting in inverse proportion to the number of parameters. A surface-cued parameterisation defining the variables in the 52 sets of curly brackets in (1.37) generates 2^{52} posssible instantiations of C_{HL}, a quite uninteresting statement, explaining nothing. Here I shall explore the idea of a PSF, or Parameter Setting Function, as a way of defining the acquisition of phonological competence.

In the framework here, this competence includes the dialectally variable 'gestural epenthesis' in *prince, length,* etc., coda lateral darkening, epenthetic /r/ in *India and Asia,* what has been characterised here as 'g-drop', and the syllabification of the glide in /CjV/ structures. In all of these cases, Southern dialects pattern differently from at least one dialect in Scotland or the North of England. Phonological competence also includes the relatively extensive vowel lengthening effect of voicing in the coda, greater in English than in other languages with the same contrast (and thus not attributable to phonetic implementation), and the subtle interactions between continuance, liquidity, voicing, and stress, in (1.33). Treating this parametrically entails a 'strong interpretation' of PPT. The parameterisation must include the whole set of 'characters' which are recognised within a community of speakers, however small, as defining their dialect or accent, i.e. all definable aspects of linguistic learnability, including what is sometimes regarded as 'phonetic detail'. It might seem that the effect of this is simply to increase the explanatory issue emerging from (1.37). But in Chapter 7, I shall consider a set of hypotheses according to which the expanatory issue is not increased, but decreased.

I have already noted that from the idea of a PSF, we might expect significant variations across individuals. In Chapter 7, I shall consider how for some individuals, in most cases to only a small degree, the indirectness of the mapping may pose a problem.

Chapter 2 asks how PSF defects, effectively SSLI, can be described in a general way.

2 A principle in disorder

Chapter 2 works towards a *general* characterisation of asymmetries in error patterns in terms of 'Phonological Parapraxis', or PP. The indulgence of the reader is sought on the point that PP is a reasonable hypothesis. It is based on a substantial body of data, as reported in Chapter 1, from the literature and from my own clinical practice, the latter summarised in Appendix 3. Collected for treatment, not research, this data consists only of errors. I shall, in Chapter 3, seek to provide a quantified basis for PP. To express its variability, it is characterised here in terms of 'limits on association'. By the notion of 'association', a melodic element is related to phonological time as a derivational event. This idea is discussed further in Chapter 5.

Section 2.1 introduces PP. Section 2.2 introduces a 'Representability Inspection'. Section 2.3 proposes that the 'noisy' data of PP is analysable and relevant. Section 2.4 describes more clinical and other data. Section 2.5 returns to the question considered in Chapter 1 concerning an alternative approach to the data here, namely as SOT's, and concludes that the approach here, in terms of PP, is justified. Section 2.6 relates PP to the PSF.

2.1 Phonological parapraxis

Use of the term, *parapraxis,* in relation to speech errors is due to Hockett (1967) who takes the idea from Freud's *Pychopathology of Everyday Life.* Stacey, editor of the 1966 English edition, notes that Freud's term for *parapraxis* was *Fehlleistung* – a 'fault function'. The term *parapraxis* is due to Brill, the first English translator. Stacey comments, "It is a curious fact that before Freud wrote this book the general concept seems not to have existed in psychology, and in English a new word had to be invented to cover it" (Freud, 1966, p. viii). Freud's data on this point consists of 83 observations of his own and 11 from an independent source.

(2.1) sets out what seem to be the main, distinctive properties of PP.

(2.1) *Properties of Phonological Parapraxis, or PP*

a) Special involvement of coronals

By the experience of the author and numerous other therapists, common speech errors in children and adults involve the coronals /s/ and /ɾ/, the former referred to as a lisp.

b) Long-term expression or developmental continuity

In Chapter 1, I described the cases of PR (see Appendix 3) and an unrelated child with fronting in infancy and later on in development what seems like context-sensitive coronal harmony in *cardigan* and other words. Seemingly similar errors are sometimes made by the parents of affected children, suggesting that this is the residue of a greater problem in infancy.

c) Prevalence within a population or consistency in an idiolect

Particular errors, such as *hippopotamus* as [hɪtəˈpɒtəməs], are heard in diverse individuals, including some adults.

d) Involvement of both melody and prosody

Melodic properties seem to be vulnerable in prosodic environments, e.g. the articulators in the onsets of the weak branches of both feet in *hippopotamus*.

e) Some lowermost thresholds

Using the term *threshold* to refer to a criterial degree of structural complexity, there seems to be a lowermost, dactyllic threshold for both metathesis and coronal harmony.

f) Multiple triggers

An error of a particular sort is occasioned at a certain threshold where various effects combine. For instance, in the case of coronal harmony, there seem to be always two coronals, one in the final syllable. Wherever labial harmonises or metathesises, there is also vocalic roundness. And so on.

g) Asymmetry

One sort of asymmetry consists in a uni-polar relation between two elements – in cases of harmony – as $\alpha \Rightarrow \beta$, but not the inverse, i.e. ◆$\beta \Rightarrow \alpha$, where α and β denote any set of one or more phonological features, e.g. *calculator* as [ˈkæɫtəlɛɪtə] not ◆[ˈkæɫkəlɛɪkə]. Another asymmetry involves a target, for instance, *gobbledigook* as [ˈgɒbəɫdɪguːp], not ◆[ˈgɒbəɫdɪbuːk]. A third involves a particular process, as in the case of *diplodocus* with copying as [dɪpləˈdəukləs], rather than deletion as ◆[dɪpəˈdəukəs].

h) Autonomy or non-reducibility to sensori-motor or other 'interface' factors

In their form and distribution, these errors are not reducible to the Articulatory/Perceptual or A/P interface. In *hospital* as [ˈhɒstɪpö], two elements, in this case the articulators, are just re-ordered.

i) Non-detectability by the speaker

Unlike slips of the tongue, parapraxic errors are commonly undetectable by the speaker, and correspondingly resistant to correction.

j) The appearance of derivational depth

In a case discussed in Chapter 1, there was distributional evidence of an ordered sequence of three steps in *cardigan* as [ˈkaːdɪntən], where the relevant processes are not attested other than in realisations such as [ˈkaːdɪdən] and [ˈkaːdɪtən].

k) Long range

Whereas harmony in competent phonology appears to be exclusively local (where the issue of locality is discussed further in Chapters 5 and 6), some aspects of parapraxis seem to be 'long range'. For instance, in *hippopotamus* as [hɪtəˈpɒtəməs], there is a potential target which seems to be 'skipped'.

l) Finite variation or variability

There is a limited degree of indeterminacy/inconsistency/variability. In *diplodocus*, all one-step errors seem to be in the strong foot, as [dɪplə'dauklәs] epenthetically, and as [dɪplə'gəukəs] or [dɪplə'dəusəs] harmonically, where the focus of one harmony seems to be the trigger of another.

m) Specified target

Across a wide range of development, articulator harmonies tend to have one target. They are mostly 'bounded'. Unbounded harmony is characteristic of disorder, e.g. [ə mə'dʒɪʃəm ɪb mə paɪm ə 'wəubək] representing *a magician is a kind of robot*.

As a way of referring to phonological incompetence of various degrees, what does the notion of parapraxis buy us?

(2.2) *Consequences and reflections of phonological parapraxis, PP*

a) Without PP, it is hard to find a non-negative characterisation of Specific Speech and Language Impairment, or SSLI from Section 1.3. By PP, it is possible to explain the three distinctive properties of SSLI, its heritability, multi-factorial expression, and extended natural history, and the novel idea of a genetic learnability trigger.

b) PP achieves a conceptual economy. If the asymmetry in children's speech errors is reduced to speech errors in general, the fact that the former are an aspect of development is co-incidental. If children's errors are defined as prolonged immaturity, the fact that they are similar to some speech defects in adults is co-incidental. If speech defects are as the residue of childhood disorder, the fact that the former pattern with 'cloth ear errors' is co-incidental. (But see Vihman, 1996, p.49, for an opposite view). PP allows generalisations across: A) 'articulatory disorder' including lisps, B) 'phonological disorder', 'dyslalia', 'developmental dyspraxia of speech', C) Smith's (1973) 'incompetence rules', D) speech disorders persisting into adulthood, E) 'cloth ear errors'.

c) By (2.1.a), the notion of PP underpins the common clinical observation that 'articulatory problems' with /r/ and /s/ seem to co-occur with 'phonological' problems more often than would be predicted by chance.

d) In respect of disorder or pathology, PP reflects a defect in the Parameter Setting Function postulated in Section 1.5. In relation to Principles and Parameters Theory, or PPT, PP characterises the situation where a parameter is either yet to be set or inaccessible to the PSF. Unusually, HI, featured in the Introduction, also had harmonies involving the functional, or non-lexical, categories. One interpretation of this is that he did not have a full grasp of the lexical/non-lexical distinction. If so, this must have had consequences for his acquisition of syntax. In point of fact, HI's syntax had previously been very delayed, and was still, at 9;0, delayed to some extent. Foreshadowing more discussion in Chapter 7, his 'labeling' of the input data was defective – with serious and far-reaching consequences.

e) In Freud's use of the term, 'parapraxis' represents a continuum between pathology and everyday dysfunction, replacing the rigid pigeon-holes of 'sanity' and 'insanity'. The idea here is similar. The scale and significance of PP varies across individuals, conditions and stages of development. For most adults, for most of the time, it is insignificant. At earlier stages of phonological development, especially where the degree of incompetence has led to referral for speech and language therapy, it is very significant. In relation to a single, notionally-incorrect realisation, it is worth distinguishing between the *threshold* and the *scope* of PP, where the former defines the degree of complexity at which it occurs and the latter defines the difference between the actual and the canonical realisation. Dorsal harmony in *diplodocus* as [dɪplə'gəukəs] would not seem to entail *ticket* as ['kɪkɪt]. The scope/threshold distinction avoids this absurdity. It ensures, in other words, that the account does not 'over-generate'. In this case, the threshold ranges from two to four syllables. The greater the disparity between the phonological complexity of the target and the individual's threshold of parapraxis, the wider the scope of the parapraxis. Take *diplodocus* as [dɪplə'gləukəs], with the copying of the lateral as well as the dorsal harmony. Here the scope of the parapraxis comprises two steps, articulator harmony and lateral copying. At a given threshold, the speaker's phonetic/phonological competence is overwhelmed, as in the case of a realisation as [gɪplə'gləuklət], where the only undisturbed consonantal constituent is the /pl/ onset. As a function of development, the *scope* of parapraxis declines, while the *threshold* tends to rise. In the case of adults' cloth ear errors, the parapraxis is (typically) narrow in scope, at a high threshold. Conversely, to characterise the scale of a disorder, as opposed to a single error, I shall speak of the *density* of the parapraxis, referring to both the scope and the threshold. On such a scale, a six year old saying *diplodocus* as [gɪplə'gləuklət], or the normally developing child at what Smith (1973) called 'Stage 1', both display a relatively dense parapraxis. At any level of development, for any density of parapraxis, it is possible to plot similarities or differences between individuals.

g) In the context of both child phonology and paediatric clinical practice, the notion of PP suggests a methodology working backwards from Stage $_n$.

It is obvious that no absolute claim can be made about the limits of parapraxis – either in terms of scope or threshold – since for any case it is always possible to find a more extreme one. Consider the seemingly common metathesis in *hospital*. One child, the speaker of *soldier* as ['həuwuv], said (consistently) *hospital* as ['hɒspəpu] with labial harmony. This was exceptional. But not one child has been observed by this author with a coronal harmony in this environment, hence ◆['hɒstətu]. While these were not the only errors with respect to this word, the total range of errors was, in fact, quite small. To this extent, the claims being made here are claims of general tendency, measured in this study in terms of *prevalence*.

Treating SOT's as matters of performance, I shall assume here that these must occur as part of the everyday human operation of a skilled system, or due to some extraneous factor, such as a psychiatric condition in general, or the special set of conditions studied by Freud. But in a way quite different from that of the Freudian tradition, I assume also that some errors are inconsequential. At the point where a skilled system has reached its limit, it must occasionally fail. Some aspects of this failure may be random – mere noise in the data. The notion of PP thus allows that SOT's do occur as one-off, phonologically-describable, events, but are not necessarily *organised* in such a way as to constitute data for phonological theory.

The idea of PP emerges in a framework quite different from the study of SOT's. The research methodologies are necessarily quite different. As I shall seek to show in Chapter 3, PP seems to be measurable, at least in principle. It is not obvious how this might be said of SOT's, although I shall describe an attempt to do just this in Section 2.5 below. Points of similarity between PP and SOT's may emerge. But there is no *a priori* reason for or against any such expectation. (In fact, as shown below, there are both similarities and differences). SOT's and PP seem to be related, but distinct. A hint along these lines is given by Berg (1992). Given the notion of 'cloth ear errors' from Chapter 1, it might be said that some SOT's are more accidental than others.

Defined on a degree of incompetence, rather than competence, PP is not a dialect. But although there are broad patterns in PP, at a certain level of detail, the distribution may be unique for every individual. To this extent it is possible to speak of idiolects.

I shall exemplify the notion of PP further in this Chapter.

2.2 Representability Inspection

This Section proposes a 'Representability Inspection', used by all competent speakers, operating parallel to, but separate from, phonological competence, monitoring speech for purposes of speech production and processing, and involved in the recognition of an error as such, as part of a normal feed-back process (see Nunes 1994).

Consider the judgement that words such as *monopoly* are 'hard to say.' What faculty is being addressed? Assume that the idea of a 'difficult word' reflects an 'Inspection'

– which can be failed. Let us postulate a 'Representability Inspection', applying generally to the representation of a word in the lexicon – uttered or not. The R-Inspection is called up: A) when a sound is heard where there is doubt about about whether it is a sound of speech; B) when the competent speaker hears a word from a non-native speaker; C) when a non-native loan word is being assimilated; D) when the hearing-conditions are adverse; E) by the experience of /bnɪk/ and other such structures imposed on the listener as a linguistic or psycho-linguistic exercise. The R-Inspection determines whether or not a particular phonological structure should be treated as interpretable – with a mapping between surface and underlying form. A difficulty in the mapping triggers an 'R-Inspection alert'.

There is some independent justification for an R-Inspection from the notion of a 'buffer', or temporary store of information, postulated in Nunes (1994), on the basis of work by Caramazza, Miceli, and Villa (1986), Bub, Black, Howell, and Kertesz (1987), Romani (1992), as the faculty which is damaged in the case of stammering. On this account, in the normally fluent population, the buffer permits the accurate integration of least three sorts of on-line feedback, auditory, proprio-ceptive, and tactile, and it facilitates the accurate phonetic control of phonological time. One input to the buffer is thus the phonetic surface. By the claim in Nunes (1994), this buffer is on more than one level.[26] If one such level is the word, the action of the buffer and the detection of (some) SOT's by some speakers presuppose both a representation and the process characterised here as the R-Inspection. On grounds of parsimony, the R-Inspection is likely to be within the buffer. On clinical evidence, the buffer does not come into operation until some time after the beginning of connected speech. The clinical evidence consists in the fact that in the literature on stammering, surveyed in Nunes (1994), there is not a single case of a child stammering on the first words. At the very earliest, the symptom seems to appear around 2;0 in children who have already been talking for several months.

The R–Inspection is different from A) the SPE evaluation metric computing the number of steps in a mapping from one representation to another; B) 'morpheme-structure conditions' as discussed (critically) by Smith (1973); C) Goldmith's 1990 licensing of features in particular syllabic environments. The R-Inspection determines

[26] Evidence for such a buffer in Nunes (1994) is from the different effects of delayed auditory feedback in the normal population and stammerers, covert stammering, and a phenomenon which seems to be the equivalent of stammering in the signing population. Extending this idea, it seems possible that it is also involved in the psycholinguistics of syntactic movement, or 'Feature-Attract', where at the highest level in this buffering, the Wh morpheme is stored, at least until the speaker or hearer arrives at the corresponding trace, possibly on the right edge of a sentence with an unlimited degree of embedding. This is consistent with the fact that while the leftwards movement of Wh morphemes is common, the rightwards movement of this morpheme seems to be unattested (see Radford, 1998). Given the notion of the buffer, this has an articulatory / perceptual explanation.

whether or not a representation is 'difficult'. But it is not all-or-nothing. It tolerates a degree of exceptionality in loan words. It measures the distance between a given structure and a current lexical item, recapitulating the process of learning a word.

Neutral between processing and production, the R-Inspection defines an individual's threshold of parapraxis. It may influence the way a newly encountered word is entered into the lexicon. This does not mean that the incompetent speaker's UR is the same as his or her realisation. But it allows that such a UR may be different from that of a fully competent speaker. So the incompetent child is likely to make more *sorts* of errors and more errors overall than the competent adult speaker.

Phonological progress requires a continuing re-evaluation of the R-Inspection. At any given point in the process of acquisition, the R–Inspection is sensitive to a particular set of factors. At Stage $_{n-1}$ it comes into play only at a high threshold of structural and/or syllabic complexity. At earlier stages, the threshold is much lower. It follows that at any point there may a Lexical Item LI_i stored in parapraxic form following an R-Inspection sensitive to one set of properties and a more recently acquired item, LI_j, minimally different from LI_i, but not subject to the same parapraxis. The effect of this situation is that acquisition may seem – misleadingly – to be by diffusion rather than across the board.

Plainly, while the principle of the R-Inspection is universal, its content is language-specific, at least to some degree determined by the PSF. For any target language, the learner has to learn what is representable and what is not. But equally the R-Inspection is separate from the grammar. Empirically there is the 'fuzziness' of the loan phonology (see Coleman, 1998), where items violating the phonotactics of the loaning language may be realised without effort and without instruction, but variably even within a dialect. By the claim here, conscious judgements about the phonotactics are thus exercised by a separate module, namely the R-Inspection, not part of the grammar.[27]

If the phonotactics are judged by the R-Inspection, as claimed here, this capacity is accessible to a stochastic device, postulated here as the first step in identifying the featural/prosodic properties of a target language. By the idea of an R-Inspection, it is possible to explain how children who detect an error such as *Melanie* as [ˈmɛnənlɪ] in their speech sometimes repeat the word, still incorrectly, but in a way that does not violate the phonemic canons of English, say as [ˈmɛnəlɪ]. Subject 32 in the 1997 experiment reported in Chapter 3, was one such child. In the framework here, this was by an R-Inspection alert.

The R-inspection is called up, at the level of consciousness, with respect to particular

[27] In this respect, the phonotactics may be similar to stylistics, dismissed from the grammar in Chomsky (1995a)

forms. This is regardless of whether the structure is novel or with an existing lexical representation, or whether the issue arises in production or processing. The R-Inspection does not predict the form of an error. It just identifies an environment where one or more errors are likely.

2.3 A failure of determinacy?

In Section 2.3, I note that from a linguistic perspective, the relevance of pathological data is not obvious. It is not only complex. It may also seem to be approaching the point of indeterminacy. Generative linguists assume a determinate 'competence' or 'I-Language' (see Chomsky 1995 a), with the effect in (2.3).

(2.3) The data of phonological performance is significant only to the extent that it reflects the I-Language of one or more individuals. Consistency is criterial.

At least in relation to the word-internal phonology, variablity and / or alternation are diagnostic of malperformance, as by the effects of disease or trauma, and nothing to do with I-Language. If the same word is elicited on 10 successive days, an I–Language effect should apply consistently in all trials; as competence is approached, variability is expected to diminish. But there are three problems. FIRST, the requirement is unnaturalistic. The task is hard to present. And it is hard to tease apart the subject's performance and his or her interpretation of the test situation. SECOND, performance may be enhanced if a test is repeated at a given level of frequency, confounding the analysis. THIRD, the procedure would be an unethical intrusion. The one time such a criterion was adopted was in a study of the acquisition of American Sign Language by a chimpanzee (see Fouts, 1998, for a critical evaluation).

In this light, consider the process, pivotal to the main argument in Smith (1973), by which a coronal stop becomes dorsalised between a stressed vowel and a UR syllabic lateral, e.g. most famously, *puddle* as [ˈpʌgəɫ]. For Smith, this is "one of the most widespread rules found in children acquiring English as their first language" (p.14). It was one of the few processes which persisted throughout most of the two years of the study. Of all the processes described by Smith, this is the only one which approaches universality (the limit case of prevalence) for children learning English. But as pointed out by Macken (1980), in an influential critique, there are exceptions. From the first coronal realisation of the ambi-syllabic stop in *little* at 2;2 it was not for another 20 months that this was reflected in all environments. Macken proposes that some items are wrongly lexicalised by an 'auditory filter'. Her rejection of Smith's across-the-board, Neo-grammarian approach was subsequently accepted by Smith himself (Smith, 1991). But he may have abandonned the original insight prematurely.

Consider the case of two speakers, AB and MN, one with *finger* as ['tɪnnə], the other with ['dɪndə], actually identical twins. In neither case is it obvious how these pathological surface forms are derivable from the input of the surface forms as spoken by competent speakers. In the framework here, there is no way of determining how these realisations were formally distinct. Both might be transcribed as ['<t/d>ɪn<d/n>ə].

On the same point, take the case of BC. At 5.3 he said *soldier* as ['səʊɫdə] and at 5;6 as ['ʃəʊɫdə]. On the most parsimonious account, the criterial non-apical or laminal property is first lost, then realised in one of the onsets, effectively by 'floating'. This does not imply that an I-Language is not involved here, but just that the I-language is not yet fully developed. (See Appendix 3 for more data on the course of phonological development in BC, AB and MN).

From the odd 'cloth ear error', marginal in relation to normal adult competence, to dense parapraxis, variation can be defined in terms of a set of elements, E, contributing to the error distribution as characterised in (1.22). The elements comprise the articulators, continuance, sibilance, affrication, roundness, etc.. They are distributed in relation to a set of phonological structures, P, involving syllabic constituency and 'foot structure' or word stress (See Lieberman and Prince, 1975, Halle 1995, and Chapter 6 here). In this terminology, it is usually the rightmost complete foot and the left branch within it which are 'strong', i.e. stressed. Using this formalism, it is possible to describe the case where processes alternate in a domain or set of domains, where the variation is within narrow limits. Here I shall treat the errors neutrally as a set of relations R, each r of R mapping e_i to e_j, an approach for which more justification is given in the form of a tentative series of hypotheses, in Chapter 7.

(2.4) *(In)competence, structural description, and change defined on variables*
In a set of phonological structures P $\{p_i,...,p_n\}$, by a set of relations R $\{r_i,...,r_n\}$, where for all r of R, the effect of r is a mapping involving one or more of the elements E $\{e_i,...,e_n\}$, where at most one e of E is null, by the relation r, e_i maps to e_j.

In (2.5), I derive, from (2.4), a set of criteria which define phonological significance in speech-error data.

(2.5) *Criteria of signficance*

a) Prevalence

r_i (e_i maps to e_j) prevails over r_j (e_j maps to e_i) in p.

In the limit, prevalence is absolute. There are no cases of r_j. Otherwise, if there are cases of r_j,they are significantly (statistically) rarer than r_i.

b) Productivity

r_i holds in p_i and p_j

A process is productive to the extent that it occurs in various domains, as in the coronal harmonies in *hippopotamus* and *archeopterix,* identical in their foot structure, similar in their phonemic structure, as [hɪtəˈpɒtəməs] and [aːtɪˈɒptərɪks].

c) Implicational predictability

r_j in p_j implies r_i in p_i

If r_j implies r_i , all speakers with r_j also have r_i. In a parametric framework, speakers with r_j have more than one parameter to be set, and are therefore not at Stage $_{n-1}$, but at Stage $_{n-k}$, where k is greater than 1.

d) Recoverability of derivation

For r of R, all e of E are minimal and positively identifiable.

Derivation is recoverable to the extent that it either involves one step, as in *hippopotamus* as [hɪtəˈpɒtəməs] (the clearest case), or there is, by (1.16), on account of the error distribution, only one plausible derivation, as in the case of *cardigan* as [ˈkaːdɪntən], with the coronalisation feeding devoicing, and the resulting structure being selectively open to epenthesis.

e) Singularity

Given a 'process', r_i in p_i, there are no cases of r_j in p_i.

Subject to the limits of observation (a limits imposed by practical necessity), a class of data is unattested, e.g. *monopoly* as ◆[ˈmənɒtəlɪ].

f) Idiolectal consistency

At a time t_i for a given child not yet at Stage $_n$, for all r of R in p, r is consistent

As is obvious, most children grow out of most errors. Development can occur in a clinical or experimental situation itself.[28] But some consistency is expected, even if this is less than in competent phonology.

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[28] Such an effect is not fanciful. The therapy described in Chapter 4 consists of an induced change at the focal point of the investigation. For this to occur by chance in any assessment, experimental or otherwise, is therefore not surprising, but even to be expected in some cases.

g) Developmental continuity

For $\mathbf{r}_i$ in $\mathbf{p}_i$ at a time $\mathbf{t}_i$ and $\mathbf{r}_j$ in $\mathbf{p}_j$ at $\mathbf{t}_{i+1}$, $\mathbf{p}_j$ is a proper subset of $\mathbf{p}_i$.

A 'process' may be context-free at some early point in phonological development and subsequently become context-sensitive, like fronting in infancy, followed a number of years later by context-sensitive coronal harmony. Or the threshold of **r** may rise. Or the scope of **r**, by **p**, may be reduced. Essentially the idea here amounts to a phonological interpretation of Atkinson's 1982 Condition II (p.11), disallowing ad hoc and unrelated descriptions of data at different stages of development.

h) Phonological plausibility

For attested $\mathbf{r}_i$ in **p** and unattested $\mathbf{r}_j$ there is no plausible or obvious non-phonological account of the asymmetry.

In the case of *Cheshire cheese,* there is a common error as [tʃɛsə ˈtʃɪːz]. The rare case of a harmonisation in the opposite direction/polarity, as [tʃɛʃə ˈtʃiːʒ] has a voiced non-apical edgemost coda The segment is attested in this position in *beige* and *rouge*. But these words may not feature in the lexicons of some younger speakers. Such an asymmetry has a plausible explanation in terms of phonotactics: the phonotactic violation is avoided. By (2.5.h) such asymmetries are not significant.

The criteria in (2.5) apply to any child phonology data. Clinical data may be misleading, by the mere fact that it is clinical. One realisation of *gobbledigook* was as [ˈhɒgəjɩjuk]. The only undisturbed element is the final coda, targeted in realisations such as [ˈgɒbəɫdɩgup]. In a derivational framework, assuming an adult-type UR (neither the framework nor the assumption accepted here), this might be defined as follows.

(2.6) *Four steps in a disordered realisation of* ***gobbledigook***

(i) Realise Dorsal in 1 stress syllable ⇒ [ˈgɒgəɫdɩguk]

(ii) Delete Sonorance ⇒ [ˈgɒgədɩguk]

(iii) Delete Consonantal properties outside 1 stress syllable ⇒ [ˈgɒgəjɩjuk]

(iv) Delete articulatory properties with no coda role ⇒ [ˈhɒgəjɩjuk]

Here the surface [g] is treated as ambi-syllabic, raising an issue to be discussed further in Section 5.2.1. Does this realisation counter-exemplify the claim that Dorsal does not target Labial? No: for these reasons: A) the observation was made once in a child with a phonological disorder; B) the (2.6) derivation is *ad hoc,* C) it is tortuous. Proceeding in the opposite direction, working backwards from Stage $_{n-1}$, I adopt the working principles in (2.7):

(2.7) *Speech errors and linguistic theory – working principles here*

a) Data

The more of the criteria in (2.5) that are satisfied by a given set of data, the greater its significance.

b) Methodology

Linguistic theory addresses a class of phenomena, including L1 acquisition, and developmental disorder, in terms of properties, as justified and shown to be necessary for the sake of learnability, descriptive adequacy, representational minimality, and conceptual parsimony.

To summarise, by (2.5) and (2.7), despite the linguistic difficulty of variable data, I have identified some criteria of significance, based on a notation in terms of variables. Such a notation is consistent with the idea of an R-Inspection as a process that only needs to be run once, where no questions are begged about the outcome.

2.4 A longitudinal test of parapraxis

Section 2.4 tests the idea of parapraxis longitudinally. If PP is a proper characterisation of phonological incompetence, it should be possible to trace particular expressions of it across different thresholds. I shall distinguish here between: A) the almost competent phonology of children, originally referred on account of some phonological problem, after they have had some treatment; B) the less competent phonology of Smith's A (see Smith 1973) from 2;2 to 3;11, treated here as early child phonology; C) disorder expressed by PP qualitatively denser than by A). By (2.5) there are 'criteria of significance' in respect of errors, as measured by prevalence, recoverability, and so on, even if the consistency is much less than in competent phonology at Stage $_n$.

By defining errors in terms of variables, with limits on the way they are represented, it is possible to avoid the implication that these errors are somehow defined by phonological rule, and to characterise what are simply tendencies in their distribution.

Section 2.4.1 looks at articulator harmonies across the broadest possible range of parapraxic thresholds – in dense and not-so-dense parapraxis. Section 2.4.2 looks at other processes.

2.4.1 Articulator harmony in parapraxis

As noted in (1.24.c), over a given range of thresholds, we can identify articulator harmonies in five out of six logically possible polarities. The sixth case appears as a disharmony. There seems to be a dactyllic threshold for parapraxic coronal harmony.

In A (see Smith, 1973), the only coronal harmony was in *connector* as [tə'nɛkɩə] at 2;9, meeting most of the conditions of (1.22.a). Let us assume that A's case is typical. FIRST, there is no reason for assuming otherwise. SECOND, a set of EAT results can be constructed retrospectively for A at 3;0, showing A's development to be within normal limits – marginally below the mean. See Appendix 7 for a summary of what Smith treats as the stages in A's development.[29]

In (2.8), A's early articulator harmony is re-interpreted in terms of articulators and syllabic constituency. Smith's 'categorial' transcription is slightly modified.

(2.8) *A's Labial and Dorsal harmony at 2;2* — data from Smith (1973)

a) *Bi-directional Labial harmony (Rule 8)* — Targets in all constituents

tweet-tweet	bi:bi:p			/w/ in onset cluster as the trigger

b) *Regressive Labial harmony (Rule 19)* — Target in onset

a) *stop*	bɒp/dɒp	*table*	'bɛɩbu	Oral stop as target
b) *knife*	maɩp	*nipple*	'mɩbu	Nasal as target
c) *shopping*	'wɒbɩn	*zebra*	'wi:bə	Fricative target, surface glide
d) *rubber*	'bʌbə	*slipper*	'bɩbə	Liquid in target, root involvement

c) *Progressive Dorsal harmony (Rule 17)* — Between obstruents, target not in stressed onset

a) *good*	gug	*biscuit*	'bɩgɩk	Coda target
b) *cloth*	gɔk	*kiss*	gɩk	Fricative target, surface stop
c) *glasses*	'ga:gɩ	*kitchen*	'gɩgɩn	Between onsets, Root involvement

d) *Regressive Dorsal harmony (Rule 19)* — Target in onset

a) *dark*	ga:k	*drink*	gɩk	Oral stop as target
b) *snake*	ŋɛɩk			Nasal as target and on surface
c) *singing*	'gɩŋɩŋ			Fricative as target, surface stop
d) *leg*	gɛk	*ring*	gɩŋ	Liquid as target, surface stop
e) *taxi*	'gɛgɩ	*chockie*	'gɔgɩ	Stop as target, surface voicing

[29] In Smith (1973) the first 4 Stages follow one another exactly, the first treated by Smith as lasting some 2 months, the second 2 weeks, the third and fourth, 4 and 3 days, respectively. Smith's Stages 5 to 29 imply a sequence of periods, each 10 or so days in length, each separate from the next stage by about 4 days, seemingly equivalent to his periods of observation in a fortnightly schedule. Smith's use of the term 'Stage' does not imply any ontological reality, just a point in sequence. It is for this reason – to avoid any possible confusion, to avoid what would otherwise be an incongruity between Smith's notion of a stage as a point in sequence and the more Piagetian notion which I adopt here – that I have re-computed Smith's 'stages' as single points in the middle of the month during which he made his observations, assuming an average month of 30.5 days in length.

There is a clear asymmetry in the treatment of the articulators. As far as Dorsal is concerned, noting that Smith makes the opposite analysis, there is evidence that A is already a 'g-drop' speaker. Given A) root harmony in *glasses* as [ˈga:gɩ], B) surface /ŋ/ as a coda and harmonic output, C) surface [ˈgɩŋɩŋ] and [ˈgɩŋ], not [ˈŋɩŋɩŋ] and [ˈŋɩŋ], on the simplest analysis, the trigger in the C) cases is a UR /g/which has separately 'coalesced' with nasality. Where the harmony is progressive, sonorants are not targeted, hence *skin* and *corner* as [ˈgɩn] and [ˈgɔnə], not [ˈgɩŋ] and [ˈgɔŋə].

(2.9) makes a general distinction between the two main cases. The appearance of directionality is claimed to be an artifact of stress and syllabification.

(2.9) For A at 2;2

a) Other than in *connector* as [təˈnɛktə], Coronal was the harmonic target, not the source.

b) In dorsal harmony, targets not in the onset of the stressed syllable were non-nasal, i.e. not in *skin*.

c) In labial harmony, semi-vocalic representation is involved – either in the trigger, in the case of /Cw/ onsets, or in the output, in cases where the target is a fricative, e.g. *zebra* as [ˈwi:bə].

Both labiality and dorsality are differentiated from coronality, the surface expression of the latter limited only by the harmony in (2.9.a).

5 months later, at 2;7, there are just two sorts of long-range articulator harmony, a labial harmony triggered by a /Cw/ cluster in the stressed onset), and a regressive dorsal harmony, targeting the stressed onset.

(2.10) *A's labial and dorsal harmony at 2;7* data from Smith, 1973

a) *Progressive labial harmony (Rule8)* Target in coda

squat	gɔp	*squeeze*	gi:b	*queen*	gi:m	*quick*	kip
squawk	kɔ:p	*squeak*	ki:p	*squash*	kɔf	*twice*	daif

b) *Regressive dorsal harmony (Rule19)* Target in stressed onset

truck	glʌk	*drink*	grɩŋk	*troddler*	glɒglə
desk	gɛk	*duck*	gʌk	*drunken*	gʌkən

At 2;7 the dorsal harmony is about to disappear. The labial harmony lasts longer. At 2;9, it becomes variable in monosyllabic, mono-morphemic roots. But in derived forms, it persists, ordered after both elements of the phonological word, the root and the morphological suffix, have been defined.

(2.11) *Labial harmony in* ***squeak*** *and its derivatives — 2;8 to 3;3*

Age			Age		
2;8.22	*squeak*	**ki:p**	2;10.20	*squeaker*	**'ki:pə**
2;9.5	*squeak*	**ki:k**	3;2.28	*squeaking*	**'ki:pɪn**
2;10.20	*squeaks*	**ki:pt**	3;3.25	*squeaky*	**'skwi:ki**

At 3;3, the round glide becomes expressible as a co-articulation in the onset of a monosyllabic root, and the harmony disappears.

Putting aside a number of alternatives, in (2.12) I present one analysis of the data in (2.7), (2.9) and (2.10). This will reflect an approach to be developed and justified in the rest of this study. I shall set aside: A) the relation between harmony in parapraxis and in competent phonology – between the stops in *long, longer,* etc.; B) the root involvement in *glasses* as ['ga:gɪ]; C) the 'misreading' of continuance in *zebra* as ['wi:bə]; and D) what I shall characterise here as an 'appropriate syllabic constituent' (here a consonantal one), all matters to be discussed in Chapters 5, 6, and 7.

In (2.12), the harmonising element is characterised as e, and the stressed and unstressed syllables as the branches of 'feet'. It is then possible to define the result as a limit on the representation of e of E. This: A) characterises phonological incompetence in a way which is consistent with Pinker's Continuity Criterion: B) addresses Grunwell's problem; C) defines diminishing degrees of parapraxis over time; D) lays the basis for a numerical evaluation of parapraxis in Chapter 3, generalising across different processes. The most long-lasting case, that of labial harmony, is defined in (2.12).

Here I adopt from Kiparsky (1982) the Elsewhere convention according to which (in the terminology here) a parapraxic relation r_i involving E in the context X is universally ordered after r_j involving E′ in X′ where E is a proper subset of E′ or X of X′.

I assume that the critical step is a failure of representation, triggering harmony.

(2.12) For A

where there is underlyingly

a non-coronal, e_i, and a contrasting element, e_j

Represent e of E as e_i

a) where e_i is Round/Labial

and/or e_i in an onset cluster with **/k/** is shown as **/kw__/**

i)	at 2;2	once in **/kw__/**
		otherwise in the onset (triggering regressive harmony)
ii)	at 2;7	once in **/kw__/**
iii)	from 2;9 to 3;3:	once in **/kw__/** after the morphology

b) where e_i is Dorsal

i)	at 2;2	other than as a nasal coda (not in *skin*)
ii)	at 2;7	in onset, with voicing contrast in target and trigger

By (2.12), two articulator harmonies are progressively reduced in scope without saying anything about the size of the domain. At 2;2, they are almost wholly bi-directional in respect of dorsality, and marginally so in respect of labiality. At 2;7, roundness in the stressed onset is realised as Labial in any final obstruent. This persists until roundness is realised in the onset as a phonetic [**kw**]. Assuming [**trɒglə**] as an intermediate form in [**glɒglə**], dorsal harmony is now exclusively regressive.

Now contrast the relatively dense parapraxis in Smith's A between 2;2 and 3;3 and higher threshold cases closer to Stage $_{n-1}$. In terms of processes and domains, without the notion of variables, it would be necessary to say that the functional roles vary, as in the case of *diplodocus* as either [**dɪplə'gəʊkəs**] or [**dɪplə'dəʊsəs**], where the **/k/** alternates between trigger and target. To avoid such absurdity we might extend the mathematical logic in (2.12) to define all featural and prosodic elements in corresponding ways. This would have the advantage of defining: A) elements seeming to have more than one role, like the **/k/** in *diplodocus* as both a harmonic focus and a trigger; B) the case where one role is played by more than element, as in the case of labial harmony with both labiality and right edge roundness; and C) where there is variability with respect to the outcome, reflecting different thresholds and idiolects, but within limits. This would define parapraxis as a tendential phenomenon. This would be quite different from the statement of rules in competent phonology. The notion of variables encodes the idea that the learner has no privileged information about the nature of the process by which the target grammar combines the elements of phonology. But the necessary formalism is tortuous and non-perspicuous. While I shall continue to use the notion of variables, I shall do so cautiously and only as necessary.

(2.13), taking account of these considerations, identifies two aspects of early phonology in Smith's A at 2;7.

(2.13) A at 2;7: Articulator harmonies between non-adjacent elements:

a) Labial harmony: roundness in the structure, a triggering element in the onset (in this case in the same segment), the target in the coda;
b) Dorsal harmony: a voicing contrast.

Naturally and unsurprisingly, as competence develops, the threshold of parapraxis rises; the conditions which limit association become more restrictive. By (2.14), as development proceeds towards the level revealed in the data in (1.22) above from a sample of unrelated, older children with various degrees of phonological disorder, the terms of (2.13) apply more restrictively – as follows.

(2.14) In a sample of idiolects, over a range of phonological competences,

a) Labial harmony: the elements listed in (2.13.a) are all separate.
b) Dorsal harmony: voicing contrast with additional structure on the left.

In a way suggestive of processes applying late, across this wide range of thresholds, there is evidence of a criterial element which may be either derived or underlying. In A's phonology at 2;7, the dorsal trigger is underlying in *duck* as [gʌk], and derived in *troddler* as [glɒglə]. Similarly, at the later stage, the roundness condition for labial harmony is underlying in *asbestos*, and derived in *animal*.

In relation to the claim in (2.1) that there is a general phenomenon which can be characterised as phonological parapraxis, it is significant that a commonality can be traced over the range from A at 2;7 to the speech of mildly disordered older children as described in (1.22).

By (1.22.a), effectively defining a dactyllic threshold in coronal harmony, this is not expected in early phonology. But this makes the threshold a very odd thing. It cannot be said that coronal harmony is conditioned by factors which tend to become more complex, i.e. restrictive, if there is no case of anything simpler.

Against this background, let us turn to two cases of coronal harmony below the dactyllic threshold in (1.22.a). In the idiolect of AC in (2.15) there is also labial harmony. In one realisation, where there are what might seem to be sources for both coronal and labial harmony, it is the former which prevails.

(2.15) *Bi-directional articulator harmony: AC at 5 years*

data from Grunwell (1987), p.p.66 & 164

a) *Coronal harmony*

pocket	**ˈpɒtɪt**	*neck*	**nɛt**
gun	**dʌn**	*dagger*	**ˈdædə**
cart	**tɑːt**	*take*	**tɛɪt**

b) *Labial harmony*

cup	**pʌp**	*peg*	**pɛb**
comb	**pəʊm**	*back*	**bæp**
game	**bɛɪm**		

The condition for the loss of dorsality in (2.15) is not the articulator itself. The words, *egg, go, cake, king* and *car,* not shown in (2.15), were realised correctly. Nor is the issue just the presence of more than one articulator, as shown by the similarly correct realisation of structures containing a Labial and a Coronal e.g. *tap* and *bat.* The condition is just stops differing in dorsality. By characterising the domain in terms of two elements, $\mathbf{e}_i$ and $\mathbf{e}_j$, both stops, it is possible to account for the case of *pocket* as [ˈpɒtɪt] rather than ◆[ˈpɒpɪt] or ◆[ˈtɒtɪt], by (2.16.a) or (2.16.b), both implying an extrinsic ordering in the 'association' of an element, as mentioned above.

(2.16) In AC's idiolect, where a phonological structure p contains $\mathbf{e}_i$ and $\mathbf{e}_j$ of E, both stops, where $\mathbf{e}_j$ is Dorsal, representation is limited: EITHER a) or b)

a) Coronal first

(i) Associate $\mathbf{e}_i$ (Coronal)

(ii) Associate $\mathbf{e}_i$ (Labial)

(iii) Associate $\mathbf{e}_j$

b) Labial first

(i) Associate $\mathbf{e}_i$ (Labial, if $\mathbf{e}_j$ is not preceded by a stressed vowel)

(ii) Associate $\mathbf{e}_j$

Both (2.16.a) and (2.16.b) involve extrinsic ordering, but quite differently in each case. By (2.16.a), Coronal associates first, at least in this idiolect. By (2.16.b) Labial associates first, other than under a special condition applying in *pocket*.

Before trying to decide between (2.16.a) and (2.16.b), consider another case, observed by the author, where articulator harmony went left and right for all three articulators. The child concerned, LM at 3;6, was largely incomprehensible to adults (even to her own mother) in continuous speech. A sample of LM's speech is shown in (2.17).

(2.17) *Bidirectional articulator and root harmonies in the case of LM at 3.6*

a) *Progressive labial harmony*

park	**pa:p**	*part*	**pa:p**	*watch*	**bɒp**	*match*	**bæp**
bridge	**bɩb**	*bottle*	**bɒp**	*spoon*	**bu:m**		

b) *Regressive labial harmony*

sleep	**bɩp**

c) *Regressive dorsal harmony (articulator alone)*

drink	**gɩk**	*talk*	**kɔ:k**

d) *Regressive dorsal ROOT harmony*

sugar	**ˈgugə**	*smoke*	**kəuk**

e) *Regressive dorsal ROOT harmony with voicing of the stressed onset*

string	**gɩŋ**	*monkey*	**ˈgʌŋkɩ**

f) *Progressive dorsal harmony*

coat	**kəuk**

g) *Coronal sonorant ROOT harmony – effectively coalescence in one case*

glove	**dʌd**	*finger*	**ˈdɩndə**

Although I am not taking a templatic approach here, I consider in (2.18) how this (bizarre) phonology with (positively) the realisation of a voicing contrast in both the onset and the coda, in *monkey* and *coat, bridge* and *sleep,* and (negatively) 'post-tonic deletion', might be described in terms of 'negative templates', 'filters', or what followers of the NP tradition tend to call an "own system".

(2.18) In templatic terms, at 3.6, LM's phonology is limited by the following factors:

a) **There are no superficial liquids or glides; all consonants are stopped.**
b) **Nasals appear only in the coda.**
c) **There is only one articulator in the word.**
d) **Coronals are voiced, and dorsal obstruent codas are voiceless.**
e) **All syllables have a UR vowel; the second syllable of *bottle* is deleted.**
f) **There is one surface consonantal segment for each syllabic constituent – with the effect of cluster reduction.**

LM's *finger* suggests an abstract UR, not motivated by the canonical form. But given that articulator harmony displays this complex polarity/directionality, what determines which way it goes in any particular case?

(2.19) *A three-way clash in LM's articulator harmonies*

a) A bleeding effect of labial harmony in *park, spoon* and *sleep.*

b) Dorsal harmony in a labial focus in *smoke* and *monkey,* not in *park.*

c) Treatment of Nasal as Coronal in *finger,* despite the cases of *string* and *monkey.*

d) Root harmony in *finger* and *glove,* containing the coronal sonorants, / n / and / l /, coalescing coronality and obstruence in the onset of *glove.*

By abandoning the notion of templates, it is possible to resolve the clash in (2.19), and characterise LM's idiolect by ordered limits on association, the first three harmonic, each applying twice, first under a condition, shown in brackets, then generally, the last effecting a general neutralisation by stopping. In (2.20), a non-affricated plosive is called a 'plain stop'.

(2.20) In LM's idiolect, where a phonological structure p contains more than one e of E (the consonantal articulators), for all e of E, Associate e (a specified property of E), in the following sequence:

(i) Labial (in an oral stop where every syllabic constituent has a plain stop),

(ii) Dorsal (where every syllabic constituent has a plain stop),

(iii) Root (where there is a both a plain stop and a Coronal),

(iv) Stop.

Harmony is effected by the fact that in a given domain, articulation is only associated once. The innermost condition in (2.20.i) stops the labial harmony from applying to *watch, match, smoke, finger* and *monkey.* (2.20.ii) allows the harmony in *monkey,* but not in *finger* or *glove.* (2.20.iii) effects a coronal Root harmony not applying to the initial element of the affricates in *match* and *watch*. This allows the labiality of the nasal and the glide to harmonise under the general condition. Showing intermediate representations abstractly – capitalised – the association limits in (2.20) account for the surface distribution of articulators in (2.17). Showing intermediate forms in capitals and faint type, sample derivations are given in (2.21). Each association limit is listed in one vertical column, the first three applying twice, i.e. cyclically.

(2.21) *Sample derivations involving the association sequence in (2.20)*

	Special (bracketed) condition			Unconditionally				
	Lab (i)	Dors (i)	Root (i)	Lab (ii)	Dors (ii)	Root (ii)	Stop	Realisation
spoon	bu:m							bu:m
watch				Bɒp			bɒp	bɒp
drink		gɪk						gɪk
sugar						ˈgugə		ˈgugə
smoke					kəʊk			kəʊk
string		gɪŋ						gɪŋ
monkey		ˈGʌŋkɪ					ˈgʌŋkɪ	ˈgʌŋkɪ
coat		kəʊk						kəʊk
glove			DʌD				dʌd	dʌd
finger			ˈDɪndə				ˈdɪndə	ˈdɪndə

As derivations, these involve the ordering in (2.20), effecting three articulator harmonies, under a bizarre set of conditions. But notice that the condition on Labial association in (2.20.i) is formally not unlike the condition in (2.16.b) in an unconnected idiolect. On standard parsimony, let us therefore conclude A) that (2.16.b) is correct; B) that a default principle of 'Labial first' in association sequence accounts for two very disordered idiolects, those of LM and AC. In broad terms, it is significant that it is necessary to postulate the principle of ordering in such cases. The principle seems likely to be robust. In Chapter 5, the argument is put that the sequence in (2.20), Labial, Dorsal, Coronal, is either unlearnt or at least a default expectation. The idea has obvious implications. If such ordering is not only preserved, but irreducible at extreme densities of PP, it requires no independent justification as a UG principle. At least one aspect of 'Grunwell's problem' can be set aside.

By the sequence in the melody/prosody relation, similar in both (2.16.b) and (2.20.i), it is possible to account for the oddness of coronal harmony in a monosyllable. In more typical idiolects at this threshold, there is no harmony because coronal association is ordered last. This leaves open the question of why it kicks in only at higher thresholds as phonological development develops – a question I shall pursue.

To conclude this Section, I have shown that general properties of parapraxis are mirrored across a wide range of development, that even in severe disorder, it is appropriate and necessary to sequence harmonies involving Coronal and other articulators. (I shall take up the issue of cyclicity in Chapter 6). The case for parapraxis as a construct is given some validity by the fact that I have been able to state some non-trivial generalisations – in (2.14) – over a wide developmental spectrum, and to do so in a way which satisfies the continuity condition in (2.5.g).

2.4.2 Other forms of phonological parapraxis

Section 2.4.2 considers forms of parapraxis other than articulator harmony. Here, it is necessary to ensure that the descriptive mechanisms both encode what actually happens and explain the fact that in parapraxis as in natural language, harmony is commoner than disharmony. But the less common cases, some satisfying all the significance criteria in (2.5), can't be disregarded. In some cases, more than one process occurs. One apparent process, the migration or harmonisation of affricate properties, seems to have been overlooked in descriptions of child-phonology hitherto. As previously, my interest is only in cases where the error distribution is asymmetric.

Section 2.4.2.1 looks at metathesis. Section 2.4.2.2 looks at errors involving sibilance. Section 2.4.2.3 looks at disharmony and mutual harmony. Section 2.4.2.4 considers the contrast between epenthesis and deletion. Section 2.4.2.5 considers a phenomenon described here as 'realignment'.

2.4.2.1 Parapraxic metathesis

In Section 2.4.2.1, I look at the general distribution of metathesis, including cases observed by Smith (1973). Smith does not doubt that the re-ordering of the segments is not random. But he notes that, "many of the examples cited also occurred in alternative forms" (p. 100).

In *hospital*, there is both metathesis and vocalic rounding – transcribed here as [ˈhɒstəpu].[30] (There is a practical limit to the closeness of transcription which can be achieved by on-line transcription in the clinic.) In some idiolects, we find the criterial consistency, as defined in (2.5.f). Other less frequent realisations were [ˈhɒfpətu] and [ˈhɒspəpu]. The common [ˈhɒstəpu] pattern co-occurred with various processes involving the adjacent obstruents, e.g. glottalisation or root metathesis. But these processes seem to be fed by metathesis, as displayed in realisations as [ˈhɒssəbu], [ˈhɒʔdəbu], [ˈhɒʔpdədu], [ˈhɒʔsəbu]. The data suggests the ordering in (2.22): A) by the ordering convention in (1.16); B) by virtue of the fact that the rounding of syllabic laterals is not preceded, in Smith (1973), by any rule affecting the articulators, other than the dorsalisation in *little*.

[30] In *hospital*, Smith (1973) observed the 'velarisation process', surfacing as [hɔspɪkəl].

(2.22) *The appearance of ordered rules in the case of* ***hospital***

(i)	ˈhɒspətʊ	ˈhɒspətʊ	ˈhɒspətʊ	ˈhɒspətʊ	ˈhɒspətʊ	Rounding
(ii)	**ˈhɒstəpʊ**	ˈhɒstəpʊ	ˈhɒstəpʊ	ˈhɒstəpʊ		Metathesis (a)
(iii)				ˈhɒtsəpʊ		Metathesis (b)
(iv)			ˈhɒssəpʊ			Root harmony
(v)					ˈhɒtpətʊ	Stopping
(vi)		ˈhɒʔtəpʊ		ˈhɒʔsəpʊ	ˈhɒʔpətʊ	Glottalisation
(vii)					ˈhɒʔptətʊ	Epenthesis
(viii)		**ˈhɒʔdəbʊ**	**ˈhɒssəbʊ**	**ˈhɒʔsəbʊ**	**ˈhɒʔpdədʊ**	Voicing

Apriori, we might expect the data to pattern with all the logically possible combinations of the eight processes in (2.22). In fact the variation is much less. Of course, the derivations in (2.22) raise Grunwell's problem in the sharpest possible way. But it may be possible to resolve the issue here in terms of sequential association.

Many have treated metathesis quite separately from harmony (see, for instance, Grammont, 1950, Bailey, 1970, Ultan, 1978, Besnier, 1987, Yip, 1989, Hume, 1991). Well known cases include modern Spanish *milagro* from late Latin *miraculum* and English *parable* and *palaver,* where the loan source for the latter is by metathesis. In both cases, given the similarity of stress in Latin and in modern English (see Halle and Idsardi, 1995), the diachronic change may have effected a prosody/melody relation similar or identical to that of *Jerusalem,* parapraxically as [ˈdʒəˈluːsəɾəm]. Having noted that the involvement of liquids is 'proverbial', Ultan writes:

> "The proneness of different phonetic classes to metathesis tends to stand in direct corelation with a hierarchy of resonance. *Mutatis mutandis,* the more resonant a sound the more susceptible it is to metathesis." (1978: 374).

But in the context of parapraxis there is a case for bringing metathesis within the ambit of the system used to explain harmony. In *animal* and other words, the two processes alternate. Here I shall invoke the notion of 'floating' as a cover term in cases where metathesis and another process (either harmony or migration) alternate.

(2.23) shows cases of metathesis between non-contiguous elements. The listing includes only one of Smith's items, namely *difficult* as [ˈgɪfətəɫt].[31] All other cases are from the clinical data. All cases are significant by the (2.5.d) criterion, i.e. one-step, involving one element in two roots, and either attested in a number of idiolects or consistently

[31] Most cases of metathesis in Smith's data do not seem to have applied consistently. The case here appears significant in as much as the process applied over a number of Smith's stages.

represented in at least one, or both. The commonality between the elements is shown as 'Comm'.

(2.23) *Metathesis as a single-step process in 'foot-plus' structures*

Word	Realisation	Comm	E	Position	E	Position
Jerusalem	dʒə'lu:sərəm	Liquid	/r/	1 str On	/l/	Rmost On
difficult	'gɩfətəɫt	Cont	/d/	1 str On	/k/	Rmost On
pentagon	'pɛŋkədən	Cont	/nt/	1 str C/0 str On	/g/	Rmost On
cardigan	'ka:gɩdən	Cont	/d/	0 str On	/g/	Rmost On
animal	'æmɩnʊ	Cont	/n/	0 str On	/m/	Rmost On
hospital	'hɒstəpʊ	Cont	/p/	0 str On	/t/	Rmost On
nobody	'nəʊdəbɩ	Cont	/b/	0 str On	/d/	Rmost On
somebody	'sʌndəbɩ	Cont	/b/	0 str On	/d/	Rmost On
Geronimo	dʒə'rɒmɩnəʊ	Cont	/n/	0 str On	/m/	Rmost On
Melanie	'mɛnəlɩ	Cor/Son	/l/	0 str On	/n/	Rmost On
desk	gɛst	Cor/Ob	/d/	On	/k/	C

NB: Commonality includes Cor(onality), Son(orance), Liquid(ity) and Cont(inuance). E(lement) and 'Position' are shown according to UR left-to-right order, where the position is characterised as 1 str(ess), 0 str(ess) or R(ight)most On(set).

What defines the context here?

In (2.24), with respect to all the examples in (2.23) apart from *desk*, the singularity and association limits are stated in terms of variables, both to state the double directionality of the process, and to express Macken's (1995) insight that coronality is always involved. Here I shall invoke the notion of 'markedness', as introduced into the study of phonological acquisition by Smith (1973), to be discussed further in Chapter 5. By this idea, within minimal pairs, there is a difference in the amount of phonetic information that is encoded underlyingly. In a way that is both influenced by the work of Rice and Avery (1991 and 1995), and with some amendments to be discussed and justified in Chapter 5, I shall accordingly treat one member of a minimal pair as marked in relation to the other. Accordingly, I shall treat /l/ as marked in relation to /n/, /r/ as marked in relation to /l/, and either Labial or Dorsal as marked in relation to Coronal.

(2.24) *Representation limit effecting metathesis in words of at least three syllables*

> Where a structure p contains e_i and e_j of E, differing only in markedness (ignoring Voicing) AND there is
>
> a) an e of E in the rightmost syllable;
>
> b) e_i relatively unmarked, Coronal
>
> c) in the case of a dactyllic structure
>
>   a) Sonorance in an edgemost syllable
>
>   b) (typically) Labial;
>
>   c) e of E in the onset.
>
> Associate e_j In foot where the stressed syllable is light AND
where there is roundness on the right edge
OR where e_j is Dorsal
Otherwise outside foot

(2.24) defines the directionalities in both (2.23) and the now seemingly re-lexicalised *sea anemone* (once a cloth-ear error in some idiolects?), as [ˈsiː əˈnɛnəmɩ].

The conditions on the association limit switch the linear sequence of elements subject to metathesis opposite ways round in *animal* and *hospital*, and treat Lateral differently from the other Coronal sonorant in *Melanie* and *Jerusalem*. By characterising the environment in terms of variables it is possible to express the fact that the role of sonorance in parapraxic metathesis varies between that of being one of the elements involved in *Melanie* and *Jerusalem* and one of the conditions in *animal* and *hospital*.

What about metathesis at thresholds lower than those reflected in (2.24) – not satisfying one or more of the terms on which it was defined? Smith's data includes *ask* as [aːkt], *milk* as [mlɩk], *shelf*, as [tlɛf], *wolf* as [wʊfl] (with an undarkened lateral), *penis* as [ˈpiːtɩn], *music* as [ˈmuːgɩ], *copydex* as [ˈdɒpɩgɛk], *plastic* as [ˈplækɩt], *magnet* as [ˈmæŋgɩt], *icicle* as [ˈaɩkələɫ], *bicycle* as [ˈbaɩkəsəɫ]. In all of these cases, at a lower threshold than (2.24), some of the terms in (2.24) still hold, as shown in (2.25).

(2.25) Parapraxic metathesis

a) occurs where the structure contains contrasts in respect of at least the articulator and either sonorance or continuance or both, and at least three syllables if all syllables are open, or two syllables, or a consonant cluster;

b) involves Coronal as one of the metathesising elements.

By (2.25), there is, for parapraxic metathesis, a lowermost threshold, as previously found in the case of coronal harmony. Parapraxic metathesis does not occur in CVC monosyllables, CVCV structures, or CVCVC structures where all elements are oral stops, e.g. *carpet* and *pocket*. Given (2.25.b) and the notion of markedness, parapraxic metathesis satisfies the continuity condition in (2.5.g).

In the data known to the author, there are just two cases of speech errors involving metathesis where neither element is a coronal. One is in a realisation of *gobbledigook* as [ˈgɒgəɫdɪbʊk], observed by the author. The other is in a realisation of *spaghetti* as [skəˈbɛtɪ], treated by Fromkin (1973) as a slip of the tongue, an SOT. I shall argue in Section 2.5 that SOT's should be treated as similar to, but separate from, parapraxis. Allowing that some errors may be just random, and that parapraxis reflects no more than a central tendency in errors satisfying the criteria in (2.5), it is clear that neither [ˈgɒgəɫdɪbʊk] nor [skəˈbɛtɪ] satisfy (2.5.a). The general claims in (2.24) and (2.25) can thus be upheld.

2.4.2.2 Errors involving sibilance and affrication

In Section 2.4.2.2, I look at a set of cases, some reflected in the competent phonology of certain languages, three not reflected in the competent phonology of any language and apparently not previously noted in the context of child phonology. Shaw (1991) surveys long-range apicality harmony between sibilants in competent phonology. But in parapraxis, there is 'migration', harmony, and metathesis involving both sibilance and the property of affrication. Generalising across these 'processes', in (2.26) I use the notion of 'floating' as a cover term for several different processes, but distinguish between those cases where the floating of laminality / non-apicality and / or affricate-hood is harmonic, shown as H, and those where it is not. In one case there is affricate harmony and metathesis of voicing in *sausages* as [ˈsɒdʒɪtʃɪz]. In another case (not harmonic), the floating involves both non-continuance and voicing – surfacing as [ˈdɒsɪjɪz]. In other cases, the floating allows some part of the association to fail in the UR site, as in the common case where laminality floats left to the stressed onset in *soldier,* without associating in the rightmost onset, surfacing as [ˈʃəʊɫdə]. This is shown as Non-A. In one case, this might be seen as harmonic. Laminality or non-apicality is treated as a particular sort of tongue gesture, usually grooved, as a departure from 'bare coronality' in a sibilant. In some cases, this may be the object of the process, and in other cases its domain. The clinical data is supplemented in (2.26.e) and (2.26.f) by observations by Smith (1973).

Word	Process	Object	Target site	Output
a) *Soldier*[32]	Float	Lam	1 stress Onset	ˈʃəʊɫdə
	Float	Affric	1 stress Onset	ˈtʃəʊɫdə
	Float H	Affic	Onset	ˈtʃəʊdʒə
	Float H	Lam	Onset	ˈʃəʊɫdʒə
	Float	Stop	1 stress Onset	ˈtəʊlə
	Non-A	Lam	Final Onset	ˈsəʊɫdə
	Non-A	Stop	Final Onset	ˈsəʊɫʒə
b) *sausages*	Float	Lam	1 stress onset	ˈʃɒsɪzɪz
	Non-A	Stop	Final Onset	ˈsɒsɪʒɪz
	Non-A H	Cor/Cont	Final Onset	ˈsɒsɪzɪz
	Float (H)	Affric/Voice	0 stess Onsets	ˈsɒdʒɪtʃɪz
	Float	Stop/Voice	1 stress Onset	ˈdɒsɪjɪz
c) *digital*	Float H	Affric	0 stress onset	ˈdɪdʒɪtʃʊ
	Float H	Affric	Strong foot onsets	ˈdʒɪdʒɪtʊ
	Float	Affric	Final onset	ˈdɪdɪtʃʊ
d) *spaghetti*	Float	Cont	1 stress Onset	bəˈskɛtɪ
e) *supposed*	Float	Cont	1 stress Onset	əˈspəʊzd
f) *position*	Float	Lam	1 stress onset	pəˈdʒɪsən
g) *aspadistra*	Float	/s/ Root	Strong foot	æspəˈsɪstə
	Float	Affric	1 stress onset	æspəˈdʒɪstə
	Float H	Affric	Strong foot onsets	æspəˈdʒɪstrə

NB: Floating or Non-A(ssociation) of Affric(atehood), Lam(inality), Cont(inuance), the Root, Voice, or Stop is shown in the target site – always an onset.

Where there is a surface lateral, the process is migratory, not harmonic. Noting that affricatehood does not harmonise in competent phonology, it may be significant that in all cases in (2.26) where the trigger is voiced, and the target is voiceless, the property of voicing has to be treated separately. The conclusions in (2.27) follow.

[32] The phonotactic sequence in *soldier*, consisting of a lateral in the coda of a stressed syllable with a tense vowel and an affricate in the onset of the adjacent, rightmost, syllable, is exemplified in English only by this one word. Without the tense vowel, the string consisting of a lateral coda followed by an affricate is rare. Examples are *gulch, bilge, bulge, belch, mulch , squelch* and *welch* .

(2.27) Parapraxic floating of sibilance and / or affrication

a) involves melodic elements other than voicing, as a harmony or metathesis. Hence ◆['dʒəutdʒə], ◆['dʒɒsɪdʒɪz], ◆['dɪdʒɪdʒʊ], ◆['dɪtɪdʒʊ], ◆[æspətʃɪstə], ◆['sɒdʒɪdʒɪz], etc., and exceptionally ['sɒdʒɪtʃɪz] with harmony of the affrication and metathesis of voicing;

b) only as a bounded processes, i.e. ◆['dʒɪdʒɪtʃʊ];

c) exclusively between the onsets of adjacent syllables, hence ◆['tʃɒsɪdʒɪz], and harmonically only where these syllables are open, hence ◆['tʃəutdʒə].

Given the notion of floating, an element can be realised in the 'wrong' position in the structure. All cases in (2.27) can be treated by 'limits on association'. In two cases, in *spaghetti* as [bə'skɛtɪ] and *soldier* as ['ʃəutdə], a sibilant property, the root in one, and the non-apicality of the affricate edge in the other, is realised just in the stressed onset. In *soldier* as ['təulə] and *sausages* as ['dɒsɪjɪz], the non-continuance is realised only in the stressed onset. In ['sɒdʒɪtʃɪz], the affrication is realised in the foot as well as in the final onset, whereas the voicing is realised only in the foot. In all of these cases, there are competitive, derivational analyses involving harmony, metathesis, and deletion in particular orders. But the notion of a limit on association, in some cases effected by floating, is simpler and, without evidence to the contrary, preferable.

While it is obviously undesirable to enrich the representational system, weakening typological theory in order to account for such errors, it is still necessary to define the basis for them. How is it that affrication can float in parapraxis, but not in competent phonology? Why in ['ʃəutdə], ['tʃəutdə], ['ʃəutdʒə], ['ʃɒsɪzɪz], ['dʒɪdʒɪtʊ], [bə'skɛtɪə], ['spəuzd], ['spəuzd], ['spəuzd], [ə'spəuzd], [æspə'sɪstə], [æspə'dʒɪstə], [æspə'dʒɪstrə], is the target of the floating the acoustically salient onset of the stressed syllable? And how should the role of laterality, liquidity, sonorance, rounding, and labiality, be defined so as to express the singularity of these environments without implausible and non-explanatory disjuncts? These are questions to which I shall return.

2.4.2.3 Disharmony and mutual harmony

Section 2.4.2.3 looks at disharmony in *monopoly* as [mə'nɒkəlɪ] and coalescence or mutual harmony between adjacent onset elements, in *spoon* and *smoke* as ['ɸu:n] and ['ɸɛʊk] (as noted in Chapter 1).

Consider first the disharmony in *monopoly*. Clinical data shows further errors as [məˈlɒpəlɩ], [məˈmɒpəɩ], [əˈnɒpəɩ], [əˈnɒpəlɩ], [bəˈnɒpənɩ], and [ˈnɒpəlɩ] Although on grounds of 'logical possibility' we might expect either coronal or labial harmony, neither seems to occur, at least not in isolation. Hence ◆[nəˈnɒpəlɩ], ◆[məˈnɒtəlɩ], ◆[məˈmɒpəlɩ]. As an aspect of developmentally disordered phonology, disharmony seems to be rare; it is barely mentioned in the literature as a developmental error. The structure as represented in this word may be a singularity.

By the use of variables, and the notions of markedness, foot-structure, and foot-structure, and the more specific notion of a 'stress domain', it is possible to define association limits across the structure as a whole. This is to say that every consonant is vulnerable, but in different ways, and none by articulator harmony.

(2.28) In the case of *monopoly*, where there is a set of elements E, such that within E there are four sub-sets, any of which may be characterised as E′ of E;

a) Labials differing in nasality in the onsets of syllables not bearing primary stress, nasality being marked;
b) Nasals differing in labiality in adjacent onsets, labiality being marked;
c) Coronal sonorants differing in nasality/laterality in the onsets of non-adjacent syllables, laterality being marked;
d) Round/Labial elements with syllabic roles in the same syllable, one as a coda, one as the stresssed vowel;

Associate at most one e′ of E′ in such a way that EITHER

Marked elements are not associated in the full foot	məˈnɒkəlɩ
OR No unmarked elements are associated in the full foot	məˈlɒpəlɩ
OR Marked elements are associated only in the stress domain	əˈnɒpəlɩ
OR Marked elements are associated only in the full foot	əˈnɒpəɩ
	bəˈnɒpənɩ
OR Marked elements are associated only in the foot structure	məˈmɒpəɩ
OR Elements are associated only in the foot structure	ˈnɒpəlɩ

The formulation in terms of an association limit allows a finitely variable outcome.

Why does a limit on Labial association, by (2.28), lead to dorsality? Foreshadowing more discussion below, in order to account for the case of disharmonic **/p/** ⇒ **/k/** as a special case, I shall propose the notion of Dorsal as a default in relation to a set of two articulators, itself and Labial, and Coronal as a default in respect of all the articulators. I shall discuss the mechanism of this in Chapter 5. Foreshadowing that discussion, given the notion of defaults, there are then two sorts of association, representing the specified case and the default case, obviously in that order. Given the distinctions so far, there is a sequence of association that seems to explain some aspects of the asymmetry of PP generally and of the singularity with respect to *monopoly* – as follows.

(2.29) A sequence of association and non-association (proposed here) in relation to parapraxis:

(i) Association of Labial, including the case where it applies too early, in cases such as *asbestos*, and the case where it fails in *monopoly*,

(ii) Association of Dorsal, including the case where it applies too early, in *magnet* or where it is wrongly applied as in *monopoly*,

(iii) Association of Coronal, either by copying or harmonically in the case where either Labial or Dorsal association has failed other than by (2.29.i) or (2.29.ii).

I shall return to this in Chapter 5.

Now mutual harmony. Chin and Dinnsen (1992) describe some monosyllabic onset cases. Given the notion of markedness, and assuming, standardly, that non-continuance represents the unmarked case, the asymmetry with respect to *spoon* and *smoke* as [fu:n] and [fəuk] and ◆[tu:n] and ◆[nəuk] can be explained thus.

(2.30) In particular idiolects, at moderate and severe densities of parapraxis
Where the onset contains e_i and e_j of E
Associate at most one e of E early and finally (surfacing as just the markedness)

To summarise this section, by the notions of markedness and prosodic reference, it has been possible to provide a formally consistent account of two apparently quite different sorts of process over a wide range of thresholds, thus strengthening the idea that parapraxis is a single phenomenon.

2.4.2.4 Copying and deletion

I turn now to the relation between deletion and 'copying' or 'reduplication'. In the case of deletion, articulatory/perceptual factors seem to loom large. But this sits uneasily beside the evidence of copying. The two processes cannot both be shoe-horned into the notion of 'naturalness' without some account of why it should take two opposite forms.

In the case of deletion, some structure is simply not associated. In the simplest cases this is definable as a single step, in *cardigan* as ['ka:dɪən], *pentagon* 'unnaturally' with two adjacent schwa vowels as [ˈpɛntəən], *soldier* as [ˈsəudʒə], *gobbledigook* as [ˈgɒbədɪguːk], *Jerusalem* as [dʒəˈuːsələm] and [dʒəˈruːsəəm], *Geronimo* as [dʒəˈrɒnɪəu], *archeopterix* as [aːkiˈɒptərɪs], or with only a subset of the gestures, as [aːkɪˈɒʔtərɪʔs], *hippopotamus* as [hɪˈpɒtəməs]. In *asbestos* as [æːˈbɛstɒs] there is also what seems like the compensatory lengthening of the adjacent vowel. Recalling the case of HI's *ecstasy* as [ˈɛkstəɪ], in the Introduction, and other cases, it is clear that the incompetent speaker may seem to say the difficult part and leave out the easy part. But whatever is deleted it tends not to be a coronal stop. There is one exception, namely *vegetables*, commonly as [ˈvɛdʒəbəɫz].

(2.31) A coronal stop, /t/, /d/ or /n/ tends to be invulnerable to deletion so long as it is not next to another coronal obstruent.

As noted in (1.22.f), reduplication occurred in various environments. In each one, there is at least one UR instance of each copied consonantal property. The surface form is always coronal. In the case of [ˈbʌdʒərɪgaːd], for instance, the copied property is on the left edge of the affricate. This leads to the claim in (2.32).

(2.32) *Representation limit with the effect of reduplication*

Where the representation **p** contains two elements of E, $\mathbf{e}_i$ and $\mathbf{e}_j$ with the same syllabic constituency:

a) $\mathbf{e}_j$ is null;

b) $\mathbf{e}_i$ is Coronal.

In E in **p**, Associate $\mathbf{e}_i$.

By (2.32), the melody is by the copying of existing coronal material. Given that it is coronal, plainly this represents the final step in a sequence of association.

Copying is not the reverse of non-Association, but an error of a different sort at a different point in the association sequence. Assuming that the sequence is interupted at different points in particular ways, the parapraxic copying of coronals must arise as a final step in the sequence – ordered after (2.29.iii).

2.4.2.5 The appearance of alignment

This Section considers the case where deletion involves more than one segment, changing the prosodic structure. At a low threshold, originally by the observation of Smith (1973), but also by myself in many children in my own clinics, where the structure contains a degenerate foot with /b/ in the onset, a coronal sonorant in the stressed onset, and a separate nasal in the strong foot, both the stressed onset and the preceding schwa are commonly lost. This occurred in A's idiolect in *banana, belong, baloon* as ['b anə], ['b ɒŋ], ['b u:n] around 2;6. This was described in Chapter 1 as 're-alignment'. It might also be characterised as the loss of structure.

On a loss of structure account, on the basis that phonological processes do 'one thing at a time', the vowel of the degenerate foot and the sonorant onset of the stressed syllable are lost separately, presumably in that order, suggesting /b nanə/, /b lɒŋ/, and /b lu:n/ as intermediate forms.

On a re-alignment account, the Labial is aligned to the left edge of the foot as well as the word, blocking the association of any phonotactically impermissible elements, necessarily the schwa, but also the nasal where this becomes part of an onset cluster with the Labial. On the face of it, the re-alignment account looks superior.

The notions of 'alignment' and the 'edge' are both due to Optimality Theory (see MacCarthy and Prince, 1994). OT defines all edge phenomena in terms of 'Generalised alignment', GA, applying simultaneously at both edges, as seemingly evidenced in errors involving a non-prosodically defined sequence of elements.

But despite the apparent plausibility of a re-alignment account of ['b anə] etc., here I shall argue that there is a better characterisation in terms of variables. Consider the alternations in (2.33), all obviously at a higher threshold than ['b anə].

(2.33) *Two sorts of errors involving onset liquids where there is a degenerate foot*

	a) *Re-alignment*	b) *1 str On deletion*	c) *Rmst On deletion*
Jerusalem	'dʒu:sələm	dʒə'u:sələm	dʒə'ru:səəm
Geronimo	'dʒɒnɪməu	dʒə'ɒnɪməu	'dʒɒnəəu
thermometer	'fɒmɪtə	fə'ɒmɪtə	

NB: in ['dʒɒnəəu], there is also a lowering of the penultimate vowel.

Here, where the stress domain contains a minimally contrastive set of sonorants, the association of one, or in dense parapraxis, both, is imperilled. But this does not seem to occur in *monopoly*, hence ◆['mɒpəlɪ].

In every case in (2.33), at least one sonorant is lost. Variably, the vowel of the degenerate foot and the final onset are lost as well. One or more of these may cause a vowel contour violation, such a violation being characteristically fixed by epenthesis in South-Eastern-type dialects of British English. All the items in the b) and c) columns in (2.33) contain structures which do not seem 'natural' in the sense that adjacent pairs of vowels with the leftmost surfacing as schwa are not commonly attested cross-linguistically.

While the 'realigned' cases in (2.33.a) are commoner than those in (2.33.a) and (2.33.b), it seems to be missing a generalisation to treat them separately.

In the framework here, it is possible to account for the singularity across a range of thresholds, distinguishing a Stage $_{1+i}$, representing A's phonology at 2;6 and a Stage $_{n-i}$, representing the cases in (2.33). In (2.34) the bracketed cases apply only at what I shall characterise as Stage $_{n-i}$, $i \geq 1$.

(2.34) *Representation limit with the effect of progressive non-association*

Over the range between Stage $_{1+i}$ and Stage $_{n-i}$

Where p contains

a) a degenerate foot,
b) e_i and e_j of E, sonorants in the stress domain (a minimal pair, onsets, in a trisyllabic stress domain),
c) (roundness in the stress domain),
d) a difference between e in the stressed onset and the adjacent onset, not just with respect to the articulator;

Limits: Associate at most one e of E

The notation captures the variability of the outcome at Stage $_{n-i}$. By the interaction between the terms, the environment contains four syllables at Stage $_{n-i}$. The variation between [ˈbanə], [ˈbɒŋ], [ˈbu:n] at one threshold and [fəˈɒmɩtə],. [ˈdʒu:sələm] and [ˈdʒɒnɩməu] at another depends on a set of conditions which appropriately extend those at the earlier threshold. The characterisation of the domain defines the singularity and the involvement of both roundness and labiality. The fact that this does not involve *monopoly*, i.e ◆[ˈmɒpəlɩ], is defined by the terms of (2.28) precluding those of (2.34). Because of the singularity, it is not obvious how to take this further. It is possible to characterise the representation limit by (2.34) either as the progressive loss of structure or as realignment. The latter term is more perspicuous, and I use it here, but with reference to an analysis of the (2.34) sort, not GA.

In this Section, I have taken the one case in the data here where OT might look to have the descriptive edge on PTT, and shown A) that there is an analysis in terms of variables which is descriptively superior; and B) that this is fully consistent with the notion of papapraxis as a phenomenon varying across different thresholds and with variable scope at any one.

2.4.3 Singularities and limits – not 'rules'

In sum, across a range of thresholds, for a given set of elements, the various parapraxic mappings characterised here as r of R are progressively reduced. I have illustrated an approach on which the context is defined exclusively on the prosody/melody relation, with no reference to left-to-right directionality. By the use of variables, it is possible to define finitely variable forms of parapraxis across a range of cases. The asymmetries are with respect to both harmonic and disharmonic relations between articulators, with metathesis and epenthesis always involving coronality, and so on. I have showed an inverse relation between the scope and threshold of a process as a function of development.

Essentially, I am appealing to a relation between two structures, an underlying representation and a surface form. Some of the variability has been encoded in terms of 'floating', as in the case of affricatehood and the linked feature of non-apicality. I shall argue, in Chapters 5 and 6, that this is largely by the mis-application of defaults, at a given point in the derivation. An approach to explanation is hypothesised in Chapter 7. But in relation to child phonology, the term 'float' is both theoretical and controversial. The use of it here is justified by a degree of indeterminacy in the outcome, where a lexical representation may surface in more than one way in a given idiolect or set of idiolects.

Floating can be taken as the process which allowed the historical metathesis from Old English *brid* and *acsian* to Modern English *bird* and *ask*. For each of at least two elements here, namely /r/ and /s/, there must have been a point when, for at least some speakers, these elements were floating, and subsequently a point at which, again for at least some speakers, the earlier sequence was reversed. Given current notions of a possible derivation (discussed further in Chapters 5 and 6), this sequence could not have been recoverable in the synchronic phonology. The underlying representations must have changed. But on the assumptions here, there must have been a period when, by the mechanism of floating, the linear sequence was indeterminate.

In child phonology, even in cases such as LM's, from Section 2.4.1, floating is plainly within limits. If it wasn't, the output would be uninterpretable as speech. But floating has a wider distribution in PP than in competent phonology.

I shall characterise other aspects of variability in terms of 'non-association', as in the case of *cardigan* with harmony as [ˈkaːdɪdən] and deletion as [ˈkaːdɪən]. Either the segment is not associated as a whole, or it is just the dorsality which is not associated. (See Chapters 5 and 6 for discussion of the relevant mechanisms.) Crucially, in this case and others similar, the vulnerability concerns one unstressed onset, where some of its properties are shared by another unstressed onset.

Non-association can be taken as the general mechanism of lenition. In competent English lenition applies to oral coronal stops on the right edge of the stressed syllable. The parapraxis might be characterised as an incomplete set of restrictions on lenition.

My claim here is thus that parapraxis is mainly expressed by 'floating' and 'non-association', and that elements from the underlying representation 'associate' (or don't) in particular parts of the phonological structure. The two mechanisms, floating and non-association, define different sorts of articulator harmony, both long-range. (This is not to say that there is no 'local' aspect to parapraxis, just that it is the long range aspect and the harmonising of Coronal which are problematic in relation to the No Proper Sub-set Condition). This notion of two mechanisms is justified A) by the different distributions, given in terms of variables in this Section, and more informally, but descriptively in (1.22); and B) by the fact that coronal harmony is not characteristic of early phonology, as shown by the exceptionality of the pattern in (2.15.a). On the basis of better-controlled data in the next Chapter, I shall hopefully be able to characterise the distributions of floating and non-association more precisely.

Within the framework of the association sequence in (2.29), under special conditions by the R-inspection, association may either fail entirely or be implemented out of sequence, and this may have a variety of effects.

By the use of variables, it is possible to achieve the descriptive effect of rules while avoiding the theoretical problems which they bring. (I shall still use the term 'process' for descriptive convenience.) But there may seem to be a sleight of hand here. It may seem that the novel notation is just a device, restating the idea of 'optional rules', gaining nothing. In respect of any limit, there may seem to be something *ad hoc* in the way I have characterised it. For instance, I have given no account of why roundness and labiality should have the subtle and varied effects which I have claimed they do. My claims may seem to raise Grunwell's problem in terms only slightly different from those set out in (1.9.a). To wit: how is it that incompetence is expressed in such specific ways? To this matter, at the core of this thesis, I shall return more than once – with some hypotheses for future research in Chapter 7.

2.5 Malperformance – slips of the tongue

Under the heading of malperformance, Section 2.5 considers the general nature of parapraxis; is it no different from slips of the tongue, or SOT's? Except for what I characterised in Section 1.3 as 'cloth ear errors', disruptions of (relatively) competent speech are, by definition, accidental, characteristically one-off, affecting discrete phonological elements, a matter of *performance*. Section 2.5 asks: how far is it possible to determine that a given error is *not* an SOT?

Variability is clearly an argument for a performance-based approach to children's speech errors, as well as those of adults. Indeed, I assume here that there must be some randomness in all speech errors. A key assumption in relation to SOT's is that they are recognisable by the speakers themselves as errors – at least potentially. As shown below, self-corrections or repairs are observable in the speech of children younger than those in the study here. Can children's incompetence errors be viewed as SOT's?

SOT research has generally been focused on adults. Freud's sources for the notion of parapraxis were in the work of Meringer and Mayer (1895 and 1908), now difficult to obtain. These works provided the basis for the studies of Lashley (1951) and Wells (1951). Wells proposed three laws:

(2.35) *First, Second and Third Laws of Speech Errors* Wells (1951). p.86.

a) "A slip of the tongue is practically always a phonetically possible noise."
b) "If the two original words are rhythmically similar, a blend of them will, with high probability, rhythmically resemble both of them."
c) "If the two original words contain the same sound in the same position, a blend of them will contain that sound in that position."

Wells' laws in (2.35) have been supplemented and developed in various ways, as in the following claims by Nooteboom (1969):

(2.36) *The domains of speech errors* Nooteboom(1969)

a) "Anticipations far outnumber perseverations and transpositions." (p.147)
b) "... no errors are found in which a prevocalic consonant exerts influence on a post-vocalic consonant or vice-versa." (p.149)
c) "The distance between origin and target does not generally exceed seven syllables." (p. 148)
d) "...the two elements involved in a substitution error are phonetically similar [in terms of distinctive features: AN]to one another." (p.149)
e) "....the elements involved in a phonemic speech error belong to any open class word rather than to a closed class word." (p.150)

In relation to (2.36.e), in the terminology of Minimalist, syntax, SOT'S do not occur in functional projections, traditionally treated as articles, auxiliaries, and conjunctions.

Fromkin (1971) provides a list of examples, which, in the framework of contemporary phonology, would be regarded as embodying varying amounts of melodic structure.

(2.37) *Varying amounts of melodic structure in SOT's* from Fromkin (1971)

a) Feature	*cedars of Lebanon*	ˈlɛmədən	Nasality	Onset
	spaghetti	skəˈbɛtɩ	Labial/Dorsal	Onset
	scatterbrain	ˈspædəgrɛɩn	Labial/Dorsal	Onset
	big and fat	pɩg n væt	Voicing	Onset
b) Surface root	*sing for the man*	sɩg .... mæŋ	Nasal	Coda
	sticky point	ˈspɩkɩ pɒɩnt	Labial	Onset
	auditory feedback	ˈɔ:dɩfrɩ....	Labial/Cont	Onset
	such observation	sʌb	Labial/Voice	Coda
c) Cluster	*sweater drying*	ˈdrɛdə swaɩjɩŋ		Onset
d) Vowel	*feet moving*	fu:t mi:vɩŋ	Front/ backness	
e) Rime	*heap of junk*	hʌŋk əv dʒi:p		

NB: For the sake of consistency, I translate Fromkin's 'phonemic' transcriptions according to the conventions here (see Appendix 8). Correspondingly, in the left-hand column in (2.37), I restate Fromkin's classifications in terms of the framework here.

Seeking 'to shed light on the underlying units of linguistic performance', Fromkin notes that there is one sort of element not vulnerable to 'structural loss – affricates.

(2.38) *SOT's involving whole affricate harmonies* (Fromkin 1971)

pinch hit	ˈpɩntʃ hɩtʃ
in St Louis John...	ɩn sənt dʒu:is dʒɒn
pretty chilly	ˈtʃɩtɩ ˈpɩlɩ
Chomsky and Halle	tʃɒmskɩ n tʃælɛɩ

Fromkin accordingly proposes a generalisation about the elements vulnerable to SOT's – in (2.39.a), and adds to the generalisations of Wells and Nooteboom a list of 'processes' – in (2.39.b).

(2.39) *Elements and processes in SOT's* (Fromkin 1971)

a) " ... affricates should be considered as single segments in the production of speech for speakers of English... while **[str]**, **[pl]**, **[kr]**, **[bl]** **[fr]**, etc., as well as final clusters, reveal the splitting of clusters into segments, not a single example in my own data, or the English examples cited by others, shows a splitting of [tʃ] or [dʒ] into sequence of stop plus fricative." (p.222 & 4)

b) "By far the largest percentage of speech errors of all kinds show substitution, transposition (metathesis), omission, or addition of segments the size of a phone." (p.218)

In general terms, these results have been confirmed in a number of more recent studies such as Dell (1990).

Stemberger and Stoel–Gammon (1991) attempt to control the distribution of SOT's experimentally. According to these authors, many SOT studies have shown some asymmetry in the polarity of at least one harmony. For instance, between sibilants, the harmony tends to be in favour of /ʃ/, as shown above. But widely disparate results have been obtained in attempts to determine the asymmetry in articulator harmony. Stemberger et al note some studies seeming to show that labial and dorsal harmonies are twice as common as coronal harmony. But they also draw attention to a study by Shattuck-Hufnagel and Klatt (1979), where the distribution of articulator harmony involving coronality was effectively random. Stemberger et al suggest that some of these differences must be attributable to task variables.

The technique which Stemberger et al use to try and control the SOT distribution they call the 'SLIPS'. It runs as follows. A subject is presented with two 'bias pairs' of words. A difference across both pairs defines the presence or absence of a given structural property in a syllable which is then presented again in one member of a 'target pair', in the opposite left-to-right order. For example, the presence of /l/ in the onset was presented in the bias pairs, *plush pub* and *plug puff,* and represented in the target pair, *puck plump,* with the lateral in the second rather than the first member. The subject is shown the pairs of words, one pair at a time, and asked to repeat both members of the target pair as fast as possible. The experiment measures the rate of errors in particular environments. By this SLIPS technique, Stemberger et al claim that it is coronal harmony which prevails. But the technique has two inherent problems. FIRST, the requirement to repeat words as quickly as possible is quite unnaturral. The aim seems to be to maximise the corpus. But the results may be artifactual. SECOND, there is no way of ensuring that other features, such as VOICE in oral stops, do not interact.

I turn now to children's SOT's, studied by Vihman (1978 and 1981), Stemberger (1989), Smith (1990), Jaeger (1992), and Wijnen (1992). Wijnen finds that, "incidental speech errors are considerably more frequent in children than in adults", (p. 753) and that, in this population, SOT's involve features and segments in roughly equal proportions. To the list of SOT generalisations, Wijnen adds:

(2.40) SOT's occur, "mainly in the stressed rather than the unstressed syllable."

Jaeger (1992) suggests that the incidence of SOT's in children's speech may have been overlooked. She recognises the problem of distinguishing between SOT's and 'incompetence errors', but argues that it is lessened if the subjects are personally known to the researcher. Her data consists of 829 naturalistic errors made by her own 3 children and 78 made by 29 of her children's friends and classmates. In relation to this study, the most important of Jaeger's findings concern the degree to which children's SOT's correspond to those of adults. She suggests that the timing of repairs provides the most reliable basis for comparison. Comparing her own data with that of Levelt (1983), she finds a close correspondence in the distribution of repairs within the word and at the end of it, and notes that this is unlikely to be coincidental or artifactual. But it is not clear whether Jaeger's confidence in her ability to distinguish between SOT's and incompetence errors is truly justified.

While the SOT generalisations by Wells, Nooteboom, Fromkin and Wijnen in (2.35), (2.36), (2.39), and (2.40), are largely vindicated by the evidence here, they do not explain either the asymmetries or singularities of parapraxis.

2.6 Parapraxis and the parameter setting function

By the argument of this Chapter, PP provides a generalised measure of phonological incompetence, essentially by mis-association, where the outcome is biased in non-obvious ways. This allows a reduction in the number of theoretical categories which would otherwise have to be postulated. It is clinically apt, allowing the idea of disorder as a continuum. Across this continuum, from serious disorder to marginal incompetence, there are common patterns. But it is not coherent to characterise this in terms of 'processes' in 'domains'. Processes, properly so called, are learnt. They cannot, therefore, be part of the process which acquisition, by definition, resolves.

Where have we now got? In relation to the asymmetry, the strongest generalisations are across limits on association. But what sense can we make of the notion of a lowermost threshold for coronal harmony? It seems absurd. The issue is one to which I shall return.

In a number of generalisations in this Chapter, it has been necessary to refer to the special, sometimes complementary roles of labiality and/or roundness. But the formalism developed in this Chapter says nothing about why such features should have the effects they do.

If clinical asymmetries are significant, if phonological parapraxis is an appropriate way of conceptualising this, similar or corresponding asymmetries should be found in the normally developing population. I turn to this issue in Chapter 3.

3 The experiment here

Chapter 3 reports on experimental work carried out for this study with children in main stream school, seeking to quantify the asymmetry of phonological parapraxis using data not subject to the various interacting variables which may arise in the process of referral, assessment, diagnosis, and treatment.

The first step in 1991 was a pilot study with 22 children, aged from 4;3 to 8;6. The second step in 1997 was the experimental investigation with 97 children from 4;8 to 8;6. In both, the age groups were continuous. In both, the intention was that the experiment should be 'pre-theoretical' to the extent of testing and measuring the claims from Chapters 1 and 2. Here I shall allude to the results of the pilot study only in passing and only where it is necessary for lack of other data – in the case of relatively uncommon processes. My main focus here is the 1997 study.

The 1997 experiment ran in three phases. Phase One, discussed in this Chapter, involves 96 real words. Phases Two and Three involve nonsense words. Since they bear directly on the clinical issue mentioned in the Introduction, I shall describe the results from these Phases and discuss their significance separately in Chapter 4.

The interest here and in this Chapter in particular is in any degree of asymmetry with no independent explanation. One case where there may be an independent explanation of the asymmetry is in *cardigan* unattestedly as ◆[ˈkaːgɪgən], intuitively harder than the real-word, and thus possibly insignificant. (On the way the issue of independence bears on probability, see Blalock, 1972, p. 145). In the event, there was more variablity than expected, and the error distribution in some words was less sharply asymmetric than expected. One singularity, with respect to vocalic disharmony, was unexpected. I shall group the data on the standard Occam principle according to which, without compelling reasons to the contrary, a simple statement is to be preferred over any more complex one.

Section 3.1 describes the experimental design. Section 3.2 discusses the subjects. Section 3.3 describes the response. Section 3.4 describes the Phase One data.

3.1 Goals, hypotheses, and methodology

(3.1) sets out a series of interlocking experimental goals with the aim of showing that the asymmetries and singularities of PP and the manner of overcoming it are general and predictable over a range of thresholds, on the basis that if this could be done, the notion of PP, as an incompleteness in the work of the Parameter Setting Function, or PSF, would be given empirical support.

(3.1) *Experimental goals in relation to the notion of phonological parapraxis*

a) Test and measure the claims from Chapters 1 and 2 about the hypothetical construct of 'phonological parapraxis', or PP, and determine whether its apparent asymmetry is specific to the clinical population or a general property of incompetent, phonology.

Bearing in mind that PP, as a construct, emerges from work with children with a history of speech-disorder, the testing here is done with an across-the-board sample, where there is no reason for expecting any developmental abnormality. Here the testing is quantitative, relating prevalence and variability within the data. If the asymmetry is specific to the clinical population, it may say something about developmental disorder, but it says nothing about phonological/phonetic acquisition in general. The asymmetry is of interest to phonological theory, only if it holds across the general population of L1 learners. Unless this can be shown, PP is just another term for disordered speech.

b) Test the 'productivity' of anything which seems like a 'process'.

Irrespective of whether a process/domain approach is appropriate or otherwise, it is at least necessary to show, in respect of any particular item, that it is phonologically derived. Phase Two represents an attempt to do this by a procedure like the 'clinical examination' described above, varying features of the environment one step at a time. Alternatively, this can be done by an appropriate grouping of the Phase One data.

c) Determine the thresholds of particular processes and the significance of any asymmetry at each one.

If parapraxic metathesis or coronal harmony do not occur below a trisyllabic threshold, if a sort of error only occurs at and beyond a given threshold, this is something to be explained. More generally, there is an experimental interest in measuring any degree of context-sensitivity or asymmetry of the polarity/direction in a particular case or set of cases, and using this to determine a level of significance in the data. But statistically this is difficult in cases such as *monopoly*, where a particular outcome may, hypothetically, be characteristic of PP, in this case [mə'nɒkəlɩ], but where, by the very nature of disharmony, it is not clear what it should be measured against.

d) Determine the existence of any implications within a set of test data.

For any two or more errors, the strongest claim is to the effect that one asymmetrically and absolutely implies the other. By such a claim, there are errors such that if one cannot be avoided, there is another which cannot be avoided either. Assume a set of phonological relations R containing the members r_i and r_j, where r_i represents a process in a set of words W, where r_j represents a process in W′, where W and W′ are complement sets. There is an asymmetric, implicational relation if all idiolects with r_i also have r_j, but not vice versa. Implicational relations of this sort should be characteristic of acquisition by parametric settings. If there are no such implications, this casts doubt on the 'strong parametric hypothesis' from Chapter 1 and on the notion of a corresponding learnability space. Conversely, if r_i asymmetrically implies r_j, it is plausible to suppose that speakers with r_j and not r_i have set one or more parameters in such a way as to differentiate them from the other group. The inhibition of r_i reflects a diagnostic threshold.

e) On the basis of (3.d), characterise Stage $_{n-1}$ in phonological development.

Treating processes abstractly and generally as cases of a relation **r** with respect to a set of phonological structures P, if r_i asymmetrically implies r_j, r_j does not characterise Stage $_{n-1}$. Idiolects with r_i must be at Stage $_{n-k}$ where k is greater than 1. Stage $_{n-1}$ can be characterised only by those cases where there is no such implication.

f) Reproduce the approach to the treatment of phonological disorder described in the Introduction in a controlled way with normally developing children.

If the therapeutic effect described above is real, at least some reflex of this should be demonstrable in a random sample of normally developing children. On the assumptions here, part of the clinical effect is by the expert clinician's on-line adjustment to the child's performance. This cannot be incorporated into an experiment not dedicated specifically to clinical effect. Here, for the sake of reproducibility, the procedure is standardised. A positive effect – in the direction predicted by the experiment – may be reduced by the mere fact of this standardisation. But if the clinical effect shows up in a a random sample of normally developing children despite this adversity, the significance is increased. The clinical procedure referred to above and described in more detail in Chapter 4 may be reproducing one aspect of the natural process of phonological development.

What was not appreciated in the experimental design was the conflict between (3.1.c) concerning the determination of thresholds for particular processes and (3.f) concerning the therapeutic effect described in the Introduction; any effect by (3.1.f) would tend to nullify (3.1.c). An idiolect in the process of change in real-time cannot be viewed as a system without making allowances for this process of change. To do so would require an experiment of a different sort. Accordingly, relevant aspects of the data here, from Phase Two and Phase Three, are discussed on their own in Chapter 4.

Putting this issue on one side, taken together, the terms of (3.1) bear on (3.2).

(3.2) A hypothesis

> Lieberman (1998) argues that the first modern human must have been born into a culture with referential/propositional communication using the vocal apparatus, but not a modern human language. On the basis of this and a similar idea from Glynn (1999), let us suppose that an adaptation about 150,000 years ago enabled the first modern human to impose an optimal, non-subjective analysis upon a pre-existing system of vocal communication. In this individual would then have developed the first creole, as the prototype of a finitely-learnable modern language. Crucial to this is the time-limited window of learnability, noted by Lenneberg (1967). The adaptation offers a decisive advantage to a population. If a system of communication is finitely learnable, the success of the outcome is not subject to interacting variables such as intelligence or opportunity. The possibility of meaning, as a generally shared construct, becomes available to all inheritors of the adaptation. It is possibly the step characterised in the Bible as "making the word flesh". On the hypothesis here, there is a universal grammar because there is a universal way of learning it. This is the learnability space, defining Chomky's 1995 Phonetic Form component. The corresponding biological character represents a recent, perhaps the last, addition to the human genome.

The hypothesis in (3.2) goes beyond the 'evaluation-metric' assumed in SPE. According to the evaluation-metric, the learner values a candidate rule in inverse proportion to the number of terms which it contains. This metric assigns a low value to a process such as 'gliding', in which a liquid /r/ is context-freely replaced by semi-vocalic /w/, involving the simultaneous changing of five features. Given the frequency of gliding in L1 learners of English, this cannot be right. A general algorithm for parameter-setting has to do better than this. Such an algorithm must enable the learner to determine what sort of analysis to bring to bear. In the case of L1 English learners, this includes a liquid or a glide analysis of /r/.

The evaluation-metric was effectively supplanted by an increasingly rich notion of UG, as in the work of Dresher (1999). But in the framework here, a highly enriched UG is untenable.

Obviously, the hypothesis in (3.2) makes no sense other than by a set of positive results in relation to (3.1). Against this background, let us turn to the methodology here.

It is obvious that childhood incompetence is not consistent. Variability is a factor in two ways. FIRST, a child may say a word both incorrectly and correctly (not always in this order) in the course of a session. SECOND, the linear sequence of elements may be indeterminate. In *asbestos*, Labial may float to the environment of a round vowel in a way that might be idealised as [æz'bɛstɒɾ], but in such a way that the degree and sequencing of the labial gesture are variable, crudely as [æz'bɛstɒ‹s/ɾ›]. In *monopoly*, there is variation from what seems to be full disharmony as [mə'nɒkəlɩ] to a more partial, 'non-phonemic' form as [mə'nɒkpəlɩ].[33] Similarly, lateral harmony varies between [mə'nlɒpəlɩ] and [mə'lɒpəlɩ]. With some errors plainly non-phonemic, there is an obvious question as to whether other errors were also non-phonemic, but not audibly. In the most general way, any indeterminacy, always likely to be greater in incompetent than in competent speech, necessarily compromises any description. But no (3.1.d) implications within the data are detectable unless they are encoded categorially. There is thus a methodological tension between broad and narrrow transcription. This has no easy resolution.

The experiment here was designed around a 'clinical examination' (see Piaget, 1929, p.19) involving both real and nonsense words, the former selected on the basis of (3.3) or (3.4):

(3.3) On the evidence of Chapter 1 and 2, a given word may be hard to say. The interest is both in what the EAT authors call 'discrimination', what linguists and clinicians might call 'diagnostic significance', and in the extent to which it is thought to occasion an asymmetric pattern of errors. (Here the evidence of the 1991 study was instructive). Alternatively, a word not meeting these criteria may be interestingly comparable to another which does. Thus *pentagon*, *cricketer*, and *crocodile* are interestingly comparable, in terms of melodic and prosodic structure, to *cardigan*.

(3.4) The word is either included in the EAT, or it extends the difficulty range downwards.[34]

By (3.3) and (3.4), the difficulty range of the test items is wide. By the criteria in (2.5) the most significant data is at the threshold where a subject's capacity for phonetic/phonological implementation is just starting to break down. Below this threshold, no problem is expected. Above it, the individual's capacity is overwhelmed. But this

[33] This was one of the many ways in which the 1997 phase of experimentation benefitted from the participation of JW. As an acute and careful listener she immediately detected the anomaly of these indeterminate segments.

[34] In 1997 all but one of the EAT words were included. The original EAT selection was made on the basis of the power of the words to discriminate statistically between subjects. This alone makes the words phonologically interesting. The one EAT item not included was *Indian*. It was replaced by *engine*. The author could not find one appropriate and non-racist image to elicit *Indian* from primary school children. It is not just in the case of *Indian*, that there is an ethical issue with regard to illustration. *Geronimo* was elicited by a picture of a child on a 'tarzan swing' and *eskimo* as the driver of a technologically advanced, tracked vehicle. But the issues in such cases are not clear-cut.

point cannot be determined in advance. Nor is it obvious how to rank a given set of test items in terms of relative difficulty. In the event, three children could say *diplodocus*, but not *desk*. Another two could say *diplodocus*, but not *sleeping*. (3.3) and (3.4) lead to a methodological wastefulness. But in advance of experimentation, there is no obvious way of reducing this.

The idea was that each word would constitute a significant phonological environment. In (3.5), the 96 test words are shown in italics, and listed in groups. Each of the 97 subjects aged between 4;8 and 8;6 was invited to say every word by a novel procedure to be described below. (See Section 3.2 for a more detailed discussion of the composition of the sample). The grouping is that of the presentation. This was done in the multimedia software, Macromedia Director, and shown on a laptop computer. The master-screen showed nine pulsing squares, each defining one set of items, each square in a different colour with a written title, such as 'animals', and an appropriate icon. From this display, the subject, S, was invited to make a selection. Each initial selection by S buttoned a display of between 7 and 14 stills, as listed in (3.5). Each still buttoned an animation. Some of these were funny; the tiger is windsurfing; the toothpaste on the toothbrush is spotted; and so on. The ordering of the groups and of the words within each group was made by the child. This made the elicitation natural rather than 'confrontational', and effected a degree of randomness in the presentation order.

(3.5) *Real words in the 1997 experiment*

animal	*archeopterix*	*budgerigar*	*caterpillar*	*crocodile*
diplodocus	*donkey*	*elephant*	*fish*	*hippopotamus*
horse	*monkey*	*shark*	*tiger*	
Food				
bottle	*chocolate*	*fridge*	*ketchup*	*milk*
orange	*sausage(s)*	*spaghetti*	*spoon*	*sugar*
Going away				
aeroplane	*bridge*	*chipshop*	*engine*	*escalator*
flower	*garage*	*helicopter*	*Jerusalem*	*tent*
train	*wheel(s)*	*wing(s)*	*yacht*	
Home				
aspidistra	*carpet*	*chimney*	*monopoly*	*puddle*
red	*smoke*	*square*	*yellow*	
People				
Barnaby	*cricketer*	*eskimo*	*feather*	*finger*
Geronimo	*gobbledigook*	*Melanie*	*queen*	*soldier*
teeth	*thumb*			
School				
calculator	*certificate*	*desk*	*longitude*	*magnet*
pencil	*pentagon*	*picture*	*puzzle*	*ruler*
teacher	*three*			
Times				
birthday	*Christmas*	*clouds*	*digital (watch)*	*queue*
sleep(ing)	*watch*			
Things				
cardigan	*glove*	*key(s)*	*pocket*	*stamp(s)*
string	*ticket*	*toothbrush*	*umbrella*	
Work				
aluminium	*asbestos*	*axe*	*hospital* [35]	*mahogany*
match(es)	*saw*	*scissors*	*thermometer*	

Thanks to the generosity of the school concerned, the 1997 experiment was able to involve two adults, A_1 and A_2. This made it possible to elicit the words in a natural way – as follows. S is seated between A_1 and A_2. S is told by A_1 that A_2 wants to be told what the pictures are. If S identifies an image simply by pointing to it, A_1

[35] Bearing in mind that some children may have experienced bereavement, the image for *hospital* is deliberately flip, with empty beds doing a kind of ballet.

supplies the word *sotto voce* in S's ear. S is thus required to repeat the name to A_2 in a not unnatural way. From S's point of view, the activity involves the pretence of knowing something which an adult does not, a pretence which S's were more than happy to go along with. This technique effectively encourages S to use words, some of which may be new and unfamiliar, in a way which seems like a game.

A_1 and A_2 had feedback as to which words had been looked at by the dimming of the item as soon as the animation had been run. If any of the pictures within a grouping had been viewed, the cell in the master screen was dimmed, and no-longer oscillated. If all the pictures had been viewed, the cell no longer appeared.

Let us now return to the idea in (3.1.a). If harmony is commoner than metathesis, this has an explanation in the fact that only one element is being manipulated, rather than two. But there are other cases where an asymmetry or singularity has no obvious explanation by intuition, by known phonological principles, or by independent principles of complexity and information. This is so if the harmony of a given articulator, or the metathesis of two articulators, both apply under different general sets of conditions, as has been claimed with respect to data of a particular sort in Chapters 1 and 2. This has not been demonstrated in a random sample from a normal population. But in order to do so, it is necessary to define what counts as significance in an asymmetry. Here I shall make the assumption in (3.6), focusing on minimally distinct singularities, such as those in *cardigan* and *pentagon*.

(3.6) The most significant asymmetries are those with no independent explanation.

In relation to a given 'process' in a given 'domain', there is a test of asymmetry by (3.7). By this notation, in an idiolect or a group of idiolects, it is possible to relate harmony in any polarity/direction to metathesis to epenthesis to deletion. This is parapraxis.

(3.7) *Error distribution –general test of asymmetry*

In **p** of P, a mapping relation $\mathbf{r}_i$ meeting the criteria of prevalence, predictability, recoverability, plausibility, and singularity or productivity – by (2.5) – within the intersecting sets E and E', is significant iff

a) by $\mathbf{r}_i\ \mathbf{e}_j$ maps to **e'** of E', E' includes $\mathbf{e}_i$, AND

b) if it is also the case that by $\mathbf{r}_j\ \mathbf{e}_i$ maps to $\mathbf{e}_j$

$\mathbf{r}_i$ prevails over (occurs significantly more often than) $\mathbf{r}_j$.

E is defined over a set including the null element. Different processes involving one or more of a set of elements, including harmony, metathesis, deletion, copying, and migration, can be ranked according to their frequency.

Informally, there is an asymmetry if, for a given process, it is either not reversed, or, if it is reversed, the two processes are not randomly distributed, and there is no independent account of this, for instance, by acoustic salience.

3.2 Subjects

In the 1997 design, the experiment was to be run across the whole school. In the event, due to lack of time, it was not possible to include the nursery children or children older than 8;6.

There is no reason for thinking that the 1997 sample does not represent a reasonable cross-section of the population. While many children in the school came from non-English speaking homes, only one child was excluded; he had only just started in the school, and had thus only been learning English for a few weeks.

In many studies of language/phonological development, subjects are screened for hearing loss and abnormal/delayed phonology. But this is problematic in two ways. FIRST, there is an equivocation about normality. Eliminating just one end of the ability curve distorts it in an arbitrary way. SECOND, there is no way of telling retrospectively whether the patterns of referral and diagnosis are objective, or whether the corresponding experiences are interpreted consistently by parents. What is being removed in the name of normalisation may reflect differential expectations about boys and girls. In the author's experience, adjacent speech and language therapy clinics may have a 2 to 1 variation in the proportions of boys and girls. This points to a lack of objectivity in the referral-and-diagnosis procedure which might constitute a significant interacting variable. But the effect is difficult to estimate.

Turning to hearing loss, it is similarly unclear after the event what may have been found, how accurate or reliable the results may have been, or how the parents may have interpreted the information. Neither a 'history' of hearing loss nor a speech and language therapy diagnosis can be treated as simple facts. Both may be mediated in socially significant ways, making it difficult to replicate the methodology.

On this basis, the sample here represents L1 learners of English across a particular age range. In 1997, the ages of the subjects at the beginning of Phase One of the experiment were as shown in (3.8).

(3.8) *97 Subjects from the 1997 experiment, coded by order of age*

S1	4;8	S15	5;1	S44	6;0	S63	7;0	S87	8;0
S2	4;8	S16	5;1	S45	6;1	S64	7;0	S88	8;2
S3	4;9	S17	5;1	S46	6;2	S65	7;0	S89	8;2
S4	4;9	S18	5;1	S47	6;2	S66	7;0	S90	8;2
S5	4;9	S19	5;2	S48	6;2	S67	7;0	S91	8;3
S6	4;9	S20	5;2	S49	6;3	S68	7;1	S92	8;3
S7	4;9	S21	5;2	S50	6;3	S69	7;1	S93	8;3
S8	4;9	S22	5;2	S51	6;4	S70	7;1	S94	8;4
S9	4;10	S23	5;2	S52	6;5	S71	7;1	S95	8;4
S10	4;10	S24	5;2	S53	6;5	S72	7;2	S96	8;5
S11	4;10	S25	5;2	S54	6;6	S73	7;2	S97	8;6
S12	4;10	S26	5;3	S55	6;6	S74	7;4		
S13	4;10	S27	5;3	S56	6;6	S75	7;4		
S14	4;11	S28	5;3	S57	6;7	S76	7;8		
		S29	5;4	S58	6;9	S77	7;8		
		S30	5;5	S59	6;9	S78	7;9		
		S31	5;6	S60	6;10	S79	7;9		
		S32	5;6	S61	6;11	S80	7;9		
		S33	5;6	S62	6;11	S81	7;9		
		S34	5;6			S82	7;9		
		S35	5;8			S83	7;9		
		S36	5;8			S84	7;10		
		S37	5;8			S85	7;11		
		S38	5;8			S86	7;11		
		S39	5;10						
		S40	5;11						
		S81	5;11						
		S42	5;11						
		S43	5;11						

Given that we are concerned with the distribution and direction of asymmetries in speech errors, the all-inclusive and cross-sectional nature of the sample makes it likely that any interacting variables, such as sex and social class, will be factored out.

3.3 Three phases and spontaneous development

Partly as a result of the length of the sessions in Phase One, in a way that was not expected in the experimental design, there was a four- to five-month gap between the first two phases of the 1997 experiment. This meant that the subjects could be expected to develop phonologically in that period. And so it turned out. Many words which had been judged non-canonical in Phase One were judged canonical in Phase Two. Phase Three took place between two and four days after Phase Two.

3.4 Phase One data

In Section 3.4 I describe and discuss the real word data from Phase One of the experiment. There are two questions to ask: A) does the real word data satisfy the test of asymmetry in (3.7)? B) Is the asymmetry significant?

If the relation between two sets of elements is symmetrical, possibly random, this does not undermine the claims here. In such a case there is nothing to be explained. Our interest here is just in asymmetries and singularities in the error distribution. Appendix 4 summarises all responses from all subjects in respect of those words where an asymmetry or a singularity was most clearly displayed.

Section 3.4.1 reviews the claims so far, as hypotheses. Section 3.4.2 summarises and classifies the data from Phase One of the 1997 experiment. Section 3.4.3 looks at it in more detail, and evaluates it statistically where possible and appropriate.

3.4.1 Hypotheses bearing on acquisition theory

Recall from Section 1 the idea that we might anticipate a learnability issue on points which are complex and subtle in the learnability target, like the special treatment of 'mid-foot coronal stops' in numerous forms of English – see (1.27). Adopting the notion of phonological parapraxis, or PP, to characterise a degree of incompetence, obviously unlearned, for a set of relations between elements, ranging over features, phonemes, syllables, feet, and the null element, we expect the outcomes are less than the 'logical possibilities'.

(3.9) Testable properties of PP are as follows – by current claims:

a) The onsets of stressed syllables are harmonically vulnerable only to laterality, dorsality, affrication, the combination of labiality and nasality in /m/ as a Root trigger, sibilance or a sibilant property, and conversely invulnerable to coronality.

b) Articulator harmonies involve at least two nasals or obstruents, at least one a stop, and, in the case of coronal harmony, structures containing singleton onsets with matching syllabic roles, necessarily unstressed (not in *animal* or *Geronimo*).

c) Labial is not harmonically targeted by Dorsal.

d) The gap by (1.24.c) is filled by dis-harmony in *monopoly*, by /p/ ⇒ /k/, the singularity involving sonorance, coronality, labiality, nasality and roundness in particular prosodic conditions, one the degenerate foot.

e) A coronal root element is copied where both elements have the same syllabic constituency.

f) For coronal harmony and metathesis also involving Coronal, there are lowermost thresholds defined on the prosody and melodic structure.

g) In two cases, both with a degenerate foot, /s/ is not associated canonically, in *spaghetti* migrating to the stressed syllable, in *asbestos* represented only by compensatory lengthening in the degenerate foot or by Labial harmony on the right edge.

h) Where there is a source in the onset of an unstressed syllable, just affricate structure itself or a non-apical element is parapraxically vulnerable. Hence *digital* and *soldier* as [ˈdɩdʒɩtʃəɫ] or [ˈdɩdʒɩtʃʊ] and [ˈʃəʊɫdə], but ◆[ˈdɩdʒɩdʒʊ], ◆[ˈdɩdʒɩdʒəɫ], and ◆[ˈdʒəʊɫdʒə].

i) In a set of configurations including *Jerusalem* and *yellow*, laterality floats, harmonically or otherwise, with respect to the other liquid in *Jerusalem*, and harmonically with respect to the glide in *yellow*.

3.4.2 Judgements about the realisation of real words

The experiment here is to test the claims by (3.9) in relation to the goals in (3.1).

In 21 words, there was an asymmetry in respect of at least one process/polarity/domain, or at least one gap or non-attestation, with no independent explanation as an interface effect.

(3.10) Asymmetries or singularities

animal	*archeopterix*	*asbestos*
aspidistra	*Barnaby*	*budgerigar*
calculator	*cardigan*	*crocodile*
digital	*diplodocus*	*Geronimo*
gobbledigook	*hippopotamus*	*hospital*
magnet	*monopoly*	*pentagon*
soldier	*spaghetti*	*yellow*

With 96 test words and 97 subjects, one of whom, S19, had had enough after 42 items, there were 9,258 attempts to elicit. A response to a real word was judged as canonical by (3.11.a), or as falling into one of the 16 categories in (3.11.b), not all necessarily errors, but none necessarily implying the corresponding competence. In the last resort, canonicality judgements are subjective, some of the most difficult cases concerning /s/ and /r/. The two rightmost columns in (3.11) display in the one case the numbers of responses falling into a given category and in the other the proportion of all responses which they represent.

(3.11) *Categories of response*	Number	%
a) Canonical	7,339	79%
in terms of any of a set of dialects of English, including the RP of the author, the 'Estuary English' or 'Standard SouthEast' of JW, and Cockney. Dialect variation is recorded, but not treated as non-canonical. Accordingly no account is taken of differences with respect to roots, e.g. *aeroplane* as [ˈɛəplɛɪn], *chimney* as [ˈtʃɪmlɪ] where diachronic change may be in process. *Hippopotamus* as [hɪpəˈpɒʔəməs] is treated as canonical, harmonised [hɪʔəˈpɒʔəməs] as non-canonical.		
b) Otherwise – as a set of mutually exclusive sub-categories	1,919	21%
a) Simple cluster reduction or segment deletion, e.g. *aspidistra* as [æspɪˈdɪstə], *yacht* as [ɒt], *archeopterix* as [a:kɪˈɒptrɪks], compensatory lengthening, e.g. *asbestos* as [æ:ˈbɛstɒs]	194	02.1%
b) Consonant deletion leaving impermissible vowel sequence, e.g. pentagon as [ˈpɛntəən]	5	0.05%
c) 'One-step' phonological errors involving more than one segment, including harmony, coalescence, metathesis, disharmony, reduplication, most typically harmony, e.g. *cardigan* as [ˈka:dɪdən][36]	386	04.2%
d) Non-phonemic phonetic/phonological errors involving consonants in *monopoly* as [məˈnɒpkəlɪ]	3	0.03%
e) Errors involving two or three steps, e.g. *archeopterix* as [a:tɪˈɒptərɪs] with harmony and cluster reduction	560	06%
f) Prosodic loss or realignment, eg. *monopoly* as [ˈɒpəlɪ] or [ˈnɒpəlɪ] with only the foot or stress domain elements realised or *Jerusalem* as [ˈdʒu:sələm]	59	0.64%
g) Parapraxis involving more than three 'processes' affecting consonants, beyond the point of reliable analysis or interpretation, with wide 'scope' in the (2.2.e) sense, e.g. *aspidistra* as [ɛkʃtəˈbɪstə], or *archeopterix* as [ˈa:kətʃɪʔə]	66	0.71%

[36] The idea of disharmony necessarily involving more than one segment may seem arbitrary, but as will be shown below, the idea is supported by the evidence here.

h) Seemingly context-free, 'articulatory' errors not involving vowels, variably phonetic or phonemic, e.g. incomplete rhoticisation or labialisation of /r/ – completely as [w] or partially and indeterminably as [<r /w>], indeterminate sibilance as [<s/ʃ >], anterior, non-strident realisations of /s/ as [θ] or [s̪], etc.	384	04.1%
i) Standard reduction, e.g. *hippopotamus* as [ˈhɪpəʊ] or *budgerigar* as [ˈbʌdʒɪ]	8	0.08%
j) Re-analysis, e.g. *budgerigar* as [ˈbʌdʒərɪ bɜd]	16	0.17%
k) Morpho-syntactic error, e.g. *teeth* as [ˈtiːfs]	7	0.08%
l) Categorial change in a vowel, e.g. *gobbledigook* as [ˈgɒbəɫdɪgəʊk], often with another process	20	0.22%
m) Refusal, perhaps by what was called, in Section 2.2, an 'R-Inspection alert', or perhaps because S finds the stimulus inappropriate	154	01.7%
n) Alternative, such as when S insists that the *crocodile* is an *alligator* or that the *fridge* is a *cooler*, or that the *diplodocus* is a *bracchiosaurus* (!), or that the *saw* is a *sword*, etc.	34	0.37%
o) Realisation only with care, and at an abnormally slow tempo, often with a comment to the effect that the word is felt to be 'hard to say', in the framework here, by an 'R Inspection alert'	17	0.18%
p) Variability, e.g. *spaghetti* as [ˈspkɛtɪ] and [ˈpskɛtɪ], *pentagon* as [ˈpɛndəgən] and [ˈpɛntəkən], or, in the case of any item realised twice, where one realisation is canonical and one is not	6	0.07%

Some of the response categories in (3.11) may be treated (for some purposes) as 'not wrong'. But realisations such as [ˈbʌdʒɪ] and [ˈbʌdʒərɪ bɜd] do not tell us whether S could say *budgerigar* or not. A refusal might suggest that the word was too hard for S to say. But this says nothing about the likely form of any error, if S had tried.[37]

[37] In a way that complicates the design of a database to store and analyse a response pattern such as this, it should be noted that while (3.8.a) and (3.8.b.a) to (3.8.b.k) encode judgements about the response holding for all respondents, (3.8.b.l) to (3.8.b.o) encode a judgement about the response as a single episode in respect of one individual S. (In the design of the pilot study the importance of the distinction here was not appreciated. Right or wrong judgements were made on-line and entered as a particular property of the individual response in a way that made it difficult to treat canonicality and non-canonicality in a more general way in respect of particular errors.

The number of response categories for those test items judged 'non-canonical' is inversely proportional to what some statisticians call the 'flatness' of the data.[38] Absolute flatness is achieved by a simple right or wrong criterion, treatable statistically, but at the risk of analytic error. By (3.11.b.c), (3.11.be), and (3.11.b.g), it is possible to distinguish analytically between *archeopterix* as [a:tɪˈɒptərɪks], [ˈa:tɪˈɒptərɪs], and [ˈa:kətʃɪʔə], with the parapraxic scope increasing from case to case, with one-step errors like [a:tɪˈɒptərɪks] and [ˈka:dɪdən] by (3.11.b.c) having a special status.

3.4.3 Points of central tendency

Looking at the data in more detail, hard to transcribe cases are counted as errors, but not as part of a pattern. My claims here concern cases which are not hard to transcribe. Looking at the idiolects in this experiment as a totality, I shall first identify points of central tendency, and then measure the likely significance of any resulting asymmetry or singularity, working towards a single summary tabulation.

Focusing on cases defined by (3.3), where specific asymmetries were predicted, Sections 3.4.3.1 and 3.4.3.2 look at phenomena involving articulators, roots and sibilants. Section 3.4.3.3 considers the issue of probability in general terms. Section 3.4.3.4 reviews the real-word data in relation to the goals in (3.1).

3.4.3.1 Processes involving the articulators

First take Coronal harmony, by (3.9.f) detectable at Stage $_{n-i}$, not at Stage $_1$. Coronal harmony occurred in at least one word in 56 idiolects. In the children in this experiment, it was the commonest form of articulator harmony. It was occasioned commonly and asymmetrically in the sense of (3.7) above, but to varying degrees in *archeopterix* as [a:tɪˈɒptərɪks], *calculator* as [ˈkætɫəlɛɪtə], *cardigan* as [ˈka:dɪdən], *hippopotamus* as [hɪtəˈpɒtəməs], *aluminium* as [æləˈmɪnɪən], and (perhaps) *thermometer* as [fəˈmɒnɪtə] or [θəˈmɒnɪtə]. Marginally, it occurred in *eskimo* as [ˈɛskɪnəʊ] and [ˈɛstɪməʊ], each twice and as [ˈɛssɪnəʊ] once, in *crocodile* twice as [ˈkrɒtədaɪʊ], and in *gobbledigook* in 4 cases as [ˈgɒbəɫdɪdʊk], with no instances of Labial harmony in this target. Insignificantly it occurred in *diplodocus,* twice as [dɪpləˈdəʊtəs], in *aspidistra* once as [æstrəˈdɪstə], in *mahogany* once as [məˈhɒdənɪ], in *pentagon* as [ˈpɛntɪdən] and [ˈpɛntətən], once each, but with 8 cases of metathesis, in *gobbledigook* in the final coda, but less often than labial harmony, in *cricketer* as [ˈkrɪtətə], in *axe* as [æʔts] and *clouds* as [daʊdz], once each. In cases such as *aluminium* and *thermometer,*

[38] On this point the author is endebted to Nick Bingham, who set out a number of key issues in a long personal conversation.

is this just auditory confusion? On the grounds of the distribution: No. If there is confusion here, why should it pattern the way it does?

To measure the asymmetry, let us adopt the sort-procedure in (3.12), treating errors as relations between elements. Our interest concerns the point at which 'organised complexity' begins, where the data is distributed with a significant asymmetry.

(3.12) For all cases of a relation r_i involving a maximal set of elements E, where at most one e of E is null, where there is a change with respect to e_i of E, where r_i occurs more than once in isolation, rank all cases of r_j involving e′ of E′, where E intersects with E′, where the change is not with respect to e_i.

(3.12) sorts error-data which may vary in n-ary ways into three classes, clear, simple, frequently-occurring cases, cases where one or more of the elements by the maximal case is involved a different way, and exceptional cases, not attested more than once in a clear way, and likely to be random. The last group is treated here as inconsequential. The interest is in the maximal definition of E, and the relation with E′.

Consider first the case of *cardigan*. S68 has [ˈkɑːdɪʔən]. Let us treat this as derived from [ˈkɑːdɪdən] and [ˈkɑːdɪɪən] by ordered derivational steps (by the reasoning in Chapter 1). By (3.12), let us treat as inconsequential S77's chaotic [kəˈmʌdɪgən] with the stressed vowel replaced by an entirely different one and with the addition of a degenerate foot.

In the table in (3.13), speakers are identified in small type after each example of a process effected by a particular limit. S81 is the oldest speaker with the harmonic [ˈkaːdɪdən]. The limits apply in unstressed onsets, all but 3 in the final onset. Non-association is characterised as Non-A. Errors are scattered across the sample with no clearly marked concentration over any one part of the age range. The number of idiolects displaying the effect of a particular limit is shown in the column on the right. The number of cases where the realisation is canonical is converted into a percentage in the rightmost cell on the bottom line, giving an index of the difficulty of the word; the lower this value, the more difficult the word.

(3.13) ***cardigan*** – error distribution across the sample

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Non-A	[ˈka:dɪən] S7, 11, 12, 16, 22, 26, 29, 32, 33, 39, 41, 52, 67, 76	**14**
Harmony	[ˈka:dɪdən] S5, 38, 40, 44, 53, 56, 59, 81	**8**
Harmony + Non-A	[ˈka:dɪʔən] S68	**1**
Metathesis	[ˈka:gɪdən] S42, 61, 74	**3**
Inconsequential	S77	**1**
Canonical		**72%**

In terms of processes, we find deletion, harmony or metathesis.

But the simplest description is in terms of a representational limit. The data patterns as one non-exclusive limit on dorsality, expressed in 3 ways, in 14 cases on a dorsal segment in an unstressed onset outside the foot, in 9 cases on a dorsal articulator in this position, in 3 cases on a dorsal articulator not inside the foot.

The 14 with the outright deletion are mostly younger than those with the harmony or the metathesis. Although the cross-sectional data does not allow us to be sure, it looks as though there are three stages here, one at which the non-association is complete, a later stage at which the non-association is of Dorsal, and a third at which the limit has been overcome.

As expected, ◆[ˈka:gɪgən].

All but one of these speakers have a separate problem with a specified articulator in one or more environments. The exception is S16. In his idiolect the commonest process involves the loss of a degenerate foot, typically with the effect of 'realignment'.

(3.14) Idiolect of S16 – all other words realised correctly

Lowering	Lateral loss	Lateral harmony	Voice harmony
gobbledigook	*helicpter*	*monopoly*	*pentagon*
ˈgɒbəldɪgəʊk	ˈɛnɪkɒptə	məˈlɒpəlɪ	ˈpɛndəgən
Lateral metathesis	Stopping	Deletion	Foot loss
Melanie	*glove*	*digital*	*mahogany*
ˈmɛnəlɪ	ˈglʌb	ˈdɪdʒɪtɪ	ˈmɒgənɪ
		cardigan	*asbestos*
		ˈkaːdɪən	ˈæːstɒs
			Jerusalem
			ˈdʒuːsələm[39]
			thermometer
			ˈmɒnɪʔə

The fact that the commonest error in (3.14) is the loss of degenerate feet is characteristic. All speakers with any error in respect of *cardigan* made at least one foot-structure error of the (3.14) sort or an error involving a phonotactic violation, e.g. *budgerigar* as [ˈbʌdʒəɪgaː]. There are numerous idiolects with one of the latter sorts of error, but no error in *cardigan*. There is thus an implication here of the (3.1.d) sort, an instance of a phonological relation **r** at Stage $_{n-k}$, where k > 1, such a case of **r** being *not* characteristic of Stage $_{n-1}$. The implication is asymmetric. Hence (3.15) and (3.16).

(3.15) ***cardigan***

Limits: subject to appropriate conditions discussed in Chapters 1 and 2

Where k > i ≥ 1

i) Stage $_{n-k}$ Dorsal in an unstressed onset outside/not inside foot

ii) Stage $_{n-i}$ Complete foot-structure and/or relevant phonotactics.

(3.16) In *cardigan*, at the Stage represented in (3.15.i), there is one central tendency in the error distribution, defined on the non-surfacing of dorsality, as a segment outside the foot or as an articulator outside it, or as an articulator not inside it. Any other set of relations is more difficult to state.

The justification for the class relations implicit in (3.16) is the Occam-type principle in the last sentence. I shall follow this approach in the rest of this Section.

If the unattested cases of coronal harmony in the stressed onset, dorsal harmony in

[39] On the analysis in Section 2.4.2.5 this is by the progressive loss of structure – with the effect of realignment.

either of the coronals or any combination of these, all have explanations of different sorts, standard probability tests are inappropriate. But there is still a singularity here. Ignoring one inconsequential case, *cardigan* errors tend in a single direction.

With respect to *cardigan*, these speakers have been selected randomly. According to Enfield (1972), if all members of an arbitrarily selected set confirm an expectation, this is significant down to the limit case of a set with one member. Enfield's criterion is satisfied here in a set of 26 cases, i.e. strongly.

In *calculator*, the loss of dorsality in the unstressed onset interacts with glottalisation, coda deletion, nasalisation, and raising. Along with 7 realisations surfacing as [ˈkæɫtəlɛɪtə] and 2 as [ˈkæɫʔəlɛɪʔə], there are these surface forms: [ˈkæʔəlɛɪʔə], [ˈkætənɛɪtə], [ˈkɛnʔəlɛɪʔə], [ˈkæɫtɪlɛɪtə], all clearly involving the coronal harmony as a derivational step. In 2 of these, there is also a non-canonical nasalisation. There are 5 realisations involving nasalisation – only once in isolation – and 2 one-offs, both involving the loss of dorsality in the second onset. (3.18) discounts as inconsequential only the marginal error in [ˈkæɫkəlɛɪtə]. The cases of S39 and S41 are shown twice – by harmonic non-association and by nasalisation.

(3.17) ***calculator***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Harmonic Non-A	[ˈkæɫtəlɛɪtə] S2, 3, 6, 7, 11, 33, 39, 41, 46, 49, 50, 54, 69	**13**
Gliding	[ˈkæjəlɛɪtə] S53	**1**
Root harmony?	[ˈkæɫtəkɛɪkə] S4	**1**
Nasalisation	[ˈkæɫkənɛɪtə] S59	**1**
	[kæˈnæɫkəlɛɪtə] S14	**1**
	[kæˈnæɫkənɛɪtə] S32	**1**
Nasalisation and harmony	[ˈkætənɛɪtə] S39	**1**
	[ˈkɛnʔəlɛɪʔə] S41	**1**
Inconsequential	S1	**1**
Canonical		**81%**

Laterality is lost in [ˈkætənɛɪtə], [ˈkæjəlɛɪtə], [ˈkæʔəlɛɪʔə], [kæˈnæɫkənɛɪtə], [ˈkɛnʔəlɛɪʔə], and [ˈkæɫkənɛɪtə], but not in isolation – hence ◆[ˈkækəlɛɪtə].

In (3.17), in not one case is the loss just with regard to Coronal in the final onset, hence ◆[ˈkæɫkəlɛɪkə]. There is a central tendency, represented by 13 cases of harmonic non-association in the first line and 4 more complex cases, in contrast to 5 cases with nasalisation, only 2 the same, 1 in isolation, 2 with the harmony and the nasalisation. There are not enough clear examples of the non-central processes to justify analysis. Of the 3 cases with the vulnerable dorsality preserved, S59 had previously been referred for speech and language therapy and was, as a result of this experiment, re-referred.[40] This was the child, mentioned in Section 1.3.1, whose grandfather gave information about the family history to confirm a diagnosis of phonological disorder. The central tendency, given by the simplest statement, is tested statistically in (3.18).

(3.18) In *calculator*, in 16 cases, the articulator loss is with respect to Dorsal in the first unstressed onset. In 1, as [ˈkæɫtəkɛɪkə], the articulators metathesise and one harmonises at the root. There is not one case of dorsal harmony. The probability of the first, weaker asymmetry is $\chi^2 = 16$, $P < 0.001$.

For all speakers in (3.17), there is at least one separate response suggesting a foot-structure difficulty, but not vice versa. This suggests that a difficulty with *calculator*, like one with *cardigan*, does not represent Stage $_{n-1}$. I am led to (3.19).

(3.19) ***calculator***

Limit where $k > i \geq 1$

i) Stage $_{n-k}$ Dorsal in the unstressed onset in the strong foot

ii) Stage $_{n-i}$ Foot structure

In *hippopotamus* too, most commonly attested errors involved the articulators. 23 realisations involved coronal harmony, 21 as [hɪtəˈpɒtəməs], 1 as [hɪʔəˈpɒʔəməs] and 1 with the limit set to include all unstressed onsets as [hɪtəʊˈpɒtənəs]. These contrast with 6 labial harmonies, 5 as [hɪpəˈpɒpəməs], 2 with stopping as [hɪpəˈpɒpəmət]. Minor processes include simple deletion – in 2 cases as [ˈpɒtəməs], and 1 each as [hɪˈpɒʔəməs] and [hɪpəˈpɒtəmə], spirantisation in 2 cases as [hɪpəˈpɒsəməs], nasalisation in 2 cases as [hɪpəpɒnəməs], and metathesis in 2 cases, once each as [hɪtəˈpɒpəməs] and [hɪʔəˈpɒpəməs]. No other process was attested more than once. In (3.20), I discount 13 cases – 2 lisps, 1 refusal, 2 alternatives, 1 realisation too disordered to analyse, and various processes only attested once, none involving labiality or coronality in the weak onsets in the feet.

[40] At the author's request, he was not told of any prior concerns about the speech of a given child or of prior referral for speech and language therapy before the assessment took place. Each assessment was, in this sense, carried out blind.

(3.20) ***hippopotamus***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Harmonic Non-A	[hɪtəˈpɒtəməs] S1, 6, 11, 14, 15, 19, 20, 22, 23, 27, 30, 34, 39, 49, 54, 59, 62, 71, 79, 87, 92, 93, 94, 97	**23**
Harmonic floating	[hɪpəˈpɒpəməs] S7, 28, 40, 53, 56, 61	**6**
Metathesis by floating	[hɪtəˈpɒpəməs] S8, 10	**2**
Inconsequential	S3, 9, 13, 17, 21, 24, 41, 44, 50, 57, 58, 66, 81	**13**
Canonical		**55%**

In the idiolects of S's 6, 15, 44, 49, 57, 92, and 97, there are no errors involving foot-structure. In the idiolects of S's 19, 27, 62, 93, and 94, there are no errors involving either foot-structure or a specified articulator, other than in the case of *hipppopotamus* as [hɪtəˈpɒtəməs]. There is again one central tendency, again testable statistically.

(3.21) In *hippopotamus*, hypothetically at Stage $_{n-1}$, in respect of the articulators in the unstressed onsets in the feet, there is a central tendency, represented by 23 cases of labial loss in contrast to 8 cases of coronal loss, 6 of these harmonic in the opposite polarity. In terms of harmonic polarity with a distribution in the expected polarity, where this has no independent explanation, $\chi^2 = 9.96$,, $P < 0.01$.

In *archeopterix,* 6 harmonies and other processes interact. Given the complexity of the word, it is not surprising that only two processes are attested more than once in isolation, coronal harmony in 4 realisations as [ɑːtɪˈɒptərɪks], and reduction in the coda cluster, attested twice as [ɑːkɪˈɒptərɪs], interacting with each other in 8 cases as [ɑːtɪˈɒptərɪs] and with other processes. Other processes are as follows: A) 10 realisations where onset /k/ harmonises to Labial, but only once in a one-step [ɑːpɪˈɒptərɪks] surface form, in the others with varying degrees of complexity, all different, e.g. [ɑːpɪˈɒstərɪks], [ɑːpɪˈɒptəwɛs], some complex to the point of chaos; B) 6 cases with Labial glottalised, but in all cases with the harmonisation of the /k/ on the left, in 5 of these by labialisation, in 4 of these where the Dorsal on the right is also lost – in the simplest such cases, as [aːpɪɒʔtərɪs] and [aːtɪɒʔtərɪs]; C) 3 cases of the loss of /t/, as [aːkɪˈɒpərɪks], harmonised by Labial in [aːkɪˈɒppərɪks], and by Dorsal in [aːtʃɪˈɒpkə‹r›ɪs]; D) 4 cases of glottalisation in the final coda, once as [aːpɪɒʔpəwɪʔs], in the other 3 without any surface /s/, effectively coalescence, in the simplest case as [aːkɪˈɒptətrɪʔ], but never as an isolated process;

E) 2 cases of /s/ root harmony at the expense of the labial in [aːpɪˈɒstərɪs] and [aːkɪˈɒstərɪks], the latter as the only case of this in isolation; F) realisations by processes only attested once or in interaction with others.

(3.22) groups and organises the errors by processes as represented by typical surface forms. The grouping by process has the effect of under-representing the actual complexity of the surface forms. But if we are to measure the significance of a central tendency in the data, there is no obvious alternative. (3.22) includes the case of labial harmony as [ɑːpɪˈɒptərɪks], only attested once in isolation, and the loss of the final fricative, only attested once, interacting with the coronal harmony on the left. Realisations with labial harmony are relatively complex, averaging more than 3 steps. Coronal harmonies tended to simpler, on average interacting with just one other process. By (2.5.d), derivational recoverability is a criterion of significance. Coronal harmony is formally and numerically more significant than labial harmony, the latter often, as in [aːpɪˈɒʔpəwɪʔs], beyond reliable analysis. In (3.22), the discounted cases include refusals, root harmonies, and chaotically disordered realisations, in this case outnumbering the errors involving the articulators, but in no case by a process attested more than once in isolation. Despite the numbers, this is treated here as inconsequential.

(3.22) ***archeopterix***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Harmonic Non-A	[aːtɪˈɒptərɪks] S3, 45, 54, 57, 65, 92, 96	**7**
	[aːtɪˈɒptərɪs] S1, 13, 29, 39, 43, 52, 61, 78, 85	**9**
	[aːtʃɪˈɒptərɪks] S89, 91	**2**
	[aːtɪɒptərɪʔ] S17, 44	**2**
	[aːtɪˈɒptərɪk] S15	**1**
Harmony by floating	[aːpɪˈɒptərɪks] S2, 18, 33, 55, 63	**5**
Floating and Non-A	[aːpɪˈɒptərɪs] S10, 37, 67, 70, 71	**5**
Non-A (stop)	[aːkɪˈɒptərɪs] S6, 62, 64, 73, 76, 91	**6**
Non-A (fricative)	[aːkɪɒptətrɪʔ] S47	**1**
Inconsequential	S4, 5, 7, 8, 9, 11, 14,, 20, 21, 23, 25, 26, 27, 28, 32, 34, 36, 38, 40, 41, 42, 50, 51, 53, 58, 59, 66, 68, 72, 74, 75, 79, 81, 82, 83, 86, 88, 90, 95, 97	**40**
Canonical		**20%**

Other than in one chaotic and unanalysable realisation as [ˈrɒʔkɪps], discounted in (3.22) there is not one case of dorsal harmony in the labial, hence ♦[ɑːkɪˈɒkkərɪks],

◆[ɑ:kɪ'ɒktərɪks], and so on, or of coronal harmony other than in the unstressed onset on the left, hence ◆[ɑ:kɪ'ɒttərɪks], ◆[ɑ:kɪ'ɒptərɪts], or mutual harmony, hence ◆[ɑ:kɪ'ɒptərɪt], or of Labial targeting the final /k/, hence ◆[ɑ:kɪ'ɒptərɪps]. Both dorsals are preserved in only 8 of the non-canonical realisations, each non-canonical in a different way. I am led to (3.23).

(3.23) In *archopterix*, in respect of the articulators, there are three interacting expressions of one central tendency by which Dorsal is vulnerable. In the case where only the articulator is involved, in the weak foot in 21 cases Dorsal is lost to Coronal in contrast to 10 cases where it is lost to Labial. In terms of harmonic source, as predicted, where this has no independent explanation, $\chi^2 = 3.9$, $P < 0.05$.

In this word, there is one 'process' attested three times, though not in isolation, namely the migration or loss of the /r/ in the final syllable, leading to phonotactically odd forms, e.g. [ɑ:tə'rɒptəɪs], [ɑ:tɪ'ɒptəɪs], and [ɑ:tɪ'ɒptəɪks̩]. In all cases, onset /k/ is coronalised. Applying the same criterion as in respect of *hippopotamus*, S55, S78, and S96, made an overt error on *archeopterix*, and no errors in another word involving foot structure or an articulator. This suggests (3.24).

(3.24) ***archeopterix***

Limits at 2 Stages, including a Stage $k > i \geq 1$

i) Stage $_{n-k}$ /r/ root other than in foot structure/1 stress onset.

ii) Stage $_{n-i}$ Dorsal other than in strong foot/foot structure

By (3.24), there is a developmental sequence. In a sequence of multiple parameter settings, the inhibition of the coronal harmony implies the inhibition of /r/ loss/migration. Given the wide scope of the disruption in forms such as [ɑ:tə'rɒptəɪs], this is not a startling claim. But it is consistent with the idea that the limit by (3.24.ii) may characterise Stage $_{n-1}$.

In each of these 4 cases, in *hippopotamus, cardigan, calculator,* and *archeopterix,* there is a limit on the association of a non-Coronal in an unstressed syllable. In all of the onset cases, an articulator is vulnerable to coronal harmony. Where the prevalence can be stated statistically, it is significant at the 0.05 level or higher.

What about the general claim about coronal harmony in (1.22.a) in these words? Taking account, not just of the prevalent processes, but also of the main interacting ones, by the sequential association idea in (2.29), in these cases the error consists in a step in the association sequence being either delayed or failing altogether. Assuming that any error in respect of a given structure may be triggered by any of its elements, some variety in the outcomes is not surprising – even within an idiolect.

(3.25) *A generalised harmonic limit*

> Under the special conditions described in (1.22.a), essentially involving word-internal, unstressed onsets, the representation of a non-coronal tends to fail, in an onset, typically with the effect of coronal harmony, and outside the foot structure with greater loss, including deletion and glottalisation.

An error in respect of *cardigan* does not predict an error in respect of *calculator, hippopotamus,* or *archeopterix.* 3 S's got *cardigan* wrong, in 2 cases as [ˈka:dɪən], getting the other 3 words correct. This does not falsify (3.25). The fact that the harmony is overwhelmingly coronal is given by the Association Sequence. By (2.29), the sequence is delayed.

Why do the processes take the precise form they do, under these singular conditions, and with not one case of a double harmony? Hence ♦[a:tɪˈɒptərɪts]. Why does the singularity of the environment occasion a particular range of outcomes? One possible solution, hypothesised in Chapter 7, will appeal to: A) syllabification; B) the interaction between defaults; and C) the way these are determined in the process of development.

Having looked at the clearest cases, consider now the case of *gobbledigook* occasioning a total of 70 errors, including various articulator harmonies. The /k/ on the right edge was coronalised or glottalised in 9 cases, but labialised in 16. Coronal harmony was attested 4 times in the final onset as [ˈgɒbəldɪdu:k], where both target and the notional trigger are in unstressed, non-ambisyllabic onsets. There were 2 cases of coronal harmony in the first syllable, [ˈdɒbdgʊk] and [ˈdobəlɪdəʊk] neither clear nor simple. In this word, with two articulator harmonies in the final coda, there are asymmetries, but these are distributed more complexly than expected. In the final onset and coda, coronal and labial harmony are prevalent, but only marginally. In *crocodile,* in the idiolects of S40 and S53, there is coronal harmony. There is no other process involving the articulators. Hence ♦[ˈkrɒkəgaɪʊ], ♦[ˈkrɒtəgaɪʊ]. But the numbers are too small to evaluate. By (2.5) and (3.13) we can discount a number of other cases, including those of *pentagon, aspidistra* and *diplodocus,* where coronal harmony as [ˈpɛntədən], [æstəˈdɪstrə], and [dɪpləˈdəʊtəs] is outweighed by other processes involving the same elements.

What about harmonies triggered other than by an oral stop? In *Eskimo,* discounting single cases of [ˈɛspɪgəʊ] and [ˈɛʃkɪməʊ], Coronal harmonised in [ˈɛskɪnəʊ] and as [ˈɛstɪməʊ], each twice, and the root harmonised in [ˈɛssɪməʊ] and [ˈɛssɪnəʊ], each once, in one of these with both harmonies. This is not prevalent, but there is a significant contrast with *escalator*, also occasioning root harmony, but not one case of coronal harmony. There was no coronal harmony in *animal, hospital* or *escalator*.

Coronal harmony is distributed across the sample, but it is still active in the idiolects of 6 of the 11 eight-year olds. Coronal harmony in *crocodile* or *eskimo* represents a denser parapraxis than it does in one of the other four words. This is an implicational relationship. I shall test this in due course. But note that metathesis, like coronal harmony, has a lowermost threshold. There was metathesis in *Geronimo* as [dʒəˈrɒmɪnəʊ], *animal* as [ˈæmɪnʊ], *cardigan* as [ˈkɑːgɪdən], *hippopotamus* as [hɪtəˈpopəməs], and *Jerusalem* as [dʒəˈluːsərəm]. In *hospital* as [ˈhɒstɪpʊ] and *pentagon* as [pɛŋkədən], articulator metathesis prevailed over all other processes.[41]

In *hospital*, I am discounting errors involving glottalisation other than in the /t/ as [ˈʔɒspɪʔʊ], [ˈhɒʔbɪtʊ], a labial harmony as [ˈhɒfpɪtʊ]. And I am disregarding the non-trivial, but separate, partly dialectal issue of how and how much the lateral is vocalised. We are only looking at the surface form of the stops. In *pentagon*, I discount 20 cases of voicing harmony (equally in both directions) and 2 others, none relevant here.[42] There are 3 coronal harmonies, 1 dorsal harmony, and 8 metatheses, all involving the articulators, 4 of the 8 also involving a voicing harmony (in both directions), surfacing as [pɛŋgətɛn], [pɛŋgədən], and [pɛŋkətən].

(3.26) *One limit – **hospital** – variable limit – **pentagon***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Metathesis	[hɒstɪpəl] S4, 11, 44, 53, 59, 81	**6**
Inconsequential	S3, 8, 18, 26, 28, 40, 60	**7**
Canonical		**87%**
Metathesis	[ˈpɛŋkədən] S5, 25, 26, 39, 44, 56, 73, 74	**8**
Harmony	[ˈpɛntədən] S3, 31, 59	**3**
	[ˈpɛŋkəkən] S61	**1**
Inconsequential	S2, 4, 11, 15, 16, 21, 38, 41, 43, 46, 52, 53, 69, 70, 80, 85, 84, 86, 88, 90, 92, 97	**22**
Canonical		**65%**

[41] Here I am ignoring 9 realisations of *escalator* as [ˈɛksəlɛɪtə], possibly by reanalysis – by (3.11.j) – by the child taking the input form to have an initial /ɛks/.

[42] The polarity / directionality of non-canonical harmony involving voicing may be of interest or signficance. But issue does not feature in the hypotheses under consideration here. There is no strong asymmetry on this point in the data here.

It is possible to define this distribution in terms of where the association occurs. It is as though Labial and Dorsal were 'attracted' in opposite directions in relation to the foot structure. Characterising the process in terms of 'bearers' (foreshadowing more discussion in Chapter 5, a bearer is an element to which another can associate), the conclusion in (3.27) follows.

(3.27) In respect of the articulators, there is a central tendency, represented by 6 out of 6 cases in *hospital* and by 8 out of 12 cases in *pentagon*, where a non-Coronal element is associated wherever there is an adjacent bearer. On the Enfield (1972) criterion, the case of *hospital* is significant.

By the notion of an 'adjacent bearer' labiality associates next to roundness, and dorsality next to nasality, in the case of the latter, as one constituent. The latter is dorsalised by the process. The claim in (3.27) can be re-expressed as a tendency.

(3.28) In a dactyll with a heavy stressed syllable and a closed final syllable, the likelihood of non-coronal floating is in proportion to the sharing of an articulator within the syllable and the adjacency of the bearer.

Both conditions are met in *hospital*, one is met in *pentagon*, and neither in *cardigan*. This determines the varying degrees to whch metathesis is prevalent in these words. Note that here, as in the case of coronal harmony, there is a lowermost threshold.

The non-trivial issue of the mechanism is one to which I shall return, first in Chapter 5, and then in Chapter 7.

(3.29) lists cases where for any speaker with the metathesis in *hospital* or with coronal harmony in *crocodile* or *eskimo*, there is also an difficulty with one of the words which prevalently trigger coronal harmony at what seems to be a higher threshold.

(3.29) *Testing implications: metathesis and coronal harmony thresholds*[43]

	Eskimo	*crocodile*	*pentagon*	*hospital*	*cardigan* *calculator* *hippopotamus* *archeopterix*
S3	ˈɛskɪnəʊ				a:tɪˈɒptəɪks̩
S4	ˈɛssɪnəʊ			ˈhɒstɪpʊ	ˈkæɬtəlɛɪtə
S5			ˈpɛŋkədən		ˈka:dɪdən
S11				ˈhɒstɪpʊ	hɪtəʊˈpɒtənəs
S25			ˈpɛŋkədən		a:kɪˈɒppərɪks
S26			ˈpɛŋgədən		ˈka:dɪən
S39			ˈpɛŋkətən		ˈka:dɪən
					ˈkæltəlɛɪtə
					a:tɪˈoptərɪs
					hɪtəˈpotəməs
S40		ˈkrɒtədaɪɬ			ˈka:dɪdən
S44			ˈpɛŋkətən	ˈhɒstɪpʊ	ˈka:dɪdən
S50	ˈɛstɪməʊ				ˈkæltəlɛɪtə
S53		ˈkrɒʔədaɪɬ	ˈhɒsəbʊ		ˈka:dɪdən
					ˈkætənɛɪtə
S56			ˈpɛŋgətɛn		ˈka:dɪdən
S59				ˈhɒstɪpʊ	ˈka:dɪdən
					hɪtəˈpɒtəməs
S73			ˈpɛŋgətən		a:kɪˈɒptɪs
S74			ˈpɛŋgədən		a:kɪˈɒstərɪks
S81	ˈɛstɪməʊ			ˈhɒstɪpʊ	ˈka:dɪdən
S87	ˈɛskɪnəʊ				hɪtəˈpɒtəməs

Most of the errors in the rightmost column instance one or more of the prevalent coronal harmonies identified here – in S39's case, all four of them. If S has metathesis in *hospital* or *pentagon* or coronal harmony in *eskimo* or *crocodile,* both dactylls with a short stressed vowel, there is a failure typically harmonic in *cardigan, calculator, archeopterix* or *hippopotamus* – an implication of the sort in (3.1.d). This suggests the sequence of thresholds in (3.30).

[43] With no obvious impact on the claims here, S's 53 and 59 were identified as a result of the experiment as needing direct therapy.

(3.30) Prosodic weight limits on non-coronal elements in unstressed onsets at two stages, including Stage $k > i \geq 1$

i) Stage $_{n-k}$ In dactyllic structures with a short stressed vowel, i.e. in *eskimo, crocodile, hospital,* or *pentagon*

ii) Stage $_{n-i}$ a) in *cardigan* (and/or *calculator?*), $i \neq 1$

b) *hippopotamus* or *archeopterix*, $i=1$?

There is no prediction here that every child with a single failure with respect to (3.30.i) will fail completely at (3.30.ii). The prediction is only that there will be some failure at this or these thresholds. The limit may apply in any one or more of the cases exampled here.

(3.30) is consistent with the claim in (3.31).

(3.31) In the parapraxis of normal development, the lowermost threshold for the prevalent, i.e. parapraxic, non-canonical surfacing of coronality – by metathesis or harmonically – is a dactyll with at least one heavy syllable.

Here I am discounting, as exceptional, two single cases in the 1997 experimental data of *axe* as [æʔts] and *clouds* as [daudz] from phonologically disordered S59.

At a level of competence lower than that of the speakers in the experiment here, there is one bisyllabic context where Coronal is systematically vulnerable – where /t/ or /d/ falls between a vowel and a syllabic /l/, as in *little* and *middle*. Although not one subject in the experiment dorsalised in *puddle* as [ˈpʌgʊ] or [ˈpʌgəɫ], S11, S32, S50, S77, S86, and S95, dorsalised the /t/ in *digital* as [ˈdɪdʒɪkʊ], the youngest at 4;11, the oldest at 8;4, all making three other sorts of errors, as shown in (3.32).

(3.32) Harmonic and foot structure errors in idiolects with *digital* as ['dɪdʒɪkəl]

	Harmony – Coronal trigger	Labial Harmony	Foot structure error
S11	hɪtəʊ'pɒtənəs	dɪplə'dəʊpəs	'pɛntəən, 'dʒɒmɪəʊ
S32	'gɒbəlɪgu:ʔ, fə'mɒnɪtə	æmə'mɪnɪəm ma:'mɛskos	'kænæɫkənɛɪtə
S50	hɪpə'pɒtənəs, 'ɛstɪməʊ 'gɒbəlɪgu:ɪ, 'kæɫtəlɛɪtə	dʒə'romɪməʊ	'fɒmɪtə
S77	'mæŋɪt	'gɒbəlbɪgu:k	'sɪfɪkət
S86	æstrə'dɪstə	'mɛləmɪ	'hɒgədɪ
S95	ælə'mɪnəən	dʒə'rɒmɪməʊ	ælə'mɪnəən

NB Realisations of *hippopotamus, diplodocus, pentagon, Geronimo, gobbledigook, thermometer, aluminium, calculator, asbestos, Eskimo, magnet, certificate, aspidistra, Melanie, mahogany, spagetti, budgerigar.*

Commonalities between these idiolects are listed in (3.33).

(3.33) *Representation at a stage in phonological development* – ***digital*** *as* ['dɪdʒɪkəl]

a) There is both labial harmony and at least one separate harmony in which, an element is vulnerable to a property of a coronal, typically Coronal.

b) There is a problem involving foot structure, e.g. *pentagon* as ['pɛntəən].

Given the two factors in (3.33), it is possible that the dorsalisation in *digital* represents the effect of both. In the case of (3.33.b) there is evidence of an incomplete idea of what foot structure represents. This may bear on the failure to implement coronality on the margin of a full foot. In general, it seems unlikely that both of these issues are addressed in a single developmental step. Hence (3.34).

(3.34) Dorsalisation in *digital as* ['dɪdʒɪkəl] is characteristic of Stage $_{n+k}$, k > 1.

What about harmony involving the other articulators?

Labial harmony featured in 44 idiolects. The clear evidence is in *asbestos*. In this word, just two harmonies are attested more than once, a labial harmony on the right edge and /s/ root harmony in the adjacent voiceless stop. There was 1 metathesis as [æz'dɛspɒs], 1 coalescence as ['vɛstɒf], and various disharmonies, one attested 4 times as [æz'bɛskɒs]. And there is compensatory lengthening, mainly in the initial syllable, but also in the final syllable. Discounting refusals, deletions, and various errors only attested once, the data patterns as in (3.35). One case of metathesis is shown because of the elements which are manipulated. Cases such as S54's [æ:ˈbɛstɒf] are counted as separate limits in respect of both codas, the root in one, the articulator in the other. For all but 2 S's, as for A_2, there is no reduction in the final vowel.

(3.35) ***asbestos***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Comp. Length.	[æ:ˈbɛstɒs] S16, 17, 31, 56, 60, 79, 80, 87, 91	9
	[ˈspɛstɒ:] S7, 10, 13	3
Harmony	[æzˈbɛstof] S1, 3, 15, 18, 39, 45, 54	7
Metathesis	[æzˈdɛspos] S44	1
Disharmony	[æzˈbɛskos] S29, 30, 53, 61	4
Root-harmony	[æzˈbɛssɒs] S22, 40, 60	3
Inconsequential	S2, 4, 6, 8, 9, 11, 12, 14, 20, 21, 24, 28, 32, 34, 35, 41, 42, 46, 47, 48, 49, 50, 57, 59, 62, 65, 67, 68, 70, 71, 74, 81, 90	33
Canonical		**65%**

There is not one clear coronal harmony in the /b/ or labial harmony in the /t/, hence ◆[æzˈdɛstɒs] and ◆[æzˈbɛspɒs]. Disharmonic [æzˈbɛskos], harmonic [æzˈbɛssos] and [æzˈdɛspos] by metathesis, have effects which are mutually contradictory, and possibly random. Speakers with compensatory lengthening on the right have no surface phonetic trace of the underlying syllable on the left. The oldest of these is younger than the youngest speaker with [æ:ˈbɛstɒs]. In the codas of the unstressed syllables, there are clear singularities and one asymmetry.

(3.36) In ***asbestos*** on the right edge of a prosodic element, the association of coronal /s/ is limited at Stage $_{n-k}$ and Stage $_{n-i}$, $k > i \geq 1$,

i) at Stage $_{n-k}$ as a coda in non-primary stressed syllables (3 cases);

ii) at Stage $_{n-i}$ with effects due to the adjacent vowel:

a) In the initial coda as compensatory lengthening (9 cases);

b) In final coda, floating Labial (7 cases), compensatory lengthening (3 cases).

Although there is an interface account of the non-attestation of the reverse polarity – ◆[æzˈdɛstɒs] – by acoustic salience, I draw this conclusion.

(3.37) In *asbestos*, there is a singularity with respect to the target of the articulator harmony, significant on Enfield's 1972 criterion.

Other cases of labial harmony were as follows. In *diplodocus,* there were 3 realisations as [dɪplə'dəupəs], in contrast to one coronal harmony and 2 dorsal harmonies, but in view of the distribution, with no significance. In *gobbledigook* there were 3 labial harmonies in the final coda, as ['gɒbəldɪgu:p] and 13 variants, but none with labial harmony in the final onset. Hence ◆['gɒbəldɪbu:k]. In *Barnaby,* there were 4 realisations as ['ba:məbɪ], but no coronal harmony hence ◆['ba:nədɪ]. In *aspidistra* there were 5 labial harmonies as [æspə'dɪsprə] mostly with the loss of the /r/, and 1 [æstrə'dɪstə] with /r/ migration. In *aspidistra,* the Coronal and the Labial have the same places in relation to the foot structure as in *hippopotamus*. But the patterns go opposite ways. Recall from Section 2.4.1 the key role of the glide in A's labial harmony from 2;7 to 3;3 (see Smith, 1973). In *aspidistra,* the /r/ in the representation seems to reverse the polarity/directionality of an articulator harmony from the one in *hippopotamus.* Although labial harmony was not prevalent in *aspidistra* (the prevalent harmony being triggered by the interaction between the /r/ and the adjacent stop – see below), it seems from this and the cases of *Melanie* and *Barnaby* that we need to distinguish different thresholds in labial harmony. In idiolects with labial harmony in any of these words, for the sake of accurate description the domain needs to be defined in a way which is suitably restrictive.

Let us now turn to the simplest case of articulator interactions between sonorants – in *animal*. The 10 inconsequential cases were all refusals.

(3.38) ***animal***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Harmonic floating	['æmɪmʊ] S8, 29, 40, 44, 53, 74, ['æm mʊ] S13, ['æm mə] S61	8
Floating by metathesis	['æmɪnʊ] S46, 72, 88, ['æmɪʊ] S1, ['æmʊ] S11	5
Non-association	['ænʊ] S22	1
Inconsequential	S2, 7, 9, 15, 19, 38, 47, 67, 69, 87	10
Canonical		75%

In all cases, the surface roundness and backness on the right edge and the qualities of /æ/ associate correctly. I can capture all three sorts of case, harmony, metathesis and the indeterminate case of ['æmʊ] by the limit in (3.39).

(3.39) In *animal,* Labial representation is free in the foot structure (12 cases).

This is almost the inverse of the prevalent pattern in *hospital*. There is no obvious intersection between idiolects with non-canonical *hospital* and those with non-canonical *animal*. In neither case does an error in one imply an error in the other.

In *Melanie* and *Barnaby*, there is labial, but not coronal, harmony in a nasal target, hence [ˈmɛləmɪ], but ◆[ˈnɛlənɪ], [ˈbaːməbɪ], but ◆[ˈbaːnədɪ]. In *Melanie*, 8 cases of labial harmony are balanced by [ˈmɛnəlɪ], [ˈmɛləlɪ], [ˈmɛnənɪ] and the disharmonic [ˈmɛlədɪ], in almost equal proportions. The asymmetry is only in respect of one unattested case. In *Barnaby*, 6 out of 18 errors involved the articulators in the unstressed onsets, 5 as [ˈbaːməbɪ] 1 as [ˈbaːmədɪ], in the framework here, by the floating of Labial. There were 2 nasal harmonies as [ˈbaːnəmɪ]. Otherwise, in these two words, no other process was attested more than once.

Unsurprisingly, for all 21 speakers with metathesis or labial harmony in dactyllic *animal* or *Barnaby*, there was at least one other case of harmony involving an articulator, in 20 of the 21, Labial.

(3.40) Limits on coronals in unstressed onsets at Stage $_{n-k}$ and Stage $_{n-i}$, $k > i \geq 1$, by prosodic weight

i) Stage $_{n-k}$ Limit applying in a dactyll, i.e. in *animal* or *Barnaby*.

ii) Stage $_{n-i}$ Limit applying by other conditions.

Let us now turn to dorsal harmony. There were 7 clear cases, 3 in *magnet* as [ˈmægnɪk], 2 in *diplodocus* as [dɪpləˈgəʊʃəs] and [dɪpləˈgləʊsəs] and 2 in *gobbledigook* (against expectation) as [ˈgɒgəlɪguːk] and [ˈgɒgəlɪguːk], the last outweighed by 16 cases of harmony in the opposite direction/polarity as [ˈgɒbəldɪguːp]. In *stilts*, there were four cases of dorsalisation as [ˈskɪɫts], contrasting with 8 cases of cluster reduction, 4 as [d̥ɪɫts] and 4 as [sɪɫts]. Although there is no asymmetry here, let us treat this as a harmony triggered by the surface darkness of the lateral. This leads to the implication in (3.41) and the claim in (3.42).

(3.41) In every idiolect with dorsal harmony in [ˈskɪɫts], there is another realisation involving a non-canonical surface lateral, in S21's *yellow* as [ˈlɛləʊ], in S24's *asbestos* disharmonically as [æɫbɛːtɒs], in S41's *Melanie* as [ˈmɛləlɪ], *chimnney* as [tʃɪmbəlɪ], *Jerusalem* as [luːsəfəm], and in S75's *aluminium* as [æləmɪlɪəm].

(3.42) Limits on coronality at 2 Stages

i) Stage $_{n-k}$ Limit in onset cluster with coda cluster containing dark /l/, i.e. in *stilts*.

ii) Stage $_{n-1}$ Failure to inhibit lateralisation in an underlying coronal.

In *magnet*, dorsal harmony was the only feature-changing process.[44] No other error occurred more than once. Discounting one-off errors such as [ˈmægnənt] – by reduplication, there there is thus a small, but absolute, asymmetry with respect to *magnet*. To wit ◆[ˈmædnɪt] and ◆[ˈmædnɪp].

(3.43) ***magnet***

Limit	Effects of limit	Total non-canonical/ percentage canonical
Loss of coronal in coda	[ˈmægnɪk] S21, 31, 54	3
Inconsequential	S3, 6, 7, 11, 13, 20, 40, 43, 49, 50, 57, 77	12
Canonical		85%

(3.44) In the structure represented by *magnet*, in respect of coda articulators in 3 out of 3 cases where these are involved, there is dorsal harmony. On Enfield's 1972 criterion this is significant.

Here too there is an implication. In all idiolects with the [ˈmægnɪk] error, there was a foot-structure error in *asbestos* – in S21's as [ˈbɛstɒs], in S31's as [æ:ˈbɛstɒs], in S54's as [æ:ˈbɛstɒf]. Not one of these speakers loses coda /k/ in *archeopterix* as [a:kɪˈɒptərɪs] or any variant of this. In the cases of S21, S24 and S41, with [ˈskɪɫts], the same pattern held in *asbestos*. Stated in terms of articulator weakness, these co-relations are hard to explain. But they can be explained as variable exemplars of one limit relating coronal obstruents to the prosodic structure.

[44] In the 1991 pilot study, there were also 3 exemplars of [ˈmægnɪk], and no other articulator harmonies.

(3.45) *Dorsal harmony and the vulnerability of one of a set of coronal codas near a labial*

Where A) all syllables are closed; B) there is roundness in the stressed syllable (a labial in the stressed onset), C) there is a difference of voicing between coda elements such that one (that of the final syllable) is unvoiced and one (that of another syllable) is voiced, if there is dorsal harmony in *magnet*, *asbestos* is realised with some loss of structure, implying separate limits at Stage $_{n-k}$ and Stage $_{n-i}$, $k > i \geq 1$, with respect to the association of coronals.

i) Stage $_{n-k}$ Limit applying in *stilts* or *magnet*;

ii) Stage $_{n-1}$ Limit applying in *asbestos*, by (3.36.ii).

There were no other cases of harmony involving just articulators. From the data here and previous claims, the more general claim in (3.46) follows.

(3.46) In all prevalent cases involving two articulators in parapraxic harmony or metathesis, at least one of them is coronal.

Now consider disharmony, noted in Chapter 1 in *monopoly*. In this word, 15 errors involved pre-tonic deletion, 9 involved harmony or metathesis between the /**n**/ and the /**l**/, in all cases preserving the latter. And there were 5 refusals. The data in (3.47) leads to the claim in (3.48).

(3.47) ***monopoly***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Disharmony	[**mə'nɒkəlɩ**] S6, 31, 39, 44, 88, ['**nɒkənɩ**] S5	**6**
Harmony at the root	[**mə'lɒpəpɩ**] S47, 63 [**mə'lɒpəwɩ**] S8	**3**
Obstruence	[**bə'nɒpənɩ**] S70, [**bə'nɒpəlɩ**] S2	**2**
Inconsequential	S1, 2, 3, 8, 9, 11, 12, 16, 18, 21, 22, 25, 26, 29, 34, 36, 40, 41, 46, 47, 52, 53, 57, 58, 59, 63, 76, 81, 84	**29**
Canonical		**59%**

(3.48) In *monopoly*, with 6 articulator disharmonies replacing Labial by Dorsal, 3 harmonies involving the labial root or roundness, 3 harmonies losing Nasal, with respect to the absolute prevalence of articulator disharmony over articulator harmony, there is a singularity here.

Hence ◆[**mə'mɒpəlɩ**], ◆[**nə'nɒpəlɩ**], ◆[**mə'nɒtəlɩ**]. In idiolects with any error in involving labiality in *monopoly*, harmonic or disharmonic, there was at least one articulator error in a word with three articulators.

(3.49) Limits at Stage $_{n-k}$ and Stage $_{n-i}$, $k > i \geq 1$, with respect to articulators

i) Stage $_{n-k}$ Labiality error in *monopoly* – with two articulators;

ii) Stage $_{n-1}$ No limit other than in respect of three articulators.

To conclude this discussion of articulators, let us now turn to the case where **/m/** interacts with **/r/** and **/n/** in *Geronimo* – occasioning 56 overt errors. In (3.50) the floating of Labial from the final onset into the foot is characterised as Float Lab, non-association as NA, that of **/r/** as NA **/r/**, of Labial as NA Lab, and the loss of foot structure as NA foot.

(3.50) *Limits – roots and articulators* – ***Geronimo***

Limit	Effects of particular limits	Total non-canonical / percentage canonical
Float Lab, NA /r/	[dʒə'mɒnɪməʊ] S6, 8, 46, 57, 60	
	[dʒə'mɒnɪnəʊ] S54, 81	
	[dʒə'mɒnəəʊ] S14	
	[dʒə'mɒlɪməʊ] S74	
	[dʒə'mɒnɪəʊ] S4, 5, 22, 43, 44, 66, 70, 72	
	[djə'mɒməməʊ] S3	
	[dʒə'mɒlləʊ] S17	
	[dʒə'mɒmɪəʊ] S97	
	[dʒə'mɒmɪməʊ] S1	**21**
Float Lab, NA foot	[dʒə'rɒmməʊ] S29, 34	
	[dʒə'rɒmɪəʊ] S10, [dʒə'rɒmɪdəʊ] S30	
	[dʒə'rɒmɪməʊ] S42, 50, 79, 95	
	[dʒə'rɒmɪnəʊ] S21, 31, 35, 52, 68, 69, 88, 90, 91	
	[dʒə'mɒmɪrəʊ] S41	**18**
Float Lab, NA /r/ foot	['dʒɒmɪnəʊ] S24, ['dʒæməəʊ] S53	
	[dʒə'ɒməməʊ] S9, ['dʒɒmɪməʊ] S40, ['dʒɒmɪəʊ] S11	**5**
NA /r/ foot	['dʒɒnɪməʊ] S7, 56, 58, 67, 87	
	[dʒə'ɒnɪməʊ] S38, ['də'ɛnɪməʊ] S2	**7**
NA Lab	[dʒə'rɒnɪəʊ] S62, [dʒə'rɒnɪgəʊ] S51	**2**
Inconsequential	S12, 18, 83	**3**
Canonical		**42%**

In the 56 idiolects with any error in this word – in all cases involving at least one of the sonorants, in 44 cases Labial floats into the foot, harmonically, by metathesis or by migration, in 21 of these at the expense of the /r/. In 12 cases there is some loss of structure on the left, in 10 as realignment and in 2 with some phonotactic anomaly. In 2 cases, Labial is lost, once by deletion, once by disharmony. There is not one simple coronal harmony; hence ◆[dʒəˈrɒnɪnəʊ]. By treating the non-association as progressive, it is possible to explain phonotactically deviant surface structures with two adjacent vowels of which the leftmost is schwa. Previously noted in respect of *archeopterix*, this non-association seems to occur characteristically where a liquid is at a foot-structure margin. This leads to (3.51) and (3.52).

(3.51) In *Geronimo* with two coronal sonorants in the foot, /m/ in the final onset, and roundness in the stressed and final vowels:

a) Labial is associated in the foot in 44 out of 56 cases;
b) Unless Labial associates in the foot, Coronal is not associated outside it;
c) In 33 cases, /m/ is associated and /r/ lost, in contrast to 2 vice-versa;
d) In harmonic relations involving the nasals, in 8 out of 8 cases this is at the expense of Coronal, where the non-attestation of coronal harmony was predicted, with no independent explanation, and significant on the Enfield (1972) criterion.

(3.52) Two limits with respect to *Geronimo*

i) Stage $_{n-k}$ Limit on Labial in the stress domain with all sonorant onsets;
ii) Stage $_{n-1}$ Limit applying in respect of any articulator.

There were 34 speakers who could say *animal*, but who could still not say *Geronimo*. But for all 13 of the speakers in (3.38) unable to say *animal*, there was a problem in respect of *Geronimo*, with a degenerate foot, an /r/ onset next to the degenerate foot, and roundness in both the stressed vowel and the off-glide of the final vowel. This leads to an implicational claim, going one step further than previously.

(3.53) Limits on coronal: a sequence of stages before Stage $_{n-1}$

i) Stage $_{n-m}$, m > 2: where there is no other surface coronal, i.e. in *animal*, *Barnaby*, or *Melanie*.
ii) Stage $_{n-k}$, k > 1: by (3.52.i.), where there is a degenerate foot, i.e. in *Geronimo*.

3.4.3.2 Other featural processes and singularities

This Section concerns a set of cases involving nasality, liquidity, apicality, labiality, and vocalic roundness.

As in the case of *Geronimo*, in *Jerusalem*, also with roundness in the stressed sylable, but with labiality, rather than roundness, in the final rime, there is evidence of positive interaction between the liquids. Unexpectedly, the non-apicality of /r/ sometimes floats rightwards. In (3.54), the main processes are characterised in terms of Non-Association, NA, and Floating, Fl. One realisation, as [dʒərəˈluːsɹəm], is not clearly accountable. Refusals and various processes affecting the edgemost segments, none attested more than once, are treated as inconsequential.

(3.54) *Limits with respect to roots and articulators – **Jerusalem***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
NA /r/	[dʒəˈluːsələm] S38, 70, 76, 94,	
	[dʒəˈluːsərəm] S27, 33, 54	
	[dʒəˈluːsənəm] S90, [dʒəˈluːsɹəm] S44, 92	
	[dʒəˈluːsəm] S66, [dʒəˈluːsəmən] S8, 64	
	[ˈluːsəɾəm] S41	**14**
NA /r/ as onset	[ˈdʒuːsələm] S4, 11, 12, 16, 17, 29, 30, 40, 58	**9**
NA /l/	[dʒəˈ‹r›uːsənəm] S14	
	[dʒəˈruːsɹəm] S63, 97	
	[dʒəˈruːsəm] S65, 71, 83	
	[dʒəˈɾuːsəmən] S5, 31, 56	
	[dʒəˈruːsənən] S3, [dʒəˈruːsərəm] S61	**11**
Mutual harmony	[dʒəˈwuːsəwəm] S10, 28	**2**
Vowel harmony, NA	[dʒuˈuːsəm] S53	**1**
?	[dʒərəˈluːsɹəm] S62	**1**
Fl N Apic	[dʒəˈruːʃələm] S6, 26, 59, 79	**4**
Inconsequential	S1, 2, 7, 18, 23, 50, 52, 81, 87	**9**
Canonical		**47%**

As in *Geronimo*, a central tendency is detectable – and testable statistically.

(3.55) In *Jerusalem*, /r/ fails to associate in 23 cases in contrast to laterality in 11. In 3 cases both are lost. With a distribution in the expected polarity, where this has no independent explanation, $\chi^2 = 4.24$, $P < 0.05$.

Taking *Geronimo* and *Jerusalem* together, 71 S's got one of them wrong. In 74 idiolects there was at least one articulator harmony. The proportions are almost the same. The intersection is not significant. 87 S's have either an articulator harmony or an error in respect of *Geronimo* or *Jerusalem*. The relevant factors in these two words seem to be separate from those involved in articulator harmony.

Unsurprisingly, all S's unable to say *yellow*, in 5 cases as [ˈlɛləʊ], in 1 as [ˈlɛwəʊ], were also unable to say *Jerusalem*, *Geronimo*, *monopoly*, *diplodocus*, or *digital*, all with liquidity and labiality or roundness (derived in 1 case) in a stucture with more than a full foot. Before considering the obvious implication, I am led to the claim in (3.56).

(3.56) Developmentally, the representation of roundness, labiality, liquidity and foot structure interact.

The roles of sibilance, affricatehood and non-apicality are more salient in *spaghetti*, *soldier*, *sausages*, *digital*, *chipshop* and *aspadistra*. In *spaghetti*, discounting unanalysable cases such as S4's [səˈbɛkɪ], S50's [səˈbɛtɪ], S5's [skəbəˈtɛtɪ], characterising the association of /s/ in the stressed syllable as 'migration', the data patterns as in (3.57), with a central tendency, as defined in (3.58).

(3.57) ***spaghetti***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Migration	[bəˈskɛtɪ], [ˈpskɛtɪ], [ˈskɛtɪ] S8, 11, 12, 26, 32, 41, 43, 46, 47, 52, 53, 61, 64, 68, 70, 78, 79, 81, 86, 88, 92, 97	22
Non-association	[bəˈgɛtɪ] S3, 7, 15, 31, 40, 54	6
Inconsequential	S4, 5, 50, 59, 60	5
Canonical		66%

(3.58) In *spaghetti*, /s/ floated in 22 cases, and was deleted in 6, by an expected distribution, with no independent explanation, $\chi^2 = 9.14$, $P < 0.01$.

Not only is the chance probability very low, the case by (3.58) is the reverse of what might be suggested by independent interface considerations.

In all idiolects with /s/ floating in *spaghetti*, there was articulator harmony.

(3.59) *Migration and articulator harmony in general – two stages – evidence of* ***spaghetti***

i) Stage $_{n-k}$ Limit on /s/ in a cluster in a degenerate foot;

ii) Stage $_{n-1}$ Limit on an articulator, expressed harmonically.

In *aspidistra*, in 10 cases the surface affrication of the final cluster containing stridency and non-apicality floated to the stressed onset, prototypically as [æspəˈdʒɪstrə]. In

38 cases, /r/ was lost at the root, prototypically as [æspəˈdɪstə]. In 5 cases mentioned above, Labial harmonised in the final onset. In 2 cases Labial floated elsewhere. The floating of Labial and /r/ features did not co-occur. Hence ◆[æstəˈdʒɪsprə] and ◆[æspəˈdʒɪsprə] and related forms. But given the rate of simple cluster reduction on the right edge, the asymmetry here is weak.

In other cases, the non-apicality is underlying. Out of 12 errors in *sausages*, discounting 4 'lisp effects', such as [sɒs̪ɪdʒɪz̪] and disharmonic [fɒsɪdʒ], all other errors involved de-affrication, possibly by an interface effect like cluster reduction. In 4 cases, non-apicality floated into the stressed onset, in S53 – with a phonological disorder – as [ˈʃɒʃɪʒɪz], and otherwise as [ˈʃɒsɪjɪz] and [ˈʃɒsɪdɪz]. These 4 cases are balanced by 3 as [ˈsɒsɪdɪz] with the outright loss of the non-apical gesture. There is no obvious prevalence here.

In *soldier*, the non-apicality was preserved in all cases. 7 errors involved migration or harmony in the stressed onset. Discounting S50's disharmonic [ˈsɒŋədʒə], the loss of /l/ as [ˈsəudʒə], and lisps, as [ˈs̪əuldʒə], errors involving non-apicality pattern thus.

(3.60) *Limit on non-apicality* – ***soldier***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Fl N Apic	[ˈʃəuldʒə] S53, [ˈʃəuldə] S39, 40, [ˈʃəudʒə] S51, 59	
	[ˈʃəudə] S8, 20	**7**
Deaffrication	[ˈs̪əudjə] S10, [ˈsəuldzə] S2, [ˈsəulʒə] S4, 45	**4**
Inconsequential	S3, 6, 9, 15, 21, 36, 56, 25, 50, 58, 87	**11**
Canonical		**77%**

Here there was just one realisation involving the loss of the non-apical/palatal property in [ˈsəuɫdzə], but not one losing the source element absolutely. Hence ◆[ˈsəuɫdə]. The mechanism by which non-apicality floats is a topic I shall need to return to.

In *digital*, the final onset is damaged in 29 out of 38 errors. One, in 6 cases, to be considered further in due course, is dorsalisation. In (3.61), various limits are listed under 'Final onset'. But the greatest vulnerability in this position, attested in 12 cases, involves the non-apicality of the affricate, shown in (3.61) as Fl N Apic. Conversely, non-apicality is lost in only 3 cases. De-affrication occurs in 6 idiolects. Discounting refusals, cases where S comments on the difficulty, and disregarding the surface form of the underlying lateral, the data patterns thus – where the realisation of S53 is counted twice – on account of both de-affrication and loss in the final onset.

(3.61) *Limits on non-apicality and /t/ – **digital***

Limit	Effects of particular limits	Total non-canonical/ percentage canonical
Final onset	[ˈdɪdʒɪkəl] S11, 32, 50, 77, 86, 95, [ˈdɪdʒɪəl] S31, 40,	
	[ˈdɪdʒɪləl] S5, 19, 39, [ˈdɪdʒəɫɫ] S61	
	[ˈdɪʒələl] S53, [ˈdɪdʒəəl] S20	
	[ˈdɪwəwəl] S1 [ˈdɪdʒɪ<f>ʊ] S6, [ˈdɪdzɪsəl] S2	**17**
Fl N Apic	[ˈdɪdʒɪtʃəl] S4, 10, 12, 36, 42, 68, 71, 90,	
	[ˈdɪdɪtʃəl] S27, 63, 65, 87	**12**
Deaffrication	[ˈdɪʒɪtəl] S8, 9, 81, [ˈdɪdɪʔəl] S13, [ˈdɪʒələl] S53	**5**
Inconsequential	S3, 6, 7, 16, 33, 34, 38, 46, 49, 59, 60, 66, 69, 72, 81	**15**
Canonical		**62%**

Where non-apicality floats, just affricatehood is involved. Hence ◆[ˈdɪdʒɪdʒəl]. As noted above, the affrication/palatalisation of the stressed onset is almost prevalent in *aspidistra*, but it is unattested in *digital*.

In errors involving sibilance, there seem to be three factors: A) whether the affrication is underlyingly in the foot; B) whether the structure contains a liquid; C) whether there is a contrast with respect to voicing. In the first of these respects, *sausages* is different to *soldier*, *digital*, and *aspidistra*. Confirming the claim in (3.9.h) that parapraxis affects affricatehood in isolation, I can now make the following claims relating sibilance to both laterality and foot-structure.

(3.62) *Parapraxis involving sibilance*

a) Where the structure contains a coda lateral (in *digital* and *soldier*, not in *sausages*), non-apicality is (characteristically – with 1 exception in the data here) preserved in at least one onset.

b) Non-apicality floats between onsets, harmonically or otherwise in errors involving these features, in *sausages* in 4 out of 7 cases, in *soldier* in 7 cases out of 11, in *digital* in 12 out of 18 cases, in all cases as predicted, in a way with no independent explanation.

c) Where there is a contrast with respect to voicing, non-apicality targets the stressed onset – in *aspidistra*, *sausages*, and *soldier*, not *digital*.

d) The harmonisation or floating of affricate or palatal properties does not involve voicing/is not at the root.

e) Affricates and/or /s/ clusters other than with /t/ are realised only in a full foot – with different effects in the cases of *hospital*, *spaghetti*, *Geronimo* and *Jerusalem*.

f) Root harmony triggered by /s/ approaches prevalence only in the coda of the stressed syllable – in *asbestos* as [æzˈbɛssɒs], *eskimo* as [ˈɛssɪməu], *escalator* as [ˈɛssəlɛɪtə] *aspidistra* as [æspəˈdɪssə].

In all 42 idiolects with non-apicality floating either from an affricate or the superficial affrication in *aspidistra*, there was at least one articulatory error either by harmony or by non-association. Hence (3.63).

(3.63) Since it implies a limit on an articulator, the movement of coronal fricative properties is at a threshold represented by Stage $_{n-k}$, k > 1.

Let us now return to the case of *yellow*. More evidence of a Stage $_{n-m}$.

(3.64) Since it implies (3.63), the prevalent lateral floating in *yellow* is at a relatively lower threshold, Stage $_{n-m}$, m > 2.

In relation to the claims in (3.9), the most unexpected aspect of the data here was the involvement of vowels in what seems to be a disharmony because phonetic contrast is increased.

(3.65) Vocalic disharmony occurred in words with a ternary foot, in *budgerigar* or *gobbledigook*, or with more than a simple foot and with all syllables closed, in *asbestos*, in all cases with a voiced labial stop in the stressed syllable.

In 12 idiolects, the change is in a ternary foot item; in *gobbledigook* the final vowel changes to /əu/; in *budgerigar* the stressed vowel changes to /æ/; in the idiolect of one of the twelve, in S53, both of these occur; in *asbestos* the final vowel goes to /əu/. All of these categorial changes increase the featural contrast between the vowels, in the case of /əu/ introducing a diphthong, in the case of *budgerigar* introducing a backness contrast between the stressed vowels.

In *budgerigar*, out of 38 non-canonical responses, in 5 the /d/ was copied on the right edge – prototypically as [ˈbʌdʒərɪga:d]. In all 5 idiolects there were more cases of articulator error. But there were 5 cases of affricate reduction 2 as [ˈbʌʒərɪga:] and [ˈbʌləkɪa:], 2 with the disharmonic fronting of the stressed vowel as [bælərɪga:d], and 1 as [ˈbæʃəɪkaː]. This is not prevalence.

The other case of copying was in *diplodocus* with 4 forms, prototypically as [dɪpləˈdəʊkləs]. One realisation as [dɪpləˈdɒkləs], presumably echoing an adult dialect with the word as /dɪpləˈdɒkəs/, suggests that this was not an accidental mishearing. These cases with the floating of Lateral into the strong foot contrast with one realisation with root deletion as [dɪpəˈdəʊkəs]. This floating of Lateral becomes root harmony in 2 realisations, prototypically as [dɪpləˈdəʊləs] and 3 as [dɪpləˈləʊkəs]. Various other sorts of copying and harmony involving the /s/ are occasioned in this word, but none reaching the level of prevalence.

3.4.3.3 Review of Phase One of the experiment

In this review of Phase One of the experiment here, in relation to the experimental goals concerning asymmetry, thresholds and productivity in (3.1.a), (3.1.b) and (3.1.c), claims by (3.9) now need to be revised as follows.

(3.66) *Partially revised claims*

a) Other than at a low threshold at Stage $_{n-i}$, i > 1,
   a) Articulator harmony is not prevalent in the onsets of stressed syllables.
   b) Each articulator is the prevalent harmoniser in particular environments.
   c) Articulator harmonies involve at least two nasals or obstruents, at least one a stop, in words with at least one closed syllable.
b) Against expectation, there was dorsal harmony in the /b/ in *gobbledigook*, as [ˈgɒgəlɪguːk] and [ˈgɒgəlɪluːk], not as a one-step process, and outweighed 8 times by labial harmony in the opposite direction/polarity as [ˈgɒbəɫdɪguːp] and related forms.
c) Disharmony is prevalent, on a narrow definition, as predicted in *monopoly*.
d) Reduplication is not prevalent in any of the environments here.
e) Other than with respect to two marginal cases, for coronal harmony and metathesis, there are lowermost thresholds defined on prosody and melody. Prevalent parapraxic metathesis always involves coronality.
f) Floating in *spaghetti* and compensatory lengthening in *asbestos* are prevalent in a way suggesting a singularity in each case.
g) In the onsets of unstressed, word-internal syllables, coronality is vulnerable in *digital*. Labial targets sonorants in the onset where there is roundness in at least one rime – in *Geronimo* and *animal*.

These claims lead to one hypothesis and one further, more general claim.

(3.67) The lowermost threshold for metathesis and coronal harmony and the implicational relation concerning the dorsalisation of the final /t/ in *digital*, suggest a single factor in all of these cases.

(3.68) There is no unbounded harmony as a prevalent form. Out of 45 parapraxic realisations of *Geronimo* with /m/ surfacing in the foot, there is only 1 as [dʒəˈmɒ mɪ məʊ].

Regarding the implication goal in (3.1.d), there are cases at Stage $_{n-k}$, k > 1, and at Stage $_{n-m}$, m > 2, by definition not Stage $_{n-1}$. The phenomena in (3.69) are thus all diagnostic, what Anthony, et al (1973) call 'discriminatory'.

(3.69) Parapraxis by Stages

a) Stage $_{n-m}$, m > 2

a) by (3.64)	Laterality floating in *yellow*
b) by (3.53)	Labial floating in *animal, Melanie* or *Barnaby*

b) Stage $_{n-k}$, k > 1

a) by (3.24)	Non-association of /r/ in *archeopterix*
b) by (3.15), (3.30)	Coronal harmony or metathesis in *cardigan, eskimo, crocodile, hospital,* or *pentagon*
c) by (3.19)	Coronal harmony in *calculator*
d) by (3.34)	Dorsalisation of /t/ in *digital*
e) by (3.42), (3.45)	Dorsalisation or harmony in *stilts* or *magnet*.
f) by (3.36)	Loss of /s/ in non-primary stressed syllables in *asbestos*
g) by (3.59)	The floating of /s/
h) by (3.63)	The floating of non-apicality in *soldier, sausages,* or *aspidistra*
i) by (3.49)	Disharmony in *monopoly*
j) by (3.52)	Any error in a sonorant in *Geronimo*

From the rate of errors and by the interface factor of syllabic length, *monopoly* and *Geronimo* are much harder than *eskimo* and *crocodile*. By (3.1.d), Stage $_{n-1}$ is likely to be represented by errors such as *Jerusalem* as [dʒəˈluːsərəm] and *hippoptamus* as [hɪtəˈpɒtəməs], with no implications.

Two aspects of parapraxis at Stage $_{n-1}$ can now be characterised in general terms.

(3.70) In phonological parapraxis at a point close to Stage $_{n-1}$, intersegmental processes relating articulators lead characteristically to

a) Labial floating in proportion to the number of cases of roundness/ labiality;

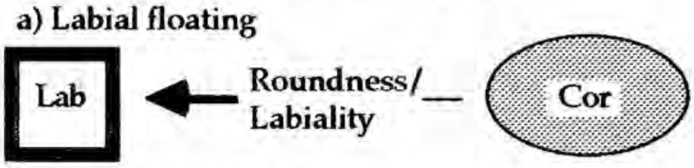
b) exclusively coronal surface forms where the domains consist of melodically and prosodically matched singleton word-internal onsets, where there is at least one other case of both the target articulator and Coronal.

Although no figures are given in (3.70), on the argument above, the opposite central tendencies and the corresponding degrees of asymmetry are statistically significant. The claim in (3.70), based on quantitive data from normally developing children is based on a belief that the ideas in (3.9) have been largely confirmed, subject to revisions in (3.66) and (3.69). This data can't be summed because the cases on which it is defined are from prior expectation (clinical experience and the pilot study). The cases are not objectively determined by random selection or by some other technique. They are selected on the very property I am seeking to measure. So it would be statistically quite misleading to try and compute the proportion of errors generally by summing the numbers involved in each case.

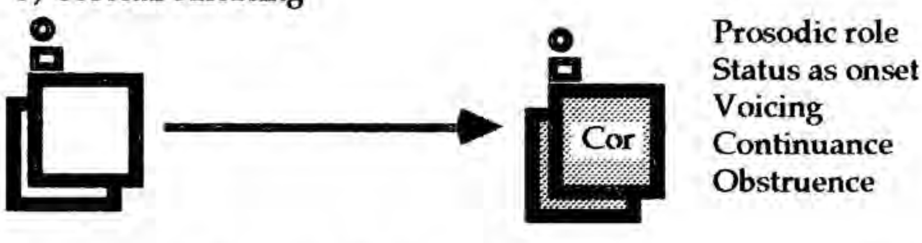
To clarify the claim in (3.70), it is re-worked in (3.71) as a graphical tabulation.

(3.71) Two opposite polarities in parapraxis

a) Labial floating



b) Coronal surfacing



By the b) case in (3.70) and (3.71) the difference between source and target is minimal, prosodically and melodically. By the a) case, this is irrelevant so long as a property of the target is echoed elsewhere in the structure. In Section 7, I shall hypothesise that the general case, by (3.70.b) and (3.71.b), extends to fronting. To do so, I shall have to assume that in very incompetent phonology (commonly in disorder and marginally in early phonology), both of the above generalisations apply across the lexicon and the individual word. I shall assume that this is not implausible.

(3.70) and (3.71) represent the simplest case, at a point close to Stage $_n$, hypothetically at Stage $_{n-1}$. Other singularities such as those in respect of *monopoly* and *hospital* occasion parapraxis of a sort which characterises an earlier developmental stage.

3.5 Conclusion

In relation to (3.1.a), I have tested and measured the claims from Chapters 1 and 2 about phonological parapraxis, and shown that the asymmetry is a general property of incompetent phonology. I have shown that in both normal development and in cases of disordered development, both the error distribution and the response to a structured presentation of nonsense words are broadly similar. This justifies the use of the cover term, 'incompetent phonology' in relation to both groups. In relation to (3.1.b), the 'productivity' of articulator harmonies, metathesis, and the floating of non-apicality have all been demonstrated. The disharmony in *monopoly* represents a singularity. In relation to (3.1.d), there are significant asymmetries: A) at Stage $_{n-1}$ by (3.70); B) evident in both the early phonology of Smith's A at 2;2 and in severe disorder, by Section 2.4.1; C) close to Stage $_{n-1}$. In the light of these findings, the notion of parapraxis seems to be well motivated.

In the framework here, Stage $_n$ exemplifies a final parametric setting. There is some corroboration of this idea in the idiolects of S15 at 5;1, S19 at 5;2, S49 at 6;3, S55 at 6;6, S83 at 7;9, S89 at 8;2, S93 at 8;3, S94 at 8;4, and S96 at 8;5. In these idiolects there were none of the errors exampled in (3.69). On the simple criterion of the number of non-canonical responses, the most competent S in the experiment was S55 with all responses canonical apart from [aːpɪoˀtərɪs], [hɛlɪkoˀtə] and [gobədɪguːk], with one harmony, one deletion and two cases of a glottalised /p/. It is not obvious how these would be inhibited by a single parametric step. On such reasoning, no S in the experiment here was at Stage $_{n-1}$ – a single step from Stage $_n$. Hence (3.72).

(3.72) At 8;6, phonological development is normally more than one step from completion.

While there was more variability in the data than expected, the experiment broadly confirms the testable claims in (3.9) – subject to the qualifications mentioned above, leading to the general claims in (3.73).

(3.73) General claims bearing on the experimental goals in (3.1)

a) The asymmetry in the data is consistent with the idea that there is a general 'pull' in a particular direction, on the hypothesis here, parapraxis. Even deletion, most easily explained as an interface effect, has a phonological aspect, with pre-tonic deletion prevailing over 'post-tonic' deletion by a factor of 2 to 1.

b) Given the way that the prosody is critically involved, representation limits, and thus phonological parameters, involve sets of features, most economically stated as variables, in prosodically defined environments. Asymmetries in phonological development occur as complex variable interactions between melody and prosody, and as singularities where phonological elements are subject to particular effects.

c) Thresholds of parapraxis can be defined in terms of asymmetric implications, some processes having lowermost thresholds. But it is not easy to determine the degree of context-sensitivity or asymmetry of the polarity / direction in a particular case.

d) In relation to (3.1.d), a number of diagnostically-significant implications have been shown in (3.69).

e) By (3.70) and (3.71), the characterisation of Stage $_{n-1}$ is by sets of features in prosodically defined environments. But given the claim in (3.72) that phonological development is typically still more than one step from completion at 8;6, and given that this was the age cut-off for the experiment here, the data here do not allow the full characterisation of Stage $_{n-1}$.

f) Stage $_{n}$ in phonological development critically entails the representation of all features in all prosodically defined structures.

By (3.73), there are connections between coronality and foot structure, between labiality and roundness, between the function of harmony and the form of the coronality. There is no obvious prospect of an explanation in terms of interface factors such as articulation, perception, or the feed-back function in speech.

Returning to the issue of SOT's considered in Section 2.5, if the phenomena treated here as parapraxis actually consists of SOT's, the SOT generalisations above are contradicted in the following ways. Contra Wijnen in (2.40), the onset of the stressed syllable is a harmonic target only in special cases (involving particular features as targets and triggers). Contra Fromkin in (2.39.a), there are the cases where an affricate element 'migrates', e.g. *soldier* as [ˈɟəʊldə]. Contra Nooteboom in (2.36.b), at least one harmonic domain contains elements differing in their role in the syllable, e.g. *asbestos* as [æzˈbɛstɒʃ].

Rather than abandoning these tenets of a well-established field, here I shall continue to construe the data here as ontologically distinct, as parapraxis.

In this Chapter, I have shown that degrees of parapraxis can be identified and that the asymmetries and singularities hold across the normally developing population. I have shown evidence that phonological is still normally in progress at the cut-off age for the experiment here. So the experimental goal in (3.1.c) of characterising parapraxis at Stage $_{n-1}$ is one goal too far. What about the goal in (3.1.b) of characterising the 'productivity' of anything which seems like a 'process' and the goal in (3.1.f) of reproducing the approach to the treatment of phonological disorder described in the Introduction? I shall turn to these issues in Chapter 4.

4 Reproducing therapeutic evidence experimentally

Chapter 4 focuses on those aspects of the experimental study here which bear most clearly on the cognitive, phonological, symptomatic approach to therapy referred to in the Introduction. I shall hypothesise that this therapy brings about a gradual but measurable increase in what is'representable' by the child's system of R-inspection. But in an unexpected way, this therapeutic success tended to get in the way of any resolution of the context-sensitivity issue also mentioned in the Introduction.

Section 4.1 turns to a research programme being carried out at exactly the same time at the same time that I was developing the therapy ideas mentioned above, both sets of thinking developing quite independently as far as I am aware. Section 4.2 describes a clinical session, seeking to convey my on-line clinical thinking. Section 4.3 describes my attempt to reproduce the same clinical effect experimentally by Phase Two of the 1997 experiment and to test it by Phase Three. Section 4.4 returns to the threshold and productivity issues in (3.1.b) and (3.1.c), attempting to compare the realisation of real words with that of minimally or variably different nonsense congeners.

4.1 Consistency and context sensitivity

Following exactly parallel reasoning to the author, the research programme to be described here used nonsense words as a way of investigating the issue of context-sensitivity in phonological processes. Chiat (1983) describes the case of a child of 5;8 with dorsal harmony in the onset, wherever there is a trigger not in the onset of the stressed syllable, and where there is otherwise fronting in the onset, giving *stick* and *tiger* with the harmony as [ˈgɪk] and [ˈkaɪgə], and *key, because, record* and *collect* with the fronting as [ˈtiː], [bɪˈdɒz], [rɪˈdɔːd], [dəˈlɛk]. Not using the conceptual framework here – it was only just emerging in phonology (see Chapter 5), Chiat was nevertheless able to draw confidence about the context-sensitivities here because the processes showed productivity in nonsense words.

With their focus on voicing and fronting, Brett, Chiat and Pilcher (1987) set out to compare the realisations of common words, rare/unfamiliar ones, and nonsense words. On the basis that nonsense words, by definition, have no previous lexical representation, these authors conclude that the familiarity of the word is irrelevant to the phonetic/phonological outcome.

Chiat (1989), looking at a 4 year-old child, found that stopping was related to both stress and syllaibic role. An intervocalic onset was vulnerable only between unstressed vowels, as in *Parsifal* as [ˈpaːsəbəl] and *Davison* as [ˈdeɪvɪdən]. Stopping did not occur at all in the coda. It was not sensitive to sandhi effects in expressions such as in *his eye.* [45] Non-words and familiar words, were all equally subject to the same effect.

The foot, Chiat notes, "is the prosodic domain to which stopping applies" (p.233). In the framework here, the stopping in *Davison* and *Parsifal* can be defined by a representation limit according to which in a dactyl with obstruents in the onsets of both unstressed syllables differing with respect to voicing and continuance, continuance is associated only in the foot. Chiat notes that errors are in positions not definable by perceptual salience, and that fricatives in complex sequences such as *hospital* and *accident* are realised correctly, whilst those in less complex sequences are disrupted. Chiat concludes, "The complex distribution of segmental substitutions provides a unique opportunity to investigate the relation between segmental features and prosodic structure". This idea goes right to the heart of this study.

4.2 A clinical exploration of *cardigan* in one idiolect

I turn now to the approach to therapy mentioned above which led directly to the present study. To recap, the child is given a structured sequence of nonsense words to repeat, each pronounced by the therapist as though it were a real word, each differing minimally from the last, typically in terms of the stressed vowel and in one other way. All trial items, and all errors if any of these occur, are transcribed. The therapy approaches points of difficulty one step at a time. Unless the child so requests, errors are not pointed out. All efforts are praised unconditionally. To a degree, this remodels a Piagetian 'clinical examination' (see Piaget, 1929).

In this light, consider BC, at 4;7, with *cardigan,* with mutual harmony as [ˈkaːdə‹l/ɫ›əŋ]. As this example may show, he was mostly incomprehensible, other than in context, to adults other than his mother (see Appendix 3 for more examples of BC's speech from this assessment). BC's treatment consisted in 14 half-hour sessions, each focusing on a different phonological area. In a general assessment at 5;3 the /g/ in *cardigan* was gestured non-specifically with dorsality but no true obstruence – in a way which might be represented as [ˈkaːdɩ‹g›ən], obviously an advance on [ˈkaːdə‹l/ɫ›əŋ], but still with a non-phonemic error. By (1.22.a), both the stress pattern and the rightmost coda contribute to the common parapraxis in this word. The fact that in BC's case the parapraxis was different might be treated as part of the symptomatology. One session was devoted to structures of this sort. It as follows – where the 'comments' in the righthand column represent a post hoc attempt to reconstruct my on-line, clinical thinking. In the column headed 'BC', realisations are shown only in the case of errors; realisations were canonical – by my own on-line judgement – unless otherwise indicated.

[45] The significance of morpheme boundaries was also noted by Gandour (1981).

(4.1) *Treatment session focusing on* ***cardigan*** *– BC at 5;3*

Trial	Therapist	BC	Comments
1	kə'daɪkɪ	kə'gaɪkɪ	Easier than *cardigan*
2	kə'nəʊkə		With nasal, lessening the difficulty?
3	kə'na:kɪ		With /ɪ/ on the right – increasing the difficulty?
4	kə'lu:kɪ		With lateral – increasing the difficulty?
5	gə'lɛɪkə	gə'ne:kə	With voicing – increasing the difficulty?
6	gə'di:kə		With /ə/ on the right – easier than kə'daɪkɪ?
7	kə'du:kɪ		Success – progress on trial 1
8	kə'ti:kə	kə'ki:kə	Back to dorsal harmony similar to trial 1
9	kə'nɔ:kə		Parallel to trial 2
10	kə'ne:kɪ		Parallel to trial 3
11	kə'di:kɪ		Success – parallel to trial 7
12	kə'du:kə		In view of trial 8 failure, seeking to generalise
13	kə'da:kɪ		Similar
14	gə'de:kə		Similar – but with voicing in leftmost onset
15	'gɪnəkɪ		Shifting to target stress contour
16	'gɒnɪkə		Generalising
17	'gɛdəkɪ		Target stress contour, oral stops throughout
18	'gɒdɪkə		Generalising
19	'gʌdəkɪ		Generalising again
20	kə'tu:kə	kə'ku:kə	Back to dorsal harmony similar to trial 1
21	gə'dɔ:kɪ		Voicing in two onsets
22	kə'daʊkə		Devoicing leftmost onset
23	'kɔ:dəkɪ		Reverting to target structure – with tense vowel
24	'kædɪkə		Laxing stressed vowel
25	'kɛtəkɪ		Generalising
26	'kɒtəkə		Generalising again
27	'kɪtəkɪ		Generalising again
28	'kætɪkə		Generalising again
29	'gu:tɪkə		Voicing stresed onset and tensing vowel
30	'ke:dəkɪ		Shifting the voicing
31	'ka:dɪkə		Generalising
32	'ke:dəgən		Rightmost coda, voicing final onset
33	'kɔ:dəkɪn		Reversing voicing contrast in final onset
34	'ka:dɪgən		Target – success!

In this sort of phonologically organised therapy, the nature and size of each step is obviously crucial. In (4.1) the first nonsense word occasions a dorsal harmony. The next three items are intended to be easier – with a coronal sonorant as the onset of the stressed syllable. The error on the fifth trial is not easy to analyse. This, like any error on the part of the child, is treated as an error by the therapist in the structuring of the nonsense word sequence. It requires a change of therapeutic direction.

By 5;6, as can be seen from Appendix 3, BC's errors were of the sort discussed in the previous Chapter. They were age-appropriate. He was now comprehensible and within the normal range of speech development on standardised assessment. The therapy had achieved success, and was therefore ended.

According to the therapy described here, the individual steps, i.e. the succession of nonsense forms, are perceptually and phonologically minimal. On an auditory basis, the possibility for confusion is maximised. Two predictions follow:

(4.2) *Two auditory predictions*

a) Auditory confusion is concentrated in areas of greatest phonological difficulty.
b) Accurate internalisation of barely-perceived minimal differences will be low.

Taken together, these predictions are disconfirmed by the therapy in (4.1). But this is consistent with the notion of a Parameter Setting Function, genomically sensitive to spoken input, focused on particular contrasts. The disconfirmation of (4.2.a) and (4.2.b) justifies the claim that phonological parapraxis is not reducible to the interface, but 'autonomous', by (2.1.h).

By the therapy in (4.1), the child has an artificially enhanced experience of what PPT calls 'theory selection'. This occurs in a perhaps more structured form than by everyday interaction. But it is like everyday experience in that there is no drilling, repetition or correction. The fact that it seems to be possible to mimic a natural process in an artificial way suggests that the idea of a parameter setting function may be on the right lines. I shall return to the more general issues here at the end of this Chapter.

4.3 [dʒəˈruːsələm], I can say that now

Section 4.3. describes the attempt to reproduce the clinical effect in (4.1) in a controlled, experimental context with normally developing children. The reasoning was that if a clinical effect could be demonstrated in normally developing children, the use of the same procedure in the clinical context was soundly based. But for the sake of the experiment, the procedure diverged from clinical practice in four ways.

(4.3) *Experimental adaptation of a clinical examination*

a) The examination began with a series of trials in which the basic structure of the word was manipulated in relation to what clinical practice and the 1991 experiment suggested was a more or less predictable bias in the outcome. The structure was changed in the predicted way, in the counter-predicted way, and with respect only to the vowel structure. The motivation here was in respect of the productivity issue in (3.1.b). If a given process was truly productive and not a random error occasioned by a given degree of phonological complexity, it should apply in some contexts and not in others. By contrast, with the aim of ensuring that the child achieved instant and consistent success, in my clinical practice, in the first instance I would seek to eliminate every aspect of the structure which seemed at all likely to occasion a parapraxis.

b) In clinical practice, I presented nonsense words simply as nonsense words. By contrast, in the 1997 experimental study the nonsense words were presented as cartoon characters, each one different, on a computer monitor – with the deliberate aim of strengthening the relation in S's mind between a given nonsense form and a real word congener. For instance, in the case of *magnet*, the nonsense words were represented on screen as clowns with magnet-shaped bodies. In relation to the tarzan swing image for *Geronimo*, the 23 nonsense words were given as the names of adventure-sporting adults. The 19 nonsense words for *digital* were based on a character with eyes in the style of a digital watch. For *monopoly*, there were 15 characters, all in clothes seemingly made from the board of the well-known game. The 14 nonsense words for *aspidistra* named characters dressed in green leaves. And so on. The motivation here was to reduce the extent to which the child's response to the requirement to repeat a particular nonsense form might be influenced by a real word congener. In clinical practice this hardly seemed to occur. But the 1991 experiment revealed a clear difference between the clinical and normally developing populations in terms of the extent to which they could relate a given nonsense form to a real word congener. Unsurprisingly, given the known linkage between phonological disorder and poor meta-linguistic skills, summarised in (1.25) above, phonologically disordered children did not seem very aware of such links. But normally developing children seemed to detect them with ease. And this threatened to make aspects of their data hard to interpret. It did just this in the 1991 pilot study. I changed the methodology in 1997 accordingly.

c) For the sake of replicability, no allowance was made on-line for the individual's manner of response. This again breached the underlying idea of the therapy, described in Section 4.1 of trying to structure the child's experience so as to ensure an unbroken series of successes.

d) In respect of any given structure, the number of trials was limited to the number of previously prepared cartoons – reduced from between 50 and 150 to between 8 and 23.

Each of these differences between clinical practice and experimental methodology could be predicted to make the latter less effective than the former. If the equivalent of a clinical effect can still be produced in the normally developing population despite the factors in (4.7), the implications of such an effect for clinical practice are all the stronger.

As noted at the beginning of this Chapter, in a way which was not obvious in the experimental design, the very idea of trying to reproduce the effect of the therapy experimentally bears directly on the 'threshold' and 'productivity' issues in (3.1.b) and (3.1.c). Both issues are formalised in (4.4).

(4.4) For a postulated mapping relation r with respect to a phonological structure s_i and a distinct form s_j, r should be demonstrable in a set of one or more environments, where the difference between s_i and s_k is varied in controlled steps, initially minimal, where by (2.1.f) there may be more than one criterial aspect of the environment. Productivity can be measured by the extent to which r continues to hold despite changes with respect to s_i. The smaller the number of these changes, the more singular the environment.

a) Is r indeed a mapping relation?

b) If r is a mapping, which factors are criterial, and to what degree?

In principle, one way of characterising r is to look at the effect of small changes in the structure. But a 'clinical effect' by (3.1.f), compromises (4.4.a) and b). Consider the idea in (4.5).

(4.5) Experimental assessment with respect to r effects a learning experience.[46]

Call this the 'dynamic hypothesis'. If (4.5) is true, the reliability of any testing of (4.4) is in inverse proportion to its thoroughness. Taking account of the considerations in (4.3) the effect by (4.5) was not expected to be strong in an experimental situation. Conversely, if (4.5) is true, this bears heavily on the treatment of the data here.

Obviously it was not possible to investigate the phonological environments of all errors by all subjects. In Phase Two errors were investigated subject to the criteria in (4.6).

(4.6) Criteria for Phase Two investigations – in the case of a given S

a) S's Phase One error took the form of a single step.

b) S made an error (of any sort) at the beginning of Phase Two.

c) For the Phase One sample as a whole, the word occasioned at least 6 errors.

[46] From the perspective of the profession of speech and language therapy, this may be a matter of some significance. It was the original motivation for the author.

Unsurprisingly some S's who had made a narrow scope error in Phase One made no such error on the same word a few months later. In these cases, the environment was not investigated further. 2 S's repeated all of the previously incorrect words without error. For them, the experiment terminated at this point. For any one S, the Phase Two investigation concerned up to 8 sets of nonsense words, each associated with 1 real word. As soon as S got tired or bored, the investigation ended.

As with the real words in Phase One, with the real and the corresponding nonsense words in Phase Two, A_1 quietly told S the character's name, and asked S to tell it to A_2 If necessary A_2 repeated the request to S to repeat the name. For each nonsense word, a still was shown on the laptop monitor.

With praise given for every response, Phase Two proceeded as follows. First, the environment was manipulated – always with a change in the vowel, with just this, with the effect of the prevalent process in the consonant structure of the corresponding real word, with the opposite effect, with that of a different sort of consonantal change, up to a limit of seven trials. Then the complexity of the structure was reduced, eliminating one or more elements. Then the original structure was re-built, element by element, with the child being asked to repeat the form at each stage. As a penultimate step S was asked to repeat a form, where the only change was in respect of one or two vowels. And finally S was asked to repeat the real-word target.

In terms of both the responses and the effects, the case of *magnet* is typical. The form with a change in just the stressed vowel was /ˈmɒgnɪt/. The prevalent process effect was mimicked in /ˈmɪgnɪk/. The effect of seemingly unattested processes was mimicked in /ˈmʌdnɒt/ and /ˈmʌgnɪp/. The 'rebuilding' process involved /ˈhʌknɪ/, /ˈmɒgnɪt/, /ˈhɒgnɪt/, /ˈwɪgnɪt/, /ˈmɛgnɪs/ and /ˈmɒgnɪt/. With only six phonemes in the word, the investigation sequence thus involved only 11 trials, including the initial and the final repetitions of the target word. The investigation sequence was as shown in (4.7). In each of these cases, the still was of a clown with a body formed from two magnets. The 'canonical' forms – as given to the child – are shown in slashes. The sequence is that of the numbers.

(4.7) Investigation of the *magnet* environment

1 *magnet*	2 /ˈmɒgnɪt/	6 /ˈhʌknɪ/	10 /ˈmɒgnɪt/	11 *magnet*
	3 /ˈmʌdnɒt/	7 /ˈhɒgnɪt/		
	4 /ˈmʌgnɪp/	8 /ˈwɪgnɪt/		
	5 /ˈmɪgnɪk/	9 /ˈmɛgnɪs/		

Call this an 'investigation sequence', its length varying according to the complexity of the word involved. But for all S's whose idiolects were investigated in respect of a given word, the investigation sequence remained invarient. Because the extent of the Phase Two investigation depended on S's performance in Phase One, the set of environments investigated varied from S to S. And S's varied in how much of the work they were prepared to take.

It was expected that by the careful organisation of the investigation sequence and by emphasising the connection between a nonsense word and its real word congener (showing the former as some sort of lampoon in relation to the latter – in this case by clowns with magnet-shaped bodies) there would be minimal confusion between the two, and it would be possible to measure r by (4.4) with some accuracy.

6 of the 214 investigations concerned the *magnet* environment. One child, S21, in this case with the prevalent [ˈmægnɪk] recorded on two occasions, in this case 5 months apart, says /ˈmɒgnɪt/ as [ˈmɒgnɪk], showing a degree of productivity, then says all the other items in (4.7) correctly, including *magnet*. For S21, this small experience of 9 nonsense words seemed to inhibit the dorsal harmony. Another, starting with [ˈmægənɪt] got the rest of the paradigm in (4.7) correct from the first trial. Four children either returned to the original error or made a different error. The other two S's with [ˈmægnɪk] at Phase One seemed to have grown out of this by Phase Two.

Generally, the investigation sequence was longer and more complex than by (4.7), as shown in (4.8) in respect of *cardigan* and in (4.9) in respect of *Geronimo*. But the methodological protocol was the same as in respect of *magnet*. The child was asked to repeat each of these forms, one by one, being praised or thanked on each occasion, with no clue being given as to the success of the performance or otherwise, and with no reference being made to the phonological structure or form.

(4.8) Investigation sequence – *cardigan*

1 *cardigan*	2 /ˈkiːdəgən/	7 /ˈhɛɪtəkɪ/	18 /ˈkuːdəgən/
	3 /ˈkædəgən/	8 /ˈhəʊtɪkəl/	19 *cardigan*
	4 /ˈkuːdəgən/	9 /ˈhaɪdəkɪ/	
	5 /ˈkɛɪgəgən/	10 /ˈhætəkən/	
	6 /ˈkaɪdədən/	11 /ˈhəʊdɪkəl/	
		12 /ˈkuːtəkɪ/	
		13 /ˈkiːtəkə/	
		14 /ˈkuːdəkɛɪn/	
		15 /ˈkəʊdɪgəʊl/	
		16 /ˈkɔːdəkɪ/	
		17 /ˈkɔːdɪgəl/	

(4.9) Investigation sequence – *Geronimo*

1 *Geronimo*	2 /dʒəˈrɪnɪmɛɪ/	7 /ˈrʌnəmuː/	23 /dʒəˈrɪnɪmɛɪ/
	3 /dʒəˈrʌnɪmɔː/	8 /həˈrænəbaː/	24 *Geronimo*
	4 /dʒəˈrɛnəmiː/	9 /həˈrɪnɪmɛɪ/	
	5 /dʒəˈmænɪmaɪ/	10 /dəˈlænəməu/	
	6 /dʒəˈrɪnənəu/	11 /dəˈrɛnəmaɪ/	
		12 /sɪrəˈnuːpɪ/	
		13 /zɒrəˈdaːmə/	
		14 /zærəˈdɔːmɪ/	
		15 /zɪrəˈnəumə/	
		16 /dʒɛrəˈnuːmɪ/	
		17 /dʒɒrəˈnuːmə/	
		18 /dʒəˈruːnəpɪ/	
		19 /dʒəˈraːnɪbəu/	
		20 /dʒəˈrɔːdəmɪ/	
		21 /dʒəˈrɛdɪmə/	
		22 /dʒəˈruːnɪmaɪ/	

The investigation by (4.8) for S74 is shown in (4.10). His Phase One realisation of the word is shown in the first line. The first and the last of a series of canonical realisations are shown in full. Apart from this a continuous series of canonical realisations is shown as .... Nonsense-forms as presented to the child are shown in slashes. The child's realisations (if different in any way from the form presented) are shown conventionally in square brackets. Aged 7;8 at Phase Two, S74 was the oldest child in the study with any sort of *cardigan* error.

(4.10) S74 – *cardigan* Phase Two investigation. Phase One: [ˈkaːgɪdən]

cardigan	[ˈkaːdɪdən]
/ˈkiːdəgən/	[ˈkiːdədən]
/ˈkædəgən /	[ˈkædədən]
/ˈkuːdəgən/	(canonical)
.....	
cardigan	(canonical)

S74 has the prevalent coronal harmony in *cardigan* and the same process in /ˈkiːdəgən/ and /ˈkædəgən/, showing that the process is productive in his idiolect to this degree. Then /ˈkuːdəgən/ is realised correctly, and S74's limit on Dorsal in the final onset seems to disappear. And S74 says the rest of the items in (4.8) including *cardigan* canonically – the word *cardigan* itself, seemingly for the first time.

In relation to the *Geronimo* environment, S74 responded as shown in (4.11).

(4.11) S74 – *Geronimo* Phase Two investigation. Phase One: [dʒəˈmɒnɪməʊ]

Geronimo	[dʒəˈmɒnɪəʊ]
/dʒəˈrɪnɪmeɪ/	[dʒəˈmɪnɪmeɪ]
/dʒəˈrʌnɪmɔː/	[dʒˈmʌnɪmɔː]
/dʒəˈrenəmiː/	[dʒəˈmenəmiː]
/dʒəˈmænɪmaɪ/	(canonical)
....	
Geronimo	(canonical)

Again there is evidence of productivity in the labial root harmonies in S74's realisations of /dʒəˈrɪnɪmeɪ/, /dʒəˈrʌnɪmɔː/, /dʒəˈrenəmiː/, similar to his realisation of *Geronimo* as [dʒəˈmɒnɪəʊ], with the sole difference that in the case of the nonsense word realisations, the source is preserved. Again the investigation ends with the target word realised canonically – again seemingly for the first time.

Because the experiment ran out of time, Phase Two was only run with 63 subjects with 214 investigations of particular real-word environments. On the criteria in (4.6), investigations were run in respect of *animal, archeopterix, asbestos, aspidistra, calculator, digital, diplodocus, eskimo, glove, gobbledigook, hippopotamus, hospital, Jerusalem, mahogany, monopoly, pentagon,* and *spaghetti.*

In the limit case, the investigation effects no change. The target real-word is realised with the same error on the first and last trials. All the intervening nonsense-congeners are realised correctly. In such idiolects, there are two possibilities

(4.12) Singularity

EITHER b) A phonological relation r occurs only in the real word, not in any of a set of minimally different congeners;

OR b) The word is wrongly lexicalised.

The case by (4.12) is uncommon, occurring in an isolated way in two investigations of different words, but in a general way only in the investigation of *monopoly*. This is to say that in the case of this one word there was no evidence of productive disharmony in any investigation.

One investigation with respect to *monopoly* proceeded as follows:

(4.13) S16 – *monopoly* Phase Two investigation. Phase One: [məˈnlɒpəlɩ]

monopoly	[məˈnɒkəlɩ]
/məˈnɩpəlɩ/	[məˈnɩpənɩ]
/məˈnæpələ/	[məˈnæpənə]
/məˈlʌpələ/	[məˈnʌpənə]
/məˈnɩpənɩ/	(canonical)
/məˈnækəlɩ/	(canonical)
/məˈnɩtəlɩ/	[məˈnɩtənɩ]
/ˈnɛpəlɩ/	(canonical)
/ˈnɒbələu/	(canonical)
/fəˈlɒfəlɩ/	[fəˈlɒpəlɩ]
/bəˈnuːfəlɩ/	(canonical)
/bəˈnɔːbələ/	[əˈnɔːbələ]
/pəˈdæpəlɩ/	[məˈnæpəlɩ]
/məˈdɛpələ/	(canonical)
/məˈdɛpələ/	(canonical)
/məˈnɩpəlɩ/	[məˈnɩpənɩ]
monopoly	(canonical)

Neither in this investigation, nor in any of the other 10 investigations with respect to this word, was there any reflex of the dorsal disharmony, not where the consonant structure was manipulated minimally – in /məˈnɩpəlɩ/ and /məˈnæpələ/ – or in any other case. Hence (4.14).

(4.14) With respect to dorsal disharmony, the structure of *monopoly* represents a singularity.

Within the investigations as a whole, there are at least 3 criteria on which the productivity of any particular sort of parapraxis can be measured.

(4.15) For a given S, in 214 investigations of target-word environments, in realisations involving the mapping of an element e_i onto a distinct element e_j by a relation r, there was evidence of productivity in these proportions (the proportion shown as the number of cases and as a percentage):

a) A generally prevalent **r** is attested across S's entire sample, in S's first Phase Two realisation, and subsequently in at least one nonsense-form.

Example: S21 with dorsal harmony in *magnet* as [ˈmægnɪk] and /ˈmɒgnɪt/ as [ˈmɒgnɪk] and S46 with /s/ migration in *spaghetti* as [bəˈskɛtɪ] and every relevant congener, namely /spəˈgætɪ/, /spəˈbɪtə/, /spəˈguːdɪ/, /spəˈgædə/, and /spəˈgɒtə/, where, in both of these cases, on the final trial the realisation was correct.

90, 42%

b) **r** is repeated as an aspect of S's idiolect.

Example: S73 with, exceptionally, fricative deletion in *archeopterix* as [aːkɪˈɒptərɪk] and the same effect in /ɛɪkɪˈæptərɪks/, /uːkɪˈɛptərɛks/, and /əukɪˈʌptərɪks/ in an investigation where there is no clinical effect.

39, 18%

c) Prevalent **r** occurs in at least one of S's nonsense form realisations, but not in S's realisation of the real-word congener.

Example: S31 with *digital* with the uncommon root harmony of /l/ as [ˈdɪdʒɪlɪ] and with non-apical floating in /ˈdɒdʒɪtəl/ as [ˈdɒdʒɪtjʊ] and with the same in /ˈdædʒɪtəl/, where this is also reflected in the final, seemingly-improved realisation as [ˈdɪdʒɪtjʊ], and S43 with, initially, epenthesis in the real word as [ˈmænəgɪt], and then /ˈhɒgnɪt/ as [ˈhɒgnɪk].

29, 14%

The strongest evidence of productivity is by (4.15.a). This is satisfied in 90 out of 214 investigations. Weaker evidence of productivity – by (4.15.b) and (4.15.c) is satisfied in a further 68 investigations. There is one or another sort of evidence of productivity in 158 out of 214 investigations, i.e. 74% of all cases.

Other than with respect to the special case of *monopoly*, I am led to (4.16).

(4.16) In relation to the question in (4.4) about a relation r mapping e_i onto e_j, the data contain three sorts of evidence consistent with a relation r, expressing a central tendency in the error distribution with respect to a structure, a tendency manifested in different ways in different idiolects.

What effect did the investigations have? If a phonological structure s was realised wrongly, both in the Phase One assessment and at the beginning of Phase Two, it is reasonable to assume that for S, over the time period between Phase One and Phase Two, s was beyond S's phonetic/phonological competence. One measure of the effect of the investigation is by the realisation at the end of Phase Two. Out of 214 investigations concerning the environments listed above carried out with 62 children, the results were as follows.

(4.17) A target word at the end of Phase Two was

a) Canonical – by a reasonable presumption for the first time – according to the judgment of A_1 and A_2 on line, where this is also supported by the tape record

89

b) Unchanged – the null hypothesis– with no discernible difference between the first and last realisation

61

c) Different, still not canonical, representing all other cases

89

If at the end of Phase Two a phonological structure s was realised canonically, it seems reasonable to assume that this was for the first time. Given the large number of actual forms of error, the chance probability of this result seems quite small.

The case by (4.17.a) was reached in at least one investigation with 54 out of 62 or 81% of subjects. A structured investigation with respect to a set of up to 21 nonsense words led to a situation in which a phonological structure s could be pronounced canonically, presumably for the first time. This leads to the claim in (4.18).

(4.18) In incompetent phonology (not just in pathology), an input-output relation r in respect of a phonological structure s can be inhibited in the course of a structured phonological investigation.[47]

[47] Given that the investigation was research driven, it is significant that in numerous cases clinical judgement would have led to a complete restructuring of the nonsense word sequence. This

Is the improvement by (4.18.a) just a temporary enhancement of S's performance in an artificial situation? In the experimental design, as noted above, it was not expected that a brief experience with at most 21 nonsense words would have anything more than a marginal effect on the child's phonology. So a significant effect in relation to the 'clinical effect' by (3.1.f) and the 'dynamic hypothesis' by (4.5) was not expected. But conversely, it was expected that it would be possible to measure r by (4.4). So when experimental time started to run out, the latter seemed more important

To test the 'dynamic hypothesis', Phase Three took place at least 2 days and at most 5 days after Phase Two. Real words, of which the phonological environments had been worked on in Phase Two, were re-assessed to measure the effect, if any, of work done by the child in the context of Phase Two.

Due to lack of time, Phase Three was run with only the last 18 S's to be seen in Phase Two. For all S's who completed Phase Three, complete details are given of their Phase Two and Phase Three performances in Appendix 5. To block any experimenter effect, neither A_1 nor A_2 could see the result of the previous work. This was a blind trial. In Phase Three, there were 61 reassessments of a real word of which the environment had been worked on in Phase Two. In these sessions, typically lasting no more than a few minutes, there were, on average, just over 3 trials which were criterial.

In (4.19) showing the Phase Three results, the number of cases in which a particular result was achieved is shown in bold in the column on the right hand edge.

(4.19) Phase Three results

a)	Phase Two realisation by (4.19.a). Phase Three canonical. Stable gain.	**20**
b)	Newly canonical.	**6**
c)	Seemingly an improvement on the form at the end of Phase Two.	**1**
d)	Phase Two realisation by (4.19.b). Phase Three error as at start of Phase Two. No stable gain.	**5**
e)	Phase Three error as at the end of Phase Two. Stable parapraxis.	**21**
f)	Phase Three error as at the beginning of Phase Two. Stable parapraxis.	**8**

The 6 cases in which improvement occurred after Phase Two balance the 5 in which the Phase Two improvement did not last. Given the timescale, the specificity of the effect, and the fact that the purpose of the experiment was not disclosed to S, no more than a small part of this effect can be attributed to spontaneous development. Hence (4.20).

might reasonably be expected to have raised the proportion of third time repetitions being judged canonical. But this would have made the experiment impossible to reproduce.

(4.20) After a clinical investigation, in 80% of those cases, where by the procedure exampled in (4.7), (4.8) and (4.9), a consistent parapraxis is inhibited in the course of the session, this effect is:

a) not an artifact of the clinical situation, but evidence of stability or permanence;

b) mirrored in the non-impaired population as an aspect of normal development;

c) not great in size, but robust enough to stand up in a standardised, experimental situation – by the the disadvantageous conditions of a replicable experiment in (4.3) above.

The procedure has the potential to effect a lasting change in what the child knows.

Given that the dynamic effect by (4..5) was stronger than expected it was not possible to measure the effect by (4.4) with any accuracy.

4.4 Conclusion

In this Chapter I have related A) the result of an experimental procedure carried out with a cross section of normally developing children; and B) a phonologically motivated therapeutic approach.

With regard to the experimental procedure, more clearly than expected, the goal by (3.1.f) has been met. The dynamic hypothesis by (4.5) is either confirmed, or is at least supported. But as noted above, to an unexpected degree, this success by (3.1.f) compromises the goal by (3.1.c). If S is in the middle of a learning experience, it is not possible to determine the thresholds of particular processes and the significance of any asymmetry at each one, since it is not known where S is at with respect to this learning experience. Putting this differently, the experiment was more revealing therapeutically and less revealing as regards the context-sensitivity isssue from the Introduction than had been expected.

Albeit on a small scale, the effect by (4.20) is consistent with the effect of the therapy as described in Section 2.5. The claim in (4.20) bears on S's competence in a small domain (on average 3 words) in a small, but random, sample of 18 subjects. The effect of the therapy described in Section 4.2 can be replicated in a randomly selected, normally developing sample.

By the reasoning in Section 4.2, the auditory predictions in (4.2) are disconfirmed.

By the apparent permanence of single successful trials, it is not likely that the core mechanism involves the rehearsal of a series of muscular co-ordinations; the effect does not seem likely to be accountable in sensori-motor terms. A more plausible account, one to which I shall return in Section 7, is that the child is being helped to explore a relevant part of the learnability space – relevant for him or her at the time in question – by ringing a set of changes in a logical way. The process is an essentially cognitive one. It mimics a process normally carried by the child in his or her own mind. But even in the normally developing child it can be enhanced with adult help. In cases of disordered development, the value and importance of such help increases in proportion to the disorder. The fact that the enhancement can be achieved in both the normally developing child and in the impaired child suggests that a therapy based on this idea is securely based in theory and in practice. Going beyond the claims in (4.18) and (4.20), the data is consistent with the hypothesis in (4.21).

(4.21) *Mechanism of a cognitive, phonological, symptomatic approach to therapy*

> A parapraxic association limit L effected by the R-inspection can be permanently inhibited by a process in which the child is led to explore in an organised and structured way the set of factors which define L, factors which exist in the form of an incomplete parameterisation.

There is no claim here to the effect that the therapy described in Section 4.2 is the only way of inhibiting L by (4.21). Nor is there any attempt to discard traditional sensori-motor approaches to the treatment of phonological disorders. The mere fact that the process by (4.21) is an essentially cognitive one does not mean that the association limit L cannot be addressed physically. In Chapter 7, I shall propose a way of characterising phonological parameters which includes an irreducible physical element. The therapy in Section 4.2 just supplements traditional approaches on the basis of the (4.21) mechanism. legitimising a practice which starts from what the child can say rather than from what he or she can't say. Achievable goals are set session by session and trial by trial. Failures will occur, but these are to be seen in terms of an over-optimistic therapeutic path – in 4 out of the 34 trials in (4.1).

By (4.21), the child is not confronted by failure, but encouraged by success. The process is one of exploration and discovery in the child's mind with respect to a given learnability space. There is no need for 'home practice' or 'reinforcement'. By the same token, the guidance has to be expert. It cannot easily be automated or managed in a group or devolved to an untrained person or incorporated into a 'home programme'.

(4.21) allows a 'child's own system', but of a constrained sort. While disorders group together, particularly within families, and even more so in identical twins, every incompetent idiolect may be unique. But the number of variables is quite small. What are they? The next Chapter takes one step towards an answer to this question.

5 Representational enrichment

Chapter 5 looks at both context-free and context-sensitive phenomena in terms of the now well-established 'non-linear' model of phonological representation which gives us the notions of 'floating' and 'non-association', informally introduced in Section 2.4.1. As noted in Chapter 1, this model is being increasingly invoked in work on both normal and abnormal aspects of child phonology. Here I shall use this model to account for some aspects of the asymmetry of parapraxis. I shall characterise parapraxis in terms of a failure at some point in a sequence of structure-building. This term is used here without implying a particular solution of the psycho-linguistic directionality issue in (1.1). I shall adopt the insight from Lodge (1995) and others that structure-building is non-destructive.

Sections 5.1 and 5.2 describe how representation in terms of 'feature-geometry' has replaced the 'linear segmentality' of SPE. Here it is assumed that A) the evidence of phonology at Stage $_{n-1}$ bears directly on the theory of feature-geometry, and B) conversely, this should not involve any weakening of the theory's assumptions. Section 5.3 introduces the notion of syllabic projection – little considered in Child Phonology until Iverson and Wheeler (1987). Section 5.4 re-defines the typology of speech errors.

5.1 Geometrical approaches to quality and quantity

In the framework of a universal 'hierarchy' or 'geometry' of categorial nodes, Section 5.1 develops the idea of surface forms built derivationally from minimal underlying matrices, by a process of 'alphabet formation'. I shall argue for maximally-binary branchedness in respect of the geometry, and consider the implications of this. I shall lay out a basis for the mechanism of various processes, some with what seem to be functionally quite different effects, e.g. harmony and metathesis.

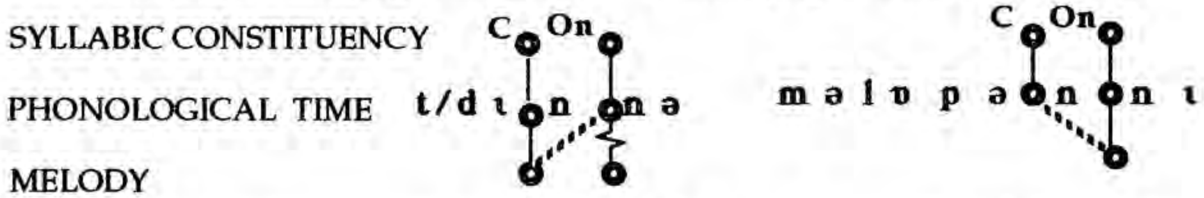
In relation to the domains of both harmony and neutralisation, Goldsmith (1976) and Kahn (1976) were amongst the pioneers in suggesting the need for a hierarchical model of phonological representations, i.e. with levels of *dependency* and *projection*. The main levels of projection (Kahn's insight) were the syllable and its constituents, including the onset. The main aspect of dependency (Goldsmith's insight) involved a formal distinction between units of timing and the melody, the separation of 'tiers', characterised as 'autosegmental', defining subordinate aspects of the melody, and the directional 'association' of elements, relating elements to 'bearers' – from left to right in the default case.[48]

[48] Goldsmith's main empirical motivation was to account for the tonology of African languages, particularly that of Igbo.

On this approach, representations can be construed in terms of what will be chararacterised here as 'head/dependency' relations – which may be one-to-one, many-to-one or one-to-many in either direction. (5.1) shows two incorrect branchings reflecting different degrees of incompetence in English, both showing phonotactically non-canonical surface geminates – as [n n] in two realisations of different words. The parapraxis is at different thresholds and in opposite directions. But both realisations fail to observe the prohibition in English on surface geminates in mono-morphemic environments. In the version of the non-linear framework assumed here, in the errors in (5.1), nasality 'spreads' from a node on the melody tier where it is correctly and/or underlyingly specified. (5.1.a) returns to the case of *finger* from the idiolect of a phonologically-disordered, 4 year-old, monozygotic twin. Here the spreading is from coda to the final onset where it displaces a separate melody. The notation does not reflect the fact that in both cases there is more than one 'process' – with stopping and indeterminate voicing in the leftmost onset and the fact that it is Dorsal which is lost on the right. In (5.1.b), the spreading creates an epenthetic coda. The spreading relation is shown by a dotted line, the displacement – or non-association – by a broken one.(5.1.b) shows *monopoly* with gemination and metathesis from S3 at 4.9 from Chapter 3, with a phonological delay, not a disorder.

(5.1) *Two to one linkages in both directions in incompetent representations of English*

a) ***finger*** – *stopping, root harmony* b) ***monopoly*** – *metathesis, gemination*



NB: The phonemic representation is just for the sake of exposition. I show only some of those aspects of the representation relevant to the point under discussion here – one difference and one similarity between the two cases.

(5.1.a) preserves the underlying specification of two units of phonological time, the nasality in the leftmost, and the non-continuance of both, but loses dorsality and the contrast with the voiced oral stop. This speaker was barely comprehensible. In (5.1.b) the surface gemination presupposes an intermediate, independently attested form [mə'lɒpənɪ] – by metathesis. The process in (5.1.b) consists in the replication of the nasal by a second derivational step. The ordering is obvious; A) the data includes not one case of one-step gemination; hence ◆[mən'nnɒpəlɪ] and ◆[mə'nɒpəllɪ]; and B) the metathesis under such a condition would be hard to define as a process.[49]

[49] The separation between melodic and timing levels raises an obvious question about the ontological status of the phoneme, its definition seeming to refer either to both levels at once. Here I

The difference between the two cases is expressed in the different directions of the branching and by the fact that it is only in (5.1.a) that a link is broken (or not made in the framework here) as shown by the jagged line. The formalism describes the fact that a given phonetic surface is shared by two elements defining phonological time, part of the underlying structure in (5.1.a), by epenthesis in (5.1.b).

The notion of spreading has been widely adopted because it provides a suitably restrictive and parsimonious account of harmony and assimilation, as aspects of the phonology of many languages, including English. In this study, applying the theoretical model implicit in (5.1) to the data here, I shall also be invoking the notion of structure-building. Foreshadowing more discussion in Section 5.3 and subsequently, some aspects of prosodic and melodic structure-building are language-specific.

Section 5.1. is organised as follows. Section 5.1.1 looks at various 'processes'. Section 5.1.2 outlines the idea of unary articulators, contrasts this to the notion of phonological gesture, and introduces the notion of a 'feature-geometry'. Section 5.1.3 looks at 'fronting' in the light of the 'Coronal Hypothesis' and the organisation of the 'PLACE' node and its dependents and a notion of geometrical markedness. Section 5.1.4 considers the position of coronality in a hierarchy where branching is *maximally-binary*. Section 5.1.5 considers the issues of taxonomy and cross-linguistic typology. Section 5.1.6 proposes a CAVITY node. Section 5.1.7 summarises the discussion, relating parapraxis to the failure of structure-building.

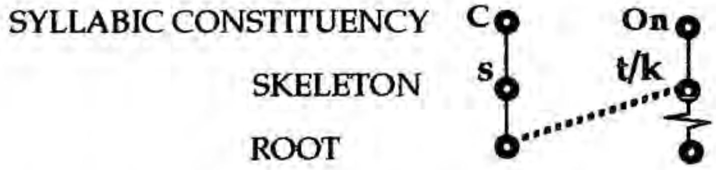
5.1.1 Roots and skeleton nodes

Section 5.1.1 looks at root harmony and compensatory lengthening by the approach illustrated in (5.1) at different thresholds of parapraxis.

A well-supported innovation of this approach is the distinction between what was characterised in (5.1) as phonological timing and the phonetic melody. In (5.2) I distinguish between the 'skeleton-node', as the unit of phonological time and the 'root', as a head of melodic structure. The Skeleton and the Root, as labeled in (5.2), comprise two 'tiers' of the representation. The spreading in (5.1) and (5.2) involves the root or the melody as a whole. In both cases in (5.2), the coda of the stressed syllable spreads to the adjacent onset, filling a skeleton slot left empty by a non-associated consonantal root. The branchedness in (5.2), as in both the cases in (5.1), defines what appears on the phonetic surface as a geminate. One thing that is not shown in (5.2) is the fact that in both cases the adjacent stressed vowel is /ɛ/.

shall continue to refer to a phonemic category shown traditionally in slashes for the sake of descriptive clarity, but without any commitment to its ontological status.

(5.2) *Root harmony or assimilation by means of spreading*



æz'bɛssəs, 'ɛssəlɛɩtə

Within this framework, adopted here, a phonological structure can be be thought of as being on more than one tier. So a melodic element on one tier may comprise more than a segment on another, in this case on the skeleton, or timing, tier. Because of this autonomous behaviour, it is conventionally referred to as an 'autosegment'.

In all of the 1997 data, spreading of the root, occurred in 4 sorts of error, 3 times as in (5.2) (both of these in the idiolect of S59 with a phonological disorder involving sibilance), and 8 times in the first syllable of *asbestos* as [æ:'bɛstɒs] by 'compensatory lengthening'. On the evidence of Chapter 3 this is one prevalent process here. The same process occurred just once in the cases of *aspidistra* and *magnet*. Bernhardt and Gilbert (1992) note the same process in realisations of *tap*. (5.3.a) represents this in a low threshold case from Bernhardt et al. (5.3.b) is from the data here. In both cases the environment is a left-most syllable, and the lengthened vowel is phonemically /æ/ (in British English). In all cases in (5.2) and (5.3) there is some degree of stress. In (5.3) as in (5.2), all other aspects of structure are ignored.

(5.3) *Compensatory lengthening in children's speech*

a) ***tap*** (from Bernhardt et al) b) ***asbestos, aspadistra, magnet***

tæ:

æ:'bɛstɒs, æ:pə'dɩstrə, mæ:nɩɩ

Spreading is subject to the condition that association lines do not cross. In early work this was attributed to the 'Phonological Association Convention' (see Goldsmith 1976) relating melody elements to corresponding 'bearers' automatically from left to right. Archangeli (1988) derives the same idea independently, not as the breach of a convention, but a principle of phonology. Call this the 'No Crossing Condition' or NCC. Pulleyblank (1986) proposes that association is by rule, cross-linguistically variable, therefore necessarily learned, and predictably the subject of some error in early/disordered phonology. On the evidence of parapraxis, association is learned.

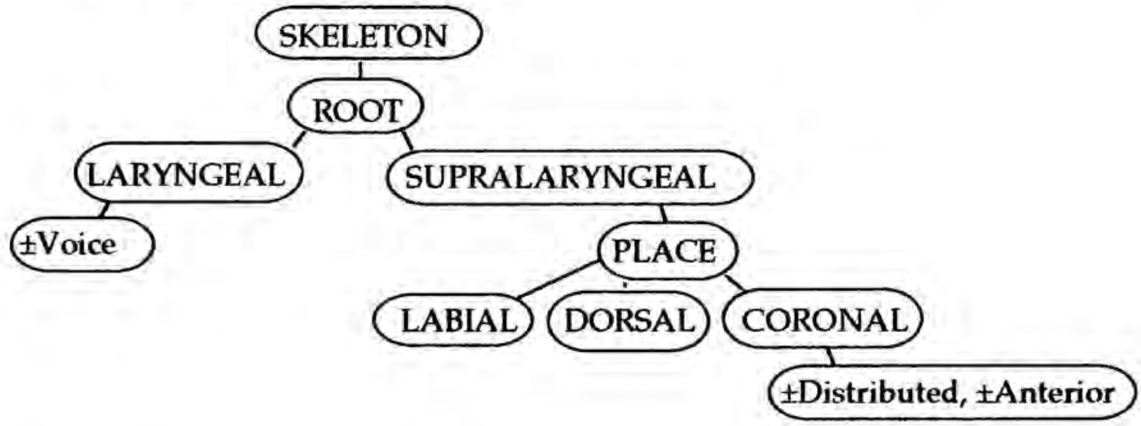
In this Section I have shown how 'geometrical', i.e. multi-dimensional adjacency can be used to characterise some aspects of parapraxis.

5.1.2 A featural geometry

This Section turns to the definition of natural phonological classes by the feature-geometry. It is assumed here that in many respects these classes reflect one or another aspect of the interface in a fairly direct way, by sensori-motor factors, by acoustics, or by some combination of these. From the learnability-perspective, these classifications would not seem to be difficult. This begs the question of why these classifications are phonetically vulnerable in the way I have shown them to be. This paradox is one to which I need to return.

Clements (1985) postulates a universal articulator head, PLACE, dominating three unranked, unary, or monovalent articulator nodes. Labial defines bi-labial and labio-dental articulations. Coronal defines dental, alveolar, palatal and palato-alveolar articulations. Dorsal defines velar and uvular articulations. On the basis of a suggestion by Lass (1976), Clements' model also includes two sub-matrices, characterised here as SUPRA-LARYNGEAL and LARYNGEAL, defining mutually exclusive aspects of the phonetic melody headed by the ROOT and the SKELETON.[50]

(5.4) *feature-geometry – n-ary dependents and unranked articulators*[51]



A sub-hierarchy of articulators dependent on PLACE expresses one aspect of 'natural exponence'. /b/, /p/ and /m/ are natural exponents of labiality, /k/ and /g/ of

[50]According to the model of Halle and Stevens (1971), partially incorporated in Halle (1995), [±Voice] is re-defined in terms of the laryngeal features [±Tense], [±Spread] and [±Constricted]. This modification is motivated by the distribution of laryngeal features in various languages and by bio-mechanical considerations.

[51]The notion of a SUPRALARYNGEAL node is controversial. In an influential article McCarthy (1988) dismisses it on the grounds that SUPRALARYNGEAL does not spread. He proposes that PLACE is the daughter of a ROOT node with a correspondingly larger set of dependents. Here it is assumed that spreading is not the only sort of evidence relevant to geometrical theory. It is argued in Section 7 that the learnability advantages of constraining branchedness outweigh those of representational minimality.

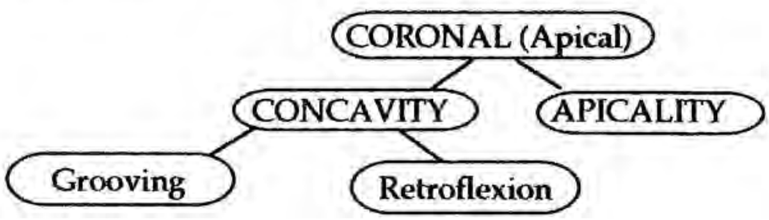
dorsality, and so on. The notion of three Unranked Unary Articulators is now well-established in phonological theory and (to a lesser degree) in the study of child phonology. By Clements' insight, what 'spreads' in the case of harmony is a continuous substring of the structure in (5.4) under conditions of adjacency and commonality, most typically between members of the same class of elements.

For some theorists, e.g. Barry (1993) and Fee (1995), the notion of feature-geometry provides a sufficient account of children's articulator harmonies. Here I shall argue that in order to account for the relations between context-free and context sensitive aspects of parapraxis it is necessary to go beyond current models (to amend the geometry in other words), and to invoke more principles.

In most geometries, including those of Clements (1985) and more recent developments discussed below, there is a sub-hierarchy dependent on Coronal, defining various articulations, including apicality, grooving and retroflexion. One of these is widely taken to be [±Anterior]. This is different to the categorial feature in SPE, discussed in Section 1.1.6.1. But the problem with [±Anterior] as a Coronal dependent is that it adds to the exponence issue in languages like English where /ʃ/ can be defined as either [–Anterior] or [+Distributed], on either of these grounds, distinct from /s/. The point also arises in languages with sibilant harmony (See Poser, 1982, Kaisse, 1985, Shaw 1991, for discussion of the various issues in one such language, Chumash).

On the basis that /ʃ/ and English /r/ require a degree of concavity in the upper surface of the articulator, it is proposed here that this should be expressed as CONCAVITY, in what anatomists call 'sagittal section' for retroflex /r/ and in 'coronal section' for grooved /ʃ/. Such an articulatory gesture involves two sets of muscle fibres in the tongue, defining the 'section' of the vocal tract at the point of maximum stricture, varying between 'grooving' in /ʃ/ and retroflexion in /r/. On the anatomical basis that different sets of interdigitating fibres are involved, transverse and longitudinal, and assuming that the default expression of Coronal is by apicality and that major classes such as liquidity and sibilance should be encoded geometrically, the corresponding sub-structure would then have the form postulated in (5.5).

(5.5) *A sub-hierarchy of CORONAL dependents*



By (5.5) the unmarked interpretation of coronality is apical. Any specification for CONCAVITY reflects an additional degree of markedness. (5.5) is consistent with what might be called the 'active articulator hypothesis', first proposed in Halle and Ladefoged (1983), further developed by Halle in subsequent work (See, for instance, Halle, 1995). It allows a non-contrastive, phonetic alternation between grooved and retroflex /r/ in English, the possibility of distinguishing between liquids by the presence or absence of CONCAVITY (defining liquidity elsewhere in the geometry).[52] The idea of defining /r/ by the presence of a node is modeled on the SPE definition of the liquid contrast (partly) with respect [±Anterior]. Ignoring phenomena such as trilling and tapping and palatal and dental forms of stop (none of these being involved in the data here), the model in (5.5) provides an articulatory account of sibilance and liquidity. I shall assume, on the basis of further discussion below, that the affrication of the stop in English *try* and *dry* is by spreading from /r/ to an adjacent coronal.

A unary, privative, or monovalent approach to PLACE features is now commonly assumed. For the preservation of the SPE notion of binarity, see Kiparsky, 1993. For the extension of the principle of monovalency from the articulators to the feature system as a whole, see Anderson and Ewen, 1987, Kaye, Lowenstamm and Vergnaud, 1990, Steriade, 1995, Harris, 1994, van der Hulst, 1996, and numerous others. The idea is sometimes expressed as in (5.6).

(5.6) * – F

By (5.6) there are no negative values. It is thus impossible for a rule to refer to [–Coronal], i.e. to labials and dorsals, as the complement of [+Coronal]. Both are prohibited. The model entails what Kiparsky (1995) calls 'intrinsic under-specification'.

Let us now apply the Unranked Unary Articulator model to child-phonology. Most developments of the 'geometrical' or 'hierarchical' approach assume that it permits just four operations: A) association; B) insertion; C) delinkage; D) spreading. 'Delinkage' is equivalent to 'non-association', preferred here on the grounds that it is consistent with idea of structure-building as non-destructive.

The Unranked Unary Articulator model thus permits any of six patterns of context-free substitution of the articulators. This give the following possibilities, showing Coronal as Cor, Dorsal as Dors, Labial as Lab, the associated feature as Ass, and the other as NA (non-association).

[52] It is possible in principle that any of the terminal nodes in (5.5) can itself be a head. This would provice an account of phonological competence in English in individuals for whom tongue grooving is phonetically impossible. But the issue is beyond our scope here.

(5.7) *Six formally equivalent patterns of delinkage and reassociation at PLACE*

	a)	b)	c)	d)	e)	f)
NA	Dors	Cor	Dors	Lab	Lab	Cor
Ass	Cor	Dors	Lab	Dors	Cor	Lab

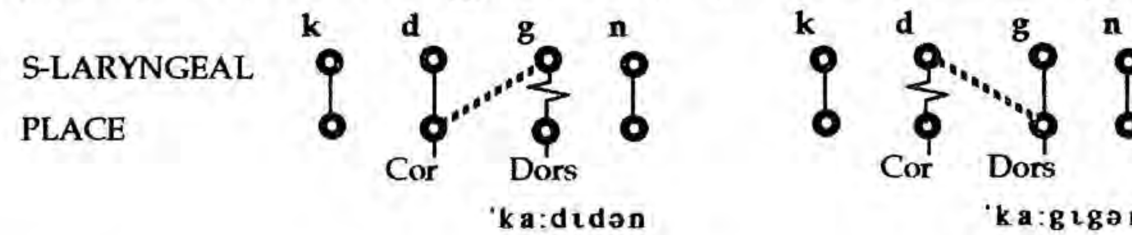
	Dors Cor	Dors Cor	Lab Dors	Lab Dors	Lab Cor	Lab Cor

But this is arbitrary. As noted in Chapter 1, it is only 'fronting', by (5.7.a) which is characteristic of child phonology; (5.7.b) is rare; (5.7.c), (5.7.d), (5.7.e), and (5.7.f), even more so. In a random sample of 100 EAT records, the author found *tent* as [kɛŋk] once, but no other articulatory, i.e. (5.7)-type, error in this word. The rarity of (5.7.c) and d) in parapraxis contrasts with the diachronic evidence of a dorsal fricative becoming a labial in *laugh, enough,* etc., underpinning the idea in Jakobson, Fant and Halle (1963) of one binary feature characterising both dorsality and labiality. Whether or not parapraxis should reflect diachrony, the possibilities by (5.7) are plainly too strong.

Let us now consider a singularity. If harmony or assimilation is by the 'spreading' of a particular substring, consisting of all the dependents of a node, is it possible to use this idea to characterise what is happening in *cardigan* as [ˈkaːdɪdən]? Recall Macken's (1995) idea that child phonology is (partially) characterised by spreading in improperly large domains. Disregarding the restrictive nature of the model in (5.2) and (5.3), what about showing the prevalent parapraxis in *cardigan* as a spreading involving PLACE and S(upra)LARYNGEAL?

(5.8) *Attested and unattested harmonies in* ***cardigan*** *– a possible analysis?*

a) *Spread PLACE (CORONAL trigger)* b) ** Spread PLACE (DORSAL trigger)*

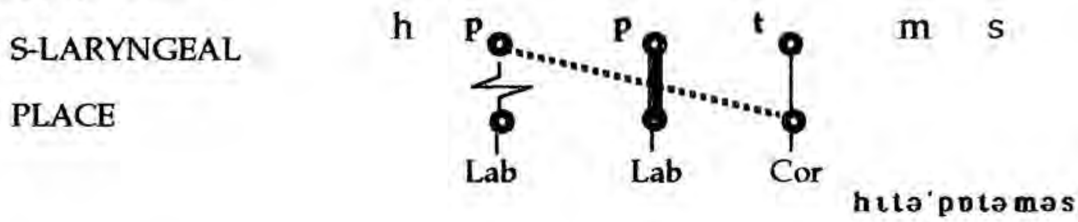


But there are three problems with (5.8). FIRST, like (5.7), (5.8) is as ad hoc as the linear analyses in Section 4. The same point also applies, in respect of *magnet* as [ˈmægnɪk], *doggy* as [ˈgɒgɪ], and other aspects of parapraxic asymmetry discussed above. SECOND, no account is given of any aspect of either the asymmetry or the singularity. THIRD, the domain elements are non-adjacent. Here Macken's (1995) idea is not accepted. I noted a serious learnability problem with it in Section 1.4.

The problem is magnified in an Unranked Unary Articulator account of the prevalent harmonic errors in *hippopotamus* and *archeopterix.* as spreading. If this involves PLACE, there is a violation of the No Crossing Condition, as shown in (5.9) and (5.10). To point up the issue, the impermissibly-crossed association line is thickened. In recognition of the fact that these are non-analyses, they are both labeled as such and starred. In both cases, all other structure is ignored. No amount of additional structure would legitimise these spreadings.

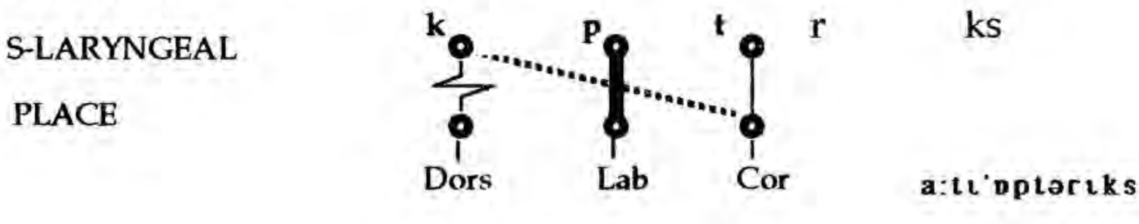
(5.9) * *Coronal harmony, labial target – NCC violation*

hippopotamus



(5.10) * *Coronal harmony, dorsal target – NCC violation*

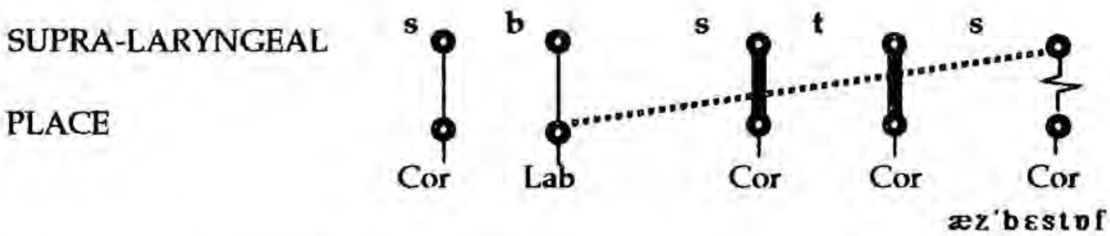
archeopterix



A more extreme case of the same sort of line-crossing arises in the case of *asbestos* as [ˈæzˈbɛstɒf]. Here there are no targets other than coronals. The target is on the 'wrong side of' two other coronals.

(5.11) * *Labial harmony, coronal target – NCC violation*

asbestos

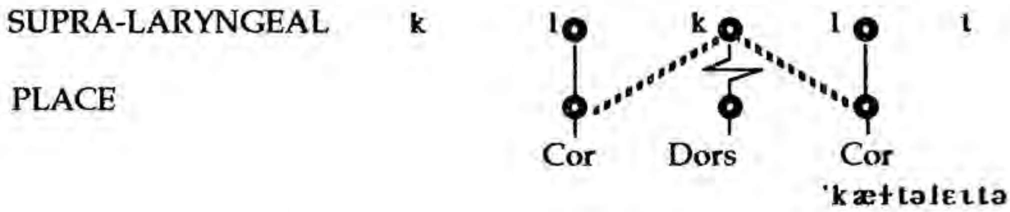


A further problem with the schema in (5.11) is that it ignores the roundness of the rightmost vowel.

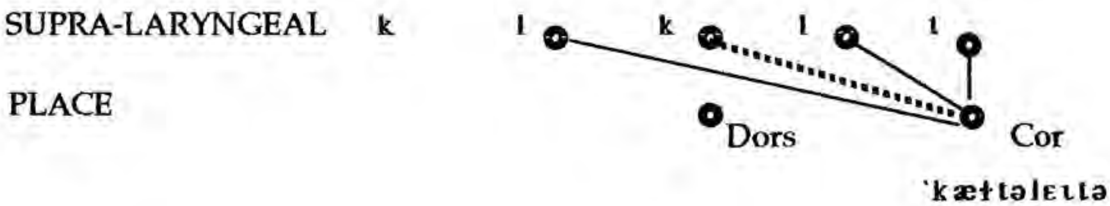
In Chapters 1 and 2, it was noted that parapraxic coronal harmony is triggered in structures with more than one underlying coronal – in all the cases cited in this Chapter. The issue is compounded in *calculator* as [ˈkæɫtəlɛɪtə]. While no version of non-linear phonology allows the multiple sourcing of a harmony, the restrictive theory implicit in (5.2) and (5.3) is additionally violated in (5.12.a) with respect to commonality, by featuring laterals and a voiceless stop, and in (5.12.b) by assigning the laterals a triggering role as 'flanking elements'. The problems in (5.9), (5.10), and (5.11) are not helped but worsened.

(5.12) *Alternative non-analyses of coronal harmony* – **calculator** – *formal violations*

a) * *2 Lateral triggers*

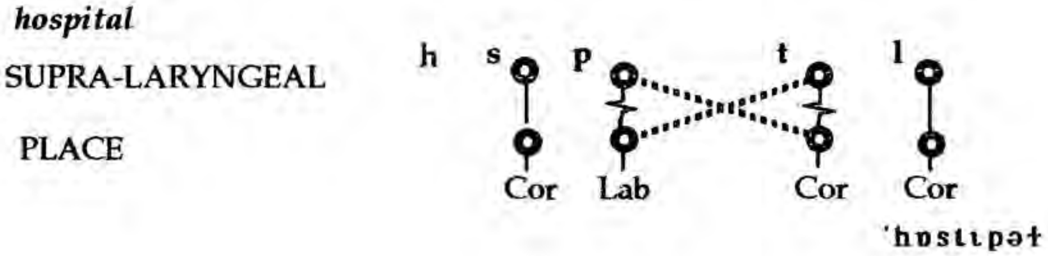


b) * *2 Lateral flanking elements*



Now consider *hospital* as [ˈhɒstəpəl]. On reasoning roughly sketched in (4.10.k), let us set aside the transformational analysis of (4.9). As in various other models, in a geometrical framework with unranked unary articulators metathesis is problematic. The approach in (5.13) spreading PLACE in adjacent onsets in opposite directions grossly violates the NCC. The stretching of the formalism explains nothing.

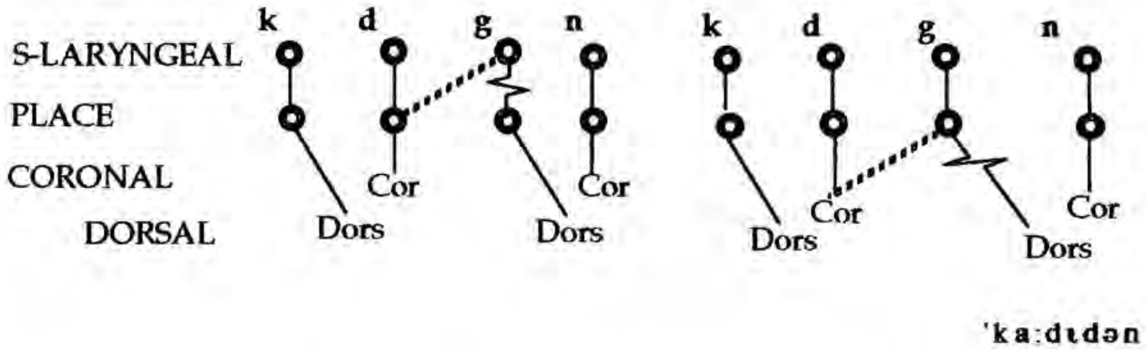
(5.13) * *Metathesis – bi-directional spreading, same domain, same tier*



In (5.8) to (5.13), there is a problem with the spreading of PLACE. One way of avoiding it is to suppose that it is the Articulator itself which spreads – not just in applications of this model to child-phonology, but generally (see Bernhardt et al, 1992, and Halle, 1995). On this approach, the parapraxis in *cardigan* is not by (5.8.a), repeated here as (5.14.a), but by (5.14.b).

(5.14) ***Cardigan** – an alternative analyses of parapraxis?*

a) *Spread PLACE (CORONAL trigger)* b) *Spread CORONAL?*



The analysis in (5.14.b) is consistent with a convention, proposed by Halle (1995) as an innovation in geometrical theory, according to which "terminal nodes spread in a given rule are all and only those dominated by by a single nonterminal node" (p.20.) The motivation for this proposal is that it describes cases – in competent phonology – where spreading involves nodes α and β, but ignores γ sister of α and β.

The analysis in (5.14.b) – with incompetent harmony on the articulator tier rather than at the PLACE node – is rejected here. FIRST, it fails to account for the cross-linguistic frequency of Coronal being targeted by Labial and Dorsal (see Mohanan, 1993). Such patterning has to be treated as an accidental property of both Labial and Dorsal articulators. SECOND, it tells us nothing about the fact that the process which it seeks to define is characteristic of child phonology, not C_{HL}. It over-generates.

Rejecting the theoretical model implicit in (5.14.b), there is no reason to modify (5.15), as a theorem implicit in Clements (1985). It is adopted here.

(5.15) *Key aspects of the thinking of Clements (1985), summarised here*

All phonological operations

a) involve elements under conditions of geometrical adjacency;
b) apply in whatever way has the simplest and the most general description (on standard Occam grounds).

By (5.15) phonological operations involve a continuous sub-string of a phonological matrix, defined both hierarchically and in the dimension of time, maximally at the root, between a consonant and vowel, and minimally at an articulator (between two coronals – as in [ʃ r i ː] in *Sri Lanka*). Both 'unnatural' harmonies and transformations, by (4.9) are prohibited. And regressive place harmony between adjacent elements within the phrase in English – by (1.35) – is defined as the spreading of GRAVITY from the onset. In relation to the concerns of this study, the effect of (5.15) is negative. It does not seem to lead us towards an account of the context-sensitive aspects of parapraxis from (3.70), figured graphically in (3.71) – repeated here as (5.16).

(5.16) In phonological parapraxis at a point close to Stage $_{n-1}$, intersegmental processes relating articulators lead characteristically to

a) Labial floating in proportion to the number of cases of roundness/ labiality;

b) exclusively coronal surface forms where the domains consist of melodically and prosodically matched singleton word-internal onsets, where there is at least one other case of both the target articulator and Coronal.

The conclusion in (5.17) follows.

(5.17) No matter how the Unranked Unary Articulator model is interpreted – as dictating the spreading of the PLACE node as in (5.14.a) or the articulators by (5.14.b) – it does not account for the asymmetry of parapraxis, as presented in Chapters 1, 2 and 3 and exampled in summary form in (5.16).

Insights similar to those based on unranked unary articulators are expressed rather differently in the various interpretations of Dependency Phonology, DP, with the articulators defined as combinations of features (see Durand, 1990). The patterns of combination are limited by the axioms of the theory – varying according to the way it is understood. The key idea is developed further in the Government Phonology of Kaye, Lowenstamm and Vergnaud (1985, 1990), Charette (1991), Backley (1993), and the Element Theory of Harris (1994 and 1996). Taking the latter as illustrative of what is, for our purposes here, a single approach, Harris characterises the articulators as R (Coronal), U (Labial) and @ (Dorsal). Attributing 'stand-alone phonetic interpretability to each melodic prime', Harris distinguishes the 'bare stopness' of [ʔ] and 'bare noise (aperiodic energy)' of [h]. While conceding that some operations, like lenition, debuccalisation, vocalisation, may require some 'mopping up' or 'repair rules' Harris (1996) insists that "... an element... requires no support from other melodic primes (redundant or distinctive) in order to achieve phonetic substantiation" (p.559) and "...all melodic operations take the form of element suppression or element accretion." (p.561). But since the articulators are primes, delinkage alone does not account for context-free coronalisation, and it is necessary to posit an additional process of relinkage.

DP is not adopted here for the reason that in relation to the issues of this study, it does not go beyond Unranked Unary Articulators. (5.17) applies to DP as much as to Unranked Unary Articulators.

In a more radical departure from the long-standing phonological canon of segmentality, McMahon, Tollfree and Foulkes, (1994) propose a version of Articulatory Phonology, AP, in which gestures constitute 'primitives throughout the derivation.' They see the UR as a score of gestures, phonetically implemented with various degrees of overlap in ways which have a critical bearing on language change. Commenting on Harris's account of lenition, they consider what sort of parametric setting would dictate a particular degree of delinkage. Citing Browman and Goldstein (1992), they describe the epenthesis in *warmth* as [wɔ:mpθ] in terms of "a period when the bilabial closure is concurrent with raised velum and open glottis, transcribable as [p]" (p.284). In relation to the coda deletion in *perfect memory* as (approximately) [ˈpə:fɪk mɛmrɪ] and assimilation in *seven plus* as [ˈsɛvəmplʌs], they propose that the relevant gestures are 'not actually erased, but hidden'. On this version of AP, there are no well-defined quantal units of phonological timing.. AP is not adopted here for the reason that such a radical departure from segmentality only serves to makes the long-distance processes of child phonology all the more mysterious. But the insights of McMahon et al may have a bearing on the form of root harmonies in obstruent clusters – as in the case of *escalator*, and partial cases of harmony or disharmony such as *monopoly* as [məˈnɒkpəlɪ] and *Melanie* as [ˈmɛlənlɪ]. Ignoring linear dictates, let us say that the [kp] and [nl] articulations are phonetically simultaneous. Because the methodology here was not an instrumental one, it is impossible to reconstruct the timing, the sequence or the articulations themselves. But impressionistically, the output is similar to the complex segments in some West African languages, described in segmental, not gestural, terms by Sagey (1986). On an AP approach some criterial aspects of the [məˈnɒkpəlɪ] realisation might be represented as in (5.18).

(5.18) ***monopoly*** – *simultaneous or nearly simultaneous articulatory gestures*

Roundness	Occlusion	Centrality	
	Labial		
	Dorsal		məˈnɒkpəlɪ

By left-to-right adjustment, the AP notation can express any degree of departure from absolute simultaneity. But the gestural approach in (5.18) fails in four ways.

FIRST, it does not identify the *source* of the dorsality. SECOND, it says nothing about either the initial labial or the roundness of the stressed vowel. THIRD, it allows the possibility that secondary dorsality might alternate with secondary coronality. FOURTH, it has nothing to say about the singularity of the environment, one which allows the dorsality to 'overwhelm' the underlying labiality, in an essentially *disharmonic* process, complementing the otherwise privileged status of Labial in relation to Dorsal.

Generally, to the extent that both gestural and dependency models treat the articulators equally, in relation to the data here, all of these models run into the same problems as those based on Unranked Unary Articulators. While the notion of the gesture has led to important insights, discussed further below, in this study I retain the notion of the segment as a way of encapsulating both the melody and a unit of timing.

Various alternatives to Unranked Unary Articulators have been proposed. In van der Hulst's 1994 Radical CV Phonology, dorsality is defined on an empty position. But in this framework, defined on the intrinsic properties of nodes, it is hard to express the contrast between the weakness of Dorsal in relation to fronting, and Dorsal as the harmoniser in *doggy* as ['gɒgɩ] etc.. By the model of Keyser and Stevens (1994), the context-free substitution of Dorsal by Coronal is between the dependents of what they call a 'Lingual' head. But this does not explain the similarity between cases where the harmonic target is Dorsal and where it is Labial, and ignores the evidence which led to the idea of [±Grave] in Jakobson at al (1963).

In sum, by the conclusion in (5.17), the Unranked Unary Articulator idea needs to be amended. But the geometrical model is an advance on the SPE 'feature stack' by virtue of the non-featural representation of quantity, the idea of PLACE as the head of what is essentially a generalised articulator node, and the more general reasons given above.

5.1.3 Ranked articulators and geometrical markedness

In this Section I shall develop a geometry which replaces the Unranked Unary Articulator idea by the 'Coronal Hypothesis' according to which Coronal is the unmarked articulator. I shall test the Coronal Hypothesis against the evidence of parapraxis. This hypothesis, tentatively considered but rejected in SPE, is commonly justified on various grounds (see Paradis and Prunet, 1991.a). According to these authors,

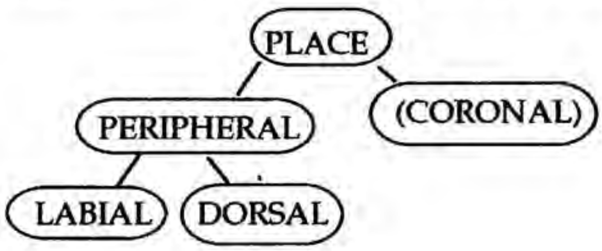
> "The under-specification of coronals is needed for most empirical problems addressed here and in the literature, although it appears that none of the present

under-specification theories can account for the full range of the properties identified as constituting the special status of coronals" (p.24).

The Coronal Hypothesis is motivated here by the need to explain singularities and asymmetries in (3.71) and (5.16) above. The distinctive role of Coronal in word-internal domains reflects the role of this node as the unmarked interpretation of Place.

According to Rice and Avery (1991), Place, unmarkedly Coronal, has a dependent which they call PERIPHERAL heading a substructure consisting of two unranked sisters, Dorsal and Labial. This geometry, said to be universal, is shown in (5.19).

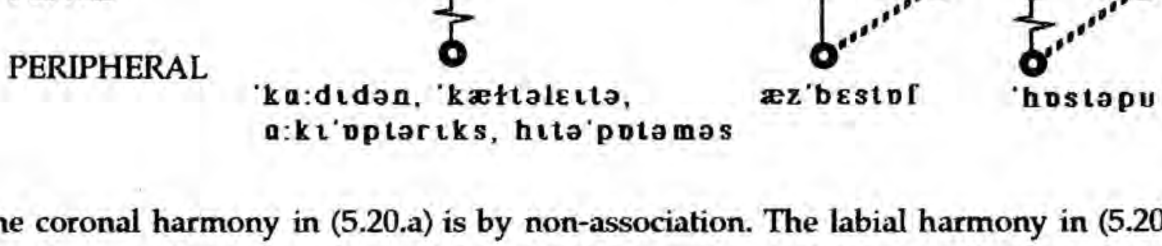
(5.19) *A 'Coronal hypothesis'* – Rice and Avery (1991, p. 103)



This represents a different sort of intrinsic under-specification to that of Unranked Unary Articulators. Unmarked 'phonetic content' is not underlyingly represented. This presupposes the building of a Coronal articulation from an otherwise empty PLACE node. Putting aside the question of how this structure-building is done and the long range of the context-sensitivity, some seemingly criterial aspects of three aspects of parapraxis are informally schematised in (5.20).

(5.20) *PERIPHERAL Spreading andnon-association*

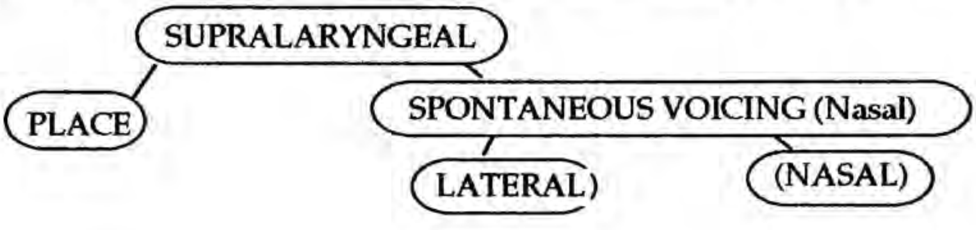
a) *Coronal harmony (Non-association)* b) *Labial harmony* c) *Metathesis*



The coronal harmony in (5.20.a) is by non-association. The labial harmony in (5.20) and the metathesis in (5.20.c) are both by the spreading of the PERIPHERAL node. The association is lost at the source and re-made elsewhere in the structure. A sub-structure dependent on Place, with Coronal interpreted by default, has these effects. FIRST, there is no surprise in the involvement of coronals in parapraxic metathesis, by (3.46). SECOND, the long-distance effects in (5.20) are not problematic. But (5.20) does not explain the singularities. In all cases there is a problem in defining: A) the separate contributions of more than one element with triggering properties and B) the target or landing site. In the case of coronal harmony, the problem is how to characterise prosodic and melodic matching.

By another of Rice and Avery's proposals, there is a SPONTANEOUS VOICING node with a default interpretation as nasal and a marked interpretation as lateral.

(5.21) Supralaryngeal [Spontaneous Voicing]– Rice and Avery (1991, p.103)

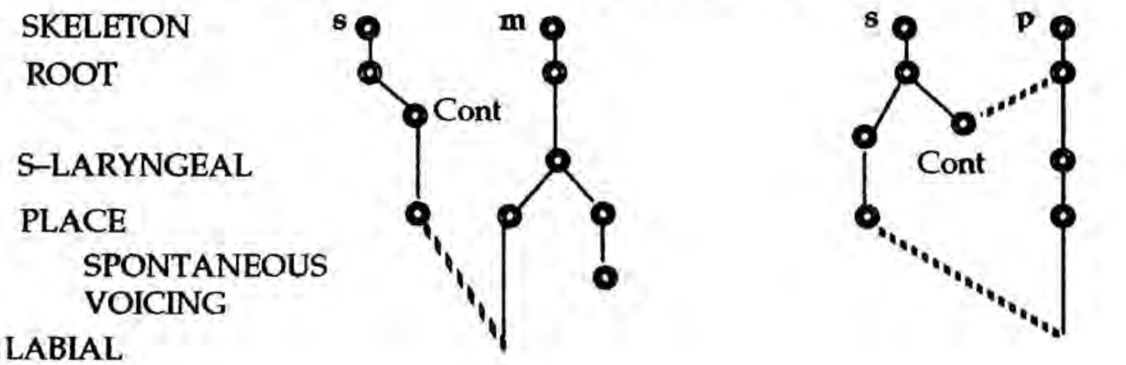


A lateral is represented by a single (marked) property. The definition of laterality by geometrical markedness makes it possible to characterise *aluminium* as [æ lə'm ɩ l ɩə m] and *monopoly* as [mə'lɒpəlɩ] as the spreading of the marked interpretation of Lateral. This prevails (weakly, on the evidence here) over the loss of markedness in realisations as [æ n ə'm ɩ n ɩə m] and [mə'n ɒ p ə n ɩ].

In a clinical development of this thinking, in what is referred to here as dense parapraxis, in a sample of children with severe disorders, Chin and Dinnsen (1992), explain the onset coalescence in (1.7) above, in *spoon* as [fu:n], *smoke* as [fəʊk], etc., by the Coronal Hypothesis. Characterising fricatives as having the property of continuance (in their framework, an immediate dependent of the root), their analysis of surface /f/ in these onsets is as follows:

(5.22) *'Coalescence'* Chin and Dinnsen (1992, pp. 276 – 8)

a) *LABIAL in case of /sm/* b) *LABIAL , [+Cont] in /sp/ and /sw/*



The analyses in (5.22) are the first step in the derivation; the second is degemination. Chin and Dinnsen produce evidence for the two-step analysis from a speech-pattern in which the second step is omitted. In the case of /sm/ Chin and Dinnsen assume that nasal spreading is blocked by a universal constraint on nasal fricatives. A universal constraint on nasal fricatives is counter-exemplified (see Mohanan, 1993). But nasal friction is typologically marked, most plausibly as an articulatory / perceptual interface effect, with the friction is drowned by the resonance.

The Coronal Hypothesis relates to speech pathology in these ways: A) As noted in Section 1.1.6, the segments commonly involved in context-free errors in adult speech are all coronals; B) In what is perhaps the commonest of these cases, that of lisps, the output forms all tend to remain coronal, most often dental, less often lateral; C) It bears on the case of fronting and the apparent over-richness of the delinkage patterns; D) Harmony and other sorts of process involve coronal and non-coronal elements in characteristically different ways.

The idea of coronality having a special status in phonology is grounded in anatomy and neuro-physiology. The articulation target in coronality is the alveolus, with a separate innervation from the rest of the palate, and selectively vulnerable in various ways, most visibly in cleft lip, and subtly where the impairment is to the sensory innervation, observed by the author in a father and son, the latter with /n/ as [ŋ].

Like Chin and Dinnsen, Rice and Avery propose that continuance is a dependent of the root. They take the view, widely accepted since SPE, that continuance is a marked property in consonants. (One of the few authors to take the opposite view is Shaw, 1991). If continuance is the marked property, the property of non-continuance (defined in terms of both articulation and the spectral distribution of aperiodic noise) still has to be built by a particular step of structure-building, one that applies only in consonants.

While Rice and Avery's notion of a marked privative hierarchy predicts the coalescence pattern in (5.22), it does not account for the singularity – consisting in the fact that in both cases the adjacent vowel is round – and otherwise as summarised in (3.71) and (5.16). Nor does it explain the derivation of /ɪ/ as [w].

Now, a question.

(5.23) *Two interpretations of the Coronal Hypothesis*

a) Coronals have no PLACE node;

b) Coronals have a PLACE node which is otherwise unmarked.

Shaw (1991) adopts a (5.23.a) interpretation. She notes the seeming rarity of consonant harmony compared to vowel harmony, and distinguishes morpheme structure constraints involving PLACE, and true phonological harmony which entails action-at-a-distance, that is, across intervening classes of segments which do not participate. She discusses examples of long-distance laryngeal harmony and harmony involving sibilance and apicality in a small number of languages. In the case of Chumash, the spreading is leftwards from the rightmost sibilant.[53] The spreading element has no bearer other than in the one class of segment. But such processes are cross-linguistically rare. Shaw proposes, as 'a candidate for a universal redundancy rule', a rule inserting coronality into structures not containing a place node (p.147).[54]

(5.23.b) is less radical than (5.23.a). Here, I shall assume (5.24).

(5.24) If the feature geometry, FG, itself is defined by the interface considerations of neuro-physiology and anatomy, etc., the interpretation of FG is learned. Given alternative theories of FG, relevant decision criteria include A) the number of phonological contrasts (valued positively), B) on-line structure-building (valued negatively); and C) learnability.

Applying the B) criterion in (5.24) to derivation, Shaw's candidate for a universal redundancy rule imposes an extra step. To allow the separate treatment of glottals, as segments with no PLACE node, in numerous languages, a Place node must be inserted to allow subsequent structure-building in all segments with an active articulator. By (5.24), (5.23.a) defines two structural contrasts between coronals and other segments, while (5.23.b) defines one. So (5.23.b) is adopted here.

In this Section, it has been shown that Rice and Avery's interpretation of the Coronal Hypothesis bears significantly on the asymmetry of parapraxis by (3.71) and (5.16). I adopt here their proposals concerning: A) a ranking relation between Coronal and the other articulators; B) a geometrical relation between laterality and nasality; C) the notion of markedness encoded by the geometry. But the precise working of these ideas raises new questions about the geometry in general and valency in particular. Rice and Avery's notion of a Peripheral node is substantially re-worked here.

5.1.4 Binary dependents within the hierarchy

With an eye to the descriptive challenge in (3.71) and (5.16) regarding the asymmetries and singularities, Section 5.1.4 contrasts two approaches to the feature-geometry.

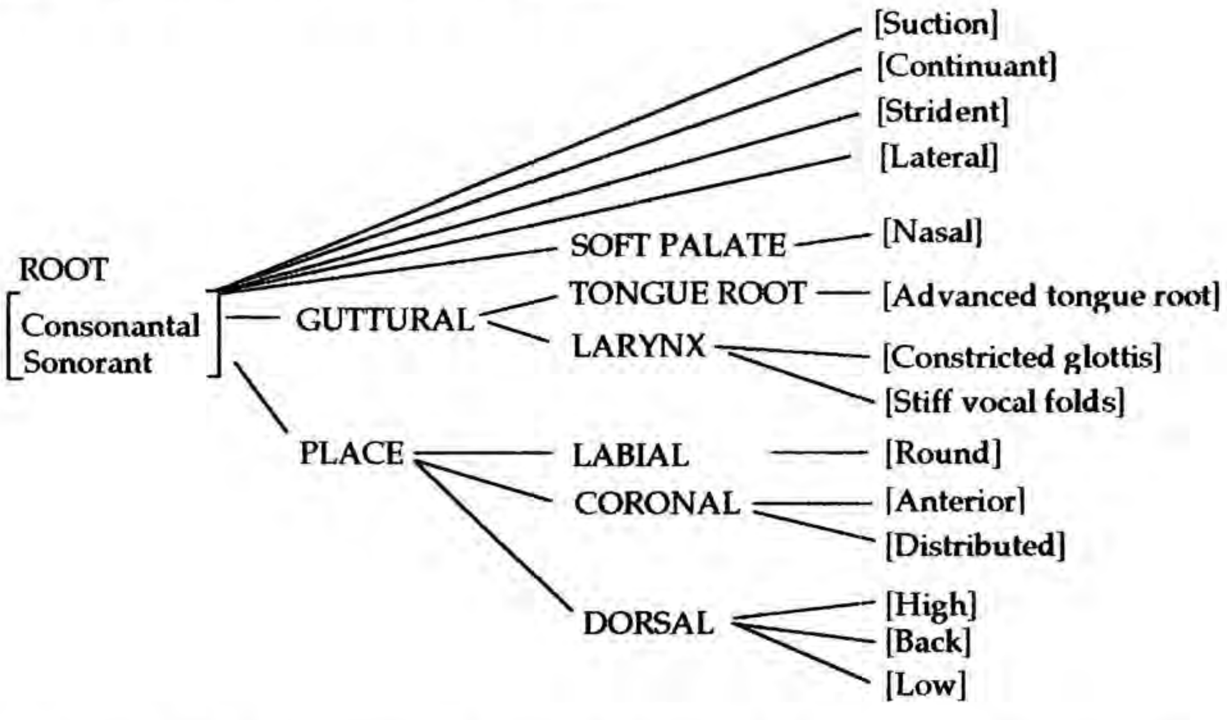
[53] Both Poser (1982) and Steriade (1987) treat this as 'feature changing' in both polarities.

[54] It is the (5.23.a) interpretation of the Coronal Hypothesis which Kenstowicz (1994) criticises. He notes that Shaw's analysis of coronal harmony in Tahltan fails to account for the case where coronality is transparent. His criticism hinges on the point that,"one of the diagnostics of an underspecified segment is its susceptiblity to assimilation" (p.521). But on the evidence of Chapter 3, at least in the case of children learning English, and from the well known case of English allegretto speech mentioned in Chapter 2, such assimilation is common.

They both preserve the principles of derivation and binary representation. They differ on whether or not the principle of binary representation is exclusive.

One of these is that of Halle (1995). It is the latest version of a model first suggested in (1983). In this model, some nodes are bi-valent while others are monovalent. To provide an account of pharyngeal, uvular articulations, and intra-oral clicks, he adds to the geometry in (5.4) a GUTTURAL head as a sister of PLACE. He assumes that "all functional feature groupings have an anatomical basis" (p.2). He distinguishes between 'articulator bound' features such as nasality and 'articulator-free' features such as continuance. Articulator-free features assimilate both singly and at the ROOT. [Consonantal] and [Sonorant], however, "never assimilate singly but only where there is total assimilation" (p.3). In (5.26), following Halle's presentation, features are characterised as [Sonorant], [Continuant], and so on. But the representation of a feature as [F] rather than [±F] has no implication regarding its interpretation as privative/unary.

(5.25) *Root dependencies* – from Halle (1995)



The geometry in (5.25) is intended to make it possible to characterise all phonemic distinctions in all known phonological inventories. It addresses descriptive issues not easily addressed in the framework of (5.4) or Rice and Avery's 1991/1995 model. It is thus possible to define dorsal laterals, uvular stops, pharyngeal obstruents, nasal fricatives, retroflex articulations, and so on, as relatively marked sorts of segment. But (5.25) also suggests what is either weak equivalence or a degree of abstract exponence. Thus a nasalised vowel may be derived from an underlying structure where nasality is spread from a consonantal element or by underlying specification. A long vowel may be underlyingly specified as tense (or 'peripheral' to use the terminology of Labov, 1994) with the length arising derivationally (by the insertion of a skeleton node) or vice versa. An obstruent can be defined on vocalic features, as in the case of Nisgha (see Kenstowicz, 1994, p.538), with dorsal, uvular, and laryngeal stops categorised as [+back]. But not all of the geometry in (5.25) is required in all languages. The exploitation of its parts is language-specific. Which parts of (5.25) are needed for a given target language, and which are not, must be learned.

As regards feature selection, it is possible that this is determined by a stochastic function, not taking account of meaning or syntactic form, available to the infant before the PSF has come on line. Such a function was discussed in Chapter 1 (see Vihman, 1994 for a survey of the general programme of research which this takes in, i.e. phonological development in the first two years).

By (5.25) LABIAL, CORONAL, DORSAL, LARYNX, SOFT PALATE and TONGUE ROOT have a dual role as articulators and as heads, the last two involved in uvular and pharyngeal articulations.[55] But the descriptive richness makes it necessary to stipulate negative constraints, for example *[–consonantal, +F] where F is 'articulator-free'. Without this provision, the feature combinatorix generates an inventory including unattested segments, such as lateral nasals.

Here the idea of [Consonantal] as a feature is rejected on account of the fact that it cannot be defined in a way that is consistent with the rest of the geometry (see Hume and Odden, 1996, for a detailed argument along these lines).

Any descriptively adequate geometry must be at least equal in scope to that of (5.25). But (5.25) preserves intact the Unranked Unary Articulator structure of (5.4). So (5.25) throws no light on the parapraxic asymmetries in (3.71) and (5.16). While (5.25) is not adopted here, it constitutes a useful reference-point by virtue of its scope.

A different interpretation of the geometrical idea has come to be known as 'Radical under-specification', RU, (see Archangeli, 1984, 1988, Pulleyblank, 1988 a, b). It emerges from earlier work by Kiparsky (1982 a, b). UG prohibits an underlying contrast with

[55] The notion of SOFT PALATE as the head of [Nasal] is motivated by typological considerations on which the evidence of this study has no clear bearing, like the fact that uvularity must stand in a marked relation to nasality. And the term [Suction] (=Ingressive airstream) is motivated by the clicks of Southern African languages. Similarly TONGUE ROOT is definitional in the case of [±Advanced Tongue Root]. But unless there is evidence of a language with underlying contrasts involving both tongue root advancement and tenseness (in such a way that neither can be attributed to the geometry or underlying glides), it seems reasonable and parsimonious to assume that the two sets of properties are somehow related. While TONGUE ROOT is not obviously relevant here , we do need to consider the underlying representation of surface schwa and syllabic sonorants. This is an issue to which we shall return.

respect to two values of a given, necessarily binary feature. Lexical representations are in part 'under-specified' or incomplete with respect to some aspects of the feature matrix. Gaps in the matrix are filled (necessarily for the sake of phonetic implementation) in the course of a derivation. Such under-specification is 'extrinsic' in the terminology of Kiparsky (1995).

(5.26) * $-\alpha$ F, in underlying representation

While (5.26) extends the learned element of markedness, it seeks, on learnability grounds, to restrict this as far as possible. From the perspective here, the interest of RU is that one of the prime motivations for its development was to account for asymmetries in the behaviour of vowels – in the widespread tendency in diverse, unrelated languages to select one of a small number of vowels for epenthesis, as a harmonic target, or as a candidate for deletion in various contexts.

(5.26) is assumed here.

5.1.5 Markedness and structure-building

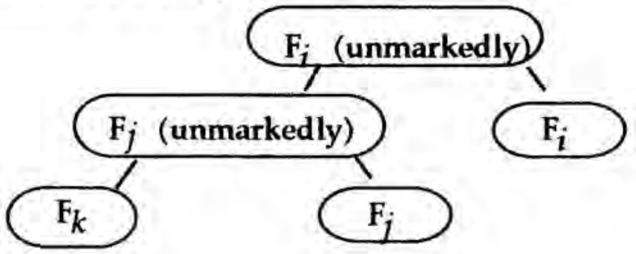
In this Section I shall apply (5.26) to the feature-geometry, exploring some consequences of the assumption in (5.27).

(5.27) In the feature-geometry, branching is maximally-binary.

Exclusive binary branching is learnable in a way in n-ary branching is not. The case of /Cjv/ structures in dialects like the author's is not counter-evidence because this can be treated derivationally. The fact that three geometrical elements on the surface have a role in the nucleus is not represented underlyingly. Following previous work by Anderson and Ewen (1987), exclusive binary branching is suggested by Van der Hulst (1994), working in the very different framework of Radical CV Phonology, or RCVP, abandoning all direct phonetic exponence of phonological features, thus reducing to the limit the number of phonological primes. In RCVP, the terminal nodes vary only with respect to one property, defined on sonority. RCVP adopts the 'extreme position'according to which "the three elements A, I U (or rather their V/C definitions) and the notion of empty location are sufficient to represent all location categories of both consonants and vowels" (p.469). Assuming that coronals are 'the least marked category', RCVP expresses the fact that they, rather than labials and dorsals, show sub-types. While dorsality, represented by an 'empty primary sub-gesture' is the 'weakest place of articulation',... 'empty structure is not at all unmarked' (p.458). While representational minimality throws no light on the data here, I shall adopt from RCVP the idea of maximally-binary branchedness, not, as in RCVP, for the sake of representation, but for the sake of learnability.

By (5.26), the role of what SPE treated as redundancy rules is now enhanced. Treating this idea geometrically, terminal elements are likely to be grouped so as to effect a set of asymmetric contrasts between three features, F_i, F_j and F_k, F_i under-specified with respect to F_j, F_j under-specified with respect to F_k. This is illustrated in (5.28).

(5.28) *Asymmetric three-way featural contrast*



The model in (5.28) predicts three-way contrasts within phonological systems, for our purposes here Coronal, Dorsal, and Labial dependents of PLACE, as in Halle (1995). It re-interprets the three basic elements of most versions of Element Theory, e.g. Harris (1994). Interpreted as an abstract representation of the Place sub-hierarchy, (5.28) does not prevent the occurrence or development of more complex sub-hierarchies, as in the case of the Semitic languages, to take just one particularly well-studied case. From this perspective, the appearance of monovalence is an artifact of structures such as (5.28). The surface phonetic form of an articulation involves a degree of on-line structure-building. If this is at all context-sensitive, this may give us a handle on the asymmetries in (3.71) and (5.16). This is the path to be taken here.

But to begin with, let us consider the more general question of fronting. Whatever account is given, it has to address the fact that fronting typically involves production alone. Being unable to discriminate dorsality/coronality in minimal pairs is not characteristic of the fronting child.

Rice and Avery's 1991 proposals predict /p/ ⇒ [t] as well as /k/ ⇒ [t]. In an amendment motivated specifically by the evidence of child phonology, Rice and Avery (1995) propose a markedness relation between Dorsal and Labial, with Dorsal as the marked interpretation; fronting is defined as a lack of markedness within the system. The child stops fronting when his or her feature geometry gets a dorsal node.

Rice and Avery's (1995) proposal is not accepted here. It raises two questions and leads to two problems. The questions are as follows. If phonological acquisition is by geometrical growth, what sort of learnability evidence forces such a step? And how does geometrical growth manifest itself other than by the overcoming of fronting? The problems include the following. FIRST, it is hard to give a corresponding account of the asymmetry of articulator harmony. SECOND, at least one other common neutralisation in child phonology, namely stopping, does not seem to be accountable in any sort of parallel way.

By (5.28), I adopt the idea of geometrically encoded markedness. On the reasoning above, the notion of default coronality, by (5.23.b), forces the notion of structure-building. I shall now use this idea to define fronting in terms of the interaction between the geometry and structure-building, reversing Rice and Avery's 1995 idea of marked dorsality and unmarked labiality. Here, abandoning the term 'PERIPHERAL' from (5.19), the head is named GRAVITY – on the basis that its dependents characterise what Jakobson et al (1963) characterised as [+Grave]. The new term is used here: A) for the sake of clarity; B) because a 'peripheral' definition of dorsality obsures an articulatory definition of pharyngeal segments; and C) because the notion of 'peripherality' is more relevant to the vowel system (see Labov, 1994). A corresponding set of marked and default interpretations is proposed in (5.29).

(5.29) *A hypothesis regarding the unmarked exponence of the articulators in English*

a) PLACE
   - a) is interpreted by default as Coronal;
   - b) dominates a class node, entitled GRAVITY;

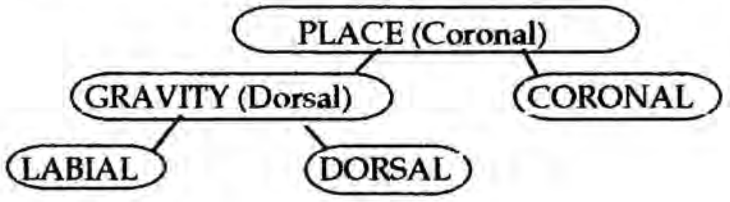
b) GRAVITY
   - a) is interpreted by default as Dorsal;
   - c) has a marked exponence as Labial.

By (5.29) there are effectively two *degrees* of GRAVITY, differing in markedness, and two defaults. one with respect to dorsality, the other with respect to coronality. The term GRAVITY reflects one aspect of the feature system of Jakobson, et al (1963). They define their binary feature [±Grave] as follows:

> "The gravity of a consonant or vowel is generated by a larger and less compartmented mouth cavity, while acuteness originates in a smaller and more divided cavity. Hence gravity characterises labial consonants as against dentals, as well as velars vs. palatals..." (p. 30).

The novel, and obviously non-standard markedness relation in (5.28.b) translates into the geometry in (5.30).

(5.30) *PLACE dependencies - implentation of (5.28)*



(5.30) does not prohibit each articulator, Coronal, Dorsal and Labial, from constituting a head. The case for (5.30) rests on: A) the Coronal Hypothesis; B) under-specification; C) markedness and binarity in the branching. In the rest of this study, I shall argue that a sub-structure of the sort illustrated in (5.30) provides the basis for an internally consistent account of both context-free and context-sensitive aspects of parapraxis involving the articulators. I shall show that it provides an account of fronting in particular.

Here it is assumed that markedness expresses a particular exponence. No further (underlying) specification is necessary. On this basis, the articulatory features are a function of markedness, either underlying, or, in the case of coronality, introduced by what I shall, for the moment, consider as a rule.

The default exponence of a node implies the association of any underlyingly unmarked phonetic content. But if structure is contingent, it is necessary to limit such association to cases where there is no marked dependent. This implies that what I shall refer to as a Default Exponence Rule, DER, is necessarily preceded by a Marked Node Association Rule, MNAR. If the GRAVITY node has a default exponence as Dorsal, the rule is restricted to cases where the class node does not dominate the one marked dependent of this node, i.e. Labial. On such reasoning, GRAVITY dependents are associated in the following sequence of structure-building.

(5.31) *structure-building rules for GRAVITY*

(i) $[\,m\,] \Rightarrow$ Labial / GRAVITY [__ m] MNAR

(ii) $[\,\emptyset\,] \Rightarrow$ Dorsal / GRAVITY [__] DER

(iii) $[\,\emptyset\,] \Rightarrow$ Coronal / PLACE [__] DER

(5.31) represents the same order which was postulated in Chapter 2 in order to capture the rare case of three-way bi-directional articulator harmony in monosyllables – in the idiolect of LM. Note that this ordering mirrors that given by Archangeli (1984 p.110) for what she treats as the (derived) properties of (binary) labiality and backness.[56] The difference between Archangeli's rules and those in (5.31) is that the

[56] According to Archangeli (1984), only positive values for [Coronal] and [Anterior] are

latter are defined on a geometry with unary heads, marked or unmarked. If the Default Exponence Rule inserting Dorsal is omitted, the rule inserting Coronal applies instead. The GRAVITY node is effectively ignored. Its marked dependent, Labial, is treated as though it stood in an equivalent relation to PLACE. On this analysis it is not the geometry of the fronting child which is deficient. Rather, there is a step in the process of structure-building which is missed. As a context-free process, fronting does not commonly persist.[57]

If redundancy rules define the phonetic implementation of markedness, is there any cross-linguistic variation? Markedness in the SPE framework is universal. In most of the discussion about coronality in the intrinsic under-specification framework, it is assumed that its unmarkedness is similarly universal. But according to Cho (1991), in Hawaian, there is evidence from the loan phonology that Dorsal is the default articulator. Cho proposes that PLACE is represented either monovalently or in terms of [±Anterior] and [±Coronal]. Representation in terms of binary features is thus a parametrical option. The evidence for the binary option is: A) the evidence for 'natural classes' defined on all four of the logical possibilities; and B) a system of three articulator harmonies in Korean, where 'velar harmony' predominates, suggesting that this is the most highly marked articulator. Here, with the aim of restricting the power of parametric alternation, it is assumed that valency cannot be parameterised, and that there must be cross-linguistic variation with respect to the markedness and thus the structure-building sequence. The difference between languages with default coronality and cases such as Hawaian and Korean might be defined on this basis.

Quite different possibilities are opened by the proposal of Keyser and Stevens (1994), mentioned above, who introduce the class node LINGUAL, defining coronality and dorsality, similar to the feature of the same name proposed (on different reasoning) by Coleman (1995). While this bears on context-free fronting in an obvious way, it throws no light on the claims in (3.71) and (5.16) concerning the asymmetric distribution of articulator harmony in high threshold parapraxis.

Consider in this light the rare case of the 'backing' child – with *tea* as [ki:]. In the framework here, this involves both the misinterpretation of the geometry and the omission of the middle step of structure-building. A developmentally-untypical structure-building sequence, invoking this principle, is postulated in (5.32).

underlyingly represented in Yawelmani, implying that this language similarly defaults to Dorsal.

[57] It appears to be unreported as an adult syndrome in English speaking populations without access to speech therapy. It took a twentieth century speech pathologist to invent the term 'fronting' in relation to children. If it ever persisted into adulthood as a specific disorder, it would surely have been observed in theatre, literature or the orthopeic tradition.

(5.32) *Hypothetical SBR sequence in a 'backing' child*

(i) [m] ⇒ Labial / GRAVITY [__] MNAR

(ii) [m] ⇒ Coronal / PLACE [__] MNAR (Omission – ••)

(iii) [Ø] ⇒ Dorsal / GRAVITY [__] DER

Returning to the prevalent case of fronting, there is a non-prevalent variation – where it is restricted to environments where /k/ does *not* precede /l/. Such children can say *clean* and *clear*, but not *key*. Encountered twice by this author, such fronting is accountable by (5.32), where the Default Exponence Rule for dorsality only applies in a particular sort of cluster, characterised here in terms of the phoneme /l/, and double-bulleted to denote the exceptionality.[58]

(5.33) *Alphabet formation for Dorsality (doubly pathological)*

[Ø] ⇒ Dorsal /[GRAVITY __] [/l/] DER ••

This context-sensitive fronting is not easily accountable in other ways – neither in a reductionist framework of the sort discussed in Chapter 4 nor by a purely geometrical approach – with reference to a 'LINGUAL' node, or by a missing Dorsal articulator. But as in the case of 'backing', the pattern in (5.32) is accountable as an uncommonly severe misconstrual of the input data – a point to which I shall return in Chapter 7.

In the framework here, parapraxis can be generally characterised as points at which the structure-building sequence fails, either generally, i.e. context-freely, or under local conditions, i.e. context-sensitively. In this way, I have been able to explain how the representation limits in Chapters 2 and 3 work, without invoking any ad hoc mechanisms.

In the case of the prevalent parapraxis in *hippopotamus* and *archeopterix* the structure-building failure is with respect to (5.31.i) or (5.31.ii) or both (in some idiolects). In these two cases, the failure is in what seem to be similar structural configurations. Why is the pattern so different from that of context-free failure? This is an issue to which I shall return.

[58] These children had no discernable problems with phonological perception. They were difficult to treat. One defeated all efforts at treatment despite great diligence on all sides.

5.1.6 The soft palate, nasality and sonorance

In this Section, I propose a CAVITY node, defined on acoustic and articulatory principles, collapsing the roles of Rice and Avery's (1995) SPONTANEOUS VOICING node and Halle's (1995) SOFT PALATE node. I shall use this idea to account phonologically for unipolar, context-free gliding, i.e. /r/ ⇒ /w/, and for one or more limits on the representation of the various sonorants prevalently targeted by the lateral in *yellow; lorry, ruler*, and *Jerusalem*.[59] Coronal is involved in every case. Adopting Rice and Avery's notion of nasality as the default expression of sonorance, /n/ has an underlying representation such that the nasality, coronality, oral closure and voicing are all built derivationally. By the proposals here:

(5.34) There is a head characterised here as CAVITY, interpreted generally as sonorance.[60]

- a) by default, i.e. in the unmarked condition, as Nasal;
- b) otherwise, i.e. markedly, as an approximant (characteristically):
  - a) a liquid (rather than laterality, as in Rice and Avery, 1991)
  - b) a glide, a transition between vocoid and non-vocoid postures, where the underlying representation involves a Dorsal dependent;
  - c) in a way unexplored here, as uvular, defining a rhotic trill, perhaps where there is no PLACE node, in the classification of liquids in dialects of French and German with uvular /r/, alternating with coronal /r/ in neighbouring, closely related languages including English.

CAVITY defines a (variable) degree of enhanced resonance, effected by the tongue as well as the soft palate. It reflects what is typically the *source* of a contrast rather than its *effect*. It contributes to the definition of an approximant. It provides a non-contradictory account of the contrasts in languages where nasality, laterality, etc., contrast in voicing.[61] The CAVITY node may reflect a common innervation through one or branches of the trigeminal nerve, the largest cranial nerve, supplying the muscles of mastication and the nasal cavity (see Warwick and Williams, 1973, p. 1001).

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[59] In a ways that is outside the scope of this study, CAVITY may also be part of the classification of stops in languages with uvular stops, where the interpretation somehow cross-classifies with non-continuance.

[60] The bare structure proposed here means that existing accounts of alternations between two representations of nasality (see Piggott, 1992) and Voicing (see Rice, 1992) have to be recast. The model developed here has the power to do this, but the task is outside our purposes here.

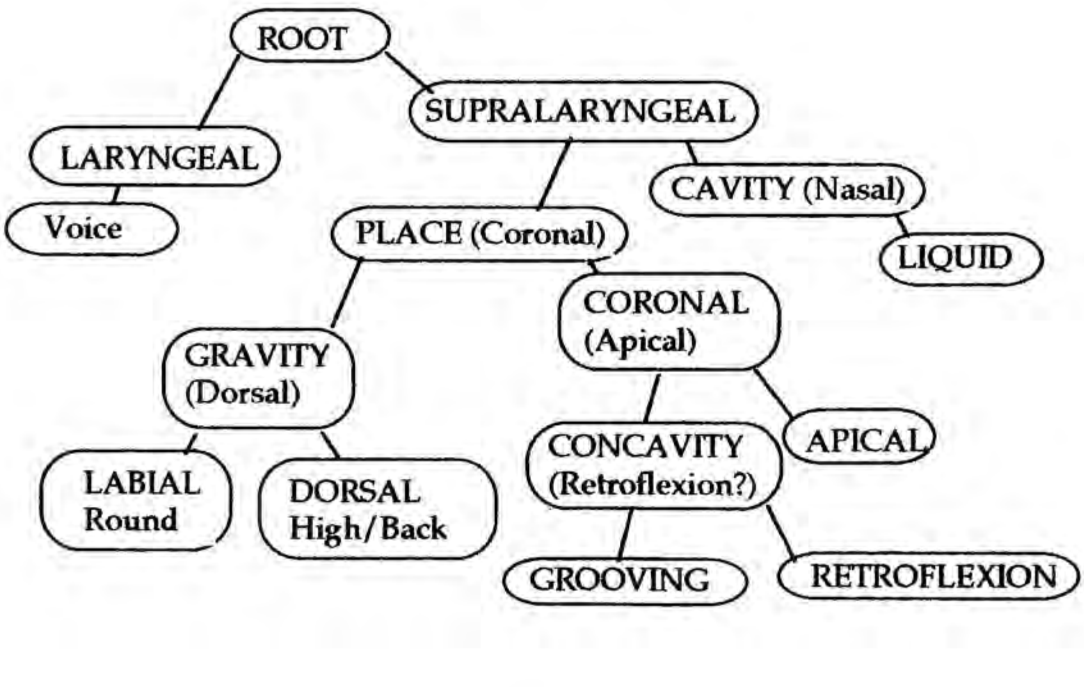
[61] The SPE notion of Laterals as non-continuant in contrast to rhotics as continuant was motivated by cases where the liquids split this way between stops and fricatives. In the framework here, it may be possible to represent such cases by language specific rules entering appropriate values for [Continuant] in liquids. But the issue is outside the terms of this discussion.

According to (5.34.a), the unmarked interpretation of the CAVITY node, postulated here, defines the opening of the velo-pharyngeal sphincter. The marked interpretations in (5.34.b) define different configurations of the oral space, hence the chosen term, drawing on the separate insights of Halle (1995) concerning a SOFT PALATE head for nasality and Rice and Avery (1991) concerning sonorance. Like GRAVITY, the CAVITY node is expressed phonetically in quite diverse ways. Like the SUPRALARYNGEAL node, it does not apear to spread. By (5.24), the mere fact that a node does not spread does not constitute an ontological argument against its existence. To permit the cases of contrastive uvularity, contrasts with respect to liquidity, and guttural elements, there has to be some additional structure – a sub-hierarchy. The geometry implicit in (5.34) is an incomplete, partial statement. The learnability space must include the possibility of defining or re-defining the geometry within some overall limits. Here I am concerned with the (5.34.b.a) and (5.34.b.b) cases defining liquids and glides.

In sum, the thrust of the proposal here is to preserve (or resurrect) the SPE view of liquids differentiated (in part) by their values for an articulatory feature. But I shall develop, in Chapter 6, the idea of an innovative dialect with /r/ as an onset glide, with its liquidity built derivationally and variably, not as part of its underlying representation.

To summarise, I have now postulated the following ROOT dependents (with a query about the default interpretation of concavity – with no evidence here):

(5.35) *A Marked hierarchical geometry with maximally-binary branching*



I postpone, until Section 5.3, issues concerning continuance and stridency.

Featurally, the model in (5.35) is richer than (5.4), let alone a system of the GP-type, designed for representational minimality. The richness of (5.35) is not a theoretical weakness if the geometry is a function of the articulatory/perceptual interface. From this perspective, the power of the geometry is not an issue. The geometry is defined by what phylogeny gives us (but see Durand 1995, for the opposite view).

Summarising Section 5.1.6, by the notion of a CAVITY node, it is possible to encode sonorance of all kinds and do without [son] as a ROOT feature. The node helps to express the phonetically very variable exponence of /r/. And, as we shall see, it can be used to account for various processes involving sonorants, including /r/ to [w], which is otherwise difficult to formalise as a natural and almost universal process in children learning English.

5.1.7 The feature geometry and derivation

In Section 5.1, the principle of derivation has been invoked in a way close to the thinking of Kiparsky (1995) and Rubach (1995), and in opposition to those geometrical models which seek to reduce derivation to the minimum, if not to eliminate it.

In a framework where phonetically expressed elements are underlyingly bi-valent, there is an unmarked value of GRAVITY as [+Dorsal] and a marked value [–Dorsal], the latter equivalent to monovalent Labial, relevant only in the case of the GRAVITY node. But here, for the sake of clarity and familiarity, I shall continue to refer to labiality as the marked exponent of a GRAVITY node, and dorsality as the unmarked exponent, using the unfamiliar notion of GRAVITY, only as and when necessary.

The notion of GRAVITY assumed here is different from the notion of [±Grave] from Jakobson et al (1963) in three key respects: A) GRAVITY represents a general headship – entailing that it is irrelevant in some cases, e.g. coronals; B) the notion of coronality is simultaneously enriched in a complementary way; C) the articulators in (5.34), are all heads.

The model in (5.34) is similar to Halle's 1995 model in that it involves the same articulators. It is different with respect to: A) exclusively binary branching; B) extrinsic under-specification, as by (5.26); C) a relatively deeper hierarchy. This combination of intrinsic and extrinsic under-specification is also different from the approach of Pulleyblank (1995) whose addition of [±Labial] to SPE's [±Coronal] and [±Anterior] predicts unattested eight-way contrasts, and is accordingly rejected here.

If Cho (1991) is correct on the point that the markedness of coronal is a cross-linguistic variable, the the interpretation of the geometry must be language-specific. A possible mechanism for this is suggested in Chapter 7.

It is assumed here that any under-specification over and above that of the geometry entails representational binarity, as agreed by Archangeli and Pulleyblank (1994), Pulleyblank (1995), Rubach (1994, 1995), Kiparsky (1993 and 1995).[62] Hence (5.36).

(5.36) A deep hierarchy with maximally-binary branchedness and corresponding rules of sequential structure-building and systematic defaulting (redundancy rule application) opens up the following lines of explanation:

a) Context-free fronting and coronal harmony both involve 'non-association'.

b) Dorsal does not spread or float to underlyingly Labial elements because Labial is associated before Dorsal in the sequence of structure-building (the special case of disharmony notwithstanding).

c) At least in respect of the articulators, there is one common sequence of structure-building attested over a wide range of parapraxis, from fronting, perhaps the commonest sort of developmental pathology, to the three-way articulator harmonies in the idiolect of LM discussed in Chapter 2.

While I have been able to describe some data which is otherwise hard to describe, the approach sketched in (5.36) carries a price. Archangeli (1984) proposed the idea of 'feature minimisation' according to which a grammar is valued by the number of features in the underlying representations. The lower the number the higher the value (p.50). Not only does a deep hierarchy not address the problem of the feature combinatorix; it seems to magnify it. Archangeli and Pulleyblank (1994) suggest that the issue of the combinatorix is best addressed, not formally by feature minimisation, but in terms of the interface phenomena of phonetic 'groundedness' or 'path conditions'. Necessarily these must be phonetically motivated. One example might be the almost, but not quite, universal coronality of laterals.

By the argument of Halle and Stevens (1971), there is a strong groundedness case for the voicing/aspiration distinction. In this study, the notion of groundedness is broadly assumed.

Here, Archangeli's 1984 idea is resurrected – with an adaptation. Chapter 7 considers a possible mechanism by which grammar is valued in inverse proportion to the

[62] The research of Archangeli and Pulleyblank has mainly concerned tone and various vowel features including Advanced Tongue Root in a large sample of languages. The pioneering research of Archangeli (1984) concerned vowel harmony in Yawelmani. The focus of Lexical Phonology as expressed in the work of Rubach and Kiparsky has been on both consonantal and vocalic phenomena where most of the data has been from languages spoken in Europe, including Finnish.

number of features which the learner is forced to select from a universal, biologically-given inventory.

Turning to the issue of representation, I have assumed that the natural phonological classes should be encoded geometrically. At least in what are characterised here as 'Greater-London' varieties of British English, these classes can be defined thus:[63]

(5.37) *Major class representations*

a) Vowels and semivowels involve representation on a tier with an unmarked GRAVITY dependent, i.e. Dorsal (see Archangeli, 1984, Sagey, 1986, Halle, 1995, but see Clements and Hume, 1995, for the contrary idea that Coronal heads vowel representations).

b) All vowels have an underlying syllabic projection (Archangeli, 1984).

c) Sonorants have a CAVITY node, underlyingly only in liquids and nasals.

d) Coronal sonorants have a syllabic projection if they are the exclusive dependent of the rime node in a rightmost unstressed syllable.

e) Glottals have no PLACE node.

In the modeling of the geometry here, the question of how vowels are represented is not raised. From the data here, it seems clear that there is a relation between labiality and roundness. In DP and related models (including Government Phonology, GP, discussed below), this observation is generalised by encoding the spectral properties of vowels and the articulatory properties of consonants by the same features. But there is a clear neuro-muscular opposition between the two sorts of gesture. The contraction is applied in opposite directions, to effect closure in labials and openness in vowels. Leaving the nature of the relation open, here I shall continue to refer to vocalic properties by their SPE classification – but with no theoretical commitment.

The issue is relevant here because of what is taken, in Chapter 6, to be the issue of where and how /ɪ/ and /ə/ fit into the representational system in contemporary dialects of Greater-London English. On the strength of Labov's (1994) analysis of (on-going) chain vowel-shifts in American English, it is assumed here that the feature [±Peripheral] is universally available. This provides more than one way of defining length or weight in vowels – geometrically by skeletal position and featurally as [+Peripheral]. The learnability issue here is one to which I return in Chapter 7.

By the abstract schema in (5.27) and its partial instantiation in (5.34), there is no conflict between the appearance of monovalency and the underlyingly binary nature

[63] There are various ways of representing /h/. Keyser and Stevens (1994) suggest a bare glottal specification. Or it may be a bare skeleton node. The issue does not bear on the central concerns of this study; /h/ appears to be transparent to all the phenonmena under discussion here.

of featural representation. This is not the binarity of SPE, but binarity which follows from the form of the hierarchy. If labials and dorsals represent different values of GRAVITY, neither has a well-defined negative value. They are both to this extent monovalent. But Coronal represented by a bare PLACE, node, distinctively does not have a GRAVITY node.

Halle and Ladefoged's 1983 idea of the 'active articulator' is assumed here. The term PLACE for the class node is inconsistent, but now established. The centrality of articulation is taken to the limit in the Articulatory Phonology of McMahon et al (1994) – with the notion of 'gesture' replacing both features and the principle of segmentality. This principle is also assumed here, but the idea of a phonological gesture is not forcibly contradictory. This is a key part of the thinking in Chapter 7.

I have been able to account for various aspects of early phonology such as fronting. But on the account so far, it is not possible to explain either the various singularities in (3.71) and (5.16) or the evidence of derivational sequence in some two-step errors described in Chapter 1, for example *cardigan* as [ˈkaːdɩntən].

5.2 Immediate prosodic/suprasegmental projections

Section 5.2, turns to what, in the name of theoretical neutrality, might be referred to as 'immediate suprasegmental projections'. Section 5.2.1 sets out key issues. Section 5.2.2 considers seminal views of the melody / prosody interaction in child phonology. Section 5.2.3 looks at some pathological evidence.

5.2.1 Issues

Key issues are as follows. In each case, the assumptions here are spelt out.

(5.38) *Issues and assumptions here*

a) The category itself.

Does the syllable exist, or can its effects be reduced to the separate effects of onset and rimal projection? (See Harris, 1994, Blevins, 1995, for opposite views on this). Is the notion of the *mora*, defined exclusively on elements analysed here as part of the rime, sufficient to account for all supposedly syllabic effects. If so, is the notion of an onset necessary? Should the notion of the mora supplant or be added to that of the syllable? Is this the domain for the computation of stress? Is this the domain of compensatory lengthening? Is the notion of the mora undermined by the typologically marked case of gemination in a leftmost onset? (see Bickmore, 1995, Hayes, 1995, Piggott, 1996, Zec, 1995). In the child phonology literature, it is now sometimes assumed that the notion of the mora should supplant that of the syllable. (See, for example, Bernhardt, 1992, Fee, 1995). Is this justifiable? Is there such a thing as the rime? Noske (1993) disputes this, treating the syllable as having three unranked constituents, onset, nucleus and coda, resurrecting the view of Clements and Keyser (1983), but on different grounds. Is it descriptively necessary to have a three-way branching in the onset and coda? (See Cairns and Feinstein, 1982). Or a four-way branching in the rime – to account for *next, least, waist,* etc.? (See Hogg and McNully, 1987). In GP, there are only onsets and rimes, with only binary-branching in each one. As categories, neither the syllable nor the coda exist. To account for items such as *chamber* and *strange,* GP treats each of the edgemost consonants as having an empty nucleus, making both of these words tri-syllabic. By the centrality of what GP characterises as Government and Licensing, the onset/rime typology is exhaustive. Denotations of stress-level and foot-structure are epiphenomenal. Kenstowizc (1994) proposes a model in which the onset branches no more than two ways and – following Kiparsky (1981) – the English rime dominates at most three elements. Onsets apparently containing three elements, the leftmost a coronal fricative, characteristic of a group of Indo-European languages including English, are analysed on the basis that the leftmost element is adjoined directly to the syllable. To account for cases such as *paint, waist, sold, wound,* noting that "dental/alveolar appears to be the unmarked point of articulation for consonants." (p.260), Kenstowicz suggests a rule adjoining a [+Coronal, +Anterior] obstruent on the right of the rime, similar to the rule adjoining /s/ on the left of the onset.

Assumptions here:

Both the onset and the syllable are needed: A) to define the exclusive involvement of the onset in parapraxic coronal harmony, by (3.71.b) and (5.16.b); B) to explain the prevalence of coda deletion over onset deletion, found only once by Chin and Dinnsen (1992) in their survey of 47 children with phonological disorders; C) to describe the symptomatology of stammering; D) for a uniform account of the prosody where this is taken to include stress. The category 'mora' may be reducible to the effect of a stage in rime formation. The issue here should be resolved separately.

The syllable dominates onset and rime. The rime, if it branches, dominates nucleus and coda. The notion of the rime itself – denied by the 'flat' theory of Noske (1993) is strongly motivated by the different treatment of rime and onset consonants in early phonology.[64] Flat theories of the syllable make it hard to describe the clinical evidence of a diagnostic contrast between coda deletion (common) and onset deletion (rare).

Developing the idea in (5.27), all branching (in phonology as well as in syntax) is maximally-binary.

Empty nuclei, dummy consonants, adjunction, branchedness, reduplication, degrees of free ordering, and the syllabic adjunction of particular onset/coda elements, occur as parameterised options, some of these raising issues to be

[64] Experimental evidence for the psychological reality of the rime has been produced by Treiman (1983), using novel word games. She found no distributional evidence for any dependency relation involving onset and nucleus ('peak' in Treiman's terminology), but strong evidence for the coherence of the onset. This conclusion is consistent with traditional poetics and children's rhymes.

discussed in Chapter 7.

b) Projections:

Are these underlying in the case of the nucleus? (See Archangeli, 1984). Are these irreversible in the derivation as in GP? (See Kaye et al, 1990). Are these possibly ambi-syllabic and/or open to re-syllabification, onto a coda at one point and onto an onset at a later point? Forcibly, if there is no syllable, there is no ambi-syllabicity or re-syllabification. Re-syllabification is dismissed by GP, but assumed in under-specification models such as that of Kiparsky (1995).

Assumptions here:

At least in typologically unmarked cases, the nucleus is underlyingly projected onto the syllabic tier. Projections are not forcibly implemented, contra GP.

There is both ambi-syllabicity and re-syllabification.

c) Rules or a template?

Is prosodic structure built, as in the work of Steriade (1982), Levin (1985), Kiparsky, (1993 and 1995) or as templates applying on one or more levels, as in the work of Halle and Vergnaud (1980), Selkirk (1982), Ito (1986, 1989)? The mora is usually seen as a template. If prosodic structure is templatic, and the template is language-specific, as it obviously has to be, and if there is any variation by rule, the learnability space is doubled. Noske's 1993 idea of 'true constituents' (functioning rather like autosegments) is pitched as an alternative to both rules and templates.

Assumption here:

For the sake of a minimal and consistently-defined learnability space, all prosodic structure is built, apart from underlyingly specified projections involving the syllable or the rime.

d) Licensing

Is licensing 'bottom-up', as in the prosodic licensing and stray erasure of Ito (1986), or 'top-down', as in the autosegmental licensing of Goldsmith (1990)?

Assumption here:

By a hypothesis to be developed in Chapter 7, the notion of licensing is either unnecessary or it is simultaneously top-down and bottom-up. Parameters are defined on both geometrical elements and their projections.

e) Definition

Should a category, known as, or equivalent to, the syllable be defined as an entity composed of subordinate units with a peak of sonority in the middle, declining in steps of a certain minimal size on each side? (See Selkirk, 1984). Or does it express one or more degrees of grammatical headedness, an irreducible effect of the asymmetry of headship/dependency relations? (See Anderson and Ewen, 1987, Durand, 1990, for a DP perspective on this). Is the category part of the interface or part of UG. See Goldsmith (1990) for a discussion of the issues here. Alternatively, can sonority be derived from the geometry? (see Rice, 1995).

Assumptions here:

The syllable has a sonority gradience for reasons associated with the perceptual aspect of the A/P interface. But as a parameterised category, the asymmetry between the onset and the rime is typical of linguistic categories generally.

Sonority is part of acoustics. The feature-geometry is an adaptive exploitation of particular anatomical and physiological structures.

f) Syllables and stress

Halle and Idsardi (1995) assume that stress and syllabification are on separate tiers. But if there is no language with elements of a syllable having separate foot level projections, Halle and Idsardi's assumption looks weak. Its main justification is that their formalism does not refer to syllabic elements. It remains possible that their formalism could be recast to overcome this problem.

Assumption here

Stress, foot structure, and syllabification are aspects of a single prosodic tier.

g) Labeling and the form of definition

Assumption here:

Given the principles of markedness and maximally-binary branchedness and at least one point of reference, the labeling of constituents is formally unnecessary. In discussion here reference is made to categories such as the onset, the rime, the coda, and so on. But given suitable principles of interpretation and an acoustic characterisation of the syllable, these are recoverable. On this basis, the R-Inspection is independent from the grammar. But the issues at stake here are beyond the scope of this study.

The assumptions in (5.38) cannot be justified in detail – each one being potentially the topic of a study in itself. They are justified collectively to the extent that they are all embodied in the hypothesis to be developed in Chapters 6 and 7.

The assumptions in (5.38) define the learnability space. English is more 'permissive' than the Romance languages in allowing branchedness throughout, with adjunction on both edges of the syllable, an optional coda with one or two elements, and syllabic coronal sonorants. But other aspects of syllabification in English are relatively unmarked.

Obviously the notion of 'projection' is rather different from the notion of association by convention. The latter is assumed in early versions of geometrical theory, and greatly developed in subsequent versions. The notion of projection is supported by the under-specification model to be considered in more detail in Chapter 6 below.

A model, as defined by the assumptions in (5.38), might be challenged on the basis of the data in (5.39). They all seem to involve more than binary branching in structures where the adjunction idea from Kenstowicz (1994) cannot be applied.

(5.39) *Evidence for three-way branchedness – challenging the assumptions here*

a) The treatment of affricates is sometimes dichotomous. In the English onset, an affricate in the onset seems to block any other element, but not in the coda. Relevant examples include *range, launch, bilge, filch,* and *finch.* The onset restriction can be explained by treating affricates geometrically – with a branching at a given level in the structure (see more discussion below). But there is a dichotomy if the 'reading' of geometrical elements proceeds independently in the onset and the coda, in the latter allowing surface structures with three root elements.

b) In many dialects of English (those characterised as 'g-drop' in Chapter 1), with a notionally underlying /g/ dropped in the roots *long* and *strong,* and preserved in *longer* and *stronger,* in the special cases of *length* and *strength* there is a superficial voiceless stop, effectively a release gesture, between the nasal and the fricative. This mirrors the case of *mince* as a near homophone of *mints,* both realised approximately as [mɪnts] but with a phonetically measurable difference in the length of the occlusion, at least for some speakers. The same problem arises in respect of *length* and *strength* in 'g-preserving' dialects where the underlying dorsality is present throughout the derivation.

c) A number of mono-morphemic cases including *next, text, sphinx, lynx, glimpse* and *tempt,* suggest to some authors, such as Kenstowicz (1994), the need to permit three-way branching in the coda, at least in principle.

Dismissing the notion of a three way branching in the rime, it is proposed here that the cases in (5.39.c) have possible analyses in (5.40). Each of these analyses has major theoretical implications, which can only be loosely sketched here.

(5.40) *Possible ways of dismissing some counter-evidence*

a) In the special cases of *glimpse* and *tempt,* the orthography is misleading. The stop is epenthetic, predictable from UR's expressing forms such as /glɪms/ and /tɛmt/, where the [p] is derived by general conditions, i.e. with no underlying representation.

b) In the case of English coda /ks/, the voiceless coronal obstruents /s/ and /t/ in *next, text, linx,* etc., adjoin to the rime.

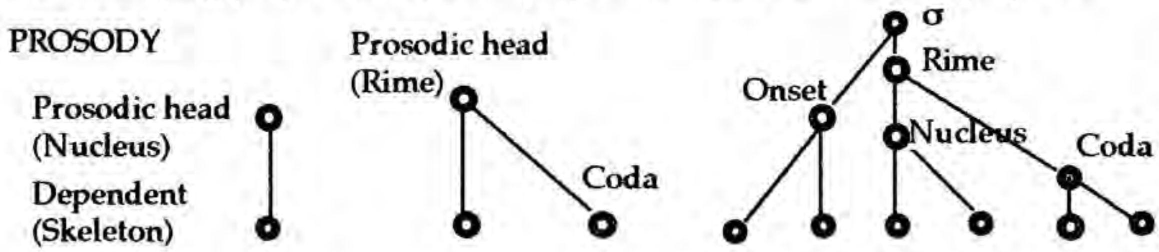
c) Cases such as *warmth, length* and *strength* are underlyingly bi-morphemic, perhaps nominalised in the lexicon – with implications for the theory of morpho-phonology.

The terms of (5.40) preserve the principle of maximally-binary branching. But the questions they raise go beyond this study. Accordingly they are left open. For reasons which will become apparent in the next two Chapters (similar to those which have emerged in syntax), it is assumed here that three-way branchedness should be treated as impossible in theory.

Without prejudging the issue of parameterisation, leaving open the sequence of structure-building, the syllabic assumptions here are sketched diagrammatically in (5.42). Here the labeling is for reference, not as a matter of definition.

(5.41) *A binary-branching theory of syllabicity*

a) Underlying projection b) Rime projection c) Full constituent projection



By (5.41.a) syllabic projection is underlying, typically in vowels, but also in parametrically-specified ways in other classes of segment – in both English and German, in sonorants. But in Semitic languages, there may be UR's with no nuclear elements. An intermediate level of rime projection is shown in (5.41.b), and full syllabification in (5.41.c). It is assumed here that the steps in (5.41) involve a series of language-specific interactions with the rest of the phonology. I postpone until Chapter 7 all consideration of how this might be parameterised.

With some of the properties of a DP dependency tree, the (5.41.c) model A) defines a coda, B) is maximally-binary branching, and C) is organised in such a way that the onset and the coda can be distinguished in purely formal terms.

In relation to the labeling issue in (5.38.g), the issue is by whether a given element is dominated by at most one branching node, A, such that A is itself dominated by at most one other branching node A'. This condition is met in the case of the onset, but not in the case of the coda. Given (5.41) the separate roles of the onset and coda can be re-analysed in terms of projection and a projection limit.

The power of this model is illustrated in (5.42) with respect to *tune* and *twin* in dialects like the author's, showing the prosodic head (conventionally) as σ, and ignoring aspects of the representation not relevant to the point at issue. In such dialects, *tune* rimes with *dune*, but not with *goon*. By (5.42), the length of the vowel in *tune* is specified, not geometrically, as permitted by (5.41), but featurally. In Chapter 7, I shall explore the possibility that this is a parameterised property of vowel length in English.

(5.42) *Underlyingrepresentations – tune and twin*

PROSODY			σ				σ	
SKELETON	X	X	X	X	X	X	X	X
ROOT	t	j	V	n	t	w	ι	n
GRAVITY (Dorsal) [Height, backness, etc.]		o				o	o	

The two glides are defined as such by the underlying representation of vocalic features at least equivalent to those defining height and backness, dependents of the unmarked exponent of the GRAVITY node. But their different roles in the syllable are defined by the fact that in the one case, the quality of the vowel is built derivationally. The corresponding SBR's are given informally here because of doubts about the proper expression of vocalic features (irrelevant here). The evidence here does not bear on the ordering of the SBR's except that (5.43.b) must follow (5.43.a).

(5.43) *Some projection rules – informally stated – in American/Greater-London English*

a) A high, front GRAVITY dependent e projects onto a bare nucleus.

b) A right sister of e is high, round, peripheral, and projects onto the nucleus.

c) A back, round GRAVITY dependent projects onto the onset.

A maximally-binary branching model of the syllable thus permits a parsimonious statement of syllabically conditioned alphabet formation rules.

Where the input contains evidence of what might be construed as ternary branching, this may be open to mis-analysis. The learnability criterion in (5.24) notwithstanding, in Chapter 7 I shall consider the possibility of a pay-off in terms of representational simplicity at Stage $_{n}$.

5.2.2 Two views of the syllable in child phonology

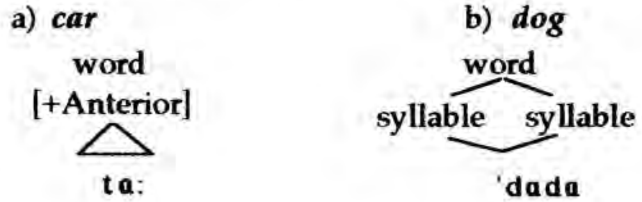
This Section focuses on proposals by Spencer (1986) and Iverson and Wheeler (1987).

Spencer (1986) uses a syllabic template and Macken's 1980 perceptual filter to address the mismatch between children's phonological discrimination and their relatively poor production. He proposes that: A) the child's system provides less than the minimal information for maintaining the full set of phonemic contrasts; B) the syllabic template is under-developed; C) the output forms are derived from a distinct lexicon. Spencer's notion of a 'despecified matrix' as the basis of 'Output Underlying representations' – OPUR's – makes it possible to translate Smith's 1973 system of more than twenty ordered rules into a non-linear framework. But Spencer retains Smith's idea of deriving the child's output from a formally distinct UR.

In this study, following Spencer, the child's ability to parse and properly analyse the input is not presupposed. This is indeed part of the learnability task. But four aspects of Spencer's model are not accepted here. FIRST, by (5.38.c) and on the reasoning of Section 2.4.1, I assume that child phonology is not accountable by a reduced syllabic template. SECOND, the notion of a distinct lexicon for the L1 learner's output seems unwarrantable. For the sake of what it is said to explain, this idea, now abandoned by its originator (see Menn and Matthei, 1992), is too powerful. THIRD, Spencer's model predicts spreading in unbounded domains, i.e. *hippopotamus* not just as the prevalent [hɪtəˈpɒtəməs], but as the rare [hɪtəˈpɒtənəs], and the unattested ◆[hɪtəˈtɒtənəs]. This over-generates, and fails on descriptive grounds. FOURTH, the notion of a distinct output lexicon is hard to reconcile with Pinker's 1984 Continuity Criterion, quoted in Section 1.4.2.

Following an approach originally due to Waterson (1971), Iverson and Wheeler (1987) suggest that particular constellations of features are associated, at a given stage of phonological development, with "certain suprasegmental constituents (rhymes, syllables, words, etc)" (p.248) rather than particular 'slots'. This is an "incorrect hypothesis" about representations; it leads to both harmony and reduplication. There is no derivational relation between the child's UR and the production form. "The hierarchical structures which are associated with the child's output representations may then be viewed as well-formedness templates which characterise, and filter, the set of admissible words in the child's language" (pp. 248 – 9).

(5.44) *Prosodic coronalisation and reduplication* (Iverson and Wheeler, 1987)



On the analysis implicit in (5.44.a), in this untypical, coronalising idiolect, the SPE articulatory feature [+Anterior] is projected onto the category, Word, incorporating the insight in (5.45).

(5.45) "One of the things a child learning a language such as English has to discover then is that features like [Voice], [Anterior], [Nasal] etc. are not properties of words, syllables or other supra-segmental constituents." (Iverson and Wheeler, 1987, p.249)

The broad thrust of (5.45) is adopted here; features can be 'projected too high' in the structure. The problem is that this predicts too much: how does a phonological system which is incompetent in the (large) sense that the projection of all features is indeterminate generate a correct left-to-right ordering of onset and nucleus? By (5.45) the speaker of (5.44) ought to be jumbling onsets and vowels.

The predictive excess is revealed in the following remark.

(5.46) "Since one of the most basic tenets of autosegmental theories of phonology is that association lines may not cross, reduplication will not be possible without violating this constraint once the child posits internal structure for syllables..." (Iverson and Wheeler, 1987, p.255).

Counter-exemplifying (5.46), in the incomprehensible idiolect of XZ there were both post-nuclear consonants *and* reduplication (see Appendix 3 for a fuller, developmental account of aspects of XZ's phonology relating to the discussion here).

(5.47) *Syllabic and segmental harmony in XZ aged 4.0*

a)	*caterpillar*	'gætəbɪbɪ	*chocolate*	'tʃɒtʃɒk	*donkey*	'dɒdɒŋ
	plastic	'plæplæk	*Christmas*	'tʃɪntʃɪn	*picture*	'pɪbɪtʃ
	umbrella	'bɛbɛ				
b)	*finger*	'hɪjɪŋ	*fussy*	'hʌvʌs	*sausages*	'hɒwɒʃ
	soldier	'həʊwʊv	*scissors*	'hi:jəz		
c)	*button*	'bʌbən	*monkey*	'mʌmɪ	*cardigan*	'kɑ:gɛŋ
	porcupine	'pɔbəʔaɪ	*Burlington*	'bə:bɪɪŋk	*bottle*	'bɒbəʊ

In (5.47.a) there is reduplication; in (5.47.b) there is glottalisation of voiceless fricatives in the stressed onset, with vowel reduplication in 3 cases and surface friction in 4 cases; in (5.47.c) there is both labial and dorsal harmony; but in all cases, in (5.47.a), (5.47.b), and (5.47.c), there is evidence of internal syllabic structure, falsifying (5.46).

Here I shall incorporate the idea from Iverson and Wheeler of an improper relation between the feature-structure and the syllabification and from Spencer the idea of an incompetent parser – with some errors reflecting a non-adult-like lexicalisation.

5.2.3 Evidence of incompetence

In Section 5.2.3, I relate some parapraxic evidenceto the claims in Section 5.2.2.

On the basis of simple and intuitive SBR's, it is now possible to simplify the account of the coalescence in *smoke* and *spoon* as [ɾəʊk] and [ɾu:n] in (5.22). It is not necessary to postulate a constraint on nasal fricatives or to account for the fact that [ɾəʊk] is superficially voiceless – always by the observation of Chin and Dinnsen (1992) and by that of this author. In such idiolects, the continuance and labiality are projected, not onto root nodes, themselves projected onto the onset, but onto the onset directly. Following Rice and Avery (1991), an AIRFLOW node is postulated as the head of continuance. I shall consider its place in the feature-geometry in Section 5.3. On this basis, the structure-building can be characterised as in (5.48).

(5.48) *Coalescence in what surfaces as a mono-segmental fricative onset*

Where, if a skeleton node e projects to the onset, e = e

a) [m] ⇒ [Cont] / Onset [AIRFLOW __] • MNAR

b) [m] ⇒ [Lab] / Onset [GRAVITY __] • MNAR

In relation to the voicelessness, two further steps are postulated, the first inserting a Laryngeal node, the second interpreting it as voiceless by default in the case of an obstruent.

Now take a set of cases reflecting lesser densities of parapraxis, all involving liquids, A) context-free /ɪ/ to [w], often characterised as 'gliding', and B) the harmonic cases of *yellow, ruler* and *lorry,* as ['lɛləʊ], ['lu:lə], and ['lɒlɩ], and *Jerusalem*, typically with the loss of /ɪ/ in the stressed syllable.[65] Note that in Greater-London English there is no evidence of /ɪ/ outside the onset. Phonetically and phonologically it patterns with /w/. In the framework here, glides have no underlying specification as sonorants, this being derivable from the fact that they are defined on vocalic features. An SBR inserts a CAVITY node wherever there is a GRAVITY dependent. In the case of vowels and semivowels, this allows the UR's in (5.49).

(5.49) Three semivocalic UR's

a)	/j/	GRAVITY [__]
b)	/w/	GRAVITY [+Back, +Round]
c)	/ɪ/	GRAVITY [+Round]

In such dialects, if an underlyingly semi-vocalic /ɪ/ has any surface retroflexion or concavity, it must get it derivationally. This requires an SBR entering the property just in the case of roundness and non-backness, the latter by default.

[65] This is ignoring the case of *yellow* as ['jɛjəʊ] where there is a context free substitution of /j/ for /l/, a situation encountered once by this author, in contrast to the more common context-free substitution of /l/ for /j/, both processes being irrelevant in the context of intersegmental relations.

(5.50) SBR's differentiating the glides

i) [Ø] ⇒ [–Back] / [GRAVITY __] DER

ii) [Ø] ⇒ CONCAVITY / [+Round] [–Back][__] DER

But in the clearest case of parapraxis, at Smith's 1973 Stage 1, /ɪ/ and /w/ are neutralised. One way of accounting for this in the framework here is to say that such speakers represent only the roundness. If this applies to the input, as by (1.1), they will be unable to ditinguish *rail* and *whale*. Such speakers can treat the non-backness of /j/ as a default consquence of non-roundness, and backness as a default consequence of roundness. These steps of structure-building apply late.

From the uncertainty in the literature about the age at which /ɪ/ is mastered (see Section 1.1), and from the observation of the two adults in the experimentation here, there is phonetic variation from /w/ to /ɪ/ both within and between idiolects. In the framework here, one way of characterising this sort of intermediate case, transcribed here as <ɪ/ w>, is by the representations in (5.49) and the omission of (5.50.ii). This may be appropriate in the case of adults with a persisting speech defect of this sort. But this does not account for those cases where, harmonically at least, the neutralisation seems to be complete. Spencer (1986) proposes the lateral spreading in (5.51).

(5.51) *Lateral harmony by spreading* – from Spencer (1986)

Here, disregarding the rest of the structure (including the head onto which the spreading occurs) to account for the asymmetry, it might be claimed that only laterality can spread. But this is stipulative, and it makes the non-prevalent cases of *Jerusalem* as [dʒə'ru:ʃələm] or [dʒə'ru:sərəm] hard to explain. A non-stipulative way of accounting for the prevalent case of lateral harmony at least is to say that the sonorance is underlyingly specified, associated early by virtue of the markedness, by (5.33.b.a), and having the effect of blocking the SBR in (5.51.i) Accordingly, this applies only in those cases where there is no /l/ in the structure.

In (5.52) there are two degrees of qualification, the more general one applying for the majority of incompetent speakers, a narrower, foot-level restriction applying in idiolects with /ɪ/ as a harmonic trigger, but only in *Jerusalem*, not *ruler* or *lorry*.

(5.52) In structures containing no underlying CAVITY node in the foot/stress domain, in a round onset, a CAVITY node is inserted.

In idiolects with a representation limit like (5.52), the alphabet formation in the glide onset cannot proceed. This triggers the association of the other sonorant.

In this Section, I have shown that many diverse, but commonly-observed aspects of parapraxis across a wide range of thresholds can be explained by the interaction between syllabic projection and feature specification.

5.3 (Non)-continuance, stridency, and sibilance

Section 5.3 extends the notion of an under-specified feature-geometry to take account of continuance, non-continuance, stridency, sibilance and the class of obstruents in which these occur together, namely affricates. Lombardi (1990) notes that affricatehood does not spread. But in parapraxis we find 'harmony' or 'migration' in *digital* as [ˈdɪdʒɪtʃəl] or [ˈdɪdɪtʃəl], *aspidistra* as [æspəˈdʒɪstrə], *soldier* as [ˈtʃəʊldə], etc., and other more disordered cases. The problem is that on our assumptions here, it is not permissible to enrich a theoretical model to characterise incompetence. We need to describe the harmony / migration as an aspect of incompetence. But this is prohibited in a competent phonology. How can we define the process other than by the spreading of affricatehood?

Affricates have three definitional properties. They are A) continuant and non-continuant on the right and left edges respectively; B) phonologically with the same articulator, though there may be some phonetic adjustment between the edges e.g. German / p f/ and English / tʃ /; C) with a single value for voicing. They also have a general phonotactic property of weight, tending not to cluster with other segments, not at all in Greek, only in the coda in English, German and Russian, and where cases such as Polish represent an uncommon exception.

Levin (1985) analyses affricates in terms of a branched structure projected onto a node on a 'higher' tier. This is developed further by Sagey (1986) and Lombardi (1990). Some of the best arguments for this approach are based on typology, where there is a split between languages without affricates, languages with affricates, and languages with different sorts of affricate. Roca (1994) upholds this view: affricates are defined on underlying branchedness; the root dominates both values of a binary feature defining continuance.

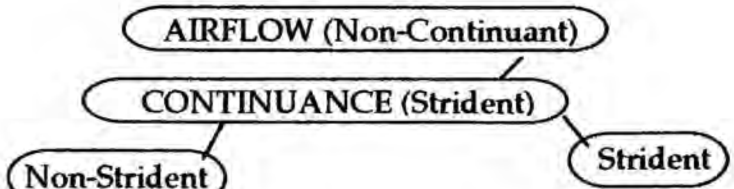
As noted by Hualde (1991), if autosegmental theory underpins a branching relation in affricates with continuant and noncontinuant dependents of a given head, a monovalent model of the Rice and Avery type implies two roots, one unmarked, the other with the marked value for continuance. But formally there is no way for the representation to contain both the marked and the default value. And this gives no geometrical explanation for the fact that there is only one featural difference between the branches. One way of capturing this is by a redundancy rule entering a default non-continuance into a left-branching root node. But this loses the insight of a distinctive geometrical property of affricates in terms of branchedness. In the context of maximally-binary branchedness, it is necessary to ask two questions: A) Where is it in the structure? B) What are its properties? Unless the branching is at the root, the phonotactic equivalence to clusters is hard to understand. But if it is, we may then have to sacrifice the principle of maximally-binary branchedness.

Rubach (1994) argues that affricates are strident stops, in a sense echoing Hualde's 1991 idea of the fricative as the dominant branch of the affricate.

Putting on one side the question of how to define the directionality with the stop on the left (see Sagey, 1986, Lombardi, 1990, Kenstowicz, 1994), let us try to reconcile Rubach's featural analysis with an under-specified feature-geometry. In English with only a voicing contrast between two affricates, there is no need for any underlying representation of the articulator, but just of the voicing and the affrication, the rest of the structure being defined by alphabet formation,

Let us adopt from Rice and Avery (1991) the idea that the head of continuance should be characterised as the AIRFLOW node. By principles common to SPE and the marked, privative geometry of Rice and Avery (1991) and (1995), the least marked consonant is a stop. In the model of Rice (1993), AIRFLOW comprises a distinct sub-hierarchy, as an immediate dependent of the ROOT. But to express the phonotactic constraint on affricates in the onset – to the effect that they do not cluster – it might seem that AIRFLOW must be an immediate dependent of the skeleton in consonants, unmarkedly as a stop, markedly as a fricative or continuant. By (5.37.a), a true consonant is a segment with no GRAVITY dependent. The default interpretation of continuance as a head is as stridency, strident by default, markedly non-strident, where the property is irrelevant other than in obstruents, characteristic only of fricatives. The corresponding sub-structure must be as sketched in (5.53).

(5.53) *AIRFLOW dependents*



Assuming maximally-binary branchedness by (5.27) and a unary root node, itself dependent on the skeleton node, as a root dominating Laryngeal and Supra-laryngeal dependents by (5.4), AIRFLOW must be the sister of the root. But this is incoherent. If the root has a sister which expresses part of the melody, it is not a root. One of our assumptions must be wrong. One solution is to qualify the constraint on branchedness by allowing that it only applies in respect of markedness. In the case of nodes constituting mutually exclusive parts of the vocal tract, both involved in every aspect of the phonetic surface, there is no markedness relation. This allows(5.54).

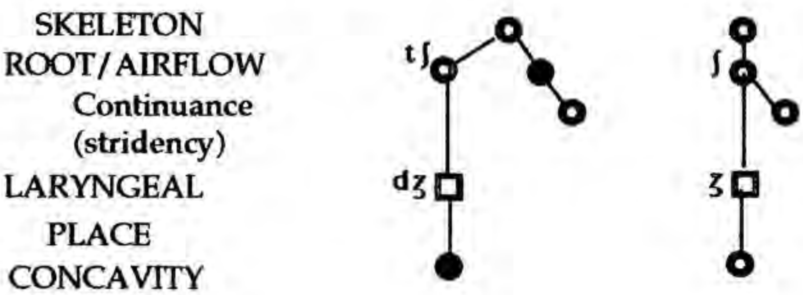
(5.54) Two claims: one geometrical, one theoretical.

a) AIRFLOW is at the ROOT, where the same node expresses the LARYNGEAL/ SUPRA-LARYNGEAL dichotomy. Markedness is involved only in the former, and only in the case of segments with no terminal dependents of PLACE, i.e. obstruents.

b) Where the featural geometry encodes a potential markedness relation, branching is maximally-binary.

On the basis of (5.53) and (5.54), one contrast in English is modeled in (5.55) – underlying properties shown non-solid, the marked case square, and derivationally built structure solid.

(5.55) *Affricate and bare sibilant*



In the affricates, the structure-building always involves a continuant interpretation of AIRFLOW, and grooving or non-apicality.[66]

[66] If surface affricates are built out of representations like (5.56), in dialects of Russian with more than one non-apical affricate, /tʃ/and /ʃtʃ/, the distinction needs to be encoded. On Halle's 1959 analysis /ʃtʃ/ is a sequence of /ʃ/ and /tʃ/. This loses sight of three things in Russian: A) affricates do not cluster in the onset; B) only /ʃtʃ/ clusters in the coda – as with /r/ in /borʃtʃ/; C) there is no phonemic equivalent to /sts/. In the framework here, one way of encoding this distinction might be in terms of the presence or absence of an underlying continuant node. But this and the issue of complex consonants and consonant clusters in Polish go beyond this study.

On the analysis here, affricates are the only segments with, underlyingly, both a root node and a (marked) root specification. As segments, affricates of any sort are marked. Fricatives have the underlyingly specified, and therefore marked, property of continuance. Unmarkedly, this is expressed as stridence. Stops have the corresponding head inserted at a late stage in structure-building. Affricates are 'read' as branched structures with both sorts of element – thus.

(5.56) *Affricate structure-building – in competent phonology – first stage*

i) m ⇒ CONTINUANT / [AIRFLOW __] MNAR

ii) [Ø] ⇒ [AIRFLOW] / [__, CONTINUANT] DER

(5.56) interprets the head of a marked sister of AIRFLOW as a second case of the same node. Subsequent rules, in (5.57), interpret the marked continuous case on the right edge as strident, and the unmarked case on the left edge of the structure, as the non-continuant gesture of occlusion.

(5.57) *Affricate structure-building – in competent phonology – second stage*

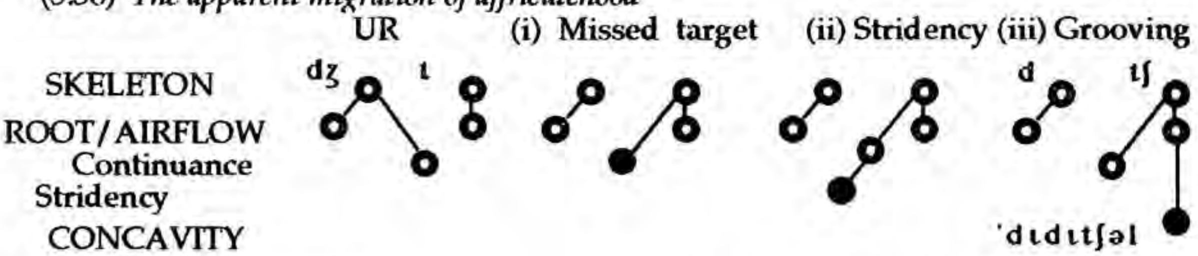
i) [Ø] ⇒ [Strident] / [CONTINUANT __] DER

ii) [Ø] ⇒ [Non-continuant] / [AIRFLOW __] DER

Subsequent steps, by default in English, insert CONCAVITY as a head and the exponence as a non-apical, laminal tongue gesture on the right edge.[67]

By (5.15) auto-segmental operations involve a continuous hierarchical sub-string. If A) the geometry is supplemented by structure-building; B) affricatehood is expressed by geometrical branchedness and featural stridency, *digital* as [ˈdɪdɪtʃəl] involves melodic structure-building in the wrong slot. In (5.58) the assignment of branchedness – by (5.57.ii) – applies in the final onset, in what is characterised as a 'missed target'. Then stridency and laminality are wrongly assigned by default. Not defining any of the singularity / context-sensitivity, the rest of the structure is omitted.

(5.58) *The apparent migration of affricatehood*



[67] For some speakers of English, seemingly with full phonetic competence, the property of tongue-grooving is impossible. A given phonetic result can be achieved in more than one way.

(5.58) does not describe the spreading of affrication, but a step of alphabet formation in the wrong position, as an instance of parapraxis. But what about the context-sensitivity? The critical step is the missing of the target in (5.56.ii). Taking account of the fact that the migration in (5.58) alternates, probably trivially, with a harmony, one condition in (5.59) is bracketed.

(5.59) *Affricate structure-building – in parapraxis – first stage*

In any unstressed onset (outside the foot)

[Ø] ⇒ [AIRFLOW] / [AIRFLOW, __ m] DER

In *aspidistra*, as [æspɪ'dʒɪstə] and in *soldier* as ['ʃəuɫdə], the building of concavity and non-apicality is only in a singleton onset. In both of these cases it is possible to define a singleton segment as an element such that there is no other element with the same immediate prosodic projection. In *aspidistra* as [æspɪ'dʒɪstrə], the structure building is in the foot, i.e. more freely, rather than less.

In Section 5.3, by amending the constraint on maximally binary-branching I have been able to define the otherwise puzzling cases of affricate harmony and migration without raising the problem that this, like a number of other aspects of parapraxis, does not occur in competent phonology.

5.4 Conclusion: the typology of speech errors

The model here and that of Halle (1995) have in common the idea that aspects of geometrical-feature headship are language-specific. For instance, one Coronal dependent is CONCAVITY, heading two different sorts of 'non-apicality', each defined on a different sort of muscular action, involving different sets of fibres, differentiating the sibilants by one of its values, defining retroflexed rhotics by the other. In a phonology without non-apical sibilants or retroflexion, CONCAVITY is redundant.

By a development of the marked, but exclusively monovalent framework of Rice and Avery (1991) and (1995), taking the geometry itself to provide the basis for 'under-specification' of a particular sort (what Kiparsky (1995) calls 'intrinsic under-specification'), I have developed a consistent and unified account of various 'processes', both context-sensitive and 'context-free'. I have shown that a context-sensitively marked feature-geometry illuminates both low and high threshold aspects of parapraxis, including both fronting and the case of affricate migration/harmony. And I have been able to justify the idea from Chapter 2 that the articulators are associated in a particular sequence, Labial, Dorsal and Coronal. Crucial to this is the idea, first associated with the work of Pulleyblank (1986), that association is by rule, i.e. learned. Given that I am postulating developmental limits on association, I can explain a degree of alternation, say between harmony and metathesis. And it is clear why parapraxic harmony tends to 'favour' a single target. If the association was effectively free, the notion of a limit would be obviously quite inappropriate.

In all the cases where Labial floats, there is vocalic roundness in the syllable of the target, the trigger, or both. Standard autosegmental theory does not allow more than one trigger. The case of parapraxis does not justify a weakening of autosegmental theory. What is floating, the labiality or the roundness? In a derivational model, the building of labiality is repeated in the rightmost onset just in those cases where there is roundness in the target rime. It is worth noting that this relation between vocalic sensitivity and labial harmony is just what we might expect if, as I have argued in Chapter 5, Labial is associated early, but after the nucleus

This reverses previous approaches, such as that of Goldsmith (1976), with association by convention from left to right (see Yip, 1989, for some critical discussion of this idea, where she points out cases where association seems to be from right to left or even from the 'edges-in').

The idea of association by rule poses a learnability issue. While this increases the descriptive power of the geometry, I shall, in Chapter 7, consider a way of possibly eliminating the category 'rule' in favour of a uniform learnability space.

By a marked, hierarchical geometry, we can now distinguish between four sorts of association error, all parapraxic, each with a range of functional effects:

(5.61) A given element or set of elements is

a) Not associated at all, with the effect of deletion or realignment
in *archeopterix* as [a:kɪˈɒptərɪs], *monopoly* as [ˈnopəlɪ], *Geronimo* as [ˈdʒonɪməʊ].

b) Not associated in full, with the effect of harmony or disharmony
in *archeopterix* and *hippopotamus* with just the PLACE node surfacing, defaulting to coronality as [a:tɪˈɒptərɪks] and [hɪtəˈpɒtəməs], without the markedness as an unmarked GRAVITY node in *monopoly* as [məˈnokəlɪ], with a stop implemented by a bare glottal gesture in *archeopterix* as [a:kɪˈɒʔtərɪʔs], with a fricative implemented only as a timing slot in *asbestos* as [æ:ˈbɛstɒs], with only the syllabic onset of a degenerate foot implemented in *Geronimo* as [dʒˈmonɪməʊ].

c) Floated, associated in the wrong position, with the effect of harmony, migration, metathesis, or reduplication
with a GRAVITY exponent floating to the right edge in *hospital* as [ˈhɒstɪpʊ], *asbestos* as [æsˈbɛstɒf], and *magnet* as [ˈmægnɪk], with the affrication moving in the same way in *digital* as [ˈdɪdɪtʃəl], with sibilant properties moving into the stressed syllable onset in *spaghetti* as [bəˈskɛtɪ] and *soldier* as [ˈʃəʊldə], with the effect of copying in *budgeriar* as [ˈbʌdʒərɪga:d].

d) Association of a contrastive element, with the effect of disharmony, partially in *monopoly* as [məˈnok pəlɪ], completely in [məˈnokəlɪ].

In all of these cases the environment is defined on particular interactions between melodic and prosodic structure.

None of the different failures of association are treated here as a generative step. By an R-Inspection, at any stage of phonological development, any word or words may be judged as being 'hard to represent' – with a degree of variability in the outcome. To the extent that this may apply to the input, this may lead to incorrect lexicalisation. This addresses Grunwell's problem to the extent that it reflects a strictly positive view of phonological acquisition; it does not attribute to the incompetent speaker something which is not part of competent phonology.

In the framework here, the patterns in (5.61) are definable by the R–Inspection taking account of a particular, interacting set of properties.

(5.62) The R Inspection is particularly sensitive to

a) Extremes of derivational length, involving roundness or labiality on the one hand and late default specifications on the other

b) Minimal degrees of melodic contrast between elements with matching syllabifications;

c) Branchedness of prosodic constituents including skeleton nodes, i.e. affricates, syllabic constituents, i.e. clusters, and rimes, i.e. codas, and metrical structure such as the feet.

All three terms of (5.62) are sensitive to the complex metrical structures of long words – but unevenly, hence the asymmetry of parapraxis and the case of singularities. By (5.62.a), there is an effect due to the fact that every coronal entails a late specification for the tongue musculature, and every nasal entails late default specifications for the open velo-pharyngeal sphincter and the oral closure, while the labiality of **/m/** is early. By (5.62.b), in crocodile, at least partly by virtue of the difference of voicing between the **/k/** and the **/d/**, the structure is easier than *cardigan*, as shown by the much smaller rate of errors (see Chapter 3). By all three terms in (5.62), not part of the grammar but part of the interface, it is possible to make progress towards a definition of the special difficulty of words like *Geronimo, Jerusalem*, and *monopoly*.

By the interaction between the feature geometry and structure building, it is possible to give an account of what seem like 'multiple triggers'.

I have made some progress, but not on the following points.

(5.63) An explanatory gap

a) The combinatorix of (5.62) is too sweeping.

b) Why is the R-Inspection biased in the way set out in (3.71) and (5.16)?

c) The mere *absence* of structure does not explain the role of non-continuance.[68]

d) What sense can be made of the notion of a lowermost threshold for metathesis and coronal harmony?

e) How can Coronal, associated late in the derivation, occasion harmony or any other process involving Labiality or Dorsal, associated earlier?

I shall address these points in Chapters 6 and 7, in the last proposing some hypotheses for future research.

[68] From a different point of view to the one adopted here, Mohannan (1993) draws attention to the characteristic role of obstruents, stops in particular, in such processes.

6 Derivation, context-sensitivity, phonetic detail

At various points, I have suggested that aspects of the data here are hard to see other than in derivational terms, e.g. *cardigan* as ['kaːdɪntən], as in some sense derived from an intermediate ['kaːdɪdən] form. In Chapter 2, I described AC's and LM's highly disordered phonologies, both with various interacting sorts of articulator harmony, in terms of a common derivational sequence, in LM's case, in a way that involved ccyclicity. In Chapter 5, I focused on melodic aspects of parapraxis. And I developed the notion of a marked hierarchical feature geometry with some aspects of under-specification as part of the learnability-space (and so not reducible to the geometry, as in Rice and Avery's 1991/1995 model). In Chapter 6, I shall develop the idea that this under-specification is defined with reference to a set of prosodic domains, one being the word. Accordingly, I shall exemplify a number of forms of context-sensitive under-specification in English. From Section 5.2.3, I assume that in innovative English dialects /r/ is no longer an underlying liquid, but a glide, with the surface liquidity built derivationally – adding a CONCAVITY node, defining a non-apical or non-anterior articulation. The phonetic surface is mapped onto the underlying representations by processes which are often assimilatory. In /tɾ/ and /dɾ/ onsets, the affrication is non-gradient. In /tɾ/ onsets, the devoicing is gradient. Other cases involve lenition of one sort or another, as with coronal stops before syllabic sonorants in English. Here there are interactions between sonorants and obstruents which may seem to obscure the elements phonetically, but to identify them phonologically.

A number of proposals have drawn attention to the need for some degree of abstraction in feature exponence (Piggot, 1991 and 1996, Rice, 1993, Iverson and Salmon, 1995, van der Hulst, 1996). The issue here is one of learnability – particularly with respect to /r/ in English: How does the learner learn to relate a form to its UR?

The issues above interact with: A) projection and association; B) foot structure and word stress; C) phonetic detail, such as aspiration and gradient phenomena; D) the proper identification by the learner of the category 'Word'.

In relation to the last, it is necessary to determine: A) what characterises the phonological word in the target language; and B) which processes apply to it. It is necessary to consider the theoretical implications of learnability in a domain where both the projections and the projection target are part of the learnability-space. It appears that the only way of doing this is by assuming some interaction between the phonology and the morphology, as argued by a number of the contributors to Hargus and Kaisse (1993). The nature of this interaction is a matter of debate. But I shall assume here that there is such an interaction. Correspondingly, I shall take the principle of cyclicity to be one that is universally available in phonology, as in syntax.

With reference to the learnability input, it is appropriate to ask how the learner identifies the proper domain of structure-building. Indirectly this bears on dialect, diachronic change, and aspects of phonetic implementation.

I shall illustrate the issues in relation to the data here. But as in Chapter 5, because of the sheer scale of the issues, I can do no more than give just a summary indication of the approach I am adopting – as opposed to giving a full justification in each case.

Section 6.1 develops the idea of under-specification from Chapter 5. Section 6.2 sets out some models of of stress and cyclicity, and characterises the data here in a corresponding way. Section 6.3 considers one aspect of the learnability-space.

6.1 Lexical Phonology and non-derivational approaches

Section 6.1.outlines a number of current responses to the 'radical' under-specification of Archangeli (1984), contrasts non-derivational approaches and the framework known as 'Lexical Phonology', and suggests that the notion of 'extrinsic under-specification' from Kiparsky (1995) contributes to a descriptive account of parapraxis.

As noted by Archangeli (1984), harmonic asymmetries are predicted by her (then) version of under-specification, with underlyingly unspecified structure built on-line. I have shown that there are systematic asymmetries in children's errors, with labial and dorsal harmony prevailing in early child phonology and coronal harmony tending to prevail above and beyond a dactyllic threshold.

The notion of on-line structure-building is now associated particularly with Lexical Phonology. The *raison d'etre* of this approach is the set of interfaces between the lexicon and the phonetic surface – see Kiparsky (1993) and (1995), and Rubach (1995). In the work of both authors, a given property may be treated in different ways at different points in this process. This mirrors the effect of a 'cycle' in derivation, an idea that looms large in SPE, but was subsequently rejected, partly on grounds of learnability. But in Lexical Phonology, the cycle is defined on interfaces between different levels or strata, at least one lexicon-internal, at least one external to the lexicon or post-lexical. While the details of this are not relevant here, if there are levels, and if there are language-specific phenomena occurring on these levels, this evidently has to be learned

Since 1984, the theory of under-specification has gone in three directions.

(6.1) *Three updates on the RU of Archangeli (1984) with no underlying binary feature contrasts*

a) Steriade (1995) and others, e.g. Hualde (1991), put forward the idea of Contrastive Under-specification, according to which features are underspecified only to the extent that they involve no underlying contrast, as, for example, with respect to apicality in English stops. Steriade abandons binarity in featural representation in favour of exclusive monovalence.

b) The 'radical' 1984 version of under-specification theory has now been abandoned by its author on the basis of what she sees as counter-examples. Archangeli and Pulleyblank (1994) argue that monovalence is the unmarked case, an expression of general tendency, what the L1 learner expects to find. 'F elements', or features, are active or inert; either combining or being prohibited from doing so. In the default case they are underlyingly 'free', associated in the course of the derivation with respect to the morpheme, but subject to language-specific conditions of combination. The set of underlying F-elements can only be determined by inspecting their behaviour. The full combination of a set of n elements generates a set of 2^n representations. Conversely, a prohibition on combination allows n+1 representations. In contra-distinction to RU "the only formal constraints on F-element combination are Representational Simplicity and Recoverability" (p. 392). Archangeli and Pulleyblank argue that what they call 'combinatorial under-specification' is consistent with OT. In their final chapter, they propose that under-specification is a constraint which can be outranked.

c) Kiparsky (1985) emphasises the difference between the structure-preserving properties of the lexicon-internal phonology and the non-categorial, sometimes gradient, but regular 'sub-segmental' properties of the 'post-lexical' phonology. Indeed, he treats this gradience as a diagnostic of post-lexical application. Kiparsky (1993) suggests that by the very alternations involved, such phenomena provide telling learnability clues. This reverses the common stand that gradience is exclusive to phonetic implementation (see, for example, Sproat, 1993). In a way that bears directly on the issue of apparent gradience in parapraxis, as characterised here by forms such as [<r/w>], Kiparsky (1985) argues that phonetic detail is irreducible. Kiparsky (1993) proposes that under-specification is radical, but context-sensitive, that for a feature F, there is a universal default of the form $[\emptyset] \Rightarrow [\alpha F]$, which may be blocked or reversed in a language-specific, necessarily parametric way. The stopping of obstruents and the voicing of sonorants are perhaps the best two candidate cases. Kiparsky discusses a Finnish case where /t/ spirantises in derived environments before /i/, for example /tilaT+i/ as [tilasi]. He proposes that the process is triggered by a language-specific reversal of default non-continuance in the morphology. The spirantisation is limited by a second rule, ordered by the Elsewhere condition, stopping obstruents. The restriction to the derived environment does not need to be specified, but falls out from an ontological distinction, assumed by Kiparsky, between what I refer to here as 'lexicon-internal' and other levels of rule application, the latter ordered later by conceptual necessity.

Kiparsky's (6.1.c) model of context-sensitive or extrinsic under-specification limits the RU claim in (5.26) to a specified UR environment, characterised as X ___ X. Thus.

(6.2) $* \ -\alpha F$ in X ___ X

(6.2) avoids a critique of RU by Hualde (1991). Hualde's critique, invoking data from Basque morphology, was part of the motivation for Archangeli's perhaps premature abandonment of RU. In a way that is quite novel in the study of child phonology, (6.2) is adopted by Dinnsen and Chin (1995) to account for variability, as in cases where fronting does not apply across the board. Under-specification generally predicts asymmetries, as noted above, in a way not predicted in any other framework. (6.2) is adopted here. The learner 'expects' that as much as possible of the surface form is defined by default structure-building, and that UR's are correspondingly minimal. Phonological acquisition consists in the progressive amendment of these expectations in the light of experience. The way UR's map onto the phonetic surface is language-specific. The actual under-specification is part of the learnability-space.

Kiparsky's notion of gradience raises two questions: A) When and how does the learner determine that a partial or gradient degree of neutralisation is restricted to a set of levels? B) How does the learnability algorithm encompass two sorts of input? To answer these questions it is necessary to relate new insights concerning prosodic, autosegmental and subsegmental representation to those concerning the phonology / morphology interface, involving both gestural and metrical phonology.

6.2 Prosody, structure, level

Section 6.2 sets out some general considerations. Section 6.2.1 considers the distinction between association and projection. Section 6.2.2 considers views of stress, as expressed by foot structure, taking as examples various forms of parapraxis involving different articulators – by (3.71) and (5.16). Section 6.2.3 turns to the phonology / morphology relation and the learnability issue which this raises – how the child construes the category, 'Word'.

6.2.1 Association and projection

In (5.63.e), I noted the absurdity of defining coronal harmony in terms of the non-association of Dorsal and Labial in favour of a property which, on the analysis here, is associated after them both. The harmony seems to be 'looking forward'. Section 6.2.1 addresses this issue by distinguishing between association and projection.

Take the critical, but clear, case of *hippopotamus* as [hɪtəˈpɒtəməs]. Following Archangeli (1984), generalising from (5.37.b), I assume here that in the typologically unmarked case, the nucleus has an underlying syllabic projection.

Projection is a representation of the speaker's knowledge. It defines the sequences of association, as a necessary aspect of articulate speech. Since all structure has to be grammatically projected, there can be no association without projection. By the distinction between projection and association, and the notion of one strictly hierarchical prosodic structure, the principle of cyclicity comes cost-free.

6.2.2 Word stress

In Chapters 2 and 3, I showed how stress interacts with melodic factors to determine parapraxis over a wide range of competence. Section 6.2.2.1 introduces three current approaches to word stress. Section 6.2.2.2 relates the data here to a generalised parametric model.

6.2.2.1 Theoretical models of stress

Here I consider various approaches to word stress in the parametric feramework, all building on insights both from SPE and from Liberman and Prince (1977). All of these approaches manipulate a small number of variables. The innovation of Liberman et al is the general framework of 'metricality'. I have already referred to the notion of the 'foot'. Liberman et al also introduce the notion of 'extrametricality', whereby an edgemost or peripheral segment, syllable, foot, phonological word, affix, is designated as "invisible for purposes of rule application" (Hayes, 1995, p.56), unmarkedly on the right edge.

According to Liberman et al, "...stress is defined in terms of a 'hierarchical rhythmic structuring' which organises the syllables..." (p. 249). In this original version of the metrical framework, there is a general principle in English which exhaustively parses the word into left branching 'trees'. The projection of two adjacent nodes onto a strong node defines a 'foot'. This approach provides a consistent and unified account of the relation between stress at both the word level and higher levels, including the phrase and sentence. The relational property of stress is directly captured by the formalism. A distinction is drawn between rules assigning syllabic structure and stress and those assigning segmental or melodic structure. Liberman and Prince also note the cases of *hullabaloo, mulligatawny, Winnepasawkee, happygolucky, tyrannosaurus,* and derivatives containing the morphemes *hetero–, helio–* and *anthropo–* where a surface foot has two adjacent weak branches on the right, counter-exemplifying the principle of binary-branching. The analysis of these dactyllic feet is a non-trivial, descriptive challenge.

In the data here, there are the cases of *gobbledigook* and *budgerigar*, both occasioning distinct patterns of parapraxis including vocalic disharmony.

Developing and extending previous work by Halle and Vergnaud (1987), seeking to unify and integrate the notions of metrical and constituent structure, Halle and Idsardi (1995), Kager (1995), Harris (1995), Hayes (1995), propose a small number of parametric alternations. Here I shall focus on the work of Halle and Idsardi (1995), updating the the work of Halle and Vergnaud (1987), here the Halle/Vergnaud/Idsardi approach, and that of Hayes (1995). With different degrees of emphasis, on both approaches, metrical structure is *built* in the Kiparsky sense. Structure is added to the UR.

By the Halle/Vergnaud/Idsardi model, stress is defined on a bracketed grid and the edges of constituents, and computed step-wise on successive 'lines' of the grid.

By the models of both Hayes and Halle/Vergnaud/Idsardi, variably, i.e. parametrically, the system generates (mostly) binary feet, and more than one level of stress, as in English, or an 'unbounded' string, i.e. with only one level of stress. A further variable parametrically defines material on the right or left edge of a stress domain (at most one syllable). Such material is discounted in the computation. It is 'extra-metrical.'

Here I shall adopt the perspectives and bracketed grid terminology of the parametric approach of Hayes and Halle/Vergnaud/Idsardi.[69]

In relation to this study, the setting for English is for left headedness within the foot (on Line 1) and for right-headedness between feet (on Line 2). This provides the characteristic pattern of primary and secondary stresses in *archeopterix, diplodocus* and *hippopotamus.*

The main differences between Hayes and Halle/Vergnaud/Idsardi are outlined in (6.3).

[69] These authors' main concerns are typological, descriptive, and theoretical. The problem is to find a model which both characterises the data and does not predict unattested stress patterns.

(6.3) *Hayes and Halle/Vergnaud/Idsardi*

a) Halle/Vergnaud/Idsardi treat stress as being on its own tier; Hayes projects it from the syllable, noting that the syllable, even if bi-moraic, is not split between feet.[70]

b) For the statement of the relevant parameters, Halle and Idsardi in particular provide a very restricted algebra of bracketing, orientation, and projection. Constituency is defined exhaustively by the position at which the parse begins, and the syllable heads are projected onto the lowest line of the grid, numbered zero. On the next line, equivalent to foot level, constituent heads are identified. Primary stress is defined on the next line, Line 2. Hayes allows more different forms of variation, for example with respect to the foot type, a moraic or a syllabic trochee or an iamb, with respect to whether degenerate feet are prohibited, and, if so, how strongly; whether clashes are resolved or not, and, if so, how.

c) Hayes's notion of extra-metricality is part of a separate sub-theory. By an innovation due originally to Idsardi, Halle and Idsardi provide a uniform treatment of extrametricality. The fact that in English and other languages an 'edgemost' element (rightmost in English) is ignored in the computation is one facet of a single theory.

d) Halle/Vergnaud/Idsardi permit the underlying representation of accent, important in the analysis of systems like Russian and Greek. This is disallowed in the Hayes model.

e) The Hayes approach assigns some significance to the perceptual interface, not admitted by Halle/Vergnaud/Idsardi.

f) Halle/Vergnaud/Idsardi claim to account for all known stress systems; Hayes fears that Halle/Vergnaud/Idsardi are buying their theoretical parsimony at the expense of descriptive coverage.

Here I shall assume A) a Hayes-type model of the stress as a projection of the syllable; and B) the notion of bracketing in the Halle/Vergnaud/Idsardi terminology.

Regarding Halle and Vergnaud's original 1987 model, Blevins (1992) detects a weak generative equivalence problem; one stress pattern may be defined by more than one combination of settings. Halle and Idsardi (1995) respond that a homogeneous combination of settings is more highly valued than a heterogeneous one. By the hypothesis in Chapter 7, the learner approaches the learnability-space in terms of variables. If this is correct, Halle and Idsardi's defence of their model is plausible.

[70] Everett (1993) and (1996) argues for a distinct stress tier on the basis of data from Banawa. This language seems to allow the syllables to be split between feet, falsifying Blevins' 1995 claim that the non-occurrence of such a process is an argument for the syllable. The question is open.

The simpler the definition of a variable, the more easily it is learnt.Aspects of this are illustrated in (6.4) with respect to two stress patterns in the word *diplodocus*.[71]

(6.4) *Two patterns of stress in* ***diplodocus***

a) *Penultimate (tense vowel)*

Line 2						x			
Line 1		x				(x)			
Line 0		(x		x		x)		x	
	d	ɪ	pl	ə	d	əʊ	k	ə	s

b) *Ante-penultimate (lax vowels)*

Line 2				x					
Line 1				x)					
Line 0		x		(x		x)		x	
	d	ɪ	pl	ɒ	d	ə	k	ə	s

Consider this in derivational terms. Halle and Idsardi suggest the sequence of steps in (6.5), exemplified here for the dominant pronunciation in (6.4.a). Assuming that the projection of the nucleus is underlying, there are seven steps, described here informally.

(6.5) Seven steps in a derivation of word-level stress

- (i) Define rightmost constituent (with long vowel);
- (ii) Mark Rightmost syllable as extrametrical;
- (iii) Define leftmost constituent (weak foot);
- (iv) Define heads of feet;
- (v) Determine rightmost limit of stress;
- (vi) Define primary stress;
- (vii) Define secondary stress and successively declining levels in order.

Stress is implemented phonetically in terms of relative prominence, as defined by the sequence in (6.5). In the account of parapraxis here, I shall have occasion to refer to this sequence.

In conclusion, I adopt a generalised, parametric model of word stress. Descriptively, it is easier to relate the data here to the Halle/Vergnaud/Idsardi model. I shall therefore follow their terminology. But I shall do so without commitment, partly because I am also assuming a Hayes-type notion of the prosody as a single tier.

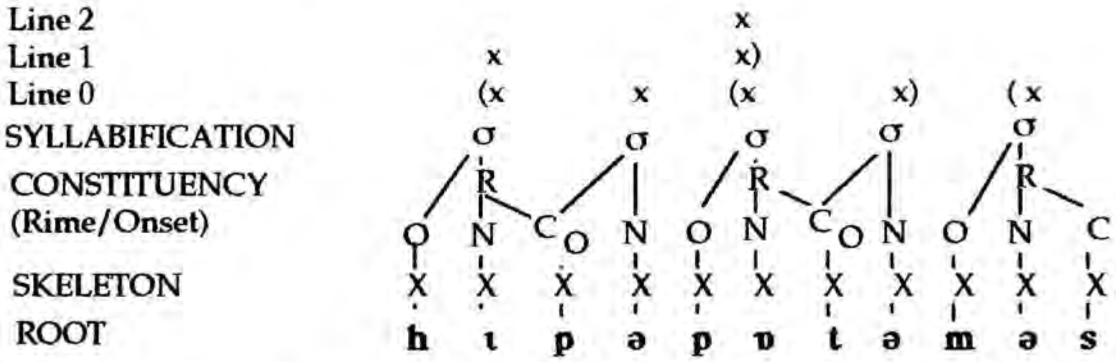
6.2.2.2 Constituents and metricality in parapraxis

In the hope of defining some aspects of singularity, I turn in this Section to the possibility of interaction between prosodic projection and structure-building.

[71] As noted in Section 3, one S plainly had this word differently lexicalised.

The commonality between the first /p/ and the /t/ in *hippopotamus* is shown in (6.6). In the spirit of compromise between Hayes and HVI, a grid is superimposed on the syllabic structure – with ambisyllabicity shown by displacing the symbols for Onset and Coda, O and C, downwards and upwards in the two cases respectively.

(6.6) ***hippotamus*** *– projections*



By (6.6), the rightmost syllable falls outside the structure of the two binary feet. These comprise the two stressed syllables and the syllables on their immediate right. In *hippopotamus,* both of the 'foot-internal' onsets are ambisyllabic. But in the case of [hɪtəˈpɒtəməs], what is the process? This can't be by rule without running into Grunwell's problem. This can't be floating because an absence of structure can't float. This can't be by spreading because of the distance between the trigger and the target. This can't be by delinkage because the trigger, by the argument of Chapter 5, is the last association in the sequence. It must be as a consequence of more general phenomena.

In the framework here, by (6.5), less stressed elements of the prosody project before more stressed elements. By (2.29) Labial associates before any other articulator. The association fails in the special case where there is a minimally different element with the same projection. The two items are subsequently associated by a step of default exponence. By the interaction between projection and association, the distinctively specified structure is now lost.

The prevalent harmony in *hippopotamus* is thus effected by the sequence in (6.7).

(6.7) A sequence of association and projection

(i) Project all elements with underlying properties (if any);

(ii) Associate projected elements subject to a set of conditions C_i:
By C_i, given two minimally different onsets, e_i and e_j, of E, different in respect of projection of Coronal in e_i,
The association sequence in respect of e_j is delayed to that of of e_i.

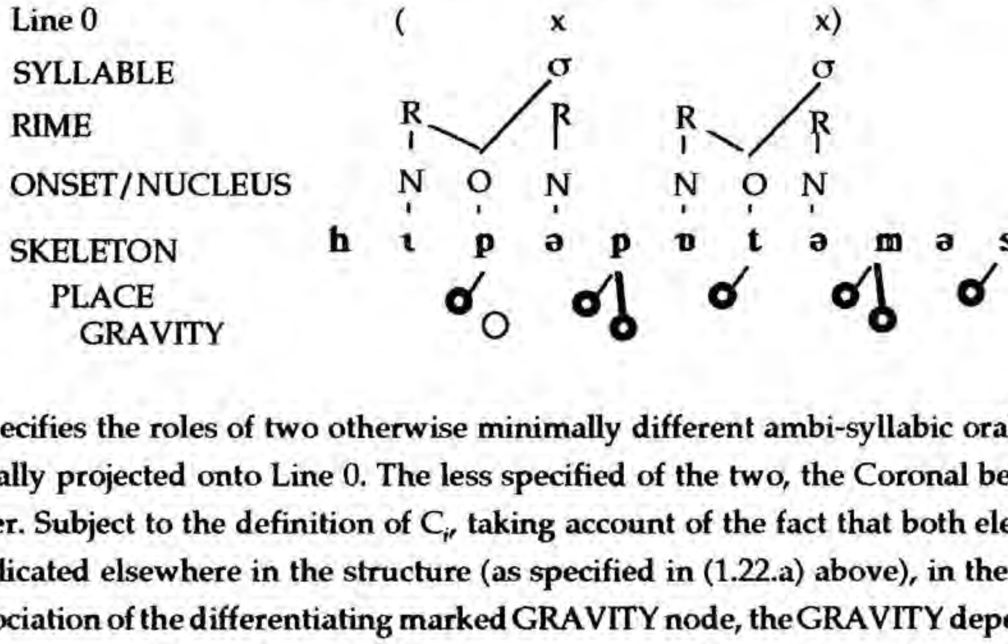
Projection precedes association. The free directionality, the fact that the two elements may be either way round from left-to-right, follows from the way C_i is defined. The 'productivity' of (6.7.ii) in an idiolect, whether it applies in just one word, or whether it applies more generally as in the idiolect of S39 mentioned in (3.29) above, is determined by the definition of C_i.

The limit by (6.7) is restated schematically in (6.8)

(6.8) Two points in a sequence of association and projection

(i) Underlying projection

(ii) Failure of association in one element with otherwise matching projections



(6.8) specifies the roles of two otherwise minimally different ambi-syllabic oral stops maximally projected onto Line 0. The less specified of the two, the Coronal becomes a trigger. Subject to the definition of C_i, taking account of the fact that both elements are replicated elsewhere in the structure (as specified in (1.22.a) above), in the target the association of the differentiating marked GRAVITY node, the GRAVITY dependent fails to associate. This is shown by the faint marking of the corresponding node and the absence of an association between it and the root. The link is not broken. It is simply not made.

In *asbestos* and *magnet*, an extrametrical coda is targeted by an element with a stressed syllable projection. The floating of a node, markedly Labial, unmarkedly Dorsal, is conditioned by extrametricality, and projection onto Line 2 of the stress tier. By (6.5.vii), if there is no other interaction, an extrametrical coda is one of the last elements to become available for phonectic interpretation. By a set of conditions C_j, distinct from C_i, the relation in (6.6.iii) is reversed, and the articulation of the final coda is advanced rather than retracted. In a given idiolect C_i and C_j must be distinct, or there would be alternation between coronal and non-coronal harmony in some environments. As I have shown in Chapters 1, 2, and 3, this is not generally the case. The distinctness holds across different idiolects.

But why do Dorsal and Labial float more freely leftwards into the foot where sonorance is part of the target – in *Geronimo, animal, pentagon,* etc.? One factor is relevant in all of these cases. Sonorance represents an increase in the underlying specification. It is associated before the default interpretation of obstruence. The other factor, relevant only in the cases of *animal* and *Geronimo*, is that there is roundness in the final rime.

For the roundness information to be available to the derivation, the relevant association must have been made, forcing a particular sequence of vocalic and consonantal associations. On the strength of Archangeli's 1984 notion of underlying nuclear projection in the lexicon-internal phonology let us assume (6.9).

(6.9) In the typologically default case, the association of vowel features (GRAVITY dependents) precedes that of consonantal features.

(6.9) is what the learner expects. This is a step towards an analysis, not by rule, but by the interaction between general principles. The threshold specificity of parapraxic environments is definable from the prosodic projection, where this includes syllabic structure, two levels of foot stucture, ambisyllabicity, and melodic interpretation. Without extrinsic ordering, aspects of parapraxis can be modeled by under-specification.

Such a relation between prosody and melody has been postulated for Yidiɲ; Crowhurst and Hewitt (1995) argue that in this language, "the construction of bounded feet and the implementation of metrical heads within them occur as separate events" (p.39), that foot construction is derivationally early, while headship is determined post-lexically. On the analysis here, this is partly true of English.

What I have not done is to show how two sets of conditions, C_i and C_j, prosodically defining particular sets of environments, are themselves deriveable from the learner's default expectations. I shall consider one way of doing this in Chapter 7.

6.3 What interpretable parameters must do

Section 6.3 focuses on A) well known problem areas in child-phonology – those concerning /s/ and /r/, where at least some of the problems are not specific to English – by (1.2) above); and B) some descriptive issues which need to be accountable by the same rubric. I shall outline a derivational model in which segments vary in the degree of their under-specification. Some surface properties are gradient. All properties have to be parameterised as part of the learnability-space.

From an idea going back to SPE, I assume here that the lexicon contains no predictable information. By the marked feature-geomety from Chapter 5, underlying forms are minimal; /t/ is a bare consonant; /s/ is a bare fricative; /n/ is a bare sonorant; /l/ is a marked sonorant; and so on. These classes are defined by a geometrical nodes such as CAVITY and AIRFLOW. Pushing this idea to the limit, regarding continuance and sonorance in English, let us make the assumptions in (6.10), with default rules varying by context, phonological level, and dialect.

(6.10) In English, the following surface features are given by default:

- a) in all dialects in
  - a) an edgemost segment preceding an onset stop, surfacing as /s/;
  - b) syllabic /n/, represented by a CAVITY node;
- b) in dialect-specific ways in 'r-drop' and more innovative dialects, where a critical diagnostic is the presence or absence of a contrast between *sawing* and *soaring*;[72]
  - a) in /r/ in the onset, underlyingly semi-vocalic, with a GRAVITY dependent,
  - b) in rimes surfacing as schwa or a melodically similar, long vowel in *her*, *fur*, etc.. with two unmarked skeleton nodes, the leftmost underlyingly projected onto the syllabic tier;
  - c) syllabic /l/, represented by a marked CAVITY node, in a position where syllabific projection is forced, surfacing with various degrees of darkness.

By the argument in Chapter 5, the structure-building in (6.10) is ordered late.

The notion of syllabic heads represented in the lexicon is now accepted in frameworks as different as GB phonology and OT. If a major class feature such as [±Consonantal] just encodes the fact that that a given element is not a syllabic head, there is a representational duplication. The feature is redundant.

By (6.10.b.c), in the word *little*, only the vowel is underlyingly projected. The projection of the syllabic lateral is part of the derivation. By a number of hypotheses to be presented in Chapter 7, this may be by a language-specific, typologically-marked, and thus hard-to-learn, parameterisation of laterality.

The claims in (6.9) are involved in the surface complexity of liquidity in English, as

[72] It is worth considering what the appropriate diagnostic is on this point. Is it a toleration of, insistence upon, consistency with respect to, or sensitivity to, this contrast? The question needs to be asked – particularly in relation to a dialect like the author's which allows the contrast but may, and does (on the observation of Mike Davenport), suppress it in performance.

surveyed in (1.33) above. Some of these phenomena are gradient. In the framework here, all of these cases manipulate only a small number of variables. The complexity stems from the number of interactions between the levels and the variables themselves.

To account for dialect-specific forms of glottalisation, it is necessary to assume that in Cockney and RP the PLACE node is is built very late, hence the non-release, but in different environments. Here we are not dealing with a derived environment, as in the case described by Kiparsky (1993), but root forms. This failure of structure building must follow the definition of the 'mid-foot' environment.

In /t ɾ/ onsets, sonorance interacts with articulation on the one hand and voicing on the other. In the framework here, the affrication represents a geometrically unmarked case where non-apicality is associated before coronality.

What is distinctive is the retroflex, phonetic character of English /ɪ/ and the lateness of the Coronal association. The gradient devoicing of liquids where they are clustered with obstruents in monosyllabic onsets is a function of the projection sequence. If language-specific variations in the effect of the coda on vowel length is any guide, one clue to the learner may be by (6.11).

(6.11) The longer the delay between the first and last steps of structure building, the greater the vulnerability of late default rules to adjacency effects. As an expression of phonetic quantity or length, skeleton slot representation varies according to the point in derivational sequence at which unmarked projections are interpreted. The later this point, the greater the variability.

By (6.11), the early projection of the stressed nuclei in *play* and *surprise* makes the adjacent liquid maximally vulnerable to the spread of default voicelessness from the adjacent stop. But this vulnerability is reduced where there is a fricative in the onset. To explain this difference, it is necessary to adopt the key idea in (6.12), minimally reworked from Archangeli (1984).

(6.12) Default rules apply as soon as the full terms of their structural description have been spelt out.

This does not mean that default rules apply early, but just that the timing of their application is given by a general principle. For instance, the default rules which define the surface forms in (6.10) all apply late.

(6.12) applies in the case of /s/ adjoined to the syllable. While the treatment of stressed monosyllables and unstressed syllables in phrases and compounds goes far beyond the scope and methodology of this study, (6.12) has the effect in (6.13).

(6.13) In a typologically unmarked way, rules of prosody and melodic structure building are interleaved.

Like (6.9), (6.13) is something the learner expects. The effect of syllabic sonorants on an adjacent /t/ or /d/ – by (1.34) above – is most easily stated by the order in (6.14) – avoiding the need for an underlying syllabic projection of the sonorant.

(6.14) *An association sequence in syllabic sonorants in English*
- (i) Sonorance
- (ii) Extrametricality
- (iii) Partial or incomplete release of the orals stop

But even if such interleaving is expected by the learner in principle, it is not easily learnt – hence the long persistence of dorsalisation in little and other similar words and the repetition of the same process in dactylls like digital for much longer, up to the age of 8;0 as shown in Chapter 3.

Turning to the rime, (6.15) develops ideas from Kiparsky (1993) and Lodge (1996).

(6.15) In the productive morphology of Greater London varieties of English
- a) The underlying specifications are continuance and nasality (and dorsality in the cases of Estuary English and RP).
- b) The default vowel is a lax, high, front /ɪ/ – other than in respect of the laxness, similar to Yawelmani and other languages (see Archangeli,1984).

Syntactic tense and number are defined on minimal specifications. Only non-nuclear slots are specified. Voicing and dorsality spread within this domain. Within the lexicon agentive "–er" and the comparative form, also surfacing as schwa, have an underlying unmarked skeleton node with a syllabic projection, not part of the morphology.[73] Complementing (6.15), in the same varieties of English:

[73] Agentive –er" plays diverse roles in *windsurfer*, either one who windsurfs or what one windsurfs on, *upper*, that which can be seen looking down in the case of a shoe, *flipper*, that which is flipped, *hooter*, used for hooting, *chopper*, used for chopping, *header*, a stroke using the head, *downer*, that which puts one down, *prayer*, as the object of praying, *terminator*, a specialised tool, the technician who uses it to terminate a computer connection, or that which terminates a chain of hard disks. This degree of semantic diversity is not consistent with productive derivation.

(6.16) In the lexicon-internal phonology, the default vowel is /ə/.

English thus has two default vowels coming into effect at different levels, schwa lexicon-internally, and /ɩ/ in the morphology, i.e. later. The extrinsic under-specification by (6.15) and (6.16), is set out in structure building sequence in (6.17).

(6.17) [NUCLEUS ___]
[Ø] ⇒ [–Peripheral] / Lexical word [____]
Elsewhere, [Ø] ⇒ [+High, –Back]

The morphological elements are effectively archi-phonemic. The past tense morpheme is a coronal stop, either [t] and [d] according to the voicing of the right edge of the root rime. The third person singular verb form and the plural noun form, underlyingly both represented by a bare AIRFLOW node – an unmarked fricative, likewise display voicing by spreading – either from the consonant or from the vowel of s nucleus, inserted for the sake of syllabification where the right edge of the root is a sibilant, leading to surface forms as [s], [z] and [ɩz]. In this case (and that of the present participial form in RP-type dialects), vocalic epenthesis is syllabically conditioned. In Greater-London English as well as in the parodied, now archaic form of RP, with *huntin', shootin', fishin'*, with no superficial dorsal in the morphology, the /ɩ/ specification is determined by the point in the derivation at which this default applies. In parts of the North-West, including Manchester, there is a distinction between the nuclei of the inflections in *fishes* and *fishing*. In dialects such as Coventry, schwa insertion is more general.[74] In both cases, the structure building in (6.17) needs to be stated somewhat differently. In relation to language/dialect-specific differences, it is necessary to specify not only whether the underlying vowel is schwa, but where and when it is inserted. In this way, morphological UR's in English can be simplified. And the correct output can be derived from a sequence of all-embracing, generic steps of structure-building.

Following Giegerich (1992), Labov (1994), Kiparsky (1995), let us assume that in English (at least in most dialects) the underlying contrast between vowels is featural, not geometrical. If so phonetic length is determined derivationally. If late implementation also tends to be variable, this is consistent with the well-known sensitivity of vowel length in English to the voicing and sonorance properties of the coda – in /dɛt/, /dɛz/, /dɛd/, /dɛn/, /dɛl/, and the 'long schwa' in monosyllabic *fur* and eliptical *her* and *hers*. In true 'r-drop' dialects in all of these cases, coda /r/ is

[74] This point is due to Andy Spencer who pointed out the dialectal alternations, and provided the Coventry data.

underlying. This, along with stress, is part of the conditioning of surface length. But in dialects with /r/ as a glide, this conditioning fails. In these dialects, by the analysis in Section 5.2.3, the phonological contrast between /r/ and /l/ is strengthened by retroflexion, defined by a late default rule. By (6.2), the default representation as non-roundness is reversed just in the case of a glide in the onset.

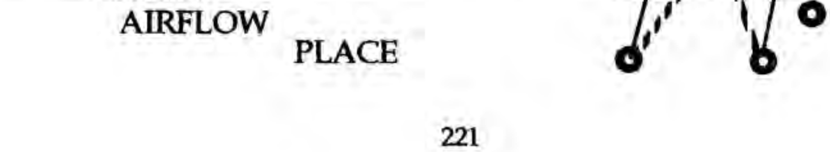
At least since metropolitan /r/ drop dialects started to develop (no later than the eighteenth century according to McMahon, 1994), the L1 learner has to consider two candidate analyses of /r/, the innovative glide analysis and a conservative rhotic analysis as an underlying liquid, kept apart from /l/ by an underlying, marked dependent of CONCAVITY, expressing the retroflexion. The issue for the L1 learner is which analysis to prefer. The issue is both derivational and phonotactic. Choice between competing analyses poses an obvious learnability problem.

Let us now turn to some coda phenomena involving stop clusters, all dialect-sensitive. The issue with regard to g-drop hinges on derivational sequence. The onset role of /g/ in *dinghy* and *finger* and its re-syllabification in *younger, longer, stronger,* involve a lexical-internal maximal projection – in the case of the derived forms into the onset of the suffix. The final syllable in *singer, singing,* and *thingy,* is not lexicon-internal.

In dialects of the British Midlands and North-West, g-drop applies only in a more limited if at all. With surface [g] in *singer, singing,* and *king,* as well as the other cases, all aspects of the melody and the skeleton node are projected independently. If and when g-drop applies has to be separately parametised for each dialect.

In Greater London dialects, in *prince, length,* and, *warmth,* a default melodic gesture is inserted between a nasal and a voiceless fricative. Functionally, the release gesture sharpens the acoustic contrast between the nasal and the fricative. Phonologically the articulator spreads in opposite directions from the obstruent and the sonorant. The properties of voicelessness and stopping are by default. The process applies very late; the epenthesis is sub-phonemic, i.e. gestural. By (6.12), dialects with the epenthesis must be characterised by a relatively early projection of the relevant elements. The process is represented schematically, but illegitimately in (6.18), with the sub-phonemic gesture shown by a correspondingly small skeleton tier node.

(6.18) * *Gestural epenthesis in the coda in metropolitan dialects of British English*



The illegitimacy of the (6.18) schema consists in the equivocation about the status of the epenthetic element. Is it a skeleton slot, or isn't it? But somehow this characteristic property of metropolitan English needs to be encoded within the learnability space.

It is not, of course, the case that the two sorts of process, the g-drop and the gestural epenthesis need to be related to one another. But given that they co-occur in a large group of regional dialects there is an explanatory advantage in showing a relation. I return to both of these issues, the epenthesis and the g-drop, in Chapter 7.

Now take the case of sibilance. A lisp represents the only sort of speech error to have a generic label in the non-technical lexicon. /s/ is the least marked fricative on numerous grounds. But why is it developmentally hard? Assuming a universal feature-geometry and minimal UR's, the voicelessness, coronality, apicality, and stridency, are all inserted derivationally as DER's. If so, the surface non-stridency of most lisps – dental, interdental, or lateral, is a failure to implement a late step in the derivation. The peculiarity of a lateral lisp is that there is not just a failure of structure-building, but an incorrect step, namely the building of a cavity node. The different patterns of lisps in English and Welsh speaking areas is likely to be related to different organisations of the default rules with respect to the voiceless fricatives.

On the assumptions here, /s/ is entirely unspecified on the left edge preceding two consonants. This entails an extrinsic reversal of the markedness of continuance. The extrinsic under-specification is defined by the structure-building sequence in (6.19) – the fact that the onset is already full shown here as [Onset [X X]].

(6.19) (i) [Ø] ⇒ [AIRFLOW + Cont] / Syll [__] [Onset [X X]]] DER
(ii) [Ø] ⇒ [+Strident] / CONTINUANCE [__]DER

To conclude, I have now found ways in which the notion of abstract exponence complements that of extrinsic under-specification, providing a plausible account of problems with /r/ and /s/, in some cases not resolved in adulthood. In normal development there is an an R-representation issue in polysyllables such as *Jerusalem* and *Geronimo*. This provides a 'cognitive' account of an otherwise puzzling aspect of the distribution of disorder.

Some, but not all, of a corresponding set of dialectal issues can be posed in the same rubric. I shall return to the obvious issue here in Chapter 7.

6.4 Conclusion – dismissing an objection

Section 6.4 adds a post-script to the discussion on valency. Lombardi (1996) modifies the idea of exclusively privative articulators, conceding that negative values enter the post-lexical phonology. She maintains that underlyingly place is privative – on the basis of: A) multiply articulated segments; B) the fact that negative values are not referred to; and C) the fact that phonological processes are categorial – unlike non-categorial, gradient phonetic rules. Developing this thinking, considering the case of privativity more generally, she surveys evidence for both 'non-labiality' in Slovak and in Danish and for 'non-coronality' in Kalenjiin and in Llasa Tibetan. Her case for negative values in the post-lexical phonology includes [–Labial] – taking this to mean Dorsal or Coronal – on the strength of the Slovak and Danish data, and [–Voice] on the strength of German data. This post-lexical reference to [–Voice], necessarily following final devoicing, creates voiceless coronals, and leads to non-structure preserving 'desonorisation' as an exceptionless process applying only to derived forms. On her proposal, there are binary features just at a phrasal level. She proposes that the selection of a particular UR value is universal – by (6.20).

(6.20) UG places no absolute restriction on when redundancy rules apply.

(6.20) is adopted here. On this account, given maximally binary branchedness and universal markedness, the issue with regard to valency is not whether the representational system is monovalent or bivalent, but when in the derivation redundancy rules apply.

In conclusion, I have shown that by combining featural geometry, prosodic structure, and extrinsic under-specification, it is possible to go some way towards an account of the role of Coronal in parapraxis. But this still doesn't fully address the explanatory gap by (5.63).

The notion of a marked geometry, as modeled here, raises serious objections, put by Harris (1994, 1996) and elsewhere – summarised in (6.21):

(6.21) *Two learnability issues for lexical phonology from Harris (1994, 1996)*

a) Structure-building puts a premium on real-time computation – obviously costly in relation to phonetic implementation and processing.

b) Under-specification implies a phonetic inventory containing 2^n elements where n is equal to the number of markedness relations.

The psycho-linguistic issues raised by Harris in (6.21) are perhaps non-decidable in phonological terms. But these issues are balanced by those in (6.22).

(6.22) *Five issues for theories of representational minimality*

a) There is a trade-off in relation to 'fast mapping' and the storage of an indefinite lexicon from UR's as given by the under-specification models of Rubach (1994), Rice and Avery (1995), Pulleyblank (1995), and Kiparsky (1995), all containing a notion of markedness, but in some cases otherwise very different from each other.

b) The derivational building of phonological structure increases redundancy in a way relevant to communication in a noisy environment.

c) The combinatorial economy achieved by monovalency is an inverse function of the depth of the hierarchy, the degree of the branchedness, and the number of sister branches permissibly open at once. As noted by Ingleby, Brockhaus and Chalfont (1996), the adoption of a unary system does not of itself decrease the combinatorix. It remains to be shown that the combinatorix is necessarily a phonological issue.

d) The 'cost' of building phonological structure is zero if its effects are reducible to the layering of the phonology.

e) There is a mis-match between the possibilites of phonetic implementation, subject to laws of inertia and the length of the neural pathway, and the potentially faster rate of auditory analysis via a shorter pathway and with no inertia effect. Given this mis-match, there is an adaptive advantage in the system being 'geared' to allow for the bottleneck of implementation, while at the same time getting an economy in terms of lexical representation.

The issue between representational parsimony and real-time processing remains an empirical one.

How does the L1 learner distinguish between quantal, categorial, phenomena in the word-internal phonology and gradient phenomena in the post-lexical phonology? Both of these issues are involved in what now appear to be representational failures, where the effect of coronal harmony follows the assignation of stress as a cyclical process. Against the background of some more general clinical and therapeutic issues, I turn to a possible mechanism for this in Chapter 7.

7 Some issues of theory, therapy and clinical practice

Chapter 7 returns to the starting point of this study. By the 'strong parametric hypothesis' from Section 1.5, speech and language acquisition is entirely by the setting of parameters. By the strictly cognitive and symptomatic approach to therapy described in Chapter 4, starting from what the child can say rather than from what he or she can't, the therapeutic task is to provide some critical help to the process of parameter setting by exploring with the child a given learnability space. If a change is effected in the mind of the child, what is this in respect of? What is the underlying mechanism? The answer to be given here is designed: A) to address the explanatory gap by (5.63); B) to hypothesise a basis for the form of phonological parameters, one parallel to the form of parameters implicit in current syntax; C) to model a general object in the treatment of most phonetic/phonological disorders.

Section 7.1 sets out the main findings here against the background of some theoretical concerns. Section 7.2 sets out a hypothesis concerning gradience. Section 7.3 leads to a possible model of parameter-setting. Section 7.4 outlines some consequences of this. Section 7.5 sets out some lines of testing and development. Section 7.6 considers the application of these ideas.

7.1 Findings and theoretical concerns

Section 7.1 sets out the main findings here, developmental, clinical, and experimental, in relation to the general issue of phonological learnability.

Empirical findings here can be summarised under three main headings.

(7.1) Key findings

a) By (3.71) and (5.16) and by previous results, there are singularities and asymmetries in the error distribution involving articulator harmony. disharmony, metathesis, segmental migration, and other processes, in all forms of incompetent phonology, in disorder, in normal development, and across the whole range of development. There is a lowermost threshold for certain processes such as metathesis and coronal harmony. What is referred to here as phonological parapraxis is generally characterised by extreme context-sensitivity, harmonic distance, and multiple triggering (Chapters 1, 2 and 3). On all of these grounds a spreading account of such phenomena faces grave difficulty (Chapter 5). There is also Grunwell's Problem and the No Proper Sub-set Problem from (Chapter 1). Chapter 6 provided a partial resolution of Grunwell's Problem with respect to the description of coronal harmony, but without resolving the explanatory gap by (5.63).

b) Phonological development is not normally complete by the age of 8;6, most children of this age making errors of a sort and on a scale which would be unlikely to be judged as reflecting an adult level of competence (Chapter 3). It follows that it is not until some time after the age of 8;6 that it is possible (in principle) to determine for sure whether a normal, adult level of phonetic/ phonological competence has been reached, or whether a problem remains.[75]

c) A therapeutic procedure, intended originally for assessment, led to what seemed to be a successful therapy, consisting, essentially, in having a child repeat a highly structured sequence of minimally-different nonsense words. The child is led to explore the definition of a possible word. By an adaptation of this procedure for the purposes of a reproducible experiment, a positive, permanent change can be effected in most members of a sample of normally-developing children. In this group, having worked on a few different word environments for between fifteen minutes and half an hour, and seemingly getting one or more of the corresponding real words right for the first time, when these words were reassessed a few days later, at least one of them was still correct. This was only a small change. But it was evidence of phonological learning happening in real-time (Chapter 4). If it is possible to reproduce with normally-developing children the effect of a strictly cognitive, symptomatic, linguistically-driven therapy which also helps phonologically-disordered children: A) this is unlikely to have a permanent effect unless it is addressing the fundamental categories of acquisition; B) this is potentially significant in relation to phonological theory; C) this leads to a non-negative characterisation of 'specific speech and language impairment'.

By (7.1.c), the therapist has a dual role – as an expert guide to the child and as an experimenter trying to determine the limits of what the child can say. The child learns how to go beyond these limits, following the phonological reasoning of the therapist. One seven-year old in the clinic did exactly this, beginning every session with a dozen or so nonsense words for me to say. While his word-sequences were less structured than mine, it was obvious that he was aware of the principles I was following. He progressed well with the therapy.

By this approach, there are small but visible gains, visible in relation to the diagnosis of disorder, and visible from one session to the next. The approach is child-centred, linguistically motivated, and avoids distress or anxiety. An immediate goal (for a session) is a word which a child can nearly say, but not quite. The child is allowed to discover how the phonological space is organised by taking particular words as examples. No matter whether responses are canonical or not, praise is given

[75] The 'in principle' qualification is necessary because there no widely accepted criterion of normal, adult phonetic/phonological competence – despite the many refererences to such and such an individual having a 'speech defect', implying strongly, but falsely, that such a criterion exists.

unquestioningly – on the reasoning that any phonetic/phonological errors after the first trial are by a misjudgement on the part of the therapist as to the child's current competence; the child is just being hurried.

Clinically, the approach by (7.1.c) seemed to work when nothing else did or when there was no other obvious avenue of treatment, as where a child could articulate every phoneme in every position, but still stumble over many words. Most of this work was done with a parent in the room. They were thus able to see the on-line progress being made. Finding that the gains were typically stable without further practice, parents were not motivated to ask for a 'exercises to do at home'. This sort of therapy, like much else in health care, is best left to someone with training.

Turning to the end-state, the process of acquisition is demonstrably and obviously finite and uniform in terms of its effect despite wide variations in input quality and consistency. Extending to phonology Chomsky's 1995 'Computation for Human Language', C_{HL}, we are led to (7.2).

(7.2) Where C_{HL} with respect to phonology is defined as Stage $_n$ and anything less as Stage $_{n-1}$, C_{HL} is finitely learnable. Phonological C_{HL} includes:

a) A given degree of abstract exponence, e.g. /r/ as a liquid or a glide, as well as whether it is phonetically retroflex or with any of the various other surface forms that have been discussed above.

b) The case where contrasting underlying forms seem to have the same surface melody, e.g. the rime in *tune* as [tju:n] not matching that in *moon* as [mu:n] in some dialects, but not in all.

c) Segmental organisation in a way that concerns A) what can appear as the head of a syllable, typically just a vowel, more exceptionally a coronal sonorant, as in English: and B) what can be adjoined to the syllable, just /s/ in English; and in relation to A) and B) with many other possibilities.

d) The relation between the morphology and phonological structure, whether the morphology is under-specified, and if so to what extent.

e) The form of the prosody, whether this involves tone, or whether this takes the form of a stress system, the English case being of at least average complexity by the analyses discussed in Chapter 6.

By (7.2), learnability is fully determined in the limit; there is no possibility of variation across the outcome forms of 'competent' grammar.

There is an important condition on (7.2) – by simple observation.

(7.3) The language learner has no privileged information about C_{HL} as a target system, where this includes the terms of (7.2) – as well as those listed in (1.37) above.

(7.3) is an issue for all language learners, irrespective of the target language. Take a child who seems to be unable to carry out a particular articulation or set of articulations at a particular point in phonological structure. One example is 'final consonant deletion', with all syllables open. At least in productive speech, the child seems to be treating all aspects of consonantal structure as properties of the onset – as is the case in many languages. It is possible that the articulation is not deleted, but mis-categorised. (7.2) and (7.3) thus lead to a view of phonetic/phononological disorders as having an irreducibly cognitive aspect.

If something has to be learned, some learners may fail on some points. But if finite learnability by (7.2) is to be ensured, both the criterial input evidence and its interpretation by the L1 language learner are likely to be subtle. If all the points in (7.2) and the various other descriptive issues in (1.37) are to be expressed parametrically it seems necessary to consider a new, more abstract view of phonological parameters.

7.2 A hypothesis concerning gradience

On the basis of the idea in (6.12) relating surface forms and derivational history, developing and going beyond the model of sound-change in Kiparsky (1995: p.644), I advance the hypothesis in (7.4):

(7.4) A necessary aspect of finite learnability in phonology is a degree of variability in the input, including allophony and gradient, post-lexical processes in the phonology of competent speakers.

(7.4) refers to variability of a different order from that which characterises child phonology. It tends to pass unnoticed, other than by specialist observers. But in a learnability space where categorisation is not labeled, a variation in variability is a potential learnability cue, albeit a subtle one.

7.3 What sort of parameters now?

On the basis of (7.1) to (7.4), Section 7.3 proposes a set of linked hypotheses about the organisation of the learnability space by the learnability mechanism itself.

The fact that there is no evidence for floating as a lexicon-internal phenomenon in

English or for the various association limits described above does not mean that the learner has no reason to consider the possibility of evidence existing. The fact of the parapraxis indicates simply that the learner has not yet determined that there is no such evidence. At a given threshold of phonological complexity, at a given point in the learner's exploration of the learnability space, say 8;6, this determination has not yet been made in full.

The input data is what the learner happens to hear. Mapping this onto a grammar requires a function which is powerful, as noted in Chapter 1, but indirect. It is powerful in as much as it has to address, simultaneously or otherwise, the 50 odd variables from (1.37), some of these restated as the intersecting set of issues in (7.2). The function has to set parameters over the whole range of phonetic/phonological variation.

Obviously we cannot resort to any theoretical machinery other than that which can be independently justified. But some aspects of the learnability space are defined by conceptual necesssity. One is the mere fact of physical implementation, characterised here as ASSOCIATE, equivalent to the notion of SPELL OUT in current, Minimalist syntax (see Chomsky 1995 a). SPELL OUT is a conceptually necessary operation splitting a structural description between those elements determined by the grammar and those determined by a universally available 'Logical Form'. In a similar way, ASSOCIATE implements both a phonetic melody and a phonological interpretation.

Another property given by conceptual necessity is the sequential, linear alignment of elements of different sorts. This includes what the theory of feature-geometry treats as an n-dimensional, representational space. Here, this is characterised as the phonological manifestation of what Minimalist syntax calls MERGE. In a syntax without MERGE, words and phrases could not be assembled into successively higher elements, starting from the finite set of lexical entries. Without MERGE in phonology, what appears on the surface as a sequence of syllables with a linear melody could not be assembled from phonological elements, underlying organised on an n-dimensional structure of tiers, defining register, tone, or stress.

MERGE applies irreducibly to the native speaker's first experience of a word, within and between segments, underlyingly specified to varying degrees. In numerous non-Indo-European languages, MERGE applies between segments and autosegments. Within limits, linear sequence can be free (see Evans, 1995). In such cases, an element appears to float, surfacing in two or more linear orders. In one such case, the floating element is an autosegmental, retroflex rhotic (Evans, p.740). In another it is schwa (Evans, p.745). But MERGE is also implicit in the derivation of a fully contrastive phonetic element from a radically under-specifed UR. For example, a voiceless coronal fricative may be underlyingly represented by no more than one of its superficial phonetic properties. Such abstractness is not specific to fricatives, but general. In a language like English, the surface representation involves the metrical projection of bounded feet. In the case of *hippopotamus*, for instance, the two instances of / p/ have quite different metrical projections. In French, but not in English, phonological MERGE involves an indefinite concatenation of melodic elements, where the left-to-right sequence of unstressed syllables (apart from an extrametrical, right-edge schwa) is defined by sequence alone. As in the case of what Minimalist syntax calls a 'numeration', in a way that encapsulates the original alphabetic insight, a phoneme can be repeated in any representation within the lexicon. In phonology, as in syntax, there is no formal bar on the repetition of a given item. In a way that goes beyond this study, in both syntax and phonology, there is some principle which disfavours the multiple repetition of an element within a single numeration or phonological structure. In a way quite unlike syntax, the phonological numeration is 'frozen' by virtue of what a lexical entry is. Because of this, principles of representation come into play. Hence the appearance of an 'R-inspection', proposed above. Whereas MERGE in syntax is both exclusively binary and an active derivational process, in phonology it is a consequence of the internal composition of representations. But these representations have to be encountered by the speaker and entered into his or her lexicon. At this point at least, the principle of MERGE applies.

By the research proposed here, parametric variation is with respect to projection – what projects where, and with what effects.

Given the idea of underlying nuclear projections (in the unmarked case – applying in English) and an association sequence determined in this way, the nucleus is projected before the onset. At least one aspect of melodic structure-building in vowels must precede the typically more complex (and more difficult to learn) structure-building of consonants. Building on the idea in (6.8), we get (7.5).

(7.5) At least in the default case (applying in English) structure building begins with the association of at least one phonetic element of the nucleus (projected underlyingly).

If stress depends on melody, the corresponding projection on the stress tier must follow at least one aspect of melodic association.

In current, Minimalist syntax, one key mechanism used to define language-specific properties is 'feature attraction', defining movement, equivalent to 'Move-α' in previous models, and the directly related variable of 'Strength' (see Chomsky, 1995 a). One possible way of adapting the notion of Strength to phonology is sketched in (7.6.a) and b).

(7.6) Strength

a) If an element is 'Strong', it is projected: A) early in the derivation; B) cyclically. Strength breaches a principle known in Minimalist syntax as PROCRASTINATE, dictating that no derivational step occurs unless it is forced to do so. PROCRASTINATE is invoked in the name of computational efficiency, by the proposal here, in a way common to syntax and phonology. By PROCRASTINATE, in the default case, association is late. The learnability diagnostic of late association is a detectable surface phonetic effect of gradience, but to different degrees at different phonological levels, where these levels include at least a lexicon-internal level and a post-lexical level.

b) Unmarkedly, a projection is weak, leading to an association only at the point when this is otherwise forced. Markedly, a projection is strong, by (7.6.a).

This is treating Strength, not as a segmental property or as some sort of diacritic, but as a parametric variable. A feature is Strong, not inherently, but by the language-specific way in which it is projected in particular classes of case.

By (7.6), the association of marked structure can be repeated, i.e. applied cyclically. So the principle of cyclicity is available to the process of structure-building, even in the case where this is not required in the phonology of the target language.

Assuming Strength as a variable, the output of the PSF is a set of conditions on MERGE, defined by (7.7).

(7.7) By MERGE, applied phonologically, two elements e_i and e_j are distinct to the extent that they are:

a) underlyingly specified in a way not given by the A/P interface; OR

b) given by a previous operation of MERGE.

By (7.7), FIRST, a phonological element may constitute any amount of phonological structure from a feature to a foot; the elements e_i and e_j are not forcibly in different segments. And SECOND, there are aspects of phonological structure which are given by the A/P interface.

On these assumptions, one possible formulation of the PSF is given in (7.8), defining how elements interact at different points in the derivation, enabling the learner to build a grammar as an operation out of successive parameterisations, which arise by repeating the same procedure with an increasingly narrow focus – by the definition of the projection, p of P, a syllabic constituent, a syllable, a foot, a word, a phrase.

(7.8) By the learner's expectation

for a set of elements, E $\{e_i, ..., e_n\}$

for a set of projections, P $\{p_i, ..., p_n\}$

E is minimal and complete (i.e. without gaps), AND

a) for the maximally distinct member of E, e_i or e_j, Strong;

b) otherwise, as late as possible where e_i is minimally distinct from e_j.

Informally, take two representations. If they are dissimilar, neutralise the distinction in favour of the most marked, favouring low threshold harmony, where the elements have different prosodic projections, at the expense of Coronal, in *knife* as [maɪp] and *doggy* as [ˈgɒgɪ]. Reverse the procedure only where the difference is minimal, in early child phonology favouring fronting in the case of minimally different onsets, and in later child phonology with a harmonic effect in environments such as *archeopterix* and *hippopotamus* where once again two elements with the same prosodic projections can be compared, where e_i and e_j are 'matching' in the sense of (1.22.a) or by (6.7) projected onto onsets with the same projection no higher than line 1. Because of the condition, (7.8.b) effects harmony only at a relatively late point in the development of phonetic/phonological competence. This leads to what is effectively a dactyllic threshold for coronal harmony. (7.8.b) opens the way to a misinterpretation of the unstressed onsets in a singular set of environments, but only at a certain threshold. So it does not apply in *knife* or *doggy* because of the differences in syllabic or prosodic projection of the two consonants. e_i and e_j are not minimally distinct. Below the (1.22.a) threshold, coronal harmony is A) not characteristic of early phonology; and B) diagnostic of severity in phonological disorder.

By (7.8), at all levels of projection, the smallest set of categories is the highest valued. This expresses the notion of 'feature minimisation' from Archangeli (1984). (7.8) reflects the idea that representation should be economical in terms of features, but exploit the principle of derivation to the full. The a) and b) terms complement the general term, but in two opposite ways.

Because the default expectations of (7.8) are genomic, i.e. universal, there are characteristic mis-representations of the input evidence. Hence parapraxis.

(7.8) applies to a single feature. Here the procedure which properly unscrambles the allophones is taken one step too far, collapsing not allophones, but features, by the single 'step' of non-association, i.e. default coronalisation.

The effect of (7.8) is that distinctiveness is lost. This is a tyrannical procedure. On its own and pursued to the limit it reduces the phonological inventory to a single element. Phonological wipe-out. What forces the learner to retreat from the consequential mis-interpretations of the input? One possible explanation is in terms of an independent process of evaluation by a two-stage decision process, for as long as the PSF is operative. If no data is encountered which constitutes a positive instance of (7.8), whatever is not found is prohibited. I state this idea as a hypothesis in (7.9).

(7.9) For a set of elements E, defined on a given state of the R-Inspection

- a) For an analysis, A, as required by (7.8), run a test T which applies A to a maximal set of objects, EP, consistent with **e** and **p**
- b) Adopt A, if and only if
    - a) EP is non-trivial, AND
    - b) there is no negative evidence.

For the learner, the negative evidence for (7.9.b.b) capable of forcing the abandonment of an incorrect analysis A is most likely to come in the form of a new word – a real one in the natural order of things, or a nonsense one by the therapy or Phase Two of the experimental procedure in Chapter 4.

(7.9) restates the principle of what Flavell (1963, p.205), summarising Piaget, calls "hypothetico-deductive operations", but below the level of consciousness. By the hypothetico-deductive principle, coming into play around 11 or 12, the child starts to take account of negative evidence. Piaget and Inhelder (1969, pp. 146-7) got children to investigate elasticity as a function of length, sectional thickness, and material. Children younger than 10 were unable to treat each of the factors separately, or to draw the appropriate conclusions. They only started to do so, without any formal teaching on this point, from around 10 or 11. This faculty emerges into consciousness at the very point when it ceases to bear on the PSF.

(7.9) does not rely on the accident of the learner encountering a particular form. By a system which is both predictive, by (7.8), and sensitive to negative evidence (in the Piagetian sense), by (7.9), the probability of decisive triggering is maximised.

By (7.9.a), the initial detection of evidence, such as that for a given system of stress or a particular pattern of syllabic structure, is a decisive event. There is evidence for this in what appear to be sudden changes in the child's grammar, as recorded by Smith (1973) and others. The evidence for (7.9.b) seems likely to be more subtle – as shown by the difficulty of determining when a given aspect of language has been mastered – in syntax as much as in phonology. But, as noted above, on the evidence of this study, the acceptance or rejection of (7.9.a) by (7.9.b) for every element for every projection (i.e. mastery of the phonological system as a whole) is not normally made before 8;6. On this approach, the setting of a parameter is a process with a beginning, by (7.9.a), and a conclusion, by (7.9.b). The metaphor of throwing a switch is appropriate for the first step, by (7.9.a), but not for the process as a whole. A more accurate metaphor for this process would be a well-conducted experiment.

With respect to a given set of **e** and **p**, at a given point, the experiment is complete – typically by the rejection of the (7.9.a) analysis. At this point, (7.8) can be run again, but in respect of a proper sub-set of the inputs to which it applied on the first run. And so on, successively until **e** and **p** are exhausted.

By the condition on distinctness in (7.7), parapraxis involves various singularities, roundness in labial harmony, the replication of an element in coronal harmony, and so on.

(7.9) provides a variable threshold for the a) and b) terms of (7.8) according to the phonological complexity of a given structure and how the learnability space is treated by the learner's R-Inspection at a given developmental point. It is activated by a degree of interaction between melody and prosody.

By (7.8) and (7.9), some aspects of an incompletely mastered phonetic/phonological system are not determinable in principle. Contra Smith (1973), the child's UR's are not equivalent to those of adults or to adult surface forms. Nor are the child's UR's the output of a set of filters, as assumed by Macken (1980) and Spencer (1986). Rather, they are defined on a system in which a given property, such as the floating of an element **e**, has not yet been excluded, other than within a given set of limits.

As (7.9.b) is pursued to the limit, the learner is pointed to an analysis of grammatical features which may be relatively subtle. There is a phonetic clue to late association in the degree of gradience. The learner does not expect abstract exponence, but is sensitive to the evidence of structure-preservation being breached. This is most likely in a variable set of implementations of the least marked, last associated elements. In the limit, the degree of phonetic gradience may provide a learnability clue regarding a rime as against an onset-analysis of the glide in /CjV/ structures.

No language is fully accountable in terms of autosegments, floated, or copied elements. At some point, every phonology displays some linearity. By (7.8), what the learner has to learn is how far the target grammar is linear and segmental, rather than how far it represents a departure from this.

The thinking here leads to the following hypotheses.

(7.10) The learner is biased towards a particular (simple, but autosegmental) analysis of the input. A linear analysis is invoked only if there is no evidence to the contrary. (7.8) and (7.9) define an active search for:

a) abstract, derived representation, where the surface structure is built by default, where this is identifiable by a degree of context-sensitive variability characteristic of late, or post-lexical, rule application;

b) a minimal representational system;

c) gaps in the phonotactics;

d) evidence of cyclicity, lenition, spreading, copying, conditional or otherwise.

(7.11) At any point before the target grammar is fully defined by successive tests by (7.8) and (7.9), the 'processes' which characterise an incomplete phonology are epiphenomenal, representing an incomplete set of parametric settings. Measured backwards from the end-state of competence, this can be characterised as parapraxis, with some vulnerable elements in phonological structure re-defined by derivational 'false economies' by (7.7).

(7.12) The distinctive asymmetries of phonological parapraxis – by (3.71) and (5.16) – are a consequence of the way the PSF is organised – by (7.9).

(7.13) A phonological parameter relates C_{HL} and A/P properties, as a featural element **e** projecting onto a phonological structure **p**.

a) Boundedness, headship, and a set of levels including the word, are given by a morphologically driven syntax, as aspects of C_{HL};

b) The feature-geometry, levels of stress, and/or pitch and tone, are defined in ways making some reference to neuro-anatomy and neuro-physiology, as part of the A/P Interface. What the learner learns is that such and such an element projects to such and such a category, where this projection may vary in its derivational effect. For example, as a way of defining intrusive /r/ in metropolitan English, where an empty onset merges with a nucleus with no underlyingly specified melody, i.e. /ə/, Roundness, as an A/P element, projects Strongly, i.e. cyclically, for as long as a projection target remains – up to the level of the phonological utterance in the sense of Nespor and Vogel (1986). In this way, both prosody and melody are defined on one (broad) learnability space.

(7.14) By the interaction of independent principles, the definition of different aspects of prosody and melody are expected by the learner to apply sequentially. This allows some interleaving. In the English case, the release gesture of the stop before a syllabic lateral is defined after the extrametricality of the lateral. The fact that the learner is on the look-out for this sort of thing does not make it easy to learn. It just makes it finitely learnable.

(7.15) Necessary aspects of finite learnability in phonology include:

a) a degree of variability in competent adult phonetics/phonology, as the input to the L1 learner, where this includes gradient, post-lexical processes, and where the 'likely suspects' are the coronals, particularly /r/ and /s/, triggering realisation problems which (with differing degrees of context sensitivity) may persist into adult life;

b) the closing, or partial closing, of the time window for the PSF.

Parameters define projections. A/P elements project onto linguistic categories. Rules are eliminated, not by reducing their effect to representation, but by the interaction between parameters, each defined on projections, and a small number of principles.

But phonological parameterisations of the sort exampled in (7.13.b) do not naturally express the range of interactions between elements, such as the case of dialectally variable 'g-drop' in English. Some possible ways of doing this are listed in (7.16).

(7.16) Possible ways of defining context-sensitive interaction between elements:

a) the availability of more than one possible projection target in respect of a given A/P element, perhaps both the coda and the rime, with some dialects being characterised by a double projection, and others not;

b) universally different limits on the interaction between Strong elements and others: A) lexicon-internally, as in *long* and *thingy*, and B) where the projection is specified by the morpho-phonology, as in *longer*, where the adjectival status is unchanged, but a semantic element is added by the fact that the –er to which the /g/ adjoins as an onset is a comparative.

By (7.8) to (7.15) the phonological learnability space is homogeneous, conceptually parsimonious, and internally consistent. This is the 'learnability pay-off' of the PSF. The input, or 'primary data' does not need to be evaluated simultaneously on disparate criteria. The same function can be repeated for a number of apparently diverse aspects of phonetic/phonological competence. The down-side is that the very step of broadening the learnability-space requires a corresponding narrowing of the 'algebra' that is used to define it. One obvious testing of the hypotheses above is with respect to descriptive adequacy. Is phonology possible with such limited tools?

7.4 A perfect system - when the word was made flesh

A parameterisation defined on the feature-geometry remains a programmatic goal - subject to further research. What does such a model achieve?

(7.17) By the model which I am proposing here:

a) There is an error in the view, widely held in Child Phonology, that phonetic/phonological disorders are generally determined by a complex mix of social, linguistic, psychological, and neurological or sensori-motor factors. By the model here, there is, commonly at least, a single disorder with respect to a Parameter Setting Function (PSF), defined by variables. By the symptomatic, cognitive procedures described in Section 4.2 many children with this sort of disorder can be helped to resolve it by exploring a given part of the learnability space, by ringing the changes in a logical way, leading to a change in the way their R-inspection is defined, with the effect that it becomes less restrictive. The exploration needs to be carried out with expert help. The generality of this claim is supported by the fact that the effect can be mimicked in normally developing children.

b) Just as current syntax abolishes rules and constructions, it is now possible in Child Phonology to abolish developmental 'processes'.

c) It is possible to resolve the apparent conundrum of SSLI and the evidence for concomitant sensory-motor deficits, surveyed by Hill (2001), if phonological parameters are defined by a universal feature-geometry projected onto a similarly universal prosody, at least the former being defined with reference to the sensori-motor apparatus. The PSF thus involves the highly-heritable biological characters which define the A/P interface (hence family resemblances). This explains how phonological symptomatologies can run in families. This point was captured by the telling comment about one child, S59 in the experiment here, by the thoughtful and observant grand-parent quoted in Chapter 1. "He sounds just like his uncle did at the same age". Such a case (far from unique) can't be explained socio-linguistically in any obvious way. It can be explained if what S59 inheritted was both a PSF defect and a character from the A/P interface.

d) If every aspect of every phonetic/phonological system, including a limited degree of abstract exponence, is exhaustively definable, by a single set of algorithms, the system is 'perfect' in Chomsky's 1995 sense, but vulnerable to the extent that a proportion of individuals may have difficulty in applying it to its fullest extent. The abstract nature of the mapping between the input data and the form of the grammar is not easy to perceive. A marginal deficiency with respect to the PSF addresses the notion of SSLI as a syndrome. This is the price of a perfect system.

By the hypothesis in (3.2), (7.9) may represent an adaptation that phylogenetically preceded the PSF as defined by (7.8).[76] But (7.9) alone does not entail that language skills were generally shared within such a population; by (7.9) alone, finite acquisition cannot be ensured. Criterial data may not be encountered. The process is probabilistic. In a society with (7.9) alone, some individuals, those most gifted in this regard, will be able, by (7.9), to progress towards a grammar. But the progress will be variable, and the degree of understanding will be unreliable across the population as a whole. By the hypothesis in (3.2) above, it was from such a society that modern homo sapiens diverged. Further to the same hypothesis, by the PSF in (7.8) and the test procedure in (7.9), the learner can impose order on a system previously lacking any such order. The scenario is essentially one suggested by Lieberman (1998). On the reasoning above, the fact that the PSF is fully accessible only during a pre-pubescent time-window is one necessary aspect of finite learnability.

The significance of the PSF as an adaptation applies within the population within which it is transmitted. With the PSF, learnability is finite. By virtue of a uniform learnability space, the learner is able to repeat a single set of procedures with respect to the input data until the grammar is complete. With finite learnability, meaning can be universally-shared between all members of a group of speakers.

A minimal, but internally-consistent, PSF provides what Chomsky calls a 'perfect system'. The PSF maps the input data onto a set of parameters, as given by the feature-geometry and a smaller set of elements defining the prosody. But this involves a very high level of abstraction. This seems likely to be a key factor in the difficulty, experienced by many learners, in mapping the input evidence onto the parameters.

By (1.25.a), the PSF is selectively vulnerable, as a heritable character, characterised here as one expression of SSLI. Depending on the criterion adopted, on the basis of numerous studies, such a defect affects between 1% and 10% of the child population, significantly more boys than girls. As is obvious, a proportion of adults have on-going problems with some long words, with one or more aspects of literacy, or with some combination of these.

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[76] Here we need to consider the evidence of skill levels in two sorts of human population, that from which modern homo-sapiens diverged, and in Neanderthal humans, most plausibly as descendants of the ancestral human line, but critically lacking the special adaptation of homo-sapiens. In the ancestral population there is the evidence of tool-making skills. In Neanderthal humans there is the evidence of burial of the dea, the use of boiled birch bark as an adhesisve, and the practise of cutting a hole in the cranium without lethal consequences. None of this is easy to reconcile with the idea of a society without language, some practical pharmacology or knowledge of hygiene, or access to negative evidence, or 'hypothetico-deductive operations' (see Piaget and Inhelder, 1969).

7.5 Testing and development

Testing and developing the hypotheses above seems to lead in these directions.

FIRST, the account here has suggested that parapraxis involves both the input (at least when a new word is encountered) and the output (at least when some words are uttered). This takes us back to the 'psycholinguistic question' in (1.1). It needs to be addressed by a methodology more based in the laboratory than the one adopted here. Despite the commitment to detail in Chapter 1, this has been thin on the ground in the data here. A laboratory-based approach to phonology at Stage $_{n-1}$ needs to look phonetic details, such as whether, and to what extent, parapraxic articulator harmonies involve the superimposition of one articulation upon another.

SECOND, the hypotheses here need to be tested against, and applied to, a range of dialects of English, and languages other than English, genetically related and unrelated.

THIRD, the data here have been all lexical and lexicon-internal. Little work has been done on the child's acquisition of the non-lexical phonology. It seems that no child learning English over-generalises from the contraction in "I'd do that" and "I wouldn't do that" to form "I'd'nt do that." If so, what learning mechanism is involved? There is no obvious cue. In the framework here, the most likely mechanism is by one parameterised projection onto a labeled, syntactic category – in a way which would not lead to the false, and seemingly unattested, overgeneralisation. What the learner learns is thus what projects where. But what is projecting here is a coda – something which does not happen in the lexicon-internal phonology. If so, the learner must have some way of distinguishing between the lexical and non-lexical phonology. If so, this has implications A) for the organisation of the phonological learnability space as a whole; B) for the phonology/morphology relation; and C) for a more general, i.e. abstract, definition of the PSF than the one in (7.8).

7.6 Application

It is telling that in two literatures, on clinical practice in relation to phonetic/ phonological disorders and on phonological theory, there is little mutual citation. It seems obvious that disorders of any sort should be treated as early as possible. But in relation to phonetic/phonological disorders this impulse may be misleading. In many parts of Britain today, it is difficult or impossible to get NHS assessment of or treatment for such disorders after 6;0. On the evidence of this study, phonological acquisition is normally still in process at 8;6. It is possible that some necessary and appropriate treatment is being denied to some children aged 6;0 and up with problems judged too minor to justify treatment, but with problems which may not resolve.

Appendix 1: Edinburgh Articulation Test

Words in the test, each tested by the child naming a picture on one page from a book

monkey	*tent*	*fish*	*train*	*umbrella*
milk	*stamps*	*queen*	*clouds*	*Christmas*
bridge	*flower*	*chimney*	*smoke*	*sleeping*
wings	*aeroplane*	*spoon*	*toothbrush*	*red*
bottle	*birthday*	*horse*	*feathert*	*elephant*
soldier	*glove*	*finger*	*thumb*	*watch three*
teeth	*pencil*	*yelllow*	*sugar*	*Indian*
matches	*scissors*	*desk*		

Scoring is generally by sequences of adjacent consonants or by clusters. In two cases those of *umbrella* and *elephant*, it is by the whole consonantal structure of the word. The total number of scored items is 68, representing the maximum possible score. The standardisation is by age-group from 3;0 to 6;0, with each year divided into four parts. A given 'raw score' is plotted against a table to give a 'Standard Score' where 100 represents the mean with a standard deviation of 15. In the oldest age-group, from 5;9 to 6;0, the raw score closest to the mean is 59, i.e. with 9 items incorrect

Appendix 2: Words used by the author for assessment

At various times, the author has drawn on words from the following list for assessment. All of them have, in one case or another, seemed to give useful diagnostic information. With older children, with phonological problems exclusive to the longer words, the bisyllables were not assessed. Conversely, in the case of younger children with severe disorders, the assessment of such words would have lead to realisations involving an unanalysable level of PP. Children were asked simply to repeat the words.

afternoon	*aluminium*	*ambulance*	*animal*	*archeopterix*
asbestos	*aspidistra*	*association*	*Barnaby*	*basket*
breakfast	*Burlington*	*button*	*calculator*	*cardigan*
cheshire cheese	*chopsticks*	*Colchester*	*conservation*	*crispbread*
Darth Vada	*digital*	*diplodocus*	*echelon*	*ecstasy*
electrician	*elephant*	*engineer*	*especially*	*eskimo*
excuses	*excavator*	*excuses*	*Exeter*	*fascination*
finish	*finicky*	*fly slowly*	*fresh flowers*	*furniture*
Geronimo	*gobbledigook*	*happy go lucky*	*hippopotamus*	*hocus pocus*
hopscotch	*hospital*	*injection*	*Ipswich*	*javelin*
Jerusalem	*juicy*	*key*	*magnet*	*mahogany*
manager	*manchester*	*Melanie*	*monopoly*	*operation*
orange	*pedicle*	*pentagon*	*picture*	*plasticine*
pocket	*polythene*	*porcupine*	*principle*	*rhinoceros*
sausages	*sea shore*	*shallow sea*	*sea anemone*	*side slip*
sister	*slap dash*	*slip shod*	*spaghetti*	*squadron*
stop flapping	*stretcher*	*ticket*	*three flies*	*topical*
triplicate	*vaccination*	*wristwatch*		

Appendix 3: Clinical data

This appendix lists data collected originally for clinical purposes.

LM	3;5
bottle	b ɒ p
bridge	b ɪ b
coat	k ə ʊ k
drink	g ɪ k
finger	ˈd ɪ n d ə
glove	d ʌ d
match	b æ p
monkey	ˈg ʌ ŋ k ɪ
park	p aː p
part	p aː p
sleep	b ɪ p
smoke	k ə ʊ k
spoon	b uː m
sugar	ˈg ʊ g ə
talk	k ɔː k
watch	b ɒ p
string	g ɪ ŋ

LM was exceptionally unintelligible to her mother at the time of referral. The family shortly moved house and the child left the clinic.

DE	3;6	4;5	4;9	5;1
finger	ˈdɪnnə	ˈtɪnnə	ˈtɪndə	✔
soldier	ˈdəʊɫdə	ˈtəʊɫdə	ˈtəʊɫʒə	
	5;11	6;3	6;5	
animal	ˈæmɪʊ	ˈæmɪmʊ	ˈæmɪmʊ	
archeopterix	aːkɪˈɒptə‹l›ɪks	aːkɪˈɒptəwɪs		
aspidstra	æ‹h›pɪˈdɪ‹h›tə	æpwɪˈdɪskə	æsəˈdɪstrə	
budgerigar			ˈbʌdʒərɪgaːd	
digital	ˈdɪdʒɪʔləɫ	ˈdɪdɪtəɫ	✔	
diplodocus	dɪpəˈdəʊʔkəs	dɪpəˈdəʊkəs	dɪpwəˈdəʊkəs	
hippopotamus	hɪpəˈpɒsəməs	hɪtəˈpɒsəməs	✔	
sausages	ˈsɒsɪzɪz	✔		
slip shod	ˈslɪpsɒd	ˈslɪpstɒdʒ	✔	
spaghetti	ˈpskɛtɪ			

AB	3;9	4;9	5;5	5;9	6;4
animal			ˈæ:məɫ		
archeopterix				da:lɪˈʔɒʔləʔlɪ	a:gɪˈɒʔtərʔs̩
asbestos				ˈæ:bɛ:dɒ	ˈæ:bɛ:dɒf
aspidistra					æʔpdəˈdɪʔdə
Barnaby					ˈba:mbəbɪ
Burlington					ˈbɜ:lɪʔtən
cardigan					ˈka:dɪən
certificate				əˈdɪʔləlәʔ	dəˈdɪkədəs̩
digital					ˈdɪʔdətəɫ
diplodocus				dɪʔləˈdəuʔlə	dɪʔləˈdəuʔkəʔs̩
eskimo					ˈɛ<f>bɪgəu
finger	ˈbɪŋə	ˈbɪŋnə	ˈbɪŋgə		
Geronimo				ˈlɒmɪnə	bɪˈgɒmɪnəu
hippopotamus				ʔɪʔˈbɒʔlə	hɪʔəˈpɒʔməs̩
hospital				ˈlɒ<f>bɪdu	ˈɒ<f>bɪdu
Jerusalem					gəˈlu:pəmən
mahogany					ˈɒgəmɪ
monopoly					bɪˈnɒpənɪ
sausages					ˈdɒsɪjɪz
slip shod				ˈlɪʔgɒ	ˈdɪʔgɒb
soldier	ˈgænʔə	ˈgəulə			
yellow	ˈdɛləu	ˈnɛləu	ˈlɛləu	✔	

MN	3;9	4;3	4;9	5;9	6;4
archeopterix				a:ʔlɪ'ɒʔtərɪʔ	a:tɪ'ɒʔtwɪks
asbestos					æ:bɛ:dɒs
aspidistra					æ‹f›pɪ'dɪstə
certificate				pə'lɪkətəl	tɪ'fɪdɪgəl
digital				'gɛtʃɪkəɫ	'dɪtʃɪkəɫ
diplodocus				dɪplə'dəʊkə	✔
eskimo					'ɛ:kɪməʊ
excavator					'ɛʔəvɛɪtə
finger	'pɪnnə	'pɪŋnə	'pɪŋgə	✔	
Geronimo					dʒə'mɒnɪməʊ
hippopotamus				hɪtə'pɒtənə	hɪtə'pɒʔməs
hospital					'hɒʃpɪtəɫ
Jerusalem					dʒə'ru:sənəm
magnet					'mægnɪk
mahogany					əm'hɒgəlɪ
monopoly				'nɒkəlɪ	ə'nɒpəlɪ
sausages					'sɒsɪʒɪz
soldier	'təʊlə	'tjəʊɫdə	'tʃəʊdʒə		
thermometer				'fɒmɪtə	
yellow	'lɛləʊ	'djɛləʊ			

AB and MN were identical twins.

PR	3;10	4;7	5;11	6;2
key	ˈtɪː	✔		
finger	ˈvɪŋgə	ˈwɪŋgə	✔	
soldier	ˈwəʊɫdə	ˈbəʊɫdə	ˈvəʊɫdə	ˈɾəʊɫdə
yellow	ˈlɛləʊ	ˈlɛləʊ	ˈlɛləʊ	ˈlɛləʊ

	6;9	7;0	7;4
archeopterix	aːgɪˈɒbdɪd	aːdɪˈɒptɪgɪˀs	
asbestos	ævˈbɛˀdɒd	æˀˈbɛˀdɒs	æːˈbɛsdɒs
cardigan	ˈkaːdɪntən	ˈkaːdɪdən	
certificate	səˈdɪsɪˀət		səˈgɪfəsəns
diplodocus	glɪpləˈgləʊkəd		dɪpəˈgəʊsəs
eskimo	ˈɛˀdɪməʊ		ˈɛksɪməʊ
Geronimo			ˈdʒɒmɪnəʊ
hippopotamus	hɪbəˈpɒmədət	hɪbəˈpɒmənəs	hɪbəˈpɒsɪməs
hospital	ˈhɒˀdəpʊ	ˈhɒˀpdɪdʊ	ˈhɒsbɪdʊ
mahogany	məˈhɒgədɪ	məˈˀɒgənɪ	əˈmɒgənɪ
monopoly			əˈnɒpəlɪ
soldier	ˈʃəʊɫdə	ˈsəʊɫdə	
yellow	ˈdjɛləʊ		

XZ	4;0	4;6	5;0	5;6
animal	'æjɪʊ	'æmbʊ	'æmmʊ	'æməmʊ
Barnaby	'baːbɪ	'baːmbɪ	✔	
Burlington	'bɜːbɪɪŋk	'bɜːlɪŋ	'bɜːlɪŋlənt	'bɜːlɪŋkən
button	'bʌbən	✔		
cardigan	'kaːdæŋ	'kaːgɛŋ	'kaːgɪdɛn	✔
caterpillar	'gætəbɪbɪ	'kæʔəpɪbɪt	✔	
chocolate	'tʃɒtʃɒk	'tʃɒtʃɒk	'tʃɒklə	✔
Christmas	'tʃɪntʃɪn	'krɪ‹s›rə‹s›		'kwɪ‹s›mə‹s›
digital	'dɪʒɪʔʊ	'dɪʔdʊ	'dɪdɪtʊ	'dɪʒɪtʊ
donkey	'dɒdɒŋ	'dɒŋʔkɪ		
eskimo	'ɛʔɪməʊ	'ɛʔɪməʊ	'ɛːgɪməʊ	✔
escalator	'ɛʔgəwɛɪwə	'ɛːgətɛɪt	'ɛːgətɛɪtə	
finger	'hiːjɪŋ	'hiːjɪŋ		
hospital	'hɒ‹ʃ›ɪʊ	'hɒʔbɪbʊ	'hɒʔbɪbʊ	'hɒstəbʊ
Indian	'iːjɪŋ	✔		
Melanie	'mɛlɪɪŋ	'mɛnɪ	'mɛləlɪ	✔
plastic	'plæplæk	'plæplæk	'plæːdɪk	✔
sausages	'hɒwɒʃ	'hɒwɒʃ	'hɒwɪhɪd	'sɒsɪʒɪz
soldier	'həʊwʊv	'həʊwəʊ		

For reasons outside the control of the child, the therapist or the mother, therapy was extremely curtailed given the evident scale of the problem. (This child was regarded by the Community Medical Officer who referred him and by the author as a high priority case.) In the first instance, he was seen once a week. Over the whole period of clinical contact, he was seen altogether on just 17 occasions. The initial interview lasted one hour, the weekly therapy sessions lasted half an hour. When sessions could only take place on a quarterly basis, they again lasted one hour. Altogether, XZ had twelve and a half hours of therapy from me.

ST	4;1	4;11	5;0	6;0	6;5
Barnaby				'baːmɪbɪ	'baːŋəbɪ
certificate					sə'tɪfɪtɪk
digital					'dɪʒɪtʊ
finger	'ɪŋə	'βɪŋə	✔		
hippopotamus				hɪtə'pɒtəməs	hɪtə'pɒtəməs

BC	4;7	5;3	5;6
animal	ˈæmmö	ˈænmö	✔
Barnaby	ˈbammɩ	ˈbadəmɩ	✔
buderigar	ˈbʌbɩgga:	ˈbʌdʒəwɩga:	✔
Burlington	ˈbɜɩŋtən	✔	✔
cardigan	ˈka:də‹l/ɫ›əŋ	ˈka:dɩ‹g›ən	✔
chocolate	ˈʒɒklɛʔ	✔	✔
crocodile	ˈkɒkədaɩɫ	✔	✔
diplodocus		plɩkəˈgəutəs	dɩpləˈgləutəs
Geronimo		ˈdʒɒnɩməu	✔
gobbledigook		ˈgɒbədɩgud	ˈgɒbədɩguk
hippotamus		bɩˈpɒʔməs	hɩtəˈpɒtəmə‹s›
hospital		ˈhɒstɩpu	ˈhɒstɩpu
Jerusalem		ədʒəˈlu:sləm	✔
mahogany		ˈhɒgənɩ	✔
Melanie		ˈmɛnənɩ	✔
soldier		ˈsəuldə	ˈʃəuldə
yellow	ˈlɛləu	=	✔

EF	5;6	5;10	6;1
archeopterix	a:kɩˈɒpədɩs	a:tɩˈɒptərɩɩ	
asbestos	æzˈbɛstɒf	✔	
cardigan			ˈka:dɩdən
certificate	dəˈfɩkətət	✔	
diplodocus	dɩpləˈdəukləs	✔	
eskimo	ˈɛksɩməu	✔	
hospital	ˈhɒʔsɩbu	ˈhɒstɩbu	✔
magnet	ˈmægnɩk		
slip shod	ˈslɩpslɒp	ˈslɩpsɒk	ˈslɩpsɒd
spaghetti	pəˈskɛtɩ		

CD	5;7	6;1
archeopterix		a:tɪ'ɒʔtrɪks
asbestos		æ:'bɛstɒ
cardigan		'ka:dɪən
certificate	sə'ɾɪkələt	sə'kɪfələt
diplodocus	ɒpə'dəutəs	dɪpəu'daukəs
Geronimo		dʒə'mɒnɪməu
Jerusalem		dʒə'lu:sɪəm
mahogany		mə'hɒbəbɪ
yellow		'lɛləu

FG	6;3
aspidistra	æspɪ'sɪstə
calculator	'kæɫtəlɛɪtə
certificate	'tɪɾɪkət
digital	'dɪdʒɪkəɫ
eskimo	'ɛspɪnəu
hippopotamus	hɪtə'pɒtəməs

JK	6;7	7;1
archeopterix	a:tɪ'ɒʔ	✔
certificate	sə'sɪɾɪkət	
digital	'dɪdʒɪtʃʊ	
hippopotamus	hɪtə'pɒtəməs	
Geronimo	dʒə'mɒnɪməu	

KL	7;3	7;5
asbestos	æz'bɛstɒf	✔
hippopotamus	hɪtə'pɒtəməs	
slip shod	'slɪpslɒd	
spaghetti	b̥ə'skɛtɪ	
thermometer	'mɒmɪtə	
Jerusalem	'dʒu:sələm	

QR	6;8	
asbestos	**ɪmˈbɛstɒs**	
aspidistra	**æpsəˈdɪpsə**	
cardigan	**ˈka:dɪdən**	
certificate	**səˈdɪʃɪɪəɪ**	
digital	**ˈdɪdɪtʃʊ**	
Geronimo	**dʒəˈmɒnɪməʊ**	
hippopotamus	**hɪpəˈpɒməs**	
hospital	**ˈhɒsɪbʊ**	
Jerusalem	**dʒəˈlu:sɪəm**	✔
mahogany	**məˈhɒŋədɪ**	
sausages	**ˈsɒdʒɪtʃɪz**	
RS	8;2	
archeopterix	**a:tɪˈɒʔtəwɪs**	**a:tɪˈɒptəwɪks**
budgerigar		**ˈbʌdʒərɪga:d**
calculator	**ˈkæɬɪəlɛɪɪə**	
diplodocus	**dɛbləˈkəʊʃəs**	**dɪpləˈkləʊkləs**
Manchester		**ˈmæntʃɪnstə**
monopoly	**məˈlɒpəlɪ**	
skeleton	**ˈskɛlɪntən**	
slip shod	**ˈslɪpʃɒt**	✔
HI	9;0	
archeopterix	**a:pɪˈɒptrɪks**	
Burlington	**ˈbɜnɪtəm**	
diplodocus	**dɪpləˈdəʊkləs**	
ecstasy	**ˈɛkstəɪ**	
fascination	**fæʃəˈnɛɪʃən**	
gobbledigook	**ˈgɒbədɪgup**	
mahogany	**mənˈhɒgəlɪ**	
slipshod	**ʃɪp ʃɒd**	

Appendix 4: Phase One of experimental investigation: outcomes for 16 words

In the case of any given word, the various outcomes can be defined in a more or less traditional way by the process involved. In the case of *cardigan*, the non-association of Dorsal contrasts with harmony and metathesis. These processes are listed here as Na, H and M. In the case of *hippopotamus*, two harmonies contrast, one prevalent, one not. These are listed as H1 and H2. In the case of *archeopterix* the contrasts are more complex, including simple coronal harmony in the /k/ onset and this and the deletion of the /k/ in the coda – as H1a and H1b, Floating is shown as F, and disharmony as D. The codes here, Na, H1, H2... and so on, are used in the table of raw data outcomes for each of the 16 words

Defining prototypical forms by formula- Key

Cardigan	Na [ˈka:dɩən], H [ˈka:dɩdən], M [ˈka:gɩdən]
Calculator	H [ˈkæɬtəlɛɩtə], M [ˈkæɬtəkɛɩkə]
Hippopotamus	H1 [hɩtəˈpɒtəməs], H2 [hɩpəˈpɒpəməs], M [hɩtəˈpɒpəməs]
Archeopterix	H1a [a:tɩˈɒptərɩks], H1b [a:tɩˈɒptərɩs], H1c [a:tʃɩˈɒptərɩks], H1d [a:tɩɒptərɩʔ], H1e [a:tɩˈɒptərɩk], H2a [a:pɩˈɒptərɩks], H2b [a:pɩˈɒptərɩs], Na1 [a:kɩˈɒptərɩs]. Na2 [a:kɩˈɒptətrɩʔ]
hospital	M [ˈhɒstəpəɬ]
Pentagon	M [ˈpɛŋkədən], H1 [ˈpɛntədən], H2 [ˈpɛŋkəgən],
Asbestos	H [æzˈbɛstɒf]
Animal	F [ˈæmɩnəɬ], [ˈæmɩməɬ]
Barnaby	H [ˈba:məbɩ], M [ˈba:mədɩ]
Magnet	H [ˈmægnɩk],
Monopoly	Dh [məˈnɒkəlɩ]
Geronimo	F1 [dʒəˈmɒnɩməʊ] etc. (no /r/), F2 [dʒəˈrɒmɩnəʊ] etc. (with /r/), F3 [ˈdʒɒmɩnəʊ] (no /r/ or weak foot), Na1 [ˈdʒɒnɩməʊ] (just realignment), Na2 [dʒəˈrɒnɩəʊ] (no /m/)
Jerusalem	Na1 [dʒəˈlu:sələm], Na2 [ˈdʒu:sələm], Na3 [dʒəˈru:sərəm], F [dʒəˈru:ʃələm]
Spaghetti	F [bəˈskɛtɩ]
Soldier	F [ˈʃəʊldə]. Na [ˈsəʊlʒə] etc.
Digital	F1 [ˈdɩdʒɩləl] etc. F2 [ˈdɩdʒɩtʃəl], [ˈdɩdɩtʃəl] Na1 [ˈdɩdʒɩkəl], [ˈdɩdʒɩəl], etc., Na2 [ˈdɩdʒɩəl], Na3 [ˈdɩdʒəəl] Na4 [ˈdɩwəwəl], Na5 [ˈdɩʒɩtəl], [ˈdɩdɩʔəl], etc.

Using this terminology of H1, H2, etc., from the key, identifying words by the first three letters, treating as irrelevant (shown as 'Irr) any non-canonical responses not bearing on a particular central tendency, showing canonical realistions as a dash, realisations of the 16 words in the key were as follows – essentially a three-dimensional matrix, defined on subjects, words, and outcomes. Each word is shown by the first three letters. S19 did not complete the investigation. Words not investigated in his case are shown as Ø.

Outcomes by subjects

S	*Car*	*Cal*	*Hip*	*Arc*	*Hos*	*Pen*	*Asb*	*Ani*	*Bar*	*Mag*	*Mon*	*Ger*	*Jer*	*Spa*	*Sol*	*Dig*
1	–	Irr	H1	H1b	–	–	H1	F	–	–	Irr	F1	Irr	–	–	Na4
2	–	H1	–	H2a	–	Irr	Irr	Irr	–	–	Irr	Na1	Irr	–	Na	–
3	–	H1	Irr	H1a	Irr	H1	H1	–	–	Irr	Irr	F1	Na3	Irr	Irr	Irr
4	–	H2	–	Irr	M	Irr	Irr	–	H	–	–	F1	Na2	Irr	Na	F2
5	H	–	–	Irr	–	M	–	–	–	–	Dh	F1	Na3	Irr	–	F1
6	–	H1	H1	Na1	–	–	–	–	–	Irr	Dh	F1	F	–	Irr	Irr
7	Na	H1	H2	Irr	–	–	CL2	Irr	–	Irr	–	Na1	Irr	Irr	–	Irr
8	–	–	M	Irr	Irr	–	–	F	–	–	H2	F1	Na1	F	F	Na5
9	–	–	Irr	Irr	–	–	–	Irr	–	–	Irr	F3	–	–	Irr	Na5
10	–	–	M	H2b	–	–	CL2	–	–	–	–	F2	Irr	–	Na	F2
11	Na	–	H1	Irr	M	Irr	Irr	F	–	Irr	Irr	F3	Na2	F	–	Na1
12	Na	–	–	–	–	–	Irr	–	Irr	–	Irr	Irr	Na2	F	–	F2
13	–	–	Irr	H1b	–	–	CL2	F	–	Irr	–	–	–	–	–	Na5
14	–	Irr	H1	Irr	–	–	Irr	–	–	–	–	F1	Na3	–	–	–
15	–	–	H1	H1e		Irr	H1	Irr	–	–	–	–	–	Irr	Irr	–
16	Na	–	–	–	–	Irr	CL1	–	–	–	Irr	–	Na2	–	–	Irr
17	–	–	Irr	H1d	–	–	CL1	–	–	–	–	F1	Na2	–	–	–
18	–	–	–	H2a	Irr	–	H1	–	–	–	Irr	Irr	Irr	–	–	–
19	Ø	Ø	H1	–	Ø	Ø	Ø	Irr	Ø	–	Ø	Ø	Ø	–	Ø	F1
20	–	–	H1	Irr	–	–	Irr	–	Irr	Irr	–	–	–	–	F1	Na3
21	–	–	Irr	Irr	–	Irr	Irr	–	–	H	Irr	F2	–	–	Irr	–
22	Na		H1	–	–	–	RH	D	–	–	Irr	F1	–	–	–	–
23	–	–	H1	Irr	–	–	–	–	–	–	–	–	Irr	–	–	–
24	–	–	Irr	–	–	–	Irr	–	Irr	–	–	F3	–	–	–	–
25	–	–	–	Irr	–	M	–	–	–	–	Irr	–	–	–	–	–
26	Na	–	–	Irr	Irr	M	–	–	–	–	Irr	–	F	F	–	–
27	–	–	H1	Irr	–	–	–	–	Irr	–	–	–	Na1	–	–	F2
28	–	–	H2	Irr	Irr	–	Irr	–	–	–	–	–	Irr	–	–	–
29	Na	–	–	H1b	–	–	Dh	F	–	–	Irr	F2	Na2	–	–	–
30	–	–	H1	–	–	–	Dh	–	Irr	–	–	F2	Na2	–	–	–
31	–	–	–	–	–	H1	CL1	–	–	H	Dh	F2	Na3	Irr	–	Na2
32	Na	Irr	–	Irr	–	–	Irr	–	–	–	–	–	–	F	–	Na1
33	Na	H1	–	H2a	–	–	–	–	Irr	–	–	–	Na1	–	–	Irr
34	–	–	H1	Irr	–	–	Irr	–	H1	–	Irr	F2	–	–	–	Irr
35	–	–	–	–	–	–	Irr	–	–	–	–	F2	–	–	–	–
36	–	–	–	Irr	–	–	–	–	–	–	Irr	–	–	–	Irr	F2
37	–	–	–	H2b	–	–	–	–	–	–	–	–	–	–	–	–
38	H	–	–	Irr	–	Irr	–	Irr	–	–	–	Na1	Na1	–	–	Irr
39	Na	H1	H1	H1b	–	M	H1	–	–	–	Dh	–	–	–	F	F1
40	H	–	H2	Irr	Irr	–	RH	F	–	Irr	Irr	F3	Na2	Irr	F	Na2
41	Na	H1	Irr	Irr	–	Irr	Irr	–	Irr	–	Irr	F2	Na1	F	–	–
42	M	–	–	Irr	–	–	Irr	–	–	–	–	F2	–	–	–	F2

43	–	–	–	H1b	–	Irr	–	–	–	Irr	–	F1	–	F	–	–
44	H	–	Irr	H1d	M	M	M	F	–	–	Dh	F1	Na1	–	–	–
45	–	–	–	H1a	–	–	H1	–	–	–	–	–	–	–	Na	–
46	–	H1	–	–	–	Irr	Irr	F	–	–	Irr	F1	–	F	–	Irr
47	–	–	–	Na2	–	–	Irr	Irr	H	–	Irr	–	–	F	–	–
48	–	–	–	–	–	–	Irr	–	–	–	H1	–	–	–	–	–
49	–	H1	H1	–	–	–	Irr	–	–	Irr	–	–	–	–	–	Irr
50	–	H1	Irr	Irr	–	–	Irr	–	–	Irr	–	F2	Irr	Irr	–	Na1
51	–	–	–	Irr	–	–	–	–	–	–	–	Na2	–	–	F	–
52	Na	–	–	H1b		Irr	–	–	–	–	Irr	F2	Irr	F	–	–
53	H	G	H2	Irr	M	Irr	Dh	F	H	–	Irr	F3	Irr	F	F	Na5
54	–	H1	H1	H1a	–	–	H1	–	–	H	–	F1	Na1	Irr	–	–
55	–	–	–	H2a	–	–	–	–	–	–	–	–	–	–	–	–
56	H	–	H2	–	M	–	CL1	–	H	–	–	Na1	Na3	–	Irr	–
57	–	–	Irr	H1a	–	–	–	–	–	Irr	Irr	F1	–	–	–	–
58	–	–	Irr	Irr	–	–	–	–	–	–	Irr	Na1	Na2	–	Irr	–
59	H	Irr	H1	Irr	M	H1	Irr	–	Irr	–	Irr	–	F	Irr	F	Irr
60	–	–	–	–	Irr	–	CL1	–	–	–	–	F1	–	Irr	–	Irr
61	M	–	H2	H1a		H2	Dh	F	–	–	–	–	Na3	F	–	F1
62	–	–	H1	Na1	–	–	Irr	–	–	–	–	Na2	Na1	–	–	–
63	–	–	–	H2a	–	–	–	–	Irr	–	H1	–	Na3	–	–	F2
64	–	–	–	Na1	–	–	–	–	–	–	–	–	Na1	F	–	–
65	–	–	–	H1a	–	–	Irr	–	–	–	–	–	Na3	–	–	F2
66	–	–	Irr	Irr	–	–	–	–	–	–	–	F1	Na1	–	–	Irr
67	Na	–	–	H2b	–	–	Irr	Irr	–	–	–	Na1	–	–	–	–
68	H	–	–	Irr	–	–	Irr	–	–	–	–	F2	–	F	–	F2
69	–	H1	–	–	–	Irr	–	Irr	–	–	–	F2	–	–	–	Irr
70	–	–	–	H2b	–	Irr	Irr	–	–	–	–	F1	Na1	F	–	–
71	–	–	H1	H2b	–	–	Irr	–	–	–	–	–	Na3	–	–	F2
72	–	–	–	Irr	–	–	–	F	–	–	–	F1	–	–	–	Irr
73	–	–	–	Na1	–	M	–	–	–	–	–	–	–	–	–	–
74	M	–	–	Irr	–	M	Irr	F	–	–	–	F1	–	–	–	–
75	–	–	–	Irr	–	–	–	–	–	–	–	–	–	–	–	–
76	Na	–	–	Na1	–	–	–	–	–	–	Irr	–	Na1	–	–	–
77	Irr	–	–	–	–	–	–	–	–	Irr	–	–	–	–	–	Na1
78	–	–	–	H1b	–	–	–	–	–	–	–	–	–	F	–	–
79	–	–	H1	Irr	–	–	CL1	–	–	–	–	F2	F	F	–	–
80	–	–	–	–	–	Irr	CL1	–	–	–	–	–	–	–	–	–
81	H	–	Irr	Irr	M	–	Irr	–	Irr	–	Irr	F1	Irr	F	–	Na5
82	–	–	–	Irr	–	–	–	–	–	–	–	–	–	–	–	–
83	–	–	–	Irr	–	–	–	–	–	–	–	Irr	Na3	–	–	–
84	–	–	–	–	–	Irr	–	–	–	–	Irr	–	–	–	–	–
85	–	–	–	H1b	–	Irr	–	–	–	–	–	–	–	–	–	–
86	–	–	–	Irr	–	Irr	–	–	–	–	–	–	–	F	–	Na1
87	–	–	H1	–	–	–	CL1	Irr	–	–	–	Na1	Irr	–	Irr	F2
88	–	–	–	Irr	–	Irr	–	F	–	–	Dh	F2	–	–	–	–
89	–	–	–	H1c	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	Irr	–	Irr	Irr	–	–	–	–	F2	Na1	–	–	F2
91	–	–	–	H1c	–	–	CL1	–	Irr	–	–	F2	–	–	–	–
92	–	–	H1	H1a		Irr	–	–	–	–	–	–	Na1	F	–	–
93	–	–	H1	–	–	–	–	–	Irr	–	–	–	–	–	–	–
94	–	–	H1	–	–	–	–	–	–	–	–	–	Na1	–	–	–
95	–	–	–	Irr	–	–	–	–	–	–	–	F2	–	–	–	Na1
96	–	–	–	H1a	–	–	–	–	–	–	–	–	–	–	–	–
97	–	–	H1	Irr	–	Irr	–	–	–	–	–	F1	Na3	F	–	–

Appendix 5: Experimental Phases Two and Three

Correct realisations of real and nonsense words shown as blank in right hand column

S1 Phase Two

Jerusalem	[dʒəˈrəusəlɛm]	/həˈrɛɪzənəp/	
/dʒəˈri:sələm/		/həˈri:səlu:b/	
/dʒəˈrəusəlɪm/		/zəˈraɪsənɛɪp/	
/dʒəˈra:sələm/		/səˈrəuzənəum/	
/dʒəˈlɛɪsələm/	[dʒəˈli:sərən]	/dəˈli:sənɛɪm/	[dəˈri:sənɛɪm]
/dʒəˈlɒsərəm/	[dʒəˈrɒsərəm]	/dəˈrɛɪsənu:m/	
/dʒəˈraɪsərəm/	[dʒəˈraɪsələm]	/dʒəˈrəuzəni:m/	
/ˈrɔ:sələ/		/dʒəˈrɛɪsəlu:m/	
/həˈrɛɪdələ/		/dʒəˈrəusələm/	
/dəˈrəudələ/		*Jerusalem*	
/dəˈrəusəlɪ/			

digital	[ˈdɪdʒɪdu:]	/ˈdæzətən/	
/ˈdɒdʒɪtəl/		/ˈdɛzədən/	
/ˈdædʒɪtəl /		/ˈtɪtʃədɛɪn/	[ˈtɪʔʃədɛɪn]
/ˈda:dətɪ/		/ˈtɒdʒɪdaɪn/	[ˈtʃɒdʒɪdaɪn]
/ˈdu:dətə/		/ˈdɛdʒɪtəun/	
/ˈhɒdətən/		/ˈdætʃəti:l /	[ˈdʒætʃəti:ɫ]
/ˈhædɪtö /		/ˈdɪtʃɪtən/	
/ˈhɛɪtɪtən/		/ˈdɒdʒɪtən/	
/ˈsʌdɪttəl/	[ˈsʌdɪtən]	/ˈdædʒɪtəl/	
/ˈtɛdɪtən/		*digital*	[ˈdʒɪdʒɪtəɫ]
/ˈdɒdɪtən/			

archeopterix	[a:tɪ:ˈɒptərɪs]	/a:ˈkʌptəræk/	[ˈrʌptəræk]
/ɛɪkɪˈæptərɒks/		/ɛɪˈkæptərɪk/	[ˈkæptərɪk]
/u:kɪˈɛptərɛks/		/u:ˈkɪptərɪt/	[u:ˈkɪptərɪp]
/əukɪˈʌptərɪks/		/i:ˈkɛptərɒt/	
/aɪtɪˈʌptərɪks/		/a:ˈkʌptərɛɪs/	
/ɔ:pɪˈɛptərɪks/	[ɔ:sɪˈɛptərɪks]	/aɪkɪˈæptərɒɪs/	
/aɪkɪˈæktərɒks/		/ɔ:kɪˈɛptərɛk/	
/u:kɪˈæptə/		/i:kɪˈʌptərɪs/	
/ɔ:kɪˈnɪptə/		/əukɪˈɒptərɛs/	
/ˈkɒptərɛs /		/aɪkɪˈæptərɛks/	
/u:ˈkɛptərɪs/	[u:ˈkɛptərɪts]	*archeopterix*	

aspidistra	[æstə'dɪst‹r›ə]	/ɛpə'dɒstə/	
/ɛspə'dæstrɪ/	[ɛstə'dæsrɪ]	ʌspə'dɑːtrə/	[ʌspə'dɑːt‹r›ə]
/ʌspə'dɒstrə/	[ʌstə'dɒs‹r›ə]	/æspə'dɔːtrɪ/	[æ‹s›pə'dɔːt‹r›ɪ]
/ɛspə'dʌsprə/	[ɛstə'bʌswə]	/ɒspə'dɛɪstɪ/	[ɒspə'dɛɪsɪ]
/ɒspə'dʒɛstə ɒ/	[pə'dʒɛstə]	/æpə'dæstrɪ/	[æpə'dæsrɪ]
/ɪspə'bɪstrɪ/	[ɪstə'bɪswɪ]	/ɪsɪ'dɛstrɪ/	[ɪsɪ'dɛsrɪ]
/ʌstə'dɛstrə/	[ʌstə'dʒɛstə]	/ʌspə'dɒstrə/	[ʌsə'dɒs‹r›ə]
/ɪspə'dʌsə/	[ɪstə'dʌsə]	*aspidistra*	[æspə'dɪs‹r›ə]
monopoly	[mə'nɒpə‹rw›i]	/fə'lɒfəlɪ/	['fɒfə‹l›ɪ]
/mə'nɪpəlɪ/	[mə'nɪpə‹rw›ɪ]	/bə'nuːfəlɪ/	[bə'nuːfə‹rw›ɪ]
/mə'næpələ/	[bə'næpəwə]	/bə'nɔːbələ/	[bə'nɔːdəwə]
/mə'lʌpələ/	[mə'nʌpəwə]	/pə'dæpəlɪ/	[ə'næpə‹rw›ɪ]
/mə'nɪpənɪ/	[mə'nɪpə‹r›ɪ]	/mə'dɛpələ/	[mə'dɛpə]
/mə'nækəlɪ/	[mə'nækə‹rw›ɪ]	/mə'nʌfəlɪ/	[mə'nʌfɪ]
/mə'nɪtəlɪ/	[mə'lɪtə‹n›ɪ]	/mə'nɪpəlɪ/	[mə'nɪpə‹rw›ɪ]
/'nɛpəlɪ/	['nɛpə‹r›ɪ]	*monopoly*	[mə'nɒpə‹r›i]
/'nɒbələʊ/			

Phase Three

archeopterix	[æspɪ'dʒɪs‹w/r›ə]	['dʒɪdʒɪtəɬ]
Jerusalem	[mə'nɒpə‹l›ɪ]	

S2 Phase Two

mahogany	[mə'hɒgədɪ]	/'hɒgənaɪ/	
/mə'hɛgənɪ/	[mə'hɛdətɪ]	/bə'hɛkənɔː/	
/mə'hɪgənɪ/	[mə'hɪgətɪ]	/bə'hɒgənəʊ/	[bə'hɒgə‹d›əʊ]
/mə'hægədɪ/	[mə'hæ‹g›ətɪ]	/mə'hɪgənuː/	
/mə'hɪbənə/	[mə'hɪbətə]	/mə'hɛgənɪ/	
/mə'hɛdənɪ/	['mə'hɛdətɪ]	*mahogany*	
/'hʌkənəʊ/			
escalator	['ɛkskəlɛɪtə]	/skə'nəʊtə/	[skə'nuːtə]
/'æskəluːtə/		/'æskənɒtɪ/	
/'ɒskəliːtə/		/'ɪskənʌtə/	
/sə'lɛɪtə/	[sə'liːtə]	*escalator*	
engine	['ɛndzɪn]	/'hɪndʒɪn/	[hɪndjɪn]
/'ʌndʒɪn/		*engine*	['ɛndzɪn]
/'nɒndʒən/			

bridge	[bə'rɛdz]	/'hɛrɪdʒ/	['hɛrɪdz]
/brɛdʒ/	[bə'rɛdz]	/'bʌrɪdʒ/	['bʌrɪdz]
/brɒdʒ/	[brɒdz]	/brɒtʃ/	[bə'rɒt‹s›]
/brʌdʒ/	[brʌdz]	/prætʃ/	['præts]
/hə'ra:tʃɪ/	[hə'ra:tʃtɪ]	/brɒdʒ/	[brɒdz]
/'hærɪtʃ/	['hærɪʔ‹s›]	*bridge*	/brɪdz]
Jerusalem	[də'lu:sərən]	/hə'rɔ:sənəp/	[hə'rɔ:səɪə]
/dʒə'ri:sələm/	[dʒə'li:sələn]	/hə'rɛɪzənəp/	[hə'‹l›ɛɪzənəp]
/dʒə'rəusələm/	[də'ʔəusɪən]	/hə'ri:səlu:b/	
/dʒə'ra:sələm/	[də'a:sənɪn]	/sə'raɪsənɛɪp/	[sə'raɪsə ɛɪp]
/dʒə'lɛɪsələm/	[də'li:sɪjən]	/sə'rəuzənəum/	[sə'ləuzəʔən]
/dʒə'lɔ:sərəm/	[də'lu:səən]	/də'lɪsənɛɪm/	[də'li:sən ʔɛɪm]
/dʒə'raɪsərəm/	[dʒə'aɪsərən]	/də'rɛɪsənu:m/	[də'li:sə ʔəm]
/'rɔ:sələ/		/dʒə'rəuzəni:m/	[dʒə'ləuzəri:m]
/hə'rɛɪdələ/	[hə'rɛɪdɪə]	/dʒə'rɛɪsəlu:m/	[də'li:sə ʔu:m]
/də'rəudələ		/dʒə'rəusələm/	[dʒə'ləusəjəm]
/də'rəusəlɪ/	[də'ʔəusəlɪ]	*Jerusalem*	[dʒə'lu:sɪjəm]
glove	[rʌb]	/'gu:ləf/	
/glɪv/	[g‹r›ɪv]	/gə'laɪv/	
/glɛf/	[g‹l›ɛ‹v›]	/kə'lu:v/	
/klɒv/	[k‹r›ɒ‹v›]	/glɪv/	[g‹r›ɪv]
/'kɔ:ləf/	['k‹r›ɔ:ləf]	*glove*	[g‹r›ʌv]
digital	['dɪdjətɪ]		
/'dɒdʒɪtəl/	['dɒdjɪtɒ]	/'dæzətən/	['dædətən]
/'dædʒɪtəl/	['dædjɪtö]	/'dɛzədən/	
/'da:dətɪ/		/'tɪtʃədɛɪn/	['tɪʔʃədɛɪn]
/'du:dətə/	['dʒu:djətə]	/'tɒdʒɪdaɪn/	['tɒdʒɪdaɪ]
/'hɒdətən/	['hɒdjətən]	/'dɛdʒɪtəun/	['dɛdjɪtəu]
/'hædɪtəl/		/'dætʃəti:l/	['dædjəti:ɫ]
/'hɛtɪtən/		/'dɪtʃɪtən/	['dʒɪt‹ʃ›ətənt]
/'sʌdɪtəl/		/'dɒdʒɪtən/	['dɒdjɪtən]
/'tɛdɪtən/		/'dædʒɪtəl/	['dædjɪtəɫ]
/'dɒdɪtən/		*digital*	

Phase Three

mahogany	[ɛndzɪdɛndɪn]	[b‹r/w›ɪdz]	['dɪ dʒətö]
escalator	[də'lu:sərəm]	[g‹r/w›ʌv]	

diplodocus	[dɪplə'ɛʊsəs]	/hɒbə'dəʊkə/	
/dɒplə'du:kəs/	[dɒplə'gu:ləs]	/hæplə'ta:kə/	[hæpə'ta:kə]
/dɛplə'daɪkəs/	[dɛplə'daɪkləs]	/hɒplə'dɛɪkɪ/	
/dɛplə'dɛɪkəs/	[dɛpdə'lɛɪkəs]	/dɛblə'ti:kə/	
/dæplə'da:təs/		/dʌplə'taɪkɪ/	
/dʌplə'gɔ:kəs/	[dʌplə'dɔ:kləs]	/hæplə'du:kən/	
/dɪblə'du:kləs/	[dɪbɪlə'du:kəs]	/hɒplə'dəʊkəl/	
/dɛplə'daɪpəs/	[dɛplə'daɪpləs]	/dæplə'di:kən/	
/hɛlə'dɔ:kə/	[hɛlə'dɔ:klə]	/dɛplə'daɪkəs/	
/hɪlə'du:kɪ/		*diplodocus*	
/hɛpə'di:kə/	[hɛlə'bi:kə]		
Jerusalem	[dʒə'lusərəm]	/hə'rɔ:sənəp/	
/dʒə'ri:sələm/	[dʒə'li:sələm]	/hə'rɛɪzənəp/	
/dʒə'rəʊsəlɪm/	[dʒə'ləʊsərɪm]	/hə'ri:səlu:b/	
/dʒə'ra:sələm/		/zə'raɪsənɛɪp/	[zə'raɪsəlɛɪp]
/dʒə'lɛɪsələm/	['dʒɛɪsənəm]	/sə'rəʊzənəʊm/	
/dʒə'lɒsərəm/		/də'li:sənɛɪm/	
/dʒə'raɪsərəm/	[dʒə'raɪsələm]	/də'rɛɪsənu:m/	[dʒə'rɛɪsənu:m]
/'rɔ:sələ/	['rɔ:sənə]	/dʒə'rəʊzəni:m/	
/hə'rɛɪdələ/	[hə'rɛɪdɪə]	/dʒə'rɛɪsəlu:m/	
/də'rəʊdələ/	[də'rəʊdɪə]	/dʒə'rəʊsələm/	
/də'rəʊsəlɪ/		/dʒə'ru:sələm/	[dʒə'nu:sənəm]
eskimo	['ɛkskɪməʊ]	/'a:kəbɔ:/	
/'ɒskɪməʊ/		/'ɔ:səmɒp/	
/'æskɪma:/		/'æskəbu:/	
/'ɒksɪmɔ:/		/'ɪskɪmɛɪ:/	
/'ɪstɪmaɪ/		/ 'ɒskɪməʊ/	['ɒspɪməʊ
/'ɛskɪni:/	['ɛʔksɪni:]	*eskimo*	['ɛ‹s›kɪməʊ
/'i:kɪmɛɪ/	['i:tɪmɛɪ		

monopoly	[məˈlɒpəmɪ]	/fəˈlɒfəlɪ/	
/məˈnæpəmə/		/bəˈnuːfəlɪ/	[bəˈluːfəmɪ]
/məˈnɪpəlɪ/	[məˈnɪpənɪ]	/bəˈnɔːbələ/	[bəˈlɔːbələ]
/məˈlʌpələ/	[məˈlʌpənə]	/pəˈdæpəlɪ	
/məˈnɪpənɪ/	[məˈnɪpəlɪ]	/məˈdɛpəl/	[ˈnɛpələ]
/məˈnækəlɪ		/məˈnʌfəlɪ/	[məˈlʌfəlɪ]
/məˈnɪtəlɪ/	[məˈlɪtənɪ]	/məˈnɪpəlɪ/	[məˈlɪpəlɪ]
/ˈnɛpəlɪ/		*monopoly*	[məˈlɒpəlɪ]
/ˈnɒbələʊ/			

Phase Three

Jerusalem I can say that now		[məˈlɒkəlɪ]	[ˈɛʔkskɪməʊ]
		[dɪpləˈdəʊkələs]	

S5	Phase Two		
glove	[glʌb]	/ˈguːləf /	
/glɪv/		/gəˈlaɪv/	
/glɛf/		/kəˈluːv/	
/klɒv/		/glɪv/	
/ˈkɔːləf/		*glove*	
pentagon	[ˈpɛnnəgən]	/ˈhɛntɪkə/	[ˈhɛndɪkə]
/ˈpʌntəgən/	[ˈpʌndəgən]	/ˈfæntəkɪ/	
/ˈpæntəgən/	[ˈpændəgən]	/ˈpuːtɪkə/	
/ˈpɪndəgən		/ˈpɔːtəkən/	[ˈpɔːkən]
/ˈpɒntəkən/	[ˈpɒntəgən]	/ˈpæntəkɪ/	
/ˈpʌŋkədən/	[ˈpɛŋgədən]	/ˈpɛɪtɪgən/	
/ˈpɪntədən/		/ˈpʌntəgən/	
/ˈhɒtɪkə/		*pentagon*	[ˈpʌndəgən]
aspidistra	[ɪæskəˈdɪsə]	/ʌspəˈdaːtrə/	[ʌspəˈdʒaːt‹r›ə]
/ɛspəˈdæstrɪ/	[ɛskəˈdʒæsrɪ]	/æspəˈdɔːtrɪ/	[æspəˈdʒɔːt‹r›ɪ]
/ʌspəˈdɒstrə/	[ʌssəˈdɒsrə]	/ɒspəˈdɛɪstɪ/	[ɒspəˈdʒɛɪs‹r›ɪ]
/ɛspəˈdʌsprə/	[ɛs‹r›əˈdʌs‹r›ə]	/æpəˈdæst‹r›ɪ/	[ɪpəˈdæsrə]
/ɒspəˈdʒɛstə/	[ɒspəˈdʒɛs‹t›ə]	/ɪsɪˈdɛstrɪ/	[ɪsɪˈdɛs‹r›ɪ]
/ɪspəˈbɪstrɪ/	[ɪspəˈbɪswi]	/ʌspəˈdɒstrə/	[ʌspəˈdʒɒs‹r›ə]
/ʌstəˈdɛstrə/	[ʌstəˈdɛs‹r›ə]	*aspidistra*	[æspəˈdʒɪs‹r›ə]
/ɪspəˈdʌsə/			

archeopterix	[aːˈkiːɒptərɪs]
/ɛɪkɪˈæptərɪks/	[ɛɪkɪˈætərɪs]
/uːkɪˈɛptərɛks/	
/əukɪˈʌptərɪks/	[əukɪˈʌptərɪs]
/aɪtɪˈʌptərɪks/	[aɪtɪˈʌptərɪs]
/ɔːpɪˈɛptərɪks/	[ɔːpɪˈɛptərɪs]
/aɪkɪˈæktərɒks/	[aɪkɪˈæktərɒs]
/uːkɪˈæptə/	[uː‹k›ɪˈæptə]
/ɔːkɪˈnɪptə/	[uːkɪˈdæptə]
/ˈkɒptərɛs/	
/uːˈkɛptərɪs/	

/aːˈkʌptəræk/	[aːˈkrʌptəræ]
/ɛɪˈkæptərɪk/	
/uːˈkɪptərɪɪ/	
/iːˈkɛptərɒt/	[iːˈkɛptərɒk]
/aːˈkʌptərɛts/	[aːˈkʌptərɛs]
/aɪkɪˈæptərɒɪs/	[aɪkɪˈæptərɒs]
/ɔːkɪˈɛptərɛk/	
/iːkɪˈʌptərɪs /	
/əukɪˈɒptərɛs/	
/aɪkɪˈæptərɛks/	[aɪkɪˈæptərɛs]
archeopterix	[aːˈkiːɒptərɪs]

spaghetti	[bəˈskɛʔɪ]
/spəˈgɒtə/	[bəˈskɒtə]
/spəˈgætɪ/	[bəˈskætɪ]
/skəˈbɪtə/	[ˈskpɪtə]
/kəˈspætɪ/	
/spəˈbɪtə/	[bəˈspɪtə]
/skəˈgʌtɪ/	[bəˈskʌtɪ]
/bəˈskɪtə/	
/bəˈkuːnɪ/	
/zəˈkɔːnə/	
/bəˈgɛɪdə/	
/pəˈgaudɪ/	

/pəˈkʌtə/	
/səˈkɒtɪ/	
/səˈkɛtə/	
/ʃəˈkætɪ/	[ʃəˈskætɪ]
/ʃəˈkɪtə/	
/pəˈgɒtɪ/	
/bəˈgaːtə/	
/spəˈguːdɪ/	[bəˈkuːdɪ]
/spəˈgædə/	[bəˈskædə]
/spəˈgɒtə/	[ˈskɒtə]
spaghetti	

Jerusalem	[ˈdʒuːsɪəm]
/dʒəˈriːsələm/	[dʒəˈriːsəəm]
/dʒəˈrausələm/	[dʒəˈrauːsɪm]
/dʒəˈraːsələm	
/dʒəˈlɛɪsələm/	[dʒəˈiːsəɪm]
/dʒəˈlɔːsərəm/	[dʒəˈrɒsə‹r›ən]
/dʒəˈraɪsərəm/	[dʒəˈraɪːsəm]
/ˈrɔːsələ/	
/həˈrɛɪdələ/	
/dəˈraudələ/	
/dəˈrausəlɪ/	

/həˈrɔːsənəp/	
/həˈrɛɪzənəp/	
/həˈriːsəluːb/	
/zəˈraɪsənɛɪp/	[ˈraɪsənɛɪp]
/səˈrauzənəum/	[ˈrauzənəum]
/dəˈlɪsənɛɪm/	
/dəˈrɛɪsənuːm/	
/dʒəˈrauzəniːm/	
/dʒəˈrɛɪsəluːm/	[dʒəˈrɛɪsənuːm]
/dʒəˈrausələm/	
Jerusalem	[dʒəˈluːsərəm]

digital	[ˈdɪdʒəö]	/ˈdɒdɪtən/	
/ˈdɒdʒɪtəl/	[ˈdɒdʒədʒö]	/ˈdæzətən/	
/ˈdædʒɪtəl/	[dædjɪdö]	/ˈdɛzədən/	
/ˈdaːdətɪ/		/ˈtɪtʃədɛɪn/	[ˈtɪʔʃədɛɪn]
/ˈduːdətə/	[ˈduːdədə]	/ˈdɛdʒɪtəʊn/	[ˈdɛdʒɪtəʊ]
/ˈhɒdətən/	[ˈhɒdədən]	/ˈdætʃətiːl/	
/ˈhædɪtəl/	[ˈhædɪdö]	/ˈdɪtʃɪtən/	[ˈdʒɪtʃətənt]
/ˈhɛtɪtən/		/ˈdɒdʒɪtən/	
/ˈsʌdɪtəl/	[ˈsʌdɪdö]	/ˈdædʒɪtəl/	[ˈdædʒɪtʃö]
/ˈtɛdɪtən/		*digital*	[ˈdɪdʒɪtʃö]

Phase Three

glove	[ˈspkɛtɪ]	[aːkɪˈɒptərɪs]	[dʒəˈruːsəm]
pentagon	[æspɪˈdɪs<r/w>ə]	[ˈdɪdʒɪtʃö]	

S6 Phase Two

Geromino	[dʒəˈrɒmɪnəʊ]	/sɪrəˈnuːpɪ/	[sɪrənəˈmuːpɪ]
/dʒəˈrɪnɪmɛɪ/		/zɒrəˈdaːmə/	
/dʒəˈrʌnɪmɔː/		/zærəˈdɔːmɪ/	
/dʒəˈrɛnəmiː/		/zɪrəˈnəʊmə/	
/dʒəˈmænɪmaɪ/	[dʒəˈrænɪmaɪ]	/dʒɛrəˈnuːmɪ/	[dʒɛrɛnəˈnuːmɪ]
/dʒəˈrɪnənəʊ/	[dʒəˈrɪnənəʊ]	/dʒɒrəˈnuːmə/	[dʒərɒnəˈnuːwə]
/ˈrʌnəmuː/		/dʒəˈruːnəpɪ/	
/həˈrænəbaː/	[həˈrænəmaː]	/dʒəˈraːnɪbəʊ/	
/həˈrɪnɪmɛɪ/		/dʒəˈrɔːdəmɪ/	
/dʒəˈlænəməʊ/	[dəˈrænəməʊ]	/dʒəˈrɛdɪmə/	
/dəˈrɛnəmaɪ/		/dʒəˈruːnɪmaɪ /	
/sɛrɪˈdaːbɪ/	[sɛrɪˈbaːbɪ]	/dʒəˈrɪnɪmɛɪ/	
		Geromino	

magnet	[ˈmæɡənɪt]	/ˈhɒɡnɪt/	
/ˈmɒɡnɪt/		/ˈwɪɡnɪt/	
/ˈmʌdnɒt/	[ˈmʌɡnɒt]	/ˈmɛɡnɪs/	
/ˈmʌɡnɪp/		/ˈmɒɡnɪt/	
/ˈmɪɡnɪk/		*magnet*	
/ˈhʌknɪ/			

archeopterix	[a:kə:ˈrɒptəmɩs]	/a:ˈkʌptəræk/	
/ɛɩkɩˈæptərɩks/	[ɛɩkɩˈæptəmɩs]	/ɛɩˈkæptərɩk/	
/u:kɩˈɛptərɛks/	[u:kɩˈɛʔkəmɩs]	/u:ˈkɩptərɩɩ/	[u:ˈkɩptərɩk]
/əʊkɩˈʌptərɩks/	[əʊkɩˈʌʔkəmɩs]	/i:ˈkɛptərɒɩ/	[i:ˈkɛptərɒk]
/aɩtɩˈʌptərɩks/	[aɩtɩˈʌptəmɩs]	/a:ˈkʌptərɛts/	[a:ˈkʌptərɛks]
/ɔ:pɩˈɛptərɩks/	[ɔ:k‹r›ɩˈɛʔtəmɩs]	/aɩkɩˈæptərɒɩs/	[aɩkɩˈæʔtərɒ]
/aɩkɩˈæktərɒks/	[aɩkɩˈæktərɒs]	/ɔ:kɩˈɛptərɛk/	[ɔ:ˈkɛptərɛk]
/u:kɩˈæptə /		/i:kɩˈʌptərɩs/	
/ɔ:kɩˈnɩptə/	[ɔ:kɩˈɩptə]	/əʊkɩˈɒptərɛs/	
/ˈkɒptərɛs/		/aɩkɩˈæptərɛks/	[aɩkɩˈæptərɛs]
/u:kɩˈɛptə‹r›ɩs/		*archeopterix*	[a:ˈki:ɒptərɩs]

aspidistra	[æsʔəˈdrɩʔptə]	/ɛpəˈdɒstə/	[ɛstəˈdɒstə]
/ɛspəˈdæstrɩ/	[ɛstəˈdæsprɩ]	/æspəˈdɔ:trɩ/	[æspəˈdɔ:t‹r›ɩ]
/ʌspəˈdɒstrə/	[ʌstəˈdɒstə]	/ɒspəˈdɛɩstɩ/	[ɒspəˈdɛɩst‹rw›ɩ]
/ɛspəˈdʌsprə/	[ɛstəˈdʌspə]	/æpəˈdæstrɩ/	[æpəˈdæst‹r›ɩ]
/ɒspəˈdʒɛstə/	[ɒstəˈdʒɛstə]	/ɩsɩˈdɛstrɩ/	[ɩsɩˈdrɛstɩ]
/ɩspəˈbɩstrɩ/	[ɩspəˈdɩsti]	/ʌspəˈdɒstrə/	[ʌstəˈdɒstə]
/ʌstəˈdɛstrə/	[ʌstəˈdrɛstə]	*aspidistra*	[æspəˈdɩstə]
/ɩspəˈdʌsə/			

diplodocus	[dɩpdəˈlɛʊkəs]	/hæpləˈta:kə/	[hæk‹l›əˈta:kə]
/dɒpləˈdu:kəs/	[dɒpləˈdu:təs]	/hæpləˈdɛɩkɩ/	[hæk‹l›əˈdɛɩkɩ]
/dɛpləˈdaɩkəs/	[dɛpləˈdaɩkləs]	/tɩpləˈtɔ:kə/	[tɩk‹l›əˈtɔ:kə]
/dʌpləˈdɛɩkəs/	[dʌptəˈdɛɩsəs]	/dɛbləˈti:kə/	[dɛ‹g›ləˈti:kə]
/dæpləˈda:təs/		/dʌpləˈtaɩkɩ/	[dʌk‹l›əˈtaɩkɩ
/dʌpləˈgɔ:kəs/	[dʌpləˈdɔ:kəs]	/hæpləˈdu:kən/	[hæk‹l›əˈdu:kən]
/dɩbləˈdu:kləs/	[dɩpləˈdu:kləs]	/hɒpləˈdəʊkəl/	[hɒk‹l›əˈdəʊkəl]
/dɛpləˈdaɩpəs/	[dɛpləˈdaɩpləs]	/dæpləˈdi:kən/	[dæk‹l›əˈdi:kən]
/hɛləˈdɔ:kə/	[hɛ‹l›əˈdɔ:kə]	/dʌpləˈdɔ:kət/	[dʌk‹l›əˈdɔ:klət]
/hɩləˈdu:kɩ/		/dɛpləˈdaɩkəs/	[dɛkləˈdaɩkləs]
/hɛpəˈdi:kə/	[hɛkəˈdi:kə]	*diplodocus*	[dɩk‹l›əˈdəʊkəs]
/hɒbəˈdəʊkə/	[hɒkəˈdəʊkə]		

Phase Three

Geronimo	*Jerusalem*	[æspəˈdɩssə]	[a:kɩˈɒptərɩs]
magnet		[dɩpləˈdɛʊkləs]	

digital	[ˈdɪdʒɪ‹n›ɒ]	/ˈdæzətən /	
/ˈdɒdʒɪtəl/	[ˈdɒdʒɪtʃö]	/ˈdɛzədən/	
/ˈdædʒɪtəl/	[ˈdædʒɪtʃö]	/ˈtɪtʃədɛɪn/	
/ˈdaːdətɪ/		/ˈtɒdʒɪdaɪn/	
/ˈduːdətə/		/ˈdɛdʒɪtəun/	
/ˈhɒdətən/		/ˈdætʃətiːl/	
/ˈhædɪtəl/		/ˈdɪtʃɪtən/	[ˈdɪtʃɪtʃən]
/ˈhɛɪtən/		/ˈdɒdʒɪtən/	[ˈdɒdʒɪtʃən]
/ˈsʌdɪtəl/		/ˈdædʒɪtəl/	[ˈdædʒɪtʃö]
/ˈtɛdɪtən/		*digital*	
/ˈdɒdɪtən/			

spaghetti	[bəˈskɛtɪ]	/pəˈkʌtə/	
/spəˈgɒtə/	[ˈskɒtə]	/səˈkɒtɪ/	chaos
/spəˈgætɪ/	[spəˈdækɪ]	/səˈkɛtə/	chaos
/skəˈbɪtə/		/fəˈkætɪ/	[fəˈskætɪ]
/kəˈspætɪ/		/fəˈkɪtə/	[ˈskɪtə]
/spəˈbɪtə/	[bəˈspɪtə]	/pəˈgɒtɪ/	[pəˈgɒkɪ]
/skəˈgʌtɪ/	[səˈgʌtɪ]	/bəˈgaːtə/	
/bəˈskɪtə/		/spəˈguːdɪ/	
/bəˈkuːnɪ/		/spəˈgædə/	[bəˈgægə]
/zəˈkɔːnə/	[skəˈkɔːnə]	/spəˈgɒtə/	
/bəˈgɛɪdə/		*spaghetti*	[bəˈskɛtɪ]
/pəˈgaudɪ/			

calculator	[ˈkæɫtəlɛɪtə]	/hɒɫkəˈnəudə/
/ˈkɒɫkjulɛɪtə/	[ˈkɒɫtəlɛɪtə]	/hɪɫkjuˈliːtɪ/
/ˈkɛɫkjulɪtə/	[ˈkæɫtəlɛɪtə]	/ˈhʌɫkəlɪt/
/ˈkɪɫkjulaːkə/	[ˈkɪɫtjulaːtə]	/ˈkæŋkənaɪt/
/ˈkæɫtələutə/	[ˈkæɫtəlɛɪtə]	/ˈkʌɫkələu/
/ˈkæntənaːtə/		/ˈkɒɫkədɪtɪ/
/ˈkɛɫtəlaɪ/		/hɪɫkəˈnəutə/
/ˈkæŋkənɔː/	[ˈkæntənɔː]	/ˈhʌɫkəlɛtə/
/ˈhʌŋkəniːtə/		/kɒɫkəˈləutə/
/hɔːkəˈnuːtɪ/		*calculator*

aspidistra	[æstəˈbɪssə]	/ɛpəˈdɒstə/	
/ɛspəˈdæstrɪ/	[ɛspəˈdæstɪ]	/ʌspəˈdɑːtrɪ/	quiet
/ʌspəˈdɒstrə/	[ʌspəˈdɒssə]	/æspəˈdɔːtrɪ/	[æspəˈdɔːt‹r›ɪ]
/ɛspəˈdʌsprə/	[ɛspəˈdʌsə]	/ɒspəˈdɛɪstɪ]	
/ɒspəˈdʒɛstə/	[ɒpəˈdɛsə]	/æpəˈdæstrɪ/	[æpəˈdæs‹r›ɪ]
/ɪspəˈbɪstrɪ/	[ɪspəˈbɪs‹r›i]	/ɪsɪˈdɛstrɪ/	[ɪsɪˈdrɛs‹r›ɪ]
/ʌstəˈdɛstrə/	[ʌsəˈdɛs‹r›ə]	/ʌspəˈdɒstrə/	[ʌspəˈdʒɒstə]
/ɪspəˈdʌsə/		*aspidistra*	[æspəˈdɪssjə]
magnet	[ˈmægənɪt]	/ˈhɒgnɪt/	
/ˈmɒgnɪt/		/ˈwɪgnɪt/	
/ˈmʌdnɒt/		/ˈmɛgnɪs/	
/ˈmʌgnɪp/		/ˈmɒgnɪt/	
/ˈmɪgnɪk/		*magnet*	[ˈmægənɪt]
/ˈhʌknɪ/	[ˈhʌkənɪ		
hippopotamus	[hɪtəˈpɒʔəməs]	/hɒfəˈbuːtə/	[hɒfəˈbuːpə]
/hɒpəˈpɛtəməs/	[hɒtəˈpɒpəməs]	/hɛfəˈpɪtəməs/	[hɛtəˈpɪtəməs]
/hæpəˈpɪtəməs/	[hæpəˈpɒtəməs]	/hɒfəˈpɒdəmɪ/	[hɒfəˈpɒpəmɪ]
/hɒpəˈpɒpəməs/	[hɪpəˈpɒpəməs]	/hæpəˈbætəmə/	[hæpəˈbæpəmə]
/hætəˈpætəməs/	[hætəˈpæpəməs]	/hɪpəˈpuːtəmɪ/	
/ˈpʌtəməs/		/hʌpəˈpʌdəmət/	[hʌpəˈpʌpəmən]
/həˈbɪdəmə/		/hɒpəˈpɑːtəmət/	[hɒpəˈpɑːpəni]
/məˈpɛdəmɪ/	[məˈpɛdəpiː]	/hɛpəˈpɛtəmən/	[hɛpəˈpɛpəmən]
/məˈbædəməs/		/hæpəˈpɪtəməs/	[hæpəˈpɪpəməs]
/məˈpɑːtəmɪ/	[ˈpɑːpəmiː]	*hippopotamus*	[hɪpəˈpɒpəməs]
/huːməˈbɛɪtə/	[huːməˈbɛɪpə]		
asbestos	[ænəˈbɛstɒs]	/ɛzˈbɑːtəu/	[ˈbɑːtəu]
/ɛzˈbʌstəs/	[ɛzˈbʌsmɒf]	/aɪˈbɪstɔː/	
/ʌzˈbɒstɪs/		/ɛzˈbæstɪ/	
/ɪzˈbæstɒf/		/ɑːˈbɒstɪt/	
/ɛzˈdɪstɒs/		/ʌzˈbɪstɪt/	
/ɛzˈdɑːtəu/		/ɒzˈbɪstɪs/	
/aɪˈdɒntəs/		/ɛzˈbʌstɒs/	[ɛːˈbʌstɒ]
/əuˈdɒstəs/		*asbestos*	[æːˈbɛstɒf]
/aɪˈbɛɪtuː/			

diplodocus	[dɪpəˈdəʊkəs]	/hɒbəˈdəʊkə/	
/dɒpləˈduːkəs/	[dɒpəˈduːkəs]	/hæpləˈtaːkə/	[hæpəˈtaːkə]
/dɛpləˈdaɪkəs/	[dɛpəˈdaɪkəs]	/hɒpləˈdɛɪkɪ/	[hɒpəˈdɛɪkɪ]
/dʌpləˈdɛɪkəs/	chaos	/tɪpləˈtɔːkə/	[tɪpəˈtɔːkə]
/dæpləˈdaːtəs/	[dæpəˈdaːsəs]	/dɛbləˈtiːkə/	[dɛbəˈtiːkə]
/dʌpləˈgɔːkəs/	[dʌpəˈdɔːkəs]	/dʌpləˈtaɪkɪ/	[dʌpəˈtaɪkɪ]
/dɪbləˈduːkləs/	[dɪbəˈduːgəs]	/hæpləˈduːkən/	[hæpəˈduːkən]
/dɛpləˈdaɪpəs/	[dɛpəˈdaɪpəs]	/hɒpləˈdəʊkəl/	[hɒpəˈdəʊkəl]
/hɛləˈdɔːkə/		/dæpləˈdiːkən/	[dæpəˈdiːkən]
/hɪləˈduːkɪ/		/dɛpləˈdaɪkəs/	[dɛpəˈdaɪkəs]
/hɛpəˈdiːkə/	[hɛpəˈduːki]	*diplodocus*	

Phase Three

spaghetti	*calculator*	[æspəˈdɪss‹r›lə]	*digital* chaos
asbestos		[hɪpəˈpɒpəməs]	

S8 Phase Two

asbestos	[æzˈbɛstɒp]	/ɛzˈbaːtəʊ	
/ɛzˈbʌstəs/	[ɛzˈbʌstɒf]	/ɛzˈbaːtəʊ	
/ʌzˈbɒstɪs/	[ʌzˈbɒstɪ‹sf›]	/ɛzˈbæstɪ	
/ɪzˈbæstɒɾ/		/aːˈbɒstɪt/	[aːˈbɒstɪʔ]
/ɛzˈdɪstɒs/	[ɛzˈdɪstɒf]	/ʌzˈbɪstɪt/	[ʌzˈbɪsnɪk]
/ɛzˈdaːtəʊ/		/ɒzˈbɪstɪs/	[ɒzˈbɪznɪs]
/aɪˈdɒntəs/		/ɛzˈbʌstɒs/	[ɛzˈbʌstɒf]
/əʊˈdɒstəs/		*asbestos*	[æzˈbɛstɒf]
/aɪˈbɛɪtuː/			

hippopotamus	[hɪtəˈpɒtəməs]	/hɒ‹f›əˈbuːtə/	
/hɒpəˈpɛtəməs/	[hɒtəˈpɛtəməs]	/hɛɾəˈpɪtəmə/	
/hæpəˈpɪtəməs/	[hætɪˈpɪtəməs]	/hɒɾəˈpɒdəmɪ/	
/hɒpəˈpɒpəməs/	[hɒtəˈpɒtəməs]	/hæpəˈbætəmət/	[hætəˈbætəmə]
/hætəˈpætəməs/		/hɪpəˈpuːtəmɪ/	[hɪtəˈpuːtəmɪ]
/ˈpʌtəməs/		/hʌpəˈpʌdəmət/	[hʌtəˈpʌdəmət]
/həˈbɪdəmə/	[həˈbɪnəmə]	/hɒpəˈpaːtəmət/	[hɒtəˈpaːtəmət]
/məˈpɛdəmɪ/		/hɛpəˈpɛtəmən/	[hɛtəˈpɛtəməm]
/məˈbædəməs/		/hæpəˈpɪtəməs/	[hætəˈpɪtəməs]
/məˈpaːtəmɪ/		*hippopotamus*	[hɪtəˈpɒtəməs]
/huːməˈbɛɪtə/			

budgerigar	[ˈbʌzdərɪgaːd]
/ˈbɪzərɪgɔː‹d›/	
/ˈbɛdʒərɪgəu/	
/ˈbɒdʒərɪgɛɪd/	
/ˈbædʒərɪbaɪ/	[ˈbædʒəʃiːbaɪ]
/ˈpaːtɪkəu/	
/ˈpɛdəgəud/	
/ˈpɒtəguːn/	

glove	[glʌb]
/glɪv/	
/glɛf/	
/klɒv/	
/ˈkɔːləf/	

Jerusalem	[dʒəˈluːsɪən]
/dʒəˈriːsələm/	[dʒəˈriːsənəm]
/dʒəˈrəusələm/	[dʒəˈrəuːsəmɪm]
/dʒəˈraːsələm/	[dʒəˈraːsəmən]
/dʒəˈlɛɪsələm/	[dʒəˈlɛɪsərəm]
/dʒəˈlɒsərəm/	
/dʒəˈraɪsərəm/	[dʒəˈraɪsəmən]
/həˈrɛɪdələ/	
/dəˈrəudələ/	[dʒəˈrəudələ]
/dəˈrəusəlɪ/	[dəˈruːsəlɪ]

diplodocus	[dɪpləˈdəukləs]
/dɒpləˈduːkəs/	[dɒpləˈduːkləs]
/dɛpləˈdaɪkəs/	[dɛpləˈdaɪkləs]
/dʌpləˈdɛɪkəs/	chaos]
/dæpləˈdaːtəs/	[dæpləˈdaːkəs]
/dʌpləˈgɔːkəs/	[dʌpləˈgɔːpəs]
/dɪbləˈduːkləs/	[dɪbləˈduːpləs]
/dɛpləˈdaɪpəs/	[dɛpləˈdaɪkəs]
/hɛləˈdɔːkə/	[hɛləˈdɔːkə]
/hɪləˈduːkɪ/	
/hɛpəˈdiːkə/	
/hɒbəˈdəukə/	

/ˈpætrɪkɛɪn/	
/ˈpɒdlɪkəul/	[ˈpɒdəlɪkəulɪ]
/ˈbædʒəlɪkɛɪ/	
/bɛdʒəˈriːkɪ/	
/bɪdʒəˈrægɪ	
/ˈbɛdʒərɪgəu/	
budgerigar	

/ˈguːləf/	
/gəˈlaɪv/	
/kəˈluːv/	
/glɪv/	
glove	

/həˈrɔːsənəp/	[həˈrɔːsələp]
/həˈrɛɪzənəp/	
/həˈriːsəluːb/	
/zəˈraɪsənɛɪp/	chaos
/səˈrəuzənəum/	
/dəˈlɪsənɛɪm/	
/dʒəˈrɛɪsənuːm/	[dʒəˈrɛɪsəmuː]
/dʒəˈrɛɪsəluːm/	
/dʒəˈrəusələm/	
Jerusalem	

/hæpləˈtaːkə/	[hæp‹l›əˈtaːkə]
/hɒpləˈdɛɪkɪ/	[hɒp‹l›əˈdɛɪkɪ]
/tɪpləˈtɔːkə/	
/dɛbləˈtiːkə/	
/dʌpləˈtaɪkɪ/	
/hæpləˈduːkən/	[hæp‹l›əˈduːkən]
/hɒpləˈdəukəl/	
/dæpləˈdiːkən/	[dækləˈdiːkən]
/dʌpləˈdɔːkət/	
/dɛpləˈdaɪkəs/	[dɛkləˈdaɪkəs]
diplodocus	

soldier	[ˈʃəuɫdə]	/dɪɫdʒɪ/	[dʒɪɫdʒɪ]
/sɪɫdʒə/	[<s>ɪɫdə]	/tɛɫdʒə/	[tʃɛɫdʒə]
/ʃu:də/		/saɪdʒɪ/	[<s>aɪdʒɪ]
/sɛɪdʒɪ/	[ʃɛɪdɪ]	/ʃu:dʒə/	[ʃu:tə]
/sʌɫdə/	[ʃʌɫdə]	/sɪɫdʒə/	[<ʃ>ɪɫdə]
/dɒndʒə/	[dʒɒndʒə]	/səuɫdʒə/	
/tɛndʒɪ/	[tjɛndʒɪ]	*soldier*	[ˈʃəuɫdə]
/sʌndʒə/			

Phase Three

diplodocus	*asbestos*	[hɪtəˈpɒtəməs]	[ʃəuɫdə]
Jerusalem	*Geronimo*	[ˈbʌbə<r/w>ɪga:]	

S9 Phase Two

monopoly	[ˈnɒpəlɪ]	/ˈnɒbələu/
/məˈnɪpəlɪ/		/fəˈlɒfəlɪ/
/məˈnæpələ/		/bəˈnu:fəlɪ/
/məˈlʌpələ/		/bəˈnɔ:bələ/
/məˈnɪpənɪ/		/pəˈdæpəlɪ/
/məˈnækəlɪ/		/məˈdɛpələ/
/məˈnɪtəlɪ/		/məˈnʌfəlɪ/
/ˈnɛpəlɪ/		/məˈnɪpəlɪ/
		monopoly

mahogany	[ˈhɒgənɪ]	/ˈhɒgənaɪ/
/məˈhɛgənɪ/		/bəˈhɛkənɔ:/
/məˈhɪgənɪ/		/bəˈhɒgənəu/
/məˈhægədɪ/		/məˈhɪgənu:/
/məˈhɪbənə/		/məˈhɛgənɪ/
/məˈhɛdənɪ/		*mahogany*
/ˈhʌkənəu/		

Phase Three

mahogany *monopoly*

S10 Phase Two

Jerusalem	[dʒə<r>u:sə<l>əm]	/həˈrɔ:sənəp/	[həˈnɔ:sərəp]
/dʒəˈri:sələm/	[dʒəˈli:səmən]	/həˈrɛɪzənəp/	
/dʒəˈrəusəlɪm/	[dʒəˈləusəmən]	/həˈri:səlu:b/	[həˈli:səbu:b]
/dʒəˈra:sələm/	[dʒəˈla:sərəm]	/səˈraɪsənɛɪp/	
/dʒəˈlɛɪsələm/	[dʒəˈli:sərəm]	/səˈrəuzənəum/	
/dʒəˈlɔ:sərəm/		/dəˈli:sənɛɪm/	
/dʒəˈraɪsərəm/		/dəˈrɛɪsənu:m/	
/ˈrɔ:sələ/		/dʒəˈrəuzəni:m/	
/həˈrɛɪdələ/	[həˈrɛɪdɪə]	/dʒəˈrɛɪsəlu:m/	
/dəˈrəudələ/	[dəˈrəudərə]	/dʒəˈrəusələm/	[dʒəˈləusərəm]
/dəˈrəusəlɪ/	[dəˈlausərɪ]	*Jerusalem*	[dʒəˈru:sərəm]

Phase Three

[dʒəˈləusərəm]

S11 Phase Two

cardigan	[ˈka:dɪən]	/ˈhəudɪkəl/	
/ˈki:dəgən/	[ˈki:dɪən]	/ˈku:ləkɪ/	
/ˈkæ:dəgən/	[ˈkæ:dɪən]	/ˈki:dəkə/	
/ˈku:dəgən/	[ˈku:dɪən]	/ˈku:dəkɛɪn/	
/ˈkɛɪgəgən/	[ˈkɛɪdɪən]	/ˈkəudɪgəul/	
/ˈkaɪdədən/	[ˈkaɪdɪən]	/ˈhɔ:dəgɪ/	
/ˈhɛɪləkɪ/	[ˈhɛɪtti:]	/ˈhu:dɪgən/	
/ˈhəulɪkəl/		/ˈki:dəgən/	[ˈki:dɪən]
/ˈhaɪdəkɪ/		*cardigan*	[ˈka:dɪən]
/ˈhætəkən/			

pentagon	ˈpɛntɪən]	/ˈfæntəkɪ/	
/ˈpɪntəgən/	[ˈpɪntɪən]	/ˈmɪntɪkə/	[ˈmɪntɪə]
/ˈpʌntəgən/	[ˈpʌntɪən]	/ˈbʌntəkɪ/	
/ˈpæntəgən/	[ˈpæntəən]	/ˈpu:lɪkə/	
/ˈpɪndəgən/	[ˈpɪndə:n]	/ˈpɔ:təkən/	[pɔ:tɪən]
/ˈpɒntəkən/	[ˈpɒntɪən]	/ˈpæntəkɪ]	
/ˈpʌŋkədən/	[ˈpʌŋkɪən]	/ˈpɛɪtɪgən/	[ˈpɛɪtɪən]
/ˈpɪntətən/	[ˈpɪntɪən]	/ˈpʌntəgən/	[ˈpʌnlɪən]
/ˈhɔ:tɪkə/	[ˈhɔ:tɪə]	*pentagon*	[ˈpɛntɪən]
/ˈhɛntɪkə/	[ˈhɛntɪə]		

spaghetti	[bəˈskɛʔɪ]
/spəˈgɒtə/	[ˈskɒʔə]
/spəˈgætɪ/	[ˈskɛʔɪ cae]
/skəˈbɪtə/	[ˈskɛʔə cae]
/kəˈspætɪ/	[ˈspækɪ]
/spəˈbɪtə/	[ˈspɪtə]
/skəˈgʌtɪ/	[ˈskɛtɪ]
/bəˈskɪtə/	
/bəˈkuːnɪ/	
/zəˈkɔːnə/	
/pəˈgɛɪdə/	[pəˈ‹g›ɛɪdə]
/pəˈgəʊdɪ/	
Geronimo	[ˈdʒɒmɪnəʊ]
/dʒəˈrɪnɪmɛɪ/	[ˈdʒɪmmɛɪ]
/dʒəˈrʌnɪmɔː/	[ˈdʒʌmɪɔː]
/dʒəˈrɛnəmiː/	[ˈdʒɛməniː]
/dʒəˈmænɪmaɪ/	[ˈdʒæməmaɪ]
/dʒəˈrɪnənəʊ/	[ˈdʒɪnəməʊ]
/ˈrʌnəmuː/	[ˈrʌməmuː]
/həˈrænəbaː/	[ˈrænəbaː]
/həˈrɪnɪmɛɪ/	[ˈrɪnəmɛɪ]
/dəˈlænəməʊ/	[ˈdæləməʊ]
/dəˈrɛnəmaɪ/	[ˈdʒɛnəmaɪ]
/sɛrɪˈdaːbɪ/	[sɛrɪˈbaːrɪ]
monopoly	[məˈbɒpəlɪ]
/məˈnɪpəlɪ/	
/məˈnæpələ/	
/məˈlʌpələ/	[ˈnʌpələ]
/məˈnɪpənɪ/	[məˈnɪpəlɪ]
/məˈnækəlɪ/	[məˈ‹l›ækəlɪ]
/məˈnɪtəlɪ/	[məˈlɪtənɪ]
/ˈnɛpəlɪ/	
/ˈnɒbələʊ/	

/pəˈkʌtə/	
/səˈkɒtɪ/	
/səˈkɛtə/	chaos
/fəˈkætɪ/	refusal
/fəˈkɪtə/	[pəˈkɪtə]
/pəˈgɒtɪ/	
/pəˈgɒtɪ/	
/pəˈgɒtɪ/	
/spəˈguːdɪ/	[ˈskuːdɪ]
/spəˈgædə/	[ˈskɛʔə cae]
/spəˈgɒtə/	[ˈpskɒʔə]
spaghetti	[ˈpskɛtɪ]
/sɪrəˈnuːpɪ/	[sɪrəˈmuːpɪ]
/zɒrəˈdaːmə/	[zɒrəˈdaːrə]
/zærəˈdɔːmɪ/	
/zɪrəˈnəʊmə/	
/dʒɛrəˈnuːmɪ/	[dʒɛ‹r›əˈnəʊmɪ]
/dʒɒrəˈnuːmə/	[dʒɒ‹r›əˈnuːmə]
/dʒəˈruːnəpɪ/	[ˈdʒuːnəpɪ]
/dʒəˈrɔːdəmɪ/	[dʒəˈmuːmɪ]
/dʒəˈrɛdɪmə/	[ˈdʒrɛmɪmə]
/dʒəˈruːnɪmaɪ/	[ˈdʒuː‹n›ɪmaɪ]
/dʒəˈrɪnɪmɛɪ/	[ˈdʒ‹r›ɪnɪmɛɪ]
Geronimo	[ˈdʒɒnɪməʊ]
/fəˈlɒfəlɪ/	[ˈfɒfəlɪ]
/bəˈnuːfəlɪ/	[‹b›əˈnuːfəlɪ]
/bəˈnɔːbələ/	[bəˈ‹n›ɔːbəbə]
/pəˈdæpəlɪ/	[ˈdæpəlɪ]
/məˈdɛpələ/	[ˈdɛpələ]
/məˈnʌfəlɪ/	[ˈmʌfəlɪ]
/məˈnɪpəlɪ/	[ˈnɪpəlɪ]
monopoly	[ˈmɒpəlɪ]

Phase Three

~~spaghetti~~	[ˈpɛntɪən]	[ˈkaːdɪən]
	[ˈdʒɒmɪnəʊ]	[ˈmɒpəlɪ]

watch	[ˈwɒʔʃ]	/ˈwʌntʃ/	[ˈwʌnʔʃ]
/ˈwɛtʃ/	[ˈwɛʔʃ]	*watch*	
/ˈwɛltʃ/	[ˈwɒʔʃ]		
Jerusalem	[dʒəˈlu:sərən]	/həˈrɔ:sənəp/	
/dʒəˈri:sələm/	[dʒəˈli:sərəm]	/həˈrɛɪzənəp/	[ˈhɛɪzənəp]
/dʒəˈrəusələm/	[dʒəˈnəu:sənɪm]	/həˈri:səlu:b/	inaudible
/dʒəˈra:sələm/		/dʒəˈla:səmən/	[zəˈraɪsənɛɪp]
/dʒəˈlɛɪsələm /	[dəˈli:sənɛɪm]	/dəˈli:sənɛɪ/	
/dʒəˈlɔ:sərəm/		/dəˈrɛɪsənu:m/	[dəˈlɛɪsəmən]
/dʒəˈrɛɪsərəm/	[dʒəˈlɛɪsəmən]	/dʒəˈrəuzəni:m/	[dʒəˈnəuzəni:m]
/ˈrɔ:sələ/		/dʒəˈrɛɪsəlu:m/	[dʒəˈlɛɪsəmən]
/həˈrɛɪdələ/		/dʒəˈrəusələm/	[dʒəˈləusəmən]
/dəˈrəudələ/	[dʒəˈləudə‹l›ə]	*Jerusalem*	[dʒəˈlu:səməm]
/dəˈrəusəlɪ/	[dəˈləusərɪ]		
Christmas	[ˈk‹r›ɪsməs]	/krəˈmɪst/	[k‹r›əˈmɪst]
/ˈkrɒsmɪs/	inaudible	/ˈkrʌsmɪt/	
/ˈkræməs/		*Christmas*	
/krəˈmɔ:s/			
gobbledigook	[ˈgɒbəlɪgu:p]	/ˈkɪbəlɪkəu/	
/ˈgɪbəɫdɪgɒk/		/ˈgɛbəlɪgɔ:/	
/ˈgʌbəɫdɪgəuk/		/ˈgɒbənɪki:/	
/ˈgɛbəɫdɪbɒk/	[ˈgɛbəɫdɪbɒp slowly]	/ˈgʌbədɪkɛɪ/	[ˈgʌbə‹d›ɪkɛɪ]
/ˈgɪgəɫdɪgæk/		/ˈwɪbəɫdɪgəu/	[ˈwɪbədɪgəu]
/ˈgæbəɫdɪgu:p/		/ˈwɒbəɫtɪkaɪ/	[ˈwɒbəlɪkaɪ]
/ˈgʌbəɫdɪgɛɪt/		/ˈhɛbəɫdɪgɪk/	[ˈhɛbəɫdɪgɪp]
/ˈhɪbədɪgæk/		/ˈgæpəɫtɪkæk/	[ˈgæpəɫtɪkæp]
/ˈhæbəlɪgɪk/	[ˈhæbəlɪgɪ]	/ˈgʌbəɫdɪgəuk/	
/ˈhɒbədɪgu:/		*gobbledigook*	[ˈgɒbəldɪgu:p
Barnaby	[ˈba:bəbɪ]	/ˈwu:dəmɪ/	[ˈwu:bədɪ]
/ˈbu:nəbə/	[ˈbu:‹n›əpə]	/ˈfaɪnəmɪ/	
/ˈbɛɪnəbɪ/	[ˈbɛɪ‹n›əpɪ]	/ˈpɛɪnəfɪ/	
/ˈbaɪnɪmə/	[ˈbaɪmɪmə]	/ˈpaunəpɪ/	
/ˈbɛnədɪ/		/ˈbi:nəbɛɪ/	
/ˈbɔ:nəbɪ/	[ˈbɔ:məbɪ]	/ˈbɔ:nəbɪ/	
/ˈhautɪmə/		*Barnaby*	

eskimo	['ɛ‹s›kɪməʊ]	/'ɑ:kəbɔ:/	
/'ɒskɪməʊ/	['ɒ‹s›kɪməʊ]	/'ɔ:səmɒp/	
/'æskɪmɑ:/	['æksɪmɑ:]	/'æskəbu:/	['æksɪbu:]
/'ɒksɪmɔ:/		/'ʌskɪmɛɪ:/	['ʌʔksɪmɛɪ:]
/'ɪstɪmaɪ/	['ɪʔsɪmaɪ]	/'ɒskɪməʊ/	['ɒʔksɪməʊ]
/'ɛskɪni:/	['ɛʔksɪni:]	*eskimo*	['ɛʔksɪməʊ]
/'i:kɪmɛɪ/			

Phase Three

Barnaby	[kwɪsməs]	['ɛʔksɪməʊ]
	[dʒə'lu:sələm]	[gɑbəlɪgu:p]

S13 Phase Two

eskimo	['ɛksɪməʊ]	/'ɑ:kəbɔ:/
/'ɒskɪməʊ/		/'ɔ:səmɒp/
/'æskɪmɑ:/	['ɛksɪməʊ]	/'æskəbu:/
/'ɒksɪmɔ:/	['ɛksɪməʊ]	/'ʌskɪmɛɪ:/
/'ɪstɪmaɪ/		/'ɒskɪməʊ/
/'ɛskɪni:/		*eskimo*
/'i:kɪmɛɪ/		
asbestos	[æz'bɛstɒf]	/ɛz'bɑ:təʊ/
/ɛz'bʌstɒs/	[ɛz'bʌstɒ‹s›]	/aɪ'bɪstɔ:/
/ʌz'bɒstɪs/		/ɛz'bæstɪ/
/ɪz'bæstɒf/		/ɑ:'bɒstɪt/
/ɛz'dɪstɒs/	[ɛz'dɪstɒ‹s›]	/ʌz'bɪstɪt/
/ɛz'dɑ:təʊ/		/ɒz'bɪstɪs/
/aɪ'dɒntəs/		/ɛz'bʌstɒs/
/əʊ'dɒstəs/		*asbestos*
/aɪ'bɛɪtu:/		
mahogany	['hɒgənɪ]	/'hɒgənaɪ/
/mə'hɛgənɪ/		/bə'hɛkənɔ:/
/mə'hɪgənɪ/		/bə'hɒgənəʊ/
/mə'hægədɪ/		/mə'hɪgənu:/
/mə'hɪbənə/		/mə'hɛgənɪ/
/mə'hɛdənɪ/		*mahogany*
/'hʌkənəʊ/		

Phase Three

eskimo *mahogany*

asbestos

S 14 Phase Two

Geronimo	[dʒəˈ‹r›ɒnɪ‹m›əʊ]	/sɪrəˈnuːpɪ/	
/dʒəˈrɪnɪmeɪ/	[dʒəˈmɪnəmeɪ]	/zɒrəˈdaːmə/	
/dʒəˈrʌnɪmɔː/	[ˈdʒʌnɪmɔː]	/zærəˈdɔːmɪ/	
/dʒəˈrɛnəmiː/		/zɪrəˈnəʊmə/	
/dʒəˈmænɪmaɪ/	[dʒəˈmənəmaɪ]	/dʒɛrəˈnuːmɪ/	
/dʒəˈrɪnənəʊ/	[dʒəˈmɪnənəʊ]	/dʒɒrəˈnuːmə/	
/ˈrʌnəmuː/		/dʒəˈruːnəpɪ/	[dʒəˈ‹r›uːnəpɪ]
/həˈrænəbaː/		/dʒəˈraːnɪbəʊ/	[dʒəˈ‹r›aːnɪbəʊ]
/həˈrɪnɪmeɪ/		/dʒəˈrɔːdəmɪ/	[dʒəˈrɛdɪmə]
/dəˈlænəməʊ/	[dəˈmænəməʊ]	/dʒəˈruːnɪmaɪ/	[dʒəˈ‹r›uːnɪmaɪ]
/dəˈrɛnəmaɪ/		/dʒəˈrɪnɪmeɪ/	[dʒəˈ‹r›ɪnɪmeɪ]
/sɛrɪˈdaːbɪ/		*Geronimo*	

gobbledigook	[ˈgɒbəlɪguːk]	/ˈkɪbəlɪkəʊ/	
/ˈgɪbəɫdɪgɒk/	[ˈgɪbəlɪgɒk]	/ˈgɛbəlɪgɔː/	
/ˈgʌbəɫdɪgəʊk/	[ˈgʌbədɪgəʊk]	/ˈgɒbənɪkiː/	
/ˈgɛbəɫdɪbɒk/		/ˈgʌbədɪkeɪ/	
/ˈgɪgəɫdɪgæk/	[ˈgɪdəɫdɪgæk]	/ˈwɪbəɫdɪgəʊ/	[ˈwɪbəlɪgəʊ]
/ˈgæbəɫdɪguːp/	[ˈgæbəlɪguːp]	/ˈwɒbəɫtɪkaɪ/	
/ˈgʌbəɫdɪgeɪt/	[ˈgʌbəlɪgeɪk]	/ˈhɛbəɫdɪgɪk/	[ˈhɛbəɫdɪgɪp]
/ˈhɪbədɪgæk/	[ˈhɪbədɪgæp]	/ˈgæpəɫtɪkæk/	[ˈgæpəlɪkæk]
/ˈhæbəlɪgɪk /		/ˈgʌbəɫdɪgəʊk/	[ˈgʌbəlɪgəʊk]
/ˈhɒbədɪguː/		/ˈgɒbəldɪguːk/	[ˈgɒbəlɪguːk]

hippopotamus	[hɪtəˈpɒtəməs]	/hɒfəˈbuːtə/	
/hɒpəˈpɛtəməs/	[hɒtəˈpɛtəməs]	/hɒfəˈpɪtəmə/	
/hæpəˈpɪtəməs/		/hɒfəˈpɒdəmɪ/	
/hɒpəˈpɒpəməs/		/hæpəˈbætəmə/	
/hʌtəˈpætəməs/		/hɪpəˈpuːtəmɪ/	[hɪtəˈpuːtəmɪ]
/ˈpʌtəməs/		/hʌpəˈpʌdəmət/	[hʌtəˈpʌdəmət]
/həˈbɪdəmə/		/hɒpəˈpaːtəmət/	[hɒtəˈpaːtəmət]
/məˈpɛdəmɪ/		/hɛpəˈpɛtəmən/	
/məˈbædəməs/		/hæpəˈpɪtəməs/	
/məˈpaːtəmɪ/		*hippopotamus*	[hɪtəˈpɒtəməs]
/huːməˈbeɪtə/			

Jerusalem	[dʒəˈru:səmən]	/həˈrɔ:sənəp/	[həˈrɔ:sə‹l›əp]
/dʒəˈri:sələm/		/həˈrɛɪzənəp/	
/dʒəˈrəusələm/		/həˈri:səlu:b/	
/dʒəˈra:sələm/		/zəˈraɪsənɛɪp/	
/dʒəˈlɛɪsələm/	[dʒəˈlɛɪsəməm]	/səˈrəuzənəum/	
/dʒəˈlɔ:sərəm/		/dəˈli:sənɛɪm/	
/dʒəˈraɪsərəm/		/dəˈrɛɪsənu:m/	
/ˈrɔ:sələ/		/dʒəˈrəuzəni:m/	
/həˈrɛɪdələ/	[həˈrɛɪdə‹l›ə]	/dʒəˈrɛɪsəlu:m/	
/dəˈrəudələ/		/dʒəˈrəusələm/	
/dəˈrəusəlɪ/	[dəˈrəusə‹l›ɪ]	*Jerusalem*	

Phase Three

Geronimo	*Jeruslaem*	[ˈgɒbəlɪgu:k]	
aspidistra		[hɪtəˈpɒtəməs]	

S15	Phase Two		
aluminium	[æləˈmɪnɪən]	/aɪˈmænɪəu/	
/ɒləˈmɒnɪəm/	[ɒnəˈmɒnɪən]	/ɛləˈmælɪə/	[ɛləˈmænɪə]
/ɛləˈmʌnɪəm/	[ɛləˈmʌnɪən]	/ɪnəˈmɒnɪu:/	
/ɪləˈmɛlɪəm/		/ɒləˈmʌnɪəup/	[ɒnəˈmʌnɪəup]
/ɪləˈmɒmɪəm/		/ɛdəˈmænɪɛɪp/	[ɛnəˈmædɪɛɪp]
/ɒnəˈmænɪəm/		/ɪnəˈmɒdɪəm/	[ɪdəˈmɒnɪəm]
/ləˈmɪnɪəm/	[nəˈmɪnɪəm]	/ɛnəˈmɛdɪəm/	
/ɒnəˈbɛnɪə		/ʌləˈmʌnɪəm/	
/ɛləˈbʌnɪə/	[ɛnəˈbʌnɪə]	*aluminium*	

Phase Three

		aluminium	chaos

S 19	Phase Two		
bridge	[b<rw>ɪdz]	/ˈhɛrɪdʒ/	
/brɛdʒ/	[bəˈrɛdz]	/ˈbʌrɪdʒ/	
/brɒdʒ/	[b<rw>ɒdz]	/bəˈrɒtʃ/	[brɒtʃ]
/brʌdʒ/	[b<rw>ʌdz]	/prætʃ/	[prætʃ]
/həˈra:tʃɪ/		/b<rw>ɒdʒ/	[b<rw>ɒdz
/ˈhærɪtʃ/		*bridge*	[b<rw>ɪdʒ]

hippopotamus	[hιtəˈpɒtəməs]	/hɒfəˈbuːtə/	
/hɒpəˈpɛtəməs/	[hɒpəˈpɒtəməs]	/hɛfəˈpιtəmə/	
/hæpəˈpιtəməs/		/hɒfəˈpɒdəmι/	
/hɒpəˈpɒpəməs/		/hæpəˈbætəmə/	
/hætəˈpætəməs/		/hιpəˈpuːtəmι/	
/ˈpʌtəməs/		/hʌpəˈpʌdəməι/	
/həˈbιdəmə/		/hɒpəˈpaːtəməι/	
/məˈpɛdəmι/		/hɛpəˈpɛtəmən/	
/məˈbædəməs/		/hæpəˈpιtəməs/	
/məˈpaːtəmι/		*hippopotamus*	
/huːməˈbɛιtə/			
Phase Three			
	[b<rw>ιdʐ]	[hιtəˈpɒtəməs]	
S 28	Phase Two		
gobbledigook	[ˈgɒbədι‹l›gəʊf]	/ˈkιbəlιkəʊ/	
/ˈgιbəłdιgɒk/		/ˈgɛbəlιgɔː/	
/ˈgʌbəłdιgəʊk/	[ˈgʌbəlιgəʊk]	/ˈgɒbənιkiː/	[ˈgɒbəlιkiː]
/ˈgɛbəłdιbɒk/	[ˈgɛbəłdιgɒk]	/ˈgʌbədιkɛι/	
/ˈgιgəłdιgæk/		/ˈwιbəłdιgəʊ/	[ˈwιbəlιgəʊ]
/ˈgæbəłdιguːp/		/ˈwɒbəłlιkaι/	
/ˈgʌbəłdιgɛιt/		/ˈhɛbəłdιgιk/	
/ˈhιbədιgæk/		/ˈgæpəłlιkæk/	
/ˈhæbəlιgιk/		/ˈgʌbəłdιgəʊk/	
/ˈhɒbədιguː/		*gobbledigook*	
archeoopterix	[aːpiːˈrɒˀkərιˀs]	/aːˈkʌptəræk/	
/ɛιkιˈæptərιks/	[ɛιk tιæp kərιˀs]	/ɛιˈkæptərιk/	
/uːkιˈɛptərɛks/	[uːpιˈɛptərɛks]	/uːˈkιptərιt/	[uːˈkιptərιk]
/əʊkιˈʌptərιks/	[əʊpιˈʌp pərιˀs]	/iːˈkɛptərɒt/	[iːˈkɛptərɒk]
/aιtιˈʌptərιks/	[aιpιˈʌptərιks]	/aːˈkʌptərɛts/	
/ɔːpιˈɛptərιks/		aιkιˈæptərɒts/	[aιpιˈkæˀtərɒts]
/aιkιˈæktərɒks/	[aιtιˈæktərɒks]	/ɔːkιˈɛptərɛk/	
/uːkιˈæptə/	[uːpιˈæptə]	/iːkιˈʌptərιs/	[iːkιˈʌktərιks]
/ɔːkιˈnιptə/	[ɔːpιˈnιptə]	/əʊkιˈɒptərɛs/	[əʊtιˈɒptərɛs]
/ˈkɒptərɛs/	[ˈkɒptərɛks]	/aιkιˈæptərɛks/	
/uːˈkɛptərιs/		*archeoopterix*	[aːpiːˈɒptərιks]
Phase Three	*gobbledigook*	[aːpiːˈɒppərιks]	

Appendix 6: 'Dorsalisation' (from Smith, 1973)

This appendix lists all examples of 'dorsalisation', vocalisation, and lateral deletion on the right of a post-vocalic lateral from the appendix in Smith (1973).

Stage	Word	Realisation	Stage	Word	Realisation
1	*little*	'didi:	11	*rattle*	'rækəl
	troddler	'lɒlə		*poodle*	'pu:gəl
	bottle	'bɔgu		*fiddle*	'figəl
	handle	'ɛŋu		*kettle*	'kɛkəl
	pedal	'bɛgu		*petal*	'pɛkəl
	candle	'gæŋgu		*kennel*	'kɛŋəl
	kettle	'gɛgu		*spindle*	'spiŋgəl
	needle	'ni:gu		*paddling pool*	'pægəlin pu:l
	middle	'migu		*tiddly winks*	'tigəli wiŋks
	puddle	'bʌgu		*antlers*	'æŋkləz
2	*troddler*	'gɒgə		*journal*	'dʒə:ŋəl
	handle	'æŋgu		*hey-diddle-diddle*	'eigigəl
4	*cattletruck*	gægugʌk		*hospital*	'hɔspikəl
	rattle	'ræku		*middle*	'migəl
	metal	'mɛgu		*muddle*	'mʌgəl
6	*little*	'didi: / 'lidi:		*pedal*	'bɛgəl
9	*little*	'lidi:		*troddler*	'gɔglə/'glɔglə
10	*bottle*	'bɔkəl		*metal*	'mɛkəl
11	*beetle*	'bi:təl		*pedal*	'pɛgəl
	little	'lidi: / 'litəl		*puddle*	'pʌgəl
	tiddly pom	'didəli: pɔm		*ladle*	'leigəl
	gentle	'dɛŋkəl		*needle*	'ni:gəl
11	*needle*	'ni:gəl	20	*difficult*	'gifətəlt
	handle	'æŋgəl	25	*cuddle*	'kʌgəl
	noddle	'nɔgəl	26	*difficult*	'difkəlt
12	*saddle*	'lægu / 'lægul	27	*Donald*	'dɒnəld
	cock-a-doodle-doo	'kɒkədu: gəldu	28	*tunnel*	'tʌnəl
13	*difficult*	'giptu		*funnel*	'fʌnəl
	ladle	'leigu / 'leigul	29	*medal*	'mɛdəl / 'mɛgəl
	mantlepiece	'mæŋku bi:t		*little*	'litəl / 'liəl

14 *little*	ˈlitəl	*bottle*	ˈbɔkəl / ˈbɔtəl
16 *difficult*	ˈgipətəl	*throttle*	ˈsrɔkəl
troddler	ˈtrɔglə	*difficult*	ˈdifikəlt
18 *cuddle*	ˈkʌdəl	*handle*	ˈhændəl
bundle	ˈbʌŋgəl	*metal*	ˈmɛtəl
19 *sandal*	ˈtæŋgəl	*puddle*	ˈpʌdəl

This data was adduced by Macken (1986) in a sweeping criticism of Smith's conclusions, too sweeping as argued in the text here. As noted in the text, Smith's 'stages' appear to correspnd to continous periods of observation. No attempt is made to justify them on the grounds of their internal content. Stages range from 1 to 2 weeks in length, separated by periods of a few days of rest perhaps, or teaching. In Appendix 7 the stages are given as in Smith's text.

Appendix 7: Smith's stages

In the text here, Smith's stages have been converted to an arbitrary chronology of months calculated in days in the middle of the period of observation. Appendix 7 converts Smith's stages into the chronology here. In the calculation of this chronology, it is assumed that all months are of equal length, i.e. 30.5 days.

1	2;1.29	11	2;6.28		
2	2;3.24	12	2;7.10		
3	2;4.8	13	2;7.25	23	3;1.28
4	2;4.13	14	2;8.7		
5	2;4.20	15	2;8.22	25	3;3.25
6	2;4.27	16	2;9.5		
7	2;5.4	17	2;9.17	27	3;6
8	2;5.18	18	2;10.1	28	3;8
9	2;6.10	19	2;10.20	29	3;10
10	2;6.17	20	2;11.15		

Appendix 8: Conventions

The observations here, not made in laboratory conditions, are transcribed broadly in standard IPA unless the point dictates otherwise (see Pullum and Ladusaw, 1986, Duckworth, Allen, Hardcastle and Ball, 1990, for different views on this). Not the main focus of discussion here, vowels are largely idealised. Primary stress is shown by a vertical dash before the syllable concerned, syllabicity by a dash above the character, voicelessness by a hollow dot, consonant geminates by doubling of the character. As in Smith (1973), in tables where the nature of entities is well-defined, slashes and brackets are omitted. But for the sake of consistency, contrast, and readability, the slash/square-bracket distinction is retained in the text and derivations. Representations are as follows.

Vowels

i:	Tense (long), high, front	*he*
ɪ	Non-tense (short, lax), high, front – alternatively (Smith, 1973) **i**	*him*
ɛɪ	Tense (long), front, mid on-glide – alternatively (Smith, 1973) e:	*hay*
ɛ	Non-tense (short, lax), front, mid	*hem*
ɛə	Tense (long), front, mid on-glide, mid off-glide	*hair*
æ	Non-tense (short, lax), front, low	*ham*
a:	Tense (long), front, low – alternatively a Gimson-like RP ɑ:	*haha*
ʌ	Non-tense (short, lax), low, back, non-round	*hum*
ɔ:	Tense (long), mid, back, round	*haw*
ɒ	Non-tense (short, lax), low, back, round	*hot*
u:	Tense (long), high, back, round	*who*
ʊ	Non-tense (short, lax), high, back, round	*hood*
aɪ	Tense (long), front, low on-glide, high off-glide	*high*
ɒɪ	Tense (long), front, low back on-glide, high front off-glide	*ahoy*
aʊ	Tense (long), low front on-glide, high, back off-glide	*how*
əʊ	Tense (long), mid on-glide, high, back off-glide	*hoe*
ə	Non-tense (short, lax), mid (high/low), mid front/back (schwa)	winner
ɜ	Tense (long), mid (high/low), mid front/back – alternatively [ə:]	*her*

Stops

t	Voiceless, coronal, apical (alveolar)	*tay*
d	Voiced, coronal, apical (alveolar)	*day*
k	Voiceless, dorsal (velar)	*Kay*

g	Voiced, dorsal (velar)	*gay*
p	Voiceless, labial (bi-labial)	*pay*
b	Voiced, labial (bi-labial)	*bay*

Fricatives

s	Voiceless, coronal, apical (alveolar)	*see*
z	Voiced, coronal, apical (alveolar)	*zoo*
ʃ	Voiceless, coronal, non-apical, (palato-alveolar)	*she*
ʒ	Voiced, coronal, non-apical, (palato-alveolar	*treasure*
f	Voiceless, labio-dental	*fee*
v	Voiced, labio-dental	*vee*
θ	Voiceless, coronal, interdental	*thigh*
ð	Voiced, coronal, interdental	*thy*
x	Voiceless, dorsal (velar) – Scottish English coda	*loch*
ɣ	Voiced, dorsal (velar) – Gaelic	*dha*

Affricates

tʃ	Voiceless, coronal, non-apical, (palato-alveolar)	*chew*
dʒ	Voiced, coronal, non-apical, (palato-alveolar)	*jew*

Liquids

l	Lateral, coronal, apical	*Lou*
r	Rhotic, coronal, non-apical, variably retroflex, alternately a glide	*rue*

Glides

j	High, front	*you*
w	High, round, back	*woo*

Other symbols encode various degrees of allophony, e.g. /l/, phonetically clear as [l], darkened as [ɫ], vocalised as [ö], the glottal stop replacing /t/ in some environments in Cockney and RP, [ŋ] as the surface coda in *sing* in most dialects of English etc..[77] Where phrases are transcribed, word-breaks are shown, with no theoretical implication, just descriptive convenience. Where appropriate, an archi-phonemic N denotes nasality

[77] The [ö] transcription of syllabic laterals in dialects such as Estuary English is due to the observations of JW, the author's collaborator in the collection of the main experimental data, with no formal training in phonetics, but an uncommonly acute natural phonetician.

in final clusters. Finer variations are not shown, partly because of the circumstances of the data collection, and partly on the assumption that transcription should encode detail only to the level that this represents the actual competence of the speaker, that some elements are best treated as indeterminate.

The notion of indeterminacy addresses a problem stemming from the use of a notation designed for a fully developed system to describe an incomplete one. As noted in the Introduction, the thinking on this point is taken from Abberton (1978 – in class), but adapted for the sake of computer input and readability. To encode the idea that an element may be indeterminate for the speaker, it is shown here between pointed brackets. Where there are two such elements, both are shown. This arises with respect to /ɹ/ – for a given developmental period at least in L1 learners of Greater London English as [<ɹ/ w>] and less standardly with respect to the apicality distinction between /s/ and /ʃ/ – as [<s/ʃ>]. This amounts to an extreme degree of broadness in transcription, appropriate where the speaker's phonological competence is in doubt. The idea is not to impute to the child a degree of competence, when the data refers to a lack of any such thing.

Round brackets are used as follows: A) standardly in the text, B) in 'linear' rule statements, C) for numbered examples, tables, quotations, etc., D) publication dates. Numbered examples contain two digits, the first denoting the chapter, the second denoting sequence within the chapter. Roman numerals denote sequence within a given example. Letters are used when there is no claim regarding the sequence.

Curly brackets are used to describe cases where a descriptive statement either applies, or doesn't – as, for instance in the case of syllable structure where it might be said that languages vary according to whether the syllable {is/is not} closed.

Alpha variables α, β, γ, δ, are used on their own to denote a single category and prefixed by + or – to denote what is referred to here as a 'polarity'.

Non-attestation is shown by a 'diamond bullet' ◆, rarther than the * of generative grammar. (In incompetent phonology, non-attestation is never absolute.)

Reference to individuals is by pairs of letters in the clinical data (randomly assigned) and by numbers in the experimental data (in order of chronological age).

Since genetic sex may be significant, reference to the general case is as *he or she*.

Parts of the data are described in terms of a mathematical logic, according to which an element e, representing any amount of phonological structure, is treated as a member of the set E. The differentiated membership of E is shown as e_i as against e_j.

REFERENCES

Abberton, E.(1978) Class lecture.

Anderson, J., Ewen, C. (1987) *Principles of dependency phonology*. Cambridge: Cambridge University Press.

Anthony, A., Bogle, D., Ingram, T.T.S., & McIsaac, M.W. (1971) *The Edinburgh Articulation Test*. Churchill Livingstone: Edinburgh.

Archangeli, D. (1984) *Underspecification in Yawelmani Phonology and Morphology*. PhD Dissertation, MIT.

Archangeli, D. (1988) Aspects of underspecification theory. *Phonology* 5, 183–208

Archangeli, D., Pulleyblank, D. (1994) *Grounded phonology*. Cambridge Massachusetts: MIT Press.

Archibald, J. (ed) *Phonological acquisition and phonological theory*. Hillsdale, New Jersey: Lawrence Erlbaum.

Aronoff, M. (1984) Voicing in Russian. In M. Aronoff and R. Ohrle (eds).

Aronoff, M. & Oehrle, R. T. (1984) *Language Sound Structure: Studies in phonology presented to Morris Halle by his teacher and students*. Cambridge Mass MIT Press.

Atkinson, M. (1982) *Explanations in the study of child language*. Cambridge: Cambridge University Press.

Atkinson, M. (1992) *Children's syntax: An introduction to principles and parameters theory*. Oxford: Blackwell.

Bach, E. (1968) Two proposals concerning the simplicity metric in phonology. *Glossa* 2: 128 – 149.

Backley, P. (1993) Coronal: The undesirable element. University College London, *Working Papers in Linguistics*. 5, 301–323

Bailey, C. J. (1970) Towards specifying constraints on phonological metathesis. *Linguistic Inquiry* 1: 147 – 149.

Ball, M. J. & Kent, R. D. (eds) (1997) *The new phonologies: developments in clinical linguistics*. San Diego: Singular

Barry, M. (1993) Syllable structure and the velar nasal in Russian. *Workshop on Cognitive Phonology*, North-West Centre for Romance Linguistics, University of Manchester.

Barry, S. (1993) Feature geometry and clinical phonology. *Workshop on Cognitive Phonology*, North-West Centre for Romance Linguistics, University of Manchester.

Berg, T. (1991) Phonological processing in a syllable-timed language with pre-final stress: evidence from Spanish speech error data. *Language and Cognitive Processes* 6/4: 265 – 307.

Berg, T. (1992) Phonological harmony as a processing problem. *Journal of Child Language* 19: 225 – 257.

Bernhardt, B. H. (1992) Developmental implications of nonlinear theory. *Clinical Linguistics and Phonetics* 6/4 : 259 – 281.

Bernhardt, B. H. and Gilbert, J. (1992) Applying linguistic theory to speech-language pathology: the case for nonlinear phonology. *Clinical Linguistics and Phonetics* 6/1 & 2: 123 – 145.

Bernhardt, B. H. and Stemberger, J. P. (1998) *Handbook of Phonological Development: From the Perspective of Constraint-based NonLinear Phonology. San Diego: Academic Press*

Bertolo, S, (1995) Maturation and learnability in parametric systems. *Language Acquisition* 4, 4 277–318.

Bertolo, S., Brohier, K., Gibson, K., Wexler, K. (1997) *Characterising conditions for cue-based learning in parametric language systems.* Poster at GALA.

Besnier, N. (1987) An autosegmental approach to metathesis in Rotuman. *Lingua.* 73, 201–223.

Bickmore, L. S. Accounting for compensatory lengthening in the CV and moraic frameworks. In J. Durand & F. Katamba (eds) , 119-148.

Bickerton, R. (1990) *Language and Species.* Chicago: University of Chicago Press

Bickmore, L. (1995) Accounting for compensatory lengthening in the CV and moraic frameworks. In J. Durand & F. Katamba (eds) 119–148.

Bird, J. & Bishop, D. (1991) Perception and awareness of phonemes in phonologically impaired children. *European Journal of Disorders of Communication* 27: 289 – 312.

Bishop, D. V. M. & Adams, C. (1990) A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. *Journal of Child Psychology and Psychiatry.*

Blalock, H. M. (1972) *Social statistics.* New York: McGraw-Hill

Blevins, J. (1992) Review of An Essay on Stress. Language. 68, 159–165.

Blevins, J. (1995) The syllable in phonological theory. In J. A. Goldsmith (ed) *The handbook of phonological theory.* Oxford: Blackwell. pp. 206–244.

Bond, Z. S. & Small, L. H. (1984) Detecting and correcting mispronunciations: a note on methodology. *Journal of Phonetics,* 12: 277 – 283.

Boomer, D. S. & Laver, J. D. (1973) Slips of the tongue. In V. A. Fromkin (ed) *Speech errors as linguistic evidence.* The Hague: Mouton.

Borer, H. (1983) *Parametric syntax.* Dordrecht: Foris.

Borer, H. and Dresher, B. (1990) In I. Roca (ed).

Bradford, A. & Dodd, B. (1994) The motor planning abilities of phonologically disordered children. *European Journal of Disorders of Communication* 29/4: 349 – 370.

Brett, L., Chiat, S. & Pilcher, C. (1987) Stages and units in output processing: Some evidence from voicing and fronting processes in children. *Language and Cognitive Processes* 3/4: 165 – 177.

Bridgeman, E., & Snowling, M. (1988) The perception of phoneme sequence: A comparison of dyspraxic and normal children. *British Journal of Disorders of Communication* 23/3: 245 – 252.

Broen, P.A., Strange, W., Doyle, S. S., & Heller, J.H. (1983) Perception and production of approximant contrasts by normal and articulation-delayed pre-school children. *Journal of Speech and Hearing Research* 26, 601 – 608.

Browman, C. P., Goldstein, L. (1992) Articulatory Phonology: an overview. *Phonetica.* 49, 3/4 155–180.

Brown, C. & Matthews, J. (1997) Acquisition of segmental structure. *McGill Working Papers in Linguistics: Special Issue On Language Acquisition.* Volume 9(1,2)

Brown, W. S. Jnr. & Goldberg, D. M. (1990) An acoustic study of the intelligible utterances of hearing-impaired speakers. *Folia Phoniatrica.* 42, 230–238.

Bromberger, S. & Halle, M. (1989) Why phonology is different. *Linguistic Inquiry.*

Bub, D., Black, S., Howell, J. & Kertesz, A. (1987) *Damage to input and output buffers: what is a lexicality effect doing in a place like that?* Hillsdale, New Jersey: Lawrence

Cairns, C.E. & Feinstein, M.H. (1982) Markedness and the theory of syllable structure. *Linguistic Inquiry.* 3: 25 – 88

Caramazza, A., Miceli, G. & Villa, G. (1986) The role of the (output) phonological buffer in reading, writing and repetition *Cognitive Neuropsychology.* 3, 37–73.

Catts, H. W. (1993) The relationship between speech-language impairments and reading disabilities. *Journal of Speech and Hearing Research.* 36/5 948–958.

Celce-Murcia, M. (1973) In V. Fromkin (ed) Speech errors as linguistic evidence.. Mouton: The Hague.

Chaney, C. (1992) Language development: Metalinguistic skills and print awareness in 3 year old children. *Applied Psycholinguistics* 13: 485 – 514.

Charette, M. (1991) *Conditions on Phonological government.* Cambridge: CUP.

Chiat, S. (1983) Why Mikeys right and my keys wrong: The significance of stress and word boundaries in a childs output system. *Cognition* 14: 275 – 300.

Chiat, S. (1989) The relation between prosodic structure, syllabification and segmental realisation: evidence from a child with fricative stopping. *Clinical Linguistics and Phonetics* 3/3: 223 – 242.

Chiat, S., Law, J. & Marshall, J. eds (1997) Language disorders in children and adults. psycholinguistic approaches to therapy. London: Whurr.

Chin, S. B. & Dinnsen, D. A. (1991) Feature geometry in disordered phonologies. *Clinical Linguistics and Phonetics* 5/4: 329–338.

Chin, S. B. & Dinnsen, D. A. (1992) Consonant problems in disordered speech: constraints and correspondence. *Journal of Child Language* 19: 259 – 286.

Cho, Y-M. Y. (1991) On the universality of the coronal articulator. In C. Paradis and J. – F Prunet (eds) 159–180.

Chomsky, C. (1969) *The acquisition of syntax in children from 5 to 10.* Cambridge

Massachusetts. MIT Press.

Chomsky, N. (1967) Some general properties of phonological rules. *Language* , 43, 102 – 128.

Chomsky, N. (1995 a) *The Minimalist Program*. Cambridge Massachusetts. MIT Press.

Chomsky, N. (1995 b) *The Minimalist Program*. Lecture at University College London.

Chomsky, N. & Halle, M . (1968) *The Sound Pattern of English*. New York: Harper and Row.

Clahsen, H. & Marcus, G. (1999) Linguistic Perspectives in Specific Language Impairment. in W. Ritchie & T. Bahtia (eds)

Clark, R. & Roberts, I. (1993) A computational model of Language Learnability and Language Change. *Linguistic Inquiry*. 24, 2 299–345

Clements, G. N. & Keyser, S-J. (1983) *CV phonology*. Cambridge, Mass.: MIT Press.

Clements, G. N. (1985) The geometry of phonological features. *Phonology Yearbook* 2: 225 – 252.

Clements, G. N. & Hume, E. V. (1995) The Internal Organisation of speech Sounds. In J. A. Goldsmith (ed) *The handbook of phonological theory*. Oxford: Blackwell. 245–306.

Clements, G. N. & Keyser, S-J. (1983) *CV phonology*. Cambridge, Mass.: MIT Press.

Coleman, J. (1995) Declarative lexical phonology. In J. Durand & F. Katamba (eds) *Frontiers of Phonology. Atoms, Structures, Derivations*. London: Longman. 333–382

Coleman, J. (1998) *Phonological representations, their names, forms, and powers*. Cambridge. Cambridge University Press.

Compton, A. J. (1970) Generative studies of childrens phonological disorders. *Journal of Speech and Hearing Disorders* 35: 315 – 339.

Compton, A. J. (1976) Generative studies of childrens phonological disorders: Clinical ramifications. In D. M. Morehead & A. E. Morehead (eds).

Crocker, J. R. (1969) A phonological model of childrens articulation competence. *Journal of Speech and Hearing Disorders* 34: 203 – 213.

Crothers, J. (1978) Typology and universals of vowel systems. Greenberg, J. H. (1978) (ed.) Universals of human language. Volume 2. Phonology.

Crowhurst, M., Hewitt, M. (1995) Prosodic overlay and headless feet in Yidin. *Phonology*. 12, 39–84.

Cruttenden, A. (1978) Assimilation in child language and elsewhere. *Journal of Child Language* 5: 373 – 378.

Cruttenden, A. (1979) *Language in infancy and childhood*. Manchester University Press.

Cutler, A. (1981) The reliability of speech error data. (editorial) *Linguistics* (Special issue) 19/7 & 8: 561 – 582

Darden, B. (1971) A note on Sommers' claim that there exist languages without CV syllables. International Journal of Australian Linguistics. 37, 126–128

Davenport, M., Hannahs, S. J. (1997) Concerning constriants in optimality theory *Newcastle and Durham Working Papers in Linguistics* 4, 69–85

Davis, S., Hammond, M. (1995) On the status of onglides in American English. *Phonology* 12, 2 159–182.

Dell, F. (1980) *Generative Phonology and French Phonology.* Cambridge University Press.

Dell, G. (1990) Effects of frequency and vocabulary type on speech errors. *Language and Cognitive Processes* 5/4: 313 – 349

Dent, H. & Letts, C. (1994) Phonological inpairment in depth: two case studies. *Child Language Seminar,* University of Wales, Bangor.

Dinnsen, D. A. (1980) Phonological rules and phonetic explanation. *Journal of Linguistics* 16: 171 – 191.

Dinnsen, D. A. (1992) Variation in developing and fully developed phonetic inventories. In C. A. Ferguson, L. Menn, C. Stoel-Gammon (eds) *Phonological development: Models, research, implications.* Timonium Maryland: York Press. 191–210

Dinnsen, D. A., Chin, S. B. (1995) On the natural domain of phonological disorders.In J. Archibald (ed) 135–150.

Dodd, B. (1975) *The acquisition of phonological skills in normal, severely subnormal and deaf children.* London University; PhD thesis.

Dodd, B. (1995) *Differential diagnosis and treatment of children with speech disorder.* Singular Publishing Group

Donegan, P. & Stampe, D. (1979) The study of natural phonology. In D. Dinnsen (ed), 126–173.

Dresher, B. E. (1999) Charting the Learning Path: Cues to Parameter Setting," *Linguistic Inquiry* 30, 27-67.

Dresher, B. E., Hulst, H. van der (1995) Global determinacy and learnability in phonology. In J. Archibald (ed) 1–21.

Dresher, E. & Kaye J. (1990) A computational learning model for metrical phonology. *Cognition.* 34, 137–195.

Dressler, W., O. Pfeiffer & J. Rennison (eds) (1981) Phonologica1980 Innsbruck: Innsbrucker Beitrage zur Sprachwissenshaft.

Duanmu, S. (1994) Syllable weight and syllabic duration: A corelation between phonology and phonetics. *Phonology.* 11, 1 1–24.

Durand, J. (1990) *Generative and non-linear phonology.* London: Longman.

Durand, J. (1995) Universalism in phonology: atoms, structures and derivations. In J. Durand & F. Katamba (eds).

Durand, J. & Katamba, F. (eds) (1995) *Frontiers of Phonology. Atoms, Structures and Derivations.* London: Longman.

Edwards, M. L. & Shriberg, L. D. (1983) *Phonology: applications in communicative disorders.*

College Hill Press, San Diego.

Enfield, R. (1972) Class lectures at the University of Essex.

Evans, N. (1995) Australian Languages. In J. A. Goldsmith (ed), 723-761.

Fee, E. J. (1995) Segments and syllables in early language acquisition. In Archibald, J. (ed) 43–61.

Ferguson, C. A., Menn, L., Stoel-Gammon, C. (eds) (1992) Phonological development: *Models, research, implications.* Timonium Maryland: York Press.

Fikkert, P. (1994) *On the acquisition of prosodic structure.* Leiden University PhD dissertation.

Flavell, J. H. (1963) *The developmental psychology of Jean Piaget.* New York: Van Nostren Reinhold.

Foley, J. (1977) *Foundations of theoretical phonology.* Cambridge: Cambridge University Press.

Fouts, R. (1997) *Next of kin: what my conversations with chimpanzees have taught me about intelligence, compassion and being human.* London: Michael Joseph.

Fowler, C. A., Treiman, R. & Cross, J. (1993) The structure of English syllables and polysyllables. *Journal of Memory and Language* 32/1: 115 – 140.

Freud, S. (1920) *Zur Psychopatholgie des Alltagsleben.* Leipzig, Vienna and Zurich, Internationaler Psychoanalytischer Verlag.. Translated and reprinted in 1966 as *The psychopathology of everyday life.* London, Ernest Benn.

Fromkin, V. A. (1968) Speculations on Performance Models. *Journal of Linguistics* 4: 47 – 68.

Fromkin, V. A. (1971) The non-anomalous nature of anomalous utterances. *Language* 47: 27 – 52. Republished in V. A. Fromkin (1973).

Fromkin V. A. (ed) (1973) *Speech errors as linguistic evidence..* Mouton: The Hague.

Fromkin, V. A. (ed) *Errors in linguistic performance: Slips of the tongue, ear, pen and hand.* New York: Academic Press.

Fudge, E. C. (1969) Syllables. *Journal of Language* 5: 253 – 286.

Gandour, J. (1981) The non-deviant nature of deviant phonological systems. *Journal of Communication Disorders* 14: 11 – 29.

Garcia, J. E., Alboa, J., Igoa, M. (1986) Movement errors and levels of processing in sentence production. *Journal of Psycholinguistic Research* 18; 145 – 161.

Giegerich, H. J. (1992) *English phonology: an introduction.* Cambridge: Cambridge University Press.

Gimson, A. C. (1962) *An introduction to the pronunciation of English.* London: Arnold. 2nd Edition 1970.

Glynn, I. (1999) An anatomy of thought. the origin and machinery of the mind. London. Weidenfeld & Nicolson.

Goad, H. (1997) in S. J. Hannahs and M. Young-Scholten (eds)

Goldsmith, J. A. (1976) *Autosegmental phonology.* PhD dissertation, MIT.

Goldsmith, J. A. (1985) Vowel harmony in Khalka Mongolian, Yaka, Finnish and Hungarian. *Phonology.* 2, 251–274

Goldsmith, J. A. (1990) *Autosegmental and metrical phonology.* Oxford: Blackwell.

Goldsmith, J. A. (ed) (1993) *The last phonological rule: Reflections on constraints and derivations.* Chicago: University of Chicago Press.

Goldsmith, J. A. (ed) (1995) *The handbook of phonological theory.* Oxford: Blackwell.

Gopnik M. (1990) Feature bound grammar and dyspraxia. *Nature* 3/44: 715.

Gopnik, M. (1993) *Workshop on genetic aspects of specific language disorder.* University of Essex.

Grammont, M. (1902) *Observations sur le language des enfants.* In Melanges linquistiques offerts a M. Antoine Meillet (pp. 61 - 82) Paris: Klinksieck.

Greenberg, J. H. (ed) (1966) *Universals of Language,* Cambridge, Mass.: MIT Press.

Greenberg, J. H., Ferguson, C. A. & Moravcsik, E. A. (eds) (1982) *Universals of Human Language.* Vol. 2: *Phonology.*

Grunwell, P. (1987) 2nd Edition *Clinical Phonology.* London: Croom Helm.

Grunwell. P. (1992) Principled decison making in the remediation of children with phonological disorders. In P. Fletcher & D. Hall (Eds) *Specific Speech and Language Disorders in Children.* London: Whurr.

Hall, D. (1999) Letter to the editor concerning Ward (1999). *International Journal of Language and Communication Disorders.* 34: 4. 445–447.

Hall, P. & Tomblin, J. B. (1978) A follow-up study of children with articulation and language disorders. *Journal of Speech and Hearing Disorders* 43: 227 – 241.

Halle, M. (1959) *The sound pattern of Russian.* The Hague: Mouton.

Halle, M. (1990) Respecting Metrical Structure *Natural Language and Linguistic Theory* 8: 147 – 176.

Halle, M. (1995) Feature Geometry and feature spreading. *Linguistic Inquiry.* 26, 1 1–46

Halle, M & Stevens, K. (1971) A note on laryngeal features. MIT-*Quarterly Progress Reports* 101: 198–213.

Halle, M. & Vergnaud, J.-R. (1980) Three dimensional phonology. *Journal of Linguistic Research* 1: 83–105.

Halle, M. & Ladefodged, P. (1983) On distinctive features and their articulatory implementation. *Natural Language & Linguistic Theory.* 1, 91–105.

Halle, M. & Mohanon, K. P. (1985) Segmental phonology of modern English. *Linguistic Inquiry.* 16, 1 57–11.

Halle, M. & Vergnaud, J.-R. (1987) *An essay on stress.* Cambridge, Mass.: MIT

Press.

Halle, M. & Idsardi, W. (1995) General properties of stress and metrical structure. In J. A. Goldsmith (ed) *The handbook of phonological theory*. Oxford: Blackwell. pp. 403–443.

Hannahs, S. J. & Young-Scholten, M. (eds) (1997) *Focus on phonological acquisition*. Amsterdam: J. Benjamins.

Hargus, S. & Kaisse, E. (eds) *Phonetics and Phonology. Volume 4. Studies in lexical phonology*. San Diego: Academic Press .

Harris, J. (1990) *Early language development: Implications for clinical and educational practice.* London: Routledge.

Harris, J. (1994) *English Sound Structure.* Blackwell.

Harris, J. (1996) Source Contrasts. Fourth Phonology Workshop. North West Centre for Romance Linguistics.

Harris, J. W. (1995) Position and edge marking in the computation of stress in Spanish. In J. A. Goldsmith (ed) 867–887.

Harrison, P. (1996) The acquisition of melodic primes in infancy. Fourth Phonology Workshop. North West Centre for Romance Linguistics.

Hayes, B. (1995) *Metrical Stress Theory: Principles and Case Studies.* Chicago: University of Chicago Press.

Heijoop, A. (1997) *Underspecification and contrast: Consonant harmony in early phonological acquisition.* Poster at GALA.

Hewitt, A. (1996) From spoken to written language disorder? A follow-up study of language unit children. *Royal College of Speech and Language Therapists: Bulletin.* 525 pp. 8–9

Hewson, C., Ladefoged, P. & Maddieson, I. (1992) Stops in the worlds languages. *Phonetica* 49: 65 – 101.

Hill, E, (2001) Non-specific nature of specific language impairment: a review of the the literature with regard to concomitant motor impairments International Journal of Language and Communication Disorders, vol. 36 No 2, 149 - 172

Hockett, C. F. (1967) Where the tongue slips, there slip I. From *To honor Roman Jakobson*. Reprinted in V. A. Fromkin (ed) (1973).

Hogg, R. & McCully, C. B. (1987) *Metrical Phonology: a coursebook.* Cambridge University Press.

Honeybone, P. (1997) Is lenition naturally optional? The nature of constraints in optimality theory. *Newcastle and Durham Working Papers in Linguistics*.

Hooper, J. B. (1976) *An introduction to Natural Generative Phonology*. New York: Academic Press.

Horstein, N. & Lightfoot, D. (1981) (eds) *Explanation in Linguistics* Longmans.

Hualde, J. (1991) *Basque phonology*. London: Routledge.

Huffman, M. K. (1997) Phonetic variation in intervocalic onset / l / s in English. *Journal* *of Phonetics.* 25, 115–141.

Hulst, H. van der (1994) Radical CV phonology: the locational gesture. *University College London, Working Papers in Linguistics.* 6, 439–478

Hulst, H. van der (1996) Symmetry in the set of phonological primes. Fourth Phonology Workshop. North West Centre for Romance Linguistics.

Hulst, H van der, & Smith, N. (eds) (1982) *The Structure of Phonological Representations.* Volumes 1 and 2. Dordrecht, Holland: Foris Publications.

Hulst, H. van der, Weijer, J. van de (1994) HIL Phonology Papers. HIL Publications No 1. Holland academic Graphics. Leiden.

Hulst, H. van der & Wejier, L. van de (1995) Vowel harmony. In J. A. Goldsmith (ed) *The handbook of phonological theory.* Oxford: Blackwell. 495–534

Hume, E. (1991) Metathesis in Maltese: Implications for the strong morphemic plane hypothesis. In T. Sherer (ed.) 157–172.

Hume, E., Odden, D. (1996) Reconsidering [Consonantal] *Phonology.* 13, 3 345–376

Hyman, L. M. (1985) *A theory of phonological weight.* Dordrecht: Foris.

Hyman, L. and Ngunga, A. (1994) On the non-universality of tonal association conventions. *Phonology.* 11, 25–68.

Ingleby, M. Brockhaus, W. & Chalfont, C. (1996) Reasoning on conceptual adequcy and generative power. Fourth Phonology Workshop. North West Centre for Romance Linguistics.

Ingram, D. (1976) *Phonological Disability in Children.* London: Edward Arnold. Republished in a 2nd Edition, 1987. London: Whurr.

Ingram, D. (1992) Early phonological acquisition: A cross-linguistic perspective. In C. A. Ferguson et al (eds), 433–423

Ingram, D. (1993) Issues in learnability and phonological theory In A. James (ed) Research on child language disorders.

Ingram, D. (1995) The acquisition of negative constraints, the OCP, and underspecified representations. In J. Archibald (ed), 63–79

Inkelas, S. (1993) Deriving cyclicity. In S. Hargus, E. Kaisse (eds) *Phonetics and Phonology. Volume 4. Studies in lexical phonology.* San Diego: Academic Press, 75–110

Ito, J. (1986) *Syllable theory in prosodic phonology.* PhD dissertation, University of Massachussets, Amherst.

Ito, J. (1989) A prosodic theory of epenthesis. *Natural Language & Linguistic Theory.* 7, 217–259.

Iverson, G. & Wheeler, D. (1987) Hierarchical structures in child phonology. *Lingua* 73: 243 – 257.

Iverson, G., Salmon, (1995) Apiration and laryngeal representation in Germanic. Phonology. *Phonology* 12, 369–396

Jaeger, J. (1992) "Not by the chair of my hinny hin hin": Some general properties of slips of the tongue in young children. *Journal of Child Language* 19: 355 – 366.

Jakobson, R. (1941) Republished in translation in 1968 as *Child Language, Aphasia and Phonological Universals.* Mouton: The Hague.

Jakobson, R., Fant, G. & Halle, M. (1963) *Preliminaries to speech analysis: the distinctive features and their corelates.* Cambridge, Mass.: MIT Press.

Jesperson, O. (1938) *Growth and Structure of the English Language.* Oxford: Blackwell. Reprinted in a 9th Edition, 1967.

Joffe, B. S., Penn, C., Doyle, J. (1996) The persisting communication difficulties of remediated language impaired children. *European Journal of Disorders of Communication* 31/4 369–386.

Jun, J. (1996) Place assimilation is not the result of gestural overlap. *Phonology.* 13, 3 377–407.

Jusczyk, P. W. (1997) *Constrainng the search for structure in the input.* GALA.

Kager, R. (1989) *A metrical theory of Stressing and destressing in English and Dutch.* Dordrecht: Foris.

Kager, R. (1995) The metrical theory of word stress. J. A. Goldsmith (ed) *The handbook of phonological theory.* Oxford: Blackwell.

Kahn, D. (1976) *Syllable-based generalizations in English phonology.* PhD Dissertation, MIT.

Kahmi, A. R., Lee. L & Nelson, K. (1985) Word, Syllable and sound awareness in language-disordered children. *Journal of Speech and Hearing Disorders* 50: 195 – 207

Kaisse, E. (1985) Connected speech: the interaction of Syntax and Phonology. Orlando: Academic Press

Kaisse, E. (1992) Can [consonantal] spread? *Language,* 68, 2 313–332.

Karmiloff-Smith, A. (1986) From meta-processes to conscious access: evidence from childrens metalinguistic and repair data. *Cognition* 23: 95 – 147.

Kaye, J., Lowenstamm, J. & Vergnaud, J.-R. (1985) The internal structure of phonological elements: a theory of charm and government. *Phonology* 2: 303 – 326.

Kaye, J., Lowenstamm, J. & Vergnaud, J.-R. (1990) Constituent structure and government in phonology. *Phonology* 7: 193 – 231.

Kaye, J. (1995) Derivations and interfaces. In J. Durand & F. Katamba (eds) *Frontiers of Phonology. Atoms, Structures, Derivations.* London: Longman. 289–332.

Kehoe, M., & Stoel-Gammon, C. (1997) The acquisition of prosodic structure: An investigation of current accounts of children's prosodic development. *Language.* 73, 1 113–144.

Kenstowicz, M. (1994) *Phonology in generative grammar.* Cambridge Mass.: Blackwell.

Keyser, S. J. & Stevens, K. N. (1994) Feature geometry and the vocal tract. *Phonology.* 11, 2 207–236

Kiparsky, P. (1981) Remarks on the metrical structure of the syllable. In W. Dressler et al (eds), 245–256.

Kiparsky, P. (1982 a) Lexical phonology and morphology. In I. S. Yang. (ed) *Linguistics in the Morning Calm.* Linguistic Society of Korea. Seoul: Hanshin.

Kiparsky, P. (1982 b) *Explanation in Phonology.* Dordrecht, Holland: Foris Publications.

Kiparsky, P. (1985) Some consequences of lexical phonology. *Phonology.* 2, 85–138

Kiparsky, P. (1993) Blocking in non-derived environments. In S. Hargus, E. Kaisse (eds), 277–314.

Kiparsky, P. (1995) The phonological basis of sound change. In J. A. Goldsmith (ed) *The handbook of phonological theory.* Oxford: Blackwell. 640–670.

Kiparsky, P. & Menn, L. (1977) On the acquisition of phonology. In J. MacNamara (ed.) *Language learning and thought.* New York: Associated Press.

Klein, H. B., Lederer, S. H. & Cortese, E. E. (1991) Childrens knowledge of auditory/articulatory correspondences: phonologic and metaphonologic. *Journal of Speech and Hearing Research* 34/3: 559 – 564.

Kornfeld, J. R. (1971 a) What initial clusters tell us about a child's speech code. *MIT: Quaterly Progress Reports.*

Kornfeld, J. R. (1971 b) Theoretical Issues in Child Phonology. *Chicago Linguistic Society* 7: 454 – 468.

Kronvall, E., Diehl, C. (1954) The relation of auditory discrimination to articulation defects of children with no known organic impairment. Journal of Speech and Hearing Disorders. 19, 335–338

Labov, W. (1994) *Principles of Linguistic Change.* Blackwell.

Ladefoged, P. & Halle, M. (1988) Some major features of the international phonetic alphabet. *Language* 64/3: 577 – 582.

Lahiri, A. & Evers, V. (1991) Palatalization and coronality. In C. Paradis & J.-F Prunet (eds) *Phonetics and phonology.* Vol. 2: *The special status of coronals: Internal and External Evidence.* New York: Academic Press.

Law, J. (ed) (1992) *The early identification of language impariment in children.* London: Chapman and Hall.

Lashley, K. (1951) The problem of serial order in behaviour In L. A Jeffress (ed) *Cerebral mechanisms in behaviour:* The Hixon Symposium. New York: Wiley.

Lasky, E. Z. Jay, B. & Hanz-Ehrman, M (1975) Meaningful and linguistic variables in auditory processing. *Journal of Learning Disabilities* 8/9.

Lass, R. (1976) *English Phonology and Phonological Theory.* Cambridge University Press.

Laver, J. (1973) The detection and correction of slips of the tongue In V. A. Fromkin (ed) *Speech errors as linguistic evidence.* The Hague: Mouton,

Law, J. (ed) (1992) *The early identification of language impariment in children.* London: Chapman and Hall

Le Normand, M. T. & Chevrie-Muller, C. (1991) A follow-up case study of transitory developmental apraxia of speech: 'L'enfant a voyelles'. *Clinical Linguistics and Phonetics*. 5, 2 99–118

Lenneberg, E. (1967) *The Biological Foundations of Language*. New York: Wiley.

Leonard, L. (1982) Phonological deficits in children with developmental language impairment. *Brain and Language* 16: 73 – 86.

Leonard, L. B., McGregor, K. K. & Allen, G. D. (1992) Gramatical morphology and speech perception in children with specific language impairment. *Journal of Speech and Hearing Research* 35/5: 1076 – 1085.

Leopold, W. (1947) *Speech development in a bilingual child*. Vol. 2: *Sound learning in the first two years*. Evanston, Ilinois: NorthWestern University Press.

Levelt, W. (1983) Monitoring and self repair in speech. *Cognition* 14: 41 – 104.

Levin, J. (1985) A Metrical theory of Syllabicity. Cambridge, Massachusetts: MIT PhD dissertation.

Lewis, B. A. (1989) Articulation skills of adults with histories of phonology disorders. American Speech and Hearing Association. Annual Convention, St Louis.

Lewis, B. A. & Freebairn, L. (1992) Residual effects of preschool phonology disorders in grade school, adolescence and adulthood. *Journal of Speech and Hearing Research* 35/4: 819 – 831

Lewis, M. M. (1936) *Infant speech: a study of the beginnings of language*. New York: Harcourt Brace.

Levelt, W. (1983) Monitoring and self-repair in speech. *Cognition* 14: 41 – 104.

Levin, J. (1985) *A Metrical theory of Syllabicity*. Cambridge Mass.: PhD Dissertation.

Levin, J (1988) *A Place for Lateral in the Feature Geometry*. Austin: University of Texas ms.

Lenneberg, (1967) *The Biological Foundations of Language*. New York: Wiley.

Leonard, L. B., McGregor, K. K. & Allen, G. D. (1992) Grammatical morphology and speech perception in children with specific language impairment. *Journal of Speech and Hearing Research*. 35, 5 1076–1085

Letts, C. & Edwards, S. (1999) Letter to the editor concerning Ward (1999). *International Journal of Language and Communication Disorders*. 34: 4. 443–445.

Lewis, B. A. (1989) Articulation skills of adults with histories of phonology disorders. American Speech and Hearing Association. Paper presented at Annual Convention, St Louis.

Lewis, B. A. & Freebairn, L. (1992) Residual effects of preschool phonology disorders in grade school, adolescence and adulthood. *Journal of Speech and Hearing Research*. 35/4 819–831.

Liberman, M. and Prince, A. (1977) On stress and linguistic rhythm *Linguistic Inquiry* 8,2: 249 – 336.

Lieberman, P. (1984) *The Biology and Evolution of Language.* Harvard University Press.

Lieberman, P. (1998) *Eve spoke: human language and human evolution.* London. Picador. 1998

Lightfoot, D. (1991) *How to set parameters: arguments from language change.* Cambridge Massachusetts: MIT Press.

Lightner, T. (1965) On the description of vowel and consonant harmony. *Word* 21: 244 – 50.

Locke, J. L. (1980) The inference of speech perception in the phonologically-disordered child. Pts I & II. *Journal of Speech and Hearing Disorders* 45: 431 – 468.

Locke, J. L. (1983) Clinical phonology: The explanation and treatment of speech sound disorders. *Journal of Speech and Hearing Disorders.* 48, 339–341

Locke, J. L. (1994) *Child Language Seminar,* University of Wales, Bangor.

Lodge, K. (1995) Kalenjin phonology and morphology: A futher exemplification of underspecification and non-destructive phonol;ogy. *Lingua* 96. 29-43.

Lodge, K. (1996) Review article: J. A. Goldsmith (ed).

Lombardi, L. (1990) The non-linear organisation of the affricate. *Natural Language and Linguistic Theory* 8: 375 – 424.

Lombardi, L. (1995) Laryngeal neutralisation and syllable well-formedness. *Natural Language & Linguistic Theory.* 13, 1 39–740

Lombardi, L. (1996) Postlexical rules and privative features. *Phonology.* 13, 1 1–38.

Lucksinger, R. (1970) Inheritance of speech defects. *Folia Phoniatrica* 22: 216 – 230.

Lundeen, D. J. (1950) The relationship of diadochokinesis to various speech sounds. *Journal of Speech and Hearing Disorders* 15: 54–59.

McCarthy. J (1988) Feature Geometry and dependency: a review *Phonetica* 43: 84 – 108.

McCarthy, J. (1989) Linear order in phonological representation. *Linguistic Inquiry.* 20, 71–99.

McCarthy, J. & Prince, A. (1993) *The emergence of the unmarked optimality in prosodic morphology.* Rutgers University Working Papers.

McCarthy, J. & Prince, A. (1994) *Generalised Alignment.* Rutgers University Working Papers.

Macken, M. A. (1980) The Childs Lexical Representation: The puzzle-puddle-pickle evidence. *Journal of Linguistics* 16: 1 – 44

Macken, M. A. (1992) Where's phonology? C. Ferguson, et al (eds), 249–269.

Macken, M. A. (1995) Phonological Acquisition. In J. A. Goldsmith (ed) , 671–696.

McMahon, A. (1994) *Understanding Language Change.* Cambridge University Press.

McMahon, A. (2000) Change, chance, and optimality. Oxford: Oxford University Press.

McMahon, A., Foulkes, P. & Tollfree, L. (1994) Gestural representation and lexical phonology. *Phonology*. 11, 277–316.

Magnusson, E. & Naucler, K. (1993) The development of linguistic awareness in language disordered children. *First Language*. 13/1: 93 – 112.

Manzini, R. & Wexler, K. (1987) Parameters, binding theory and learnability. *Linguistic Inquiry* 18: 413 – 444.

Marantz, A. (1982) Re reduplication. *Linguistic Inquiry*. 13, 435–482

Marquardt, T. P. & Saxman, H. J. (1972) Language comprehension and auditory discrimnation in articulation-deficient kindergarten children. *Journal of Speech and Hearing Research* 15: 382 – 389.

Marcus, G. and Clahsen, H. (1993) *Compounding and inflection in childrens grammars: evidence for innateness of morphological constraints.* Workshop on genetic aspects of specific language disorder, University of Essex.

Marcus, G. (1995) Children's over-regularisation of English plurals: A quantitative analysis. *Journal of Child Language* 22, 447–459.

Matthews, B. A. J. & Seymour, C. M. (1981) The performance of learning disabled children on tests of auditory discrimination. *Journal of Learning Disabilities* 14: 9 – 12.

Menn, L. (1992) Building our own models: Developmental phonology comes of age. In Ferguson at al (eds) 3–16

Menn, L., Matthei, E. (1992) The two-lexicon" account of child phonology: Looking back, looking ahead. In Ferguson et al (eds)

Meringer, R. & Mayer, C. (1895) *Versprechen und Verlesen, eine psychologisch-linguistische Studie.* Vienna.

Merringer, R. & Mayer, C. (1908) *Aus dem Leben der Sprache,* Berlin.

Mithun, B. (1996) Workshop on Mohawk. Linguistcs Association of Great Britain.

Mohanan, K. P. (1992) Emergence of complexity in phonological development. In C. Ferguson et al (eds) 211–247.

Mohanan, K. P. (1993) Fields of attraction in phonology. In J. A. Goldsmith, (ed.), 61–116.

Morehead, D. M. & Morehead, A. E. (eds) *Normal and deficient child language.* University Park Press, Baltimore, Maryland.

Morgan, R. A. (1984) Auditory discrimination in speech impaired children and normal children as related to age. *British Journal of Disorders of Communication* 18: 89 – 96.

Morse, P. A. & Snowdon, C. T. (1975) An investigation of categorical speech discrimination by rhesus monkeys. *Perception and Psychophysics* 17/1: 9 – 16.

Neils, J. & Aram, D. (1986) Family History of Children with developmental language disorders. *Perceptual and Motor Skills* 63: 655 – 658

Nespor, M. & Vogel, I. (1986) *Prosodic phonology.* Foris, Dordrecht.

Nooteboom, S. G. (1969) The tongue slips into patterns. In Nomen, (ed) *Leyden studies in Linguistics and Phonetics.* The Hague: Mouton

Nooteboom, S. G. (1980) Speaking and unspeaking: Detection and correction of phonological and lexical errors in spontaneous speech. In V. A. Fromkin (ed): 87–95.

Noske, R. (1993) *A theory of syllabification and segmental alternation.* Tubingen: Niemeyer.

Nunes, A. (1993) The case of Welsh and geometrical approaches to phonological disorder *International Clinical Phonetics and Linguistics Association,* Manchester Metropolitan University.

Nunes, A. (1994) Disfluency, Phonological disorder, and the root/skeleton distinction in phonology. *Child Language Seminar,* University of Wales, Bangor.

Ohde, R. N. & Sharf, D. J. (1988) Perceptual categorisation and consistency of synthesised /r – w/ continua by adults, normal children and /r/ misarticulating children. *Journal of Speech and Hearing Research* 31: 556 – 568.

Ouhalla, J. (1991) Functional categories and parametric variation. London: Routledge.

Padgett, J. (1991) Stricture in feature geometry. Amherst: University of Massachusetts, PhD dissertation.

Paradis, C. & Prunet, J.-F. (1991a) Introduction: Asymmetry and Visibility in Consonant Articulations. In C. Paradis and J. – F Prunet (eds).

Paradis, C. & Prunet, J.-F. (eds) (1991b) *Phonetics and phonology.* Vol. 2: *The special status of coronals. Internal and External Evidence.* Academic Press, Inc., San Diego, California.

Parlour, S. F. & Broen, P. A. (1989) Familial risk for articulation disorder: a 25-year follow-up. *19th Annual Meeting of Behavioural Genetics Association,* Charlottesville.

Paul, R. (1996) Clinical implications of the natural history of slow expressive language development. *American Journal of Speech-Language Pathology* 5, 2 5–21

Paul, R. & Jennings, P. (1992) Phonological behabviour in toddlers with slow expressive language development. *Journal of Speech and Hearing Research* 35/1: 99–107.

Piaget, J. (1929) *The child's conception of the world.* New York, Harcourt Brace.

Piaget, J. (1952) *The Origins of Intelligence in Children.* New York: International University Press.

Piaget, J. & Inhelder, B. (1969) *The psychology of the child* London: Routledge & Kegan Paul.

Piggot, G. L. (1991) Variability in Feature Dependency: the case of nasality. *Natural Language and Linguistic Theory.* 10/1: 33 – 78.

Piggot, G. (1996) Implications of consonant nasalisation for a theory of harmony *Canadian Journal of Linguistics.* 41, 2 141–174

Pinker, S. (1984) *Language learnability and language development.* Harvard University Press.

Pollock, K. E. & Keiser, N. J. (1990) An examination of vowel errors in phonologically disordered children. *Clinical Linguistics and Phonetics.* 4/2: 161–178

Poser, W. (1982) Action at a Distance. In H. Van Der Hulst & N. Smith (eds.) *The Structure of Phonological Representations.* Foris Publications, Dordrecht.

Poser, W. J. (1990) Evidence for foot structure in Japanese. *Language* 66/1: 78 – 105.

Poser, W. J. (1993) Are strict cycle effects derivable? In S. Hargus, E. Kaisse (eds), 313–320.

Potter, J, M. (1980) What was the matter with Dr Spooner? In V. A. Formkin (ed) Errors in linguistic performance: Slips of the tongue, ear, pen and hand. New York: Academic Press.

Pulleyblank, D. (1986) Rule application on a non-cyclic stratum. *Linguistic Inquiry* 17, 573–580.

Pulleyblank, D. (1989) The role of the coronal in articulator-based features. Chicago Linguistics Society.

Pulleyblank, D. (1995) Feature Geometry and Underspecification. In J. Durand & F. Katamba (eds) 3–33.

Pullum, G. K. & Ladusaw. W. (1986) *Phonetic symbol guide.* University of Chicago Press.

Raaymakers, E. M. J. A. & Crul, T. A. M. (1988) Perception and Production of the the final /s – ts/ contrast in Dutch by misarticulating children. *Journal of Speech and Hearing Disorders* 28: 262 – 270

Rice, K. (1992) On deriving sonority: a structural account of sonority relationships. *Phonology.* 9, 61–99

Rice, K. D. (1993) A re-examination of the feature [Sonorant]: the status of sonorant obstruents. *Language.* 69, 3 308–344

Rice, K. & Avery, P. (1991) On the relationship between laterality and coronality. In C. Paradis and J.-F Prunet (eds) *Phonetics and phonology.* Vol. 2: *The special status of coronals: Internal and External Evidence.* Academic Press, Inc., San Diego, California.

Rice, K., Avery, P. (1995) Variability in a deterministic model of language acquisition: A theory of segmental elaboration. In J. Archibald (ed) *Phonological acquisition and phonological theory.* Hillsdale, New Jersey: Lawrence Erlbaum. 23–42

Ritchie, W. C. & Bahtia, T. K. (eds) (1999) *Handbook of child language acquisition.* San Diego. Academic Press

Roca, I. (ed) (1990) *Logical issues in language acquisition.* Dordrecht, Holland: Foris Publications.

Roca, I. (1994) *Generative Phonology.* Routledge and Kegan Paul.

Romani, C. (1992) Are there distinct input and output buffers? Evidence from an aphasic patient with an impaired output buffer. *Language and Cognitive Processes.* 7, 133–162

Rubach, J. (1994) Affricates as strident stops in Polish. *Linguistic Inquiry.* 25, 1 119–143

Rubach, J. (1995) Representations and the Organisation of Rules in Slavic Phonology, In J. A. Goldsmith (ed) 848–866.

Ruscello, D. M., St Louis, K. O. & Mason, N. (1991) School aged children with phonologic disorders: coexistence with other speech/language disorders. *Journal of Speech and Hearing Research.* 34, 2 236–243.

Sagey, E. C. (1986) *The representation of features and relations in non-linear phonology.* PhD Dissertation MIT.

Sahlen, B. & Nettelblatt, U. (1992) Patterns of vulnerability of language in children with severe developmental language disorders. *Scandinavian Journal of Logopedics and Phoniatrics* 17: 77 – 86.

Savinainen-Makkonen, T. (1997) *How do Finnish children produce three syllable words of adult langauge.* Poster at GALA.

Scobbie, J., Hardcastle, W., Gibbon, F. and Fletcher, P. (1997) *Covert contrasts in child speech.* GALA.

Searle, J. (1993) *Development of the childs path to spoken language.* Cambridge Mass.: MIT Press.

Selkirk, E. (1982) The syllable. H. van der Hulst & N. Smith (1982, v.2) (eds) 337–383.

Selkirk, E. (1984) On the major class features and syllable theory. In M. Aronoff, & R. T. Oehrle (eds) (1984), 107–136

Selkirk, E. (1988) *Dependency, place and the notion "tier".* Amherst: University of Massachusetts ms.

Selkirk, E. (1991) A two-root theory of length. University of Massachusetts Occasional papers in Linguistics.

Sells, P. (1985) *Lectures on Contemporary Syntactic Theories.* Centre for the Study of Language and Information.

Shaw, P. (1991) Coronal harmony systems: the special status of coronal theory. In C. Paradis and J.-F Prunet (eds), 125-157.

Shattuck-Hufnagel, S. & Klatt, D. (1979) The limited use of distinctive features and markedness in speech production: evidence from speech errors. *Journal of Verbal Learning and Verbal Behavior* 18: 41 – 55.

Sherer , T. (ed) Proceedings of NELS 21 Amherst, MA: GLSA.

Sherman, D. & Geith, A. (1967) Speech sound discrimination and articulation skill. *Journal of Speech and Hearing Research* 10: 277 – 280

Shvachkin, N. (1973) The development of Phonemic speech perception in early childhood. In C. A Ferguson & D. A. Slobin (eds) *Studies of Child Language Development.* New York: Holt Rinehart and Winston: 91 – 127.

Singleton, C. (1996) A practical guide to computer support for dyslexic students. British Educational and Technical Training,

Smith, B. L. (1990) The elicitation of slips of the tongue from young children. *Applied Psycholinguistics* 11: 131 – 144.

Smith, N. (1973) *The acquisition of phonology.* Cambridge University Press.

Smith, N. (1989) *The twitter machine: Reflections on language.* Oxford: Blackwell.

Smolensky, P. (1997) *Optimality Theory.* GALA.

Sommer, B. (1970) An Australian language without CV syllables. *International Journal of Australian Linguistics.* 36, 57–58

Spencer, A. (1986) Towards a Theory of Phonological Development. *Lingua* 68: 3 – 38.

Sproat, R., Fujimura, O. (1993) Allophonic variation in English /l/ and its implications of phonetic implementation. *Journal of Phonetics.* 21, 291–311.

Stackhouse, J. & Wells, J. B. (1993) Psycholinguistic assessment of developmental speech disorders *European Journal of Disorders of Communication* 28: 331 – 348.

Stampe, D. (1969) The acquisition of phonetic representation. *Chicago Linguistic Society, Fifth Regional Meeting* 43 – 454.

Stampe, D. (1973) A dissertation on natural phonology. University of Chicago: PhD dissertation.

Stanley, R. (1967) Redundancy rules in phonology. *Language* 43: 393 – 436.

Stemberger, J. P. (1983) The nature of /r/ and /l/ in English: Evidence from speech errors. *Journal of Phonetics.* 11/2: 139–148.

Stemberger, J. P. (1988) Between-word Processes in Child Phonology. *Journal of Child Language* 15: 39 – 61.

Stemberger, J. P. (1989) Speech errors in early child language production. Journal of Memory and Language 28, 164–188

Stemberger, J. P. and Stoel–Gammon, C. (1991) The underspecification of coronals In In C. Paradis and J. – F Prunet (eds) 181–200.

Stemberger, J. P. (1992) The reliability and replicability of natural speech error data: a comparison with experimentally induced errors. In B. J. Barrrs (ed).

Steriade, D. (1982) *Greek prosodies and the nature of syllabification.* Cambridge, Massachusetts: MIT PhD dissertation.

Steriade, D. (1988) Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology.* 5, 1 73–155.

Steriade, D. (1995) Underspecification and markedness. In J. A. Goldsmith (ed) 114–174.

Strachey, J, (1966, ed) *The Psychopathology of Everyday Life.* Translation from S, Freud, 1920.

Tallal, P., Stark, R. E. & Curtiss, B. (1976) The relation between speech-perception impairment and speech-production impairment in children with developmental dysphasia. *Brain and Language* 3: 305 – 317.

Tallal, P. & Stark, R. E. (1980) Speech perception of the language delayed. In G. Yeni-Komshian, J. Kavanagh & C. Ferguson (eds.) *Child phonology.* Vol. 2: *Perception.* New York: Academic Press.

Templin, M. (1966) A study of articulation and language development during early school years. In F. Smith & G. Millers (eds) *The genesis of language.* 173–186.

Tollfree, McMahon & Foulkes (1993) Gestures and the phonetics-phonology interface. *Workshop on Cognitive Phonology,* North-West Centre for Romance Linguistics, University of Manchester.

Tomblin, J. B. (1989) *Journal of Speech and Hearing Disorders* 54: 287 – 295.

Tomes, L. & Shelton, R. L. (1989) Childrens categorisation of consonants by manner and place characteristics. *Journal of Speech and Hearing Research.* 32: 432–438

Treiman, R. (1983) The structure of spoken syllables: evidence from novel language games. *Cognition* 15: 49 – 74.

Tsimpli. I-M. & Roussou, A. (1991) Parameter resetting in L2? University College London, *Working Papers in Linguistics.*

Tunmer, W. E. Pratt, C. & Herriman, M.L., (1984, eds) *Metalinguistic awareness in children: Theory Research and Implications.* Berlin: Springer-Verlag.

Ultan, R. (1978) A typological view of Metathesis. In J. P. Greenberg, et al (eds).

Waters, R. S. & Wilson, W. A. (1976) Speech perception by rhesus monkeys: the voicing distinction in synthesized labial and velar stop consonants. *Perception and Psychophysics* 19/4: 285 – 289.

Vihman, M.W. (1978) Consonant harmony: its scope and function in child language. In J. P. Greenberg, C. A. Ferguson & E. A. Moravcsik (eds).

Vihman, M. W. (1981) Phonology and the development of the lexicon: evidence from childrens errors. *Journal of Child Language* 8: 239 – 264.

Vihman, M. W. (1996) *Phonological Development: The Origins of Language in the Child.* Oxford: Blackwell.

Warren, H. (1986) Slips of the tongue in very young children. *Journal of Psycholinguistic Research* 11: 569 – 598.

Walsh, H. (1974) On certain practical inadequacies of distinctive feature systems. *Journal of Speech and Hearing Disorders* 39: 32– 43.

Ward, S. (1999) An investigation into the effectiveness of an early intervention method for delayed language development in young children. *International Journal of Language and Communication Disorders.* 34: 3. 243–264

Warwick, R. & Williams, P (1973) *Grays Anatomy.* 35th edition London: Longman.

Waterson, N. (1971) Child Phonology: a prosodic view. *Journal of Linguistics* 7: 179 – 211.

Waterson, N. (1978) Growth of complexity in Phonological development. In N. Waterson and C. Snow (eds).

Waterson, N. (1987) *Prosodic phonology: the theory and its application to language acquisition and speech processing.* Newcastle upon Tyne: Grevatt and Grevatt..

Watson, J., Hewlett, N. (1997) *Perceptual deficit in developmental phonological disorder.*

GALA Poster.

Webster, R. L. & Lubker, B. B. (1968) Interrelationships among fluency producing variables in stuttered speech. *Journal of Speech and Hearing Research* 11: 754 – 766

Weismer, G. (1984) Acoustical analysis strategies for the refinement of phonological analysis. *American Speech and Hearing Association. Monographs* 22, 3–15

Weismer, S. J. & Hesketh, L. J. (1993) The influence of prosodic and gestural cues on novel word acquisition by children with specific language impairment. *Journal of Speech and Hearing Research* 36/5: 1913 – 1025.

Wells, R. (1951) Predicting slips of the tongue. *Yale Scientific Magazine,* Dec. 9/12. Reprinted in V. Fromkin, (1973, ed.).

Weston, A. D. & Shriberg, L. D. (1992) Contextual and linguistic corelates of intelligibility in children with developmental phonological disorders. *Journal of Speech and Hearing Research.* 35/6: 1316–1332.

Whitehurst, G., Smith, M., Fischel, J., Arnold, D. & Lonigan, C. (1991) The continuity of babble and speech in children with expressive language delay. *Journal of Speech and Hearing Research.* 34/5: 1121 – 1135.

Wijnen F. (1992) Incidental word and sound errors in young children. *Journal of Memory and Language* 31: 734 – 755.

Winitz, H. (1969) *Articulatory acquisition and behavior.* New York: Appleton Century Crofts.

Yip, M. (1989) Feature geometry and co-occurrence restrictions. *Phonology* 6: 349 – 374.

Yoder, P. (1999) Letter to the editor concerning Ward (1999). *International Journal of Language and Communication Disorders.* 34: 4. 441–443.

Zec, D. (1995) Sonority constraints on syllable structure. *Phonology.* 12, 1 85–130.